Extension Bulletin 247

January 1946

WATER SYSTEMS AND SEWAGE DISPOSAL ON THE FARM

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U. S. DEPARTMENT OF AGRICULTURE

WATER SYSTEMS ON THE FARM

DO YOU plan to install a pressure water system on your farm? Do you know what factors to consider in selecting a pump? Have you an adequate water supply? The following questions are discussed in this bulletin to give you some answers you may need:

1. **Where can you get the water?**
2. **How much water will you need?**
3. **What types of water supply systems are there?**
4. **What type of pump should you select?**
5. **What factors should you consider in selecting a pump?**
6. **What are some typical pump installations?**
7. **What size and type tank do you need?**
8. **What is a typical pipe layout within a house?**
9. **What are the specifications of an adequate pump pit?**

1 Where Can You Get the Water?

Electrically operated water systems may pump water from (1) wells, (2) springs, and (3) cisterns Regardless of the source, the water supply should be pure, dependable, and sufficient to provide water for all farm uses

Wells are classified according to the method of construction There are (1) drilled, (2) driven, (3) bored, and (4) dug wells All surface and polluted water should be prevented from entering the well

All wells should be located approximately 100 feet from any contaminating source

2 How Much Water Will You Need?

The amount of water required per day depends on the number and kind of livestock, the number of persons in the family, and the number of modern conveniences on the farm that use large amounts of water

Do not think in terms of the amount of water normally carried by hand, for this may lead to the purchase of a pump with insufficient capacity

The water required on any farm can be estimated by using table 1 This information is necessary to determine the pump capacity needed (see page 5)

TABLE 1. WATER REQUIREMENTS

	Gallons per day
Each member of family	35
Each horse	10
Each cow	25
Each hog	2
Each sheep	1½
100 chickens	5

	Gallons per hour
½ inch hose with nozzle	200
¾ inch hose with nozzle	275-300
Lawn sprinkler	200

Example of Water Used Daily

	Gallons per day
4 persons at 35 gallons	140
10 cows at 25 gallons	250
2 horses at 10 gallons	20
50 hogs at 2 gallons	100
200 chickens at 5 gallons per 100 chickens	10
TOTAL daily requirement for home and livestock	520 gallons

3 What Types of Water Supply Systems Are There?

The two main types of systems used to supply water under pressure are the gravity and the hydropneumatic.

The Gravity System. In this system, water is pumped to a storage tank of such elevation that water can flow to all outlets by gravity.

Hydropneumatic or Pressure Tank System. In this system, water and air are pumped into an airtight steel tank. The air that occupies the top part of the tank is compressed when either more air or more water is pumped into it. The pressure exerted by the compressed air forces water from the tank through the pipes to the outlets.

4 What Type of Pump Should You Select?

There are two general types of pumps, depending upon the depth from which they are designed to lift water. Hence they are known as (1) shallow well pumps and (2) deep well pumps.

Shallow well pumps are used when the suction lift is not more than 22 feet. Suction lift is the vertical distance from pump to water level, plus the friction loss in suction piping.

Deep well pumps are used where the depth to water is greater than 22 feet. These pumps are classified as (1) piston or plunger pumps and (2) ejector type pumps.

In principle of operation the piston or plunger pump is identical to that of the deep well hand pump, except for the pump head.

The ejector type pump consists of a vertical centrifugal pump and motor placed aboveground and connected by pipes to an ejector (a jet) in the well. This jet acts as a auxiliary pump, boosting the water to within suction distance of the centrifugal pump.

Unlike other deep well pumps, the ejector pump has the advantage of only one moving part and is exceptionally quiet in operation. It is not necessary to install it directly over the well; therefore the pump may be installed in the basement and pipes run underground

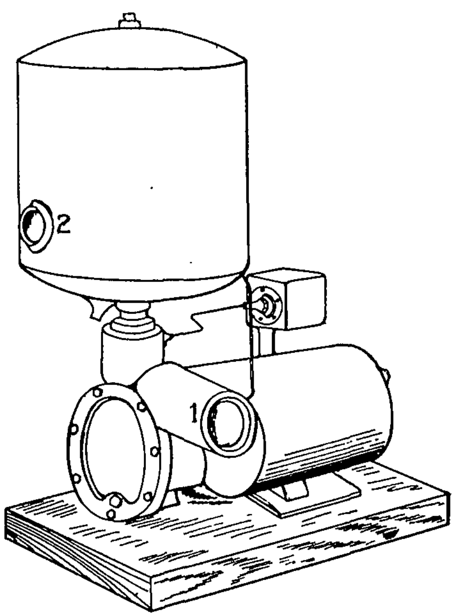


FIG. 1. Shallow well pump. 1. Suction pipe connection. 2. Discharge pipe connection.

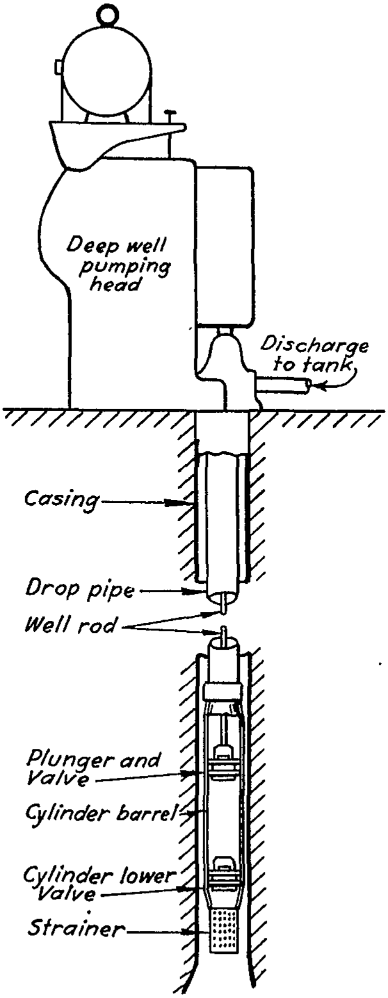


FIG. 2. Piston or plunger type pump for deep well operation

to the well. The ejector pump is ordinarily most efficient for lifts not exceeding 60 feet, and where capacity is not too large. The maximum depth recommended for this pump installation is 80 feet. If it operates against a very high pressure head no water will be delivered to the pressure tank.

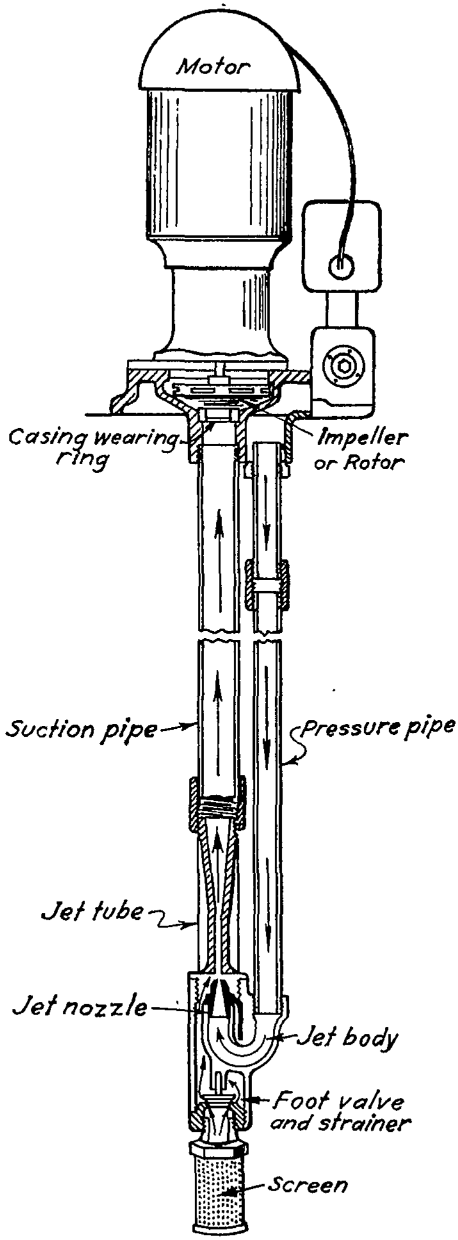


FIG. 3. Cross section of deep well jet centrifugal pump

5 What Factors Should You Consider in Selecting a Pump?

The factors to consider are friction in pipes and rated capacity of pump.

Friction. When water passes through a pipe line, a certain amount of friction causes resistance to the flow of water. The effect of this resistance is to increase the vertical height or "head" against which the pump must work and still produce an adequate flow of water at faucets or other points of discharge.

The actual resistance of a pipe line depends upon diameter of pipe, length of pipe, smoothness or roughness, number of bends, and rate of flow.

Table 2 shows, in feet and in pounds pressure, the loss of head due to friction per 100 feet of ordinary pipe, when discharging given quantities of water. A rule of thumb to follow regarding pipe size is: Do not install underground a pipe less than 1¼ inches in diameter.

EXAMPLE: What pressure in pounds or feet of head will be required to overcome friction if the flow is 5 gallons per minute through a 1¼-inch pipe 300 feet long, having three 90-degree elbows?

From table 2, friction loss in three 90-degree elbows is equal to 24 feet of 1¼-inch pipe (3 x 8) and friction loss in 100 feet of 1¼-inch pipe (5 gallons per minute flow) is .84 feet of head or .36 pounds pressure. The friction loss for 300 feet of pipe and three 90-degree elbows would be

$$\frac{324 \times 84}{100} = 2.72 \text{ ft. of head}$$

$$\frac{324 \times 36}{100} = 1.17 \text{ pounds pressure}$$

Capacity of Pump. The capacity or size of pump needed depends upon the amount of water required each day, as explained on page 3. A good rule to follow in determining pump capacity is to figure a two hour running time for the pump each day. Thus the requirements for the sample farm would be 520 gallons divided by two or a 260-gallon per hour capacity pump.

It is important to measure the yield of water from the well to see if it will furnish plenty of water for the pump when operating at maximum capacity. If the yield is small a reservoir may be required to accumulate the necessary water supply. Another alternative would be to use a pump of small capacity in conjunction with a large pressure or gravity tank.

Table 2. Pipe Friction per 100 Feet of Ordinary Iron Pipe Expressed as Feet and as Pounds for Various Rates of Flow

Flow gallon per minute	½ inch		¾ inch		1 inch		1¼ inch		1½ inch		2 inch	
	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.
2	7.4	3.2	1.9	.82								
3	15.8	6.85	4.1	1.78	1.26	.55						
4	27.0	11.7	7.0	3.04	2.14	.93	.57	.25	.26	.11		
5	41.0	17.8	10.5	4.56	3.25	1.41	.84	.36	.40	.17		
6			14.7	6.36	4.55	1.97	1.20	.52	.56	.24	.20	.086
8			25.0	10.8	7.8	3.38	2.03	.88	.95	.41	.33	.143
10			38.0	16.4	11.7	5.07	3.05	1.32	1.43	.62	.50	.216
12					16.4	7.10	4.3	1.86	2.01	.87	.70	.303
14					22.0	9.52	5.7	2.46	2.68	1.16	.94	.406
16					28.0	12.10	7.3	3.16	3.41	1.47	1.20	.520
18							9.1	3.94	4.24	1.83	1.49	.645
Feet of pipe equivalent to a 90-degree elbow	5		6		6		8		8		8	

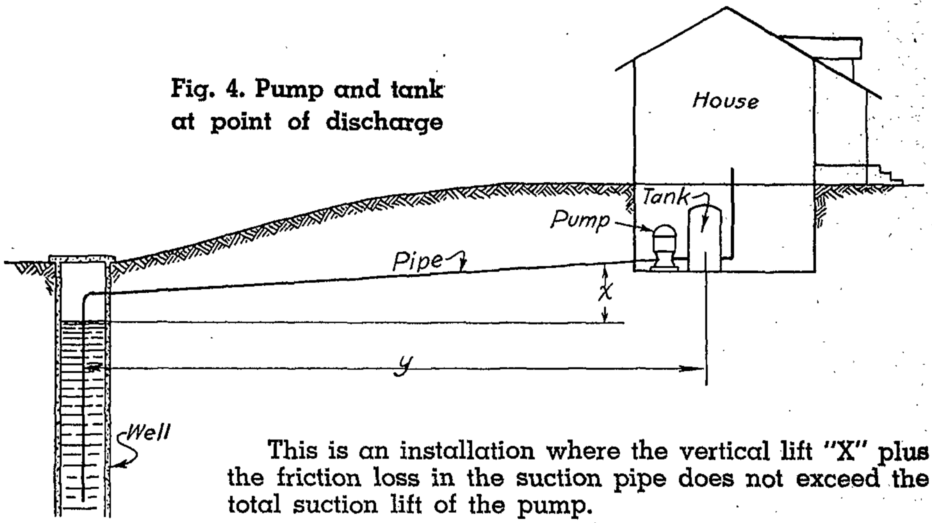
NOTE: 1 pound pressure = 2.31 feet water column. 1 foot water column = .43 pound pressure.

It is necessary to elevate a gravity tank 92.4 feet to supply the same pressure at an outlet as can be supplied by a pressure tank when the pressure is at 40 pounds per square inch.

6 What Are Some Typical Pump Installations?

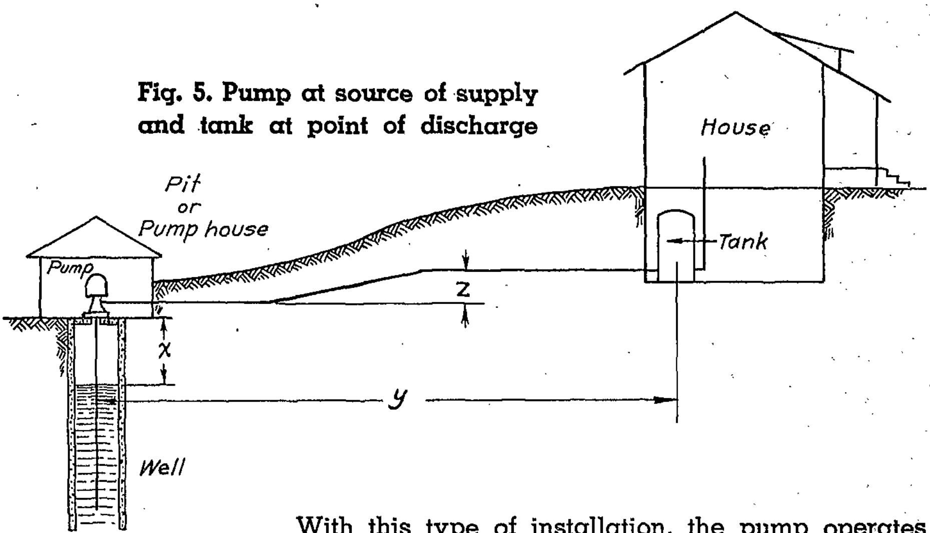
TYPICAL SHALLOW WELL INSTALLATIONS

Fig. 4. Pump and tank at point of discharge



This is an installation where the vertical lift "X" plus the friction loss in the suction pipe does not exceed the total suction lift of the pump.

Fig. 5. Pump at source of supply and tank at point of discharge



With this type of installation, the pump operates under higher pressure than shown on the pressure gauge in the tank. This extra pressure is equal to the vertical distance plus friction loss in the discharge pipe from pump to tank.

TYPICAL EJECTOR PUMP INSTALLATIONS

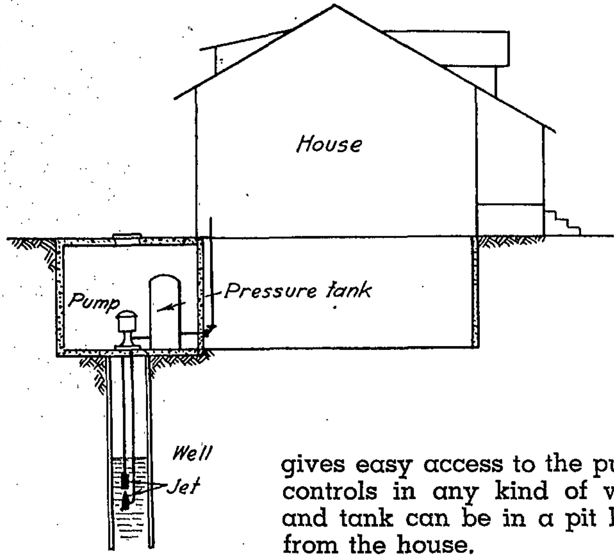
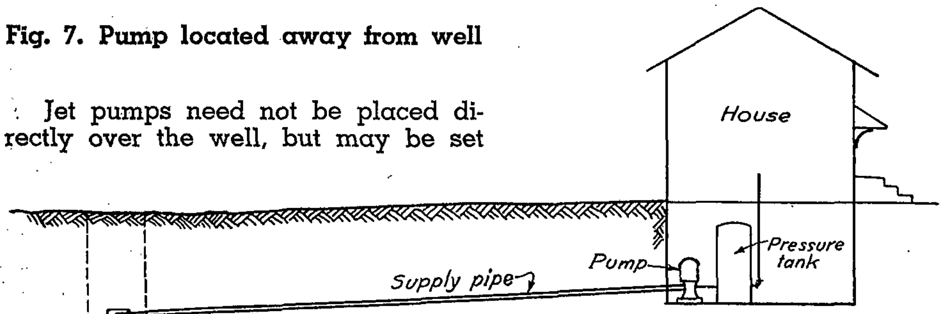


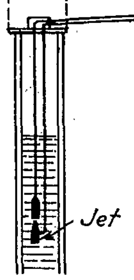
Fig. 6. Pump located over well

One of the most satisfactory installations of a deep well ejector pump water system is with the well located just outside the foundation wall of the house so that the pump room really becomes part of the basement. This gives easy access to the pump, tank, motor, and all controls in any kind of weather. However, pump and tank can be in a pit located at some distance from the house.

Fig. 7. Pump located away from well

Jet pumps need not be placed directly over the well, but may be set





a reasonable distance away at any desired and convenient location. The horizontal pipe lines should slope upward toward the pump to prevent air pockets. A small pit at the well is necessary for installing the ejector.

The size of pressure and suction pipes should be checked carefully when the pump is installed at a distance from the well.

TYPICAL PISTON OR PLUNGER PUMP INSTALLATIONS

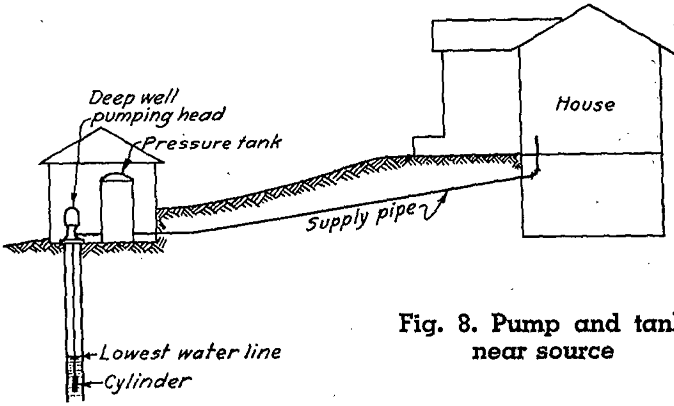
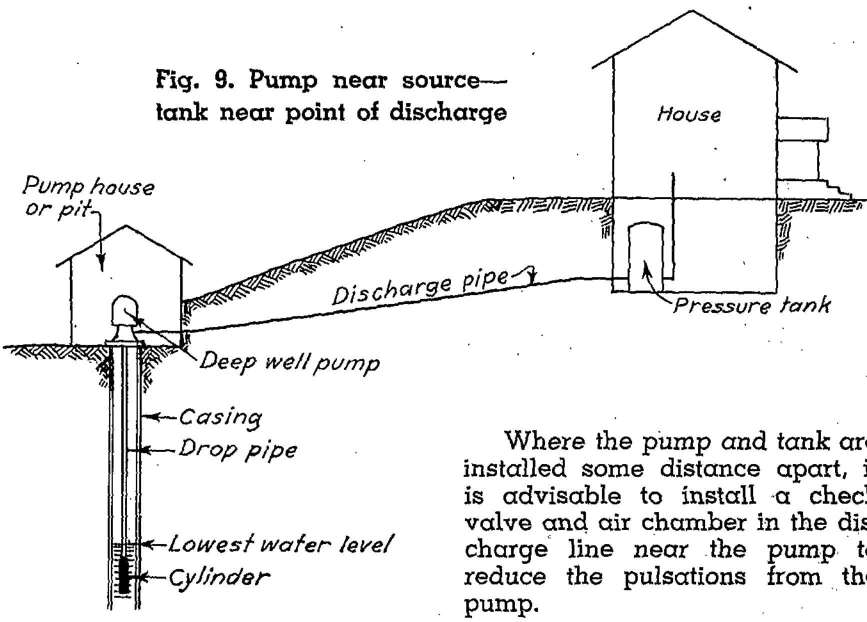


Fig. 8. Pump and tank near source

When the well is not at the point of discharge, the pump and tank may be installed in a frost-proof pit or in a well house aboveground. A lighted 40 watt bulb will usually prevent frost damage on cold nights. Always leave an opening in the ceiling of the pit or pump house to remove rods for inspection.

To conserve space in the pit, the pressure tank may be installed horizontally and buried underground with the end extending into the pit so gauges, controls, etc., may be attached.

Fig. 9. Pump near source—tank near point of discharge



Where the pump and tank are installed some distance apart, it is advisable to install a check valve and air chamber in the discharge line near the pump to reduce the pulsations from the pump.

7 What Size and Type Tank Do You Need?

Gravity Tanks. The size of storage tank for a gravity system depends upon the water needed, the amount of water at the source, and the interval between pumpings. It is advisable to construct a tank large enough to handle sprinkling of the lawn and fire protection. A minimum size should hold a week's supply.

The tanks located in buildings are usually wood or steel, while concrete tanks are placed underground on hill locations.

Pressure Tanks. A pressure tank performs two distinct functions in the operation of an automatic water system. First, it provides a storage place for water, so that the pump is not required to operate each time a small amount of water is used, thus avoiding excessive starting-and-stopping wear on the motor. Second, the pressure tank provides the necessary air pressure for operating the pressure system. When water is first pumped into the pressure tank, the air is compressed until the air pressure reaches 40 pounds per square inch, which means the tank is two-thirds filled with water and one-third filled with air. This compressed air constantly exerts a pressure in an effort to expand to its normal volume, and it is this compressed air that provides the pressure for the water system.

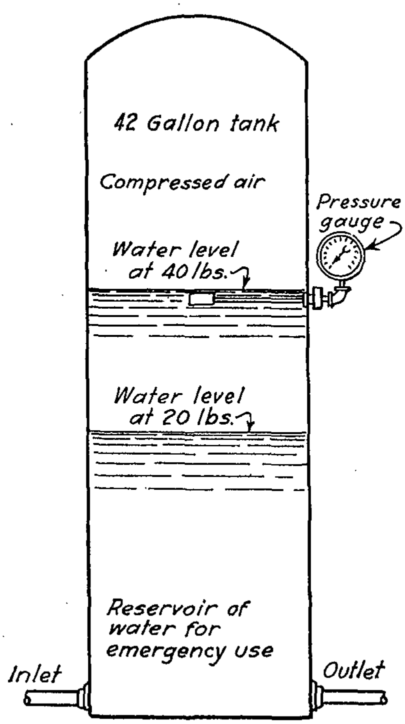


FIG. 10. Hydropneumatic or pressure tank

The pressure switch is set to start the pump operating when the pressure in the tank drops to 20 pounds per square inch, and stop when the pressure reaches 40 pounds.

At 20 pounds pressure the tank is two-fifths filled with water, and three-fifths filled with air. Thus only one-fifth of the rated capacity of the tank may be drawn before the pump will start.

It is recommended that a tank having an 8- to 10-gallon active water supply be used. Thus a 42-gallon pressure tank has been accepted as standard for most farm automatic systems. Larger sizes are needed in specific cases such as large dairy farms where water demand is unusual. However, it is sometimes more economical to construct a storage tank in the barn for dairy purposes than to increase the size of the pressure tank and pump for the entire system.

8 What Is a Typical Pipe Layout within a House?

In planning a water system for the home, it is advisable to make a tentative layout of the location and types of plumbing facilities desired.

The location of the water system determines where the starting point will be. The water supply line should be piped to the kitchen first where most water is needed and where the first

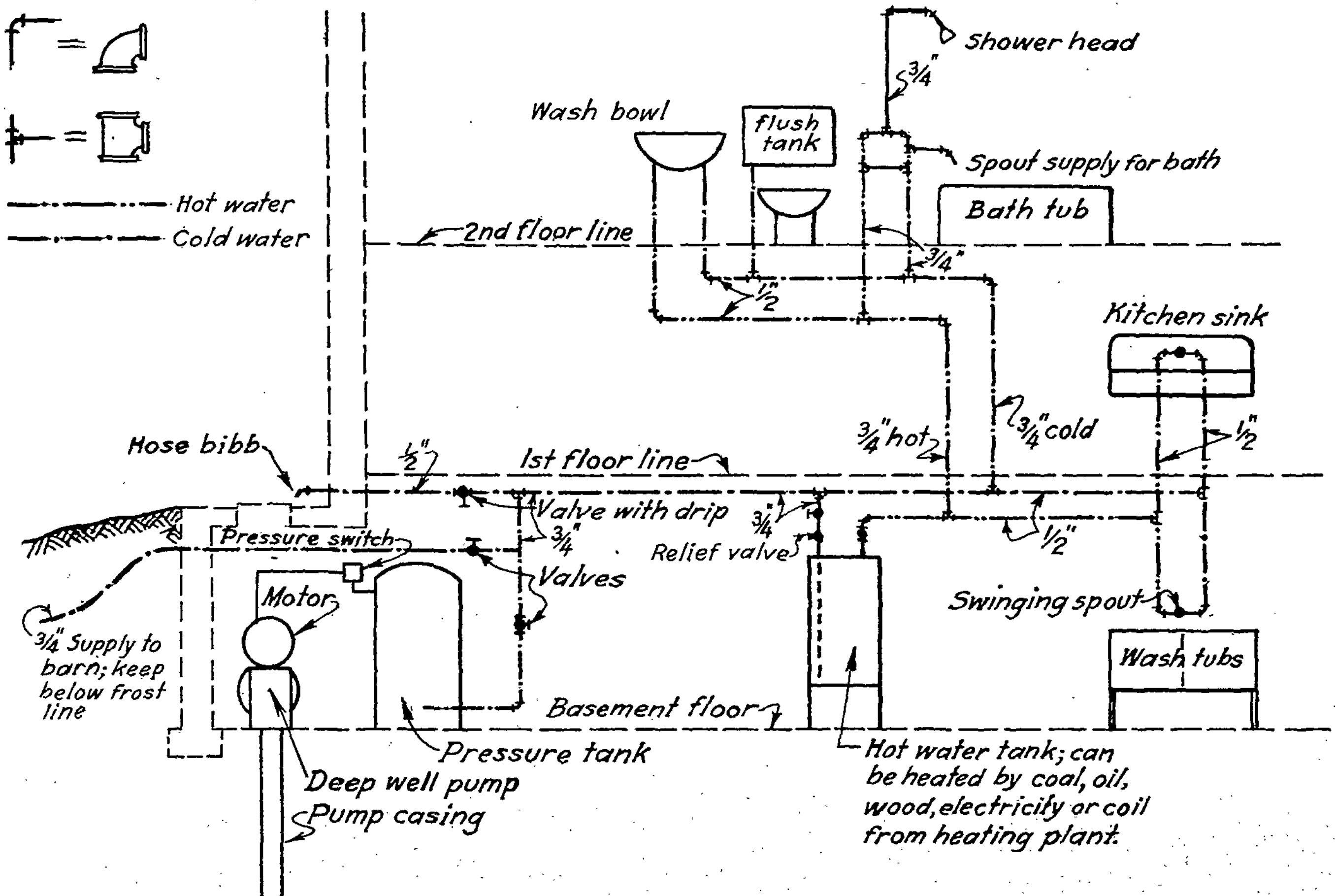


FIG. 11. Typical pipe layout within a house

piece of equipment is usually installed. Hot running water may be supplied by installing a hot water tank with a coil in the furnace. When the furnace is not operated, the hot water tank may be heated by electricity, bottle gas, or kerosene.

It is preferable to locate the bathroom directly over the kitchen from the standpoint of piping, because the hot and cold pipes may be continued instead of running another series from the basement. This also consolidates the waste disposal system. Shut-off valves should be used at every branch of the water supply line.

9 What Are the Specifications of an Adequate Pump Pit?

Aboveground installation of pumping and pressure equipment is to be preferred for reasons of better sanitation. However, the pump pit has been widely used on farms because it facilitates protection from freezing in winter and permits a colder water supply in summer. Farmers considering such installation should investigate local and Minnesota State Board of Health regulations to make sure they will not come into conflict with ordinances governing the sale of milk and other products. Objections to pump pits are based upon possible dangers of contamination of the water supply by surface water through poor drainage, backing up of drains during floods, and bad sanitation in the underground pit.

The accompanying diagram of a pump pit is presented here because such installations are widely used in spite of the possible dangers that have been suggested by sanitation engineers. Proper construction is the best protection against pit troubles.

It is important that both ventilation and drainage be adequate. Two vent pipes are desirable for ventilation, one for top ventilation and another extending down to within a foot of the floor.

Where the natural ground line falls away from the pit, the floor drain should lead to the surface, thereby providing a reliable outlet even for large amounts of water. If a surface drain is impossible, a gravel sump such as that shown in the diagram must be provided to take care of seepage. Under no circumstances should the drain be connected with the house sewer.

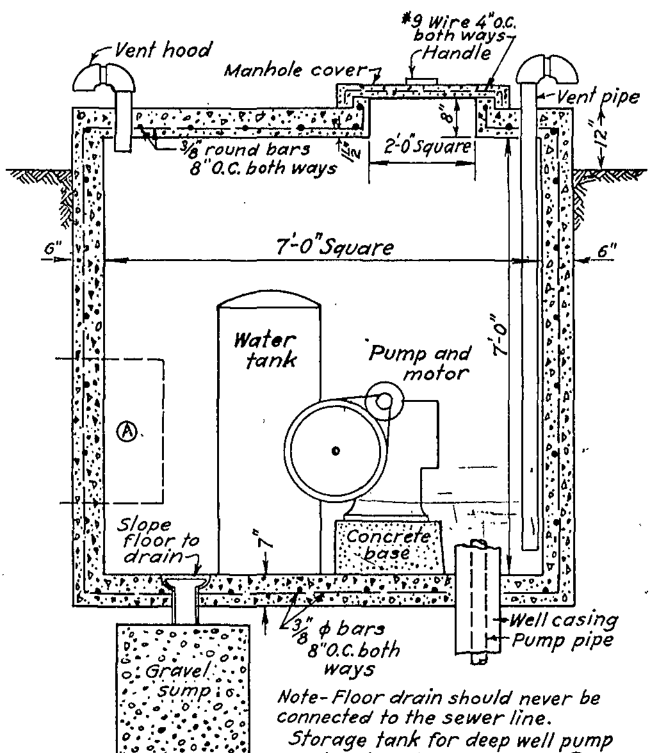


FIG. 12. Suggested construction of pump pit

SEWAGE DISPOSAL ON THE FARM

1. What are the necessary parts of a good farm sewage disposal system?

2. What size septic tank is needed?

3. Where should a septic tank be located and how constructed?

4. What are the recommended sizes and grades for the house sewer and outlet sewer?

5. What type of disposal field can be used for effluent after it has passed through the septic tank?

6. What maintenance is necessary to insure good operation of a septic tank?

1 What Are the Necessary Parts of a Good Farm Sewage Disposal System?

There are four distinct parts to a sewage disposal system, each one of which is equally important. They are:

(1) The house sewer which carries wastes from the house to the septic tank.

(2) The septic tank in which sewage treatment begins. Much of the solid matter in the sewage entering the septic tank is broken up into gases, liquids, and mineral particles through bacterial action. In a well-built system the gases pass off readily without offense, liquids flow out of the septic tank, and the heavier solids called "sludge" settle to the bottom. A scum which forms over the top of the sewage in the tank aids in decomposition.

(3) The outlet sewer which carries sewage liquids, commonly called effluent, from the septic tank to the tile disposal lines or dry well.

(4) A. The tile lines which provide disposal of sewage liquids through subsurface irrigation. Absorption and action of soil bacteria are the principal agents in this final step of the disposal process.

B. The dry well which also provides for the disposal of effluent from septic tank. Leaching is the principal agent in this process.

2 What Size Septic Tank Is Needed?

For effective operation, sewage must be retained in the septic tank about 48 hours. It is thus important to build a tank which will be large enough. The standard family-size tank, which is a rectangular one-chamber unit 6′ x 6′ x 3′, shown on page 13, is the smallest size to build even though the family consists of only two or three persons. On the other hand, this size of tank safely accommodates up to nine or ten persons.

The one dimension that has an important bearing on operation of a septic tank is the depth. The depth should

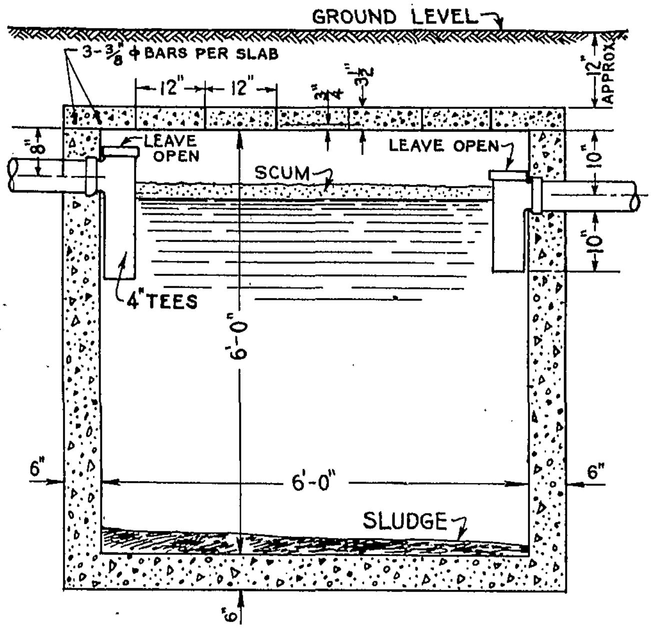


FIG. 13. Cross section of septic tank

not be less than 6 feet, otherwise sludge may be scoured out, which in time will choke the disposal tile or dry well.

Sewage disposal systems for more than 10 persons usually must be of more elaborate construction than for a family-size unit. Larger systems require:

(1) Two chamber tank with automatic siphon for periodic dosing of disposal lines.

(2) A grease trap, which is a small tank that receives wastes from kitchen sink and discharges into house sewer line.

(3) Distributing box which receives discharge from septic tank and passes effluent into disposal tile lines through four or more openings. If gate or dividing board is used, one half of lines may be dosed at a time.

This bulletin describes a simple but satisfactory poured concrete septic tank, but it may be made of rot-resistant wood, steel, brick, clay, or concrete blocks. If the tank is of adequate size, of durable material, and provided with necessary absorption area, it should function properly.

3 Where Should a Septic Tank Be Located and How Constructed?

The location of the septic tank depends upon the topography of the ground. If the ground is level it is best to locate the tank close to the house in order to get the necessary minimum grades in both house sewer and outlet sewer. The tank may be placed adjacent to the foundation wall, but should not be a part of the wall.

If grades can be easily obtained, the tank is normally located not more than 50 feet from the house. It should be approximately 75 feet from the well or water supply.

If topography will not permit locating the septic tank low enough for basement wastes, a sump pump is practical for pumping wastes into the house sewer line.

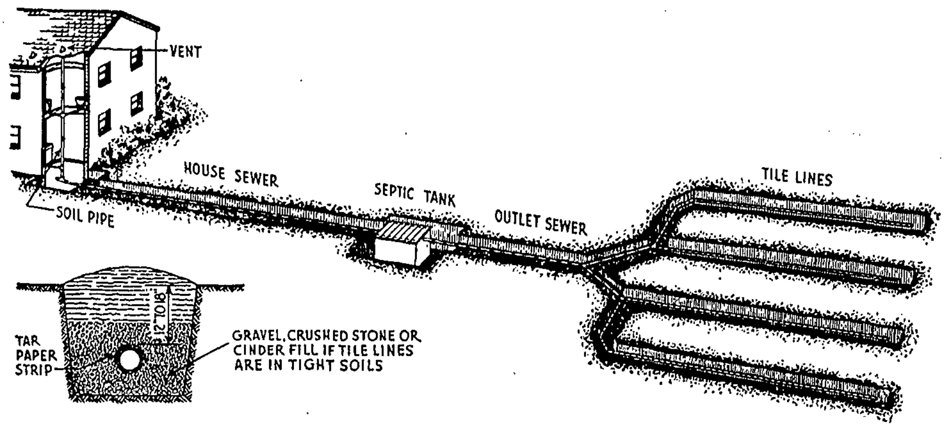


FIG. 14. Typical layout of complete sewage disposal system

The tank should be constructed to allow a minimum of one foot of earth over the cover.

After leveling the site for excavation, a plank frame should be laid out to serve as a guide for digging and to help prevent caving of the earth walls of the excavation which usually serve for outside forms. The inside forms are constructed as shown in figure 15. The inside dimensions of the plank frame should be equal to the outside dimensions of the tank. For a family-size tank, the form would be 7′ x 4′.

In constructing the tank, the inside forms should be suspended from the plank frame and braced into position. This allows concrete to be poured in one continuous operation, and danger of leaky construction joints is thus avoided. However, if for some reason the tank has to be constructed in two operations, it is recommended that the floor be poured first, leaving a very rough surface where the walls will rest. This will allow some bond between walls and floor. To improve the construction, a 6-inch metal dam may be placed along the joint or an oiled 2 x 4 may be placed half in and half out of the concrete when the floor is poured, and later removed when the wall is poured. Both of these methods will give satisfactory keys to prevent leakage.

The sewer pipe T's for entrance of the house sewer and for the outlet sewer should be fastened to the end wall forms before concrete is placed. Tops of these inlet and outlet T's should not be plugged. They should remain open so that the entire system vents

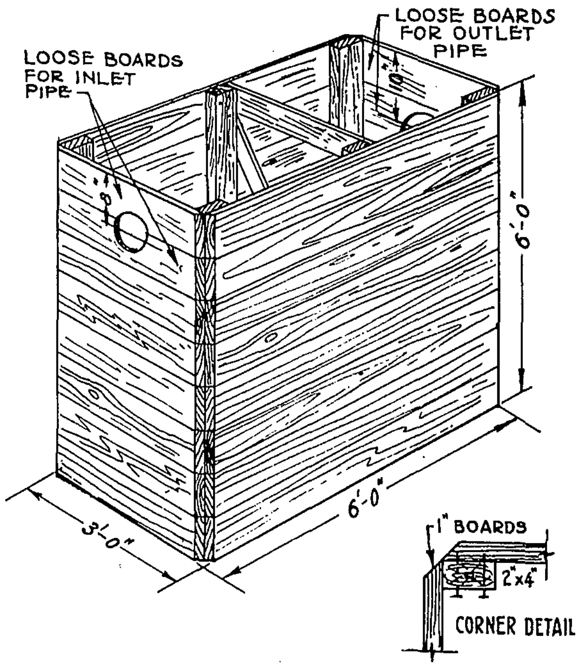


FIG. 15. General view of inside forms for septic tank

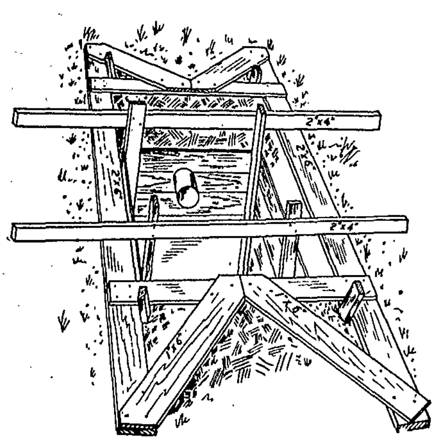


FIG 16. Inside forms for septic tank braced in position ready for pouring of concrete

freely through the house soil pipe and roof vent. An alternate method to replace the T's would be to construct baffle plates. Baffles should be approximately 12 inches from the inlet and/or outlet. They should have the same elevation as the top of the inlet and/or outlet pipe and extend downward approximately 20 inches.

To form the slot to place the baffle in, a 2″ x 1″ piece of lumber may be nailed on the outside of the inside form in the desired location.

1:2¼:3 concrete mix with not more than five gallons of water per sack of cement is suggested for the septic tank. Care should be taken to secure a workable mix and concrete should be spaded along form faces to help insure dense, watertight concrete. The family-size tank requires the following materials:

- 19 sacks cement
- 2¼ cubic yards sand
- 2½ cubic yards gravel
- 21 pieces of ⅜-inch round reinforcing bars 4 feet long

Concrete cover slabs about 3½ inches thick, 1 foot wide, and 4 feet long can be precast in simple forms. Each slab is reinforced by placing three pieces of ⅜-inch round reinforcing steel near the bottom of the slab. For convenience in moving the slabs, reinforcing steel may be bent and set in the fresh concrete to provide handles, or metal rings or old horseshoes may be used for this purpose.

4 What Are the Recommended Sizes and Grades for the House Sewer and Outlet Sewer?

The house sewer to the septic tank should be a 6-inch-diameter sewer pipe laid with tightly cemented joints and with the bell end up the slope. A minimum of 2 per cent slope, or 1 inch in 4 feet, should be given the house sewer line, and it should be laid without bends to minimize danger of clogging. A 2-inch drop between inlet and outlet of septic tank should be allowed, as shown in diagram on page 13.

The outlet sewer from the septic tank to the tile line or dry well is usually built of ordinary 4-inch drain tile. However, if it passes within 75 feet of the water supply or near willow or elm trees, it is best to use sewer pipe with tightly cemented joints. The outlet sewer should be laid on a slope of at least 1 inch in 25 feet.

5 What Type of Disposal Field Can Be Used for Effluent after It Has Passed Through the Septic Tank?

There are two common types of disposal methods used to handle effluent from the septic tank. They are (1) tile lines laid close to the surface, used in heavier soils, and (2) dry wells, used where soils are lighter and good seepage can be obtained.

Tile Lines. All tile lines should be approximately 75 feet from the water supply. In tight soils as much as 60 feet of line is needed per person. In lighter soils 30 feet of line is usually enough.

Tile lines should always be laid out in such a way that branches or extensions can readily be added if found necessary. No single line should be more than 150 feet. The lines of disposal tile should have a fall of about 1 inch in 25 feet and should be spaced about 10 feet apart. Sometimes in tight soil the slope should be cut down to 1 inch in 50 feet.

Tile are usually laid with ⅛ inch openings which are covered with small strips of tarpaper to prevent fine particles of soil from clogging the line. Disposal tile should be laid about 16 to 20 inches below the surface, usually with not more than 24 inches of cover. Soil bacteria which act on sewage to render it harmless are present in sufficient numbers only in the upper layer of soil. The best location for disposal tile is under sod and where snow will gather for frost protection.

Tile lines in tight soils should be surrounded with gravel, cinders, or other coarse material to a total width of 18 inches and a depth of 12 inches in order to hasten final disposal of sewage liquids.

In extremely tight soils, it may be necessary to supplement the gravel fill with a line of drain tile. The drain tile should be laid approximately 2 feet directly below the disposal tile with a definite outlet. If this will not handle the effluent it may be necessary to build a complete filter bed.

Dry Wells. A dry well is a cavity constructed underground to receive the water which will seep away in the surrounding soil. It is usually placed at the end of a line of absorption tile to act as a reservoir for an unusually heavy flow from the tank or may receive the flow directly from the septic tank under unusually open soil conditions.

The walls of the dry well should be of open construction. Any masonry material such as concrete blocks, bricks, stone, or tile laid up without mortar will be satisfactory. No floor is needed. The capacity should be approximately the size of the septic tank.

6 What Maintenance Is Necessary to Insure Good Operation of a Septic Tank?

The septic tank requires very little attention if the disposal system is well built. The sludge should be removed from the tank every 5 to 10 years. If sludge becomes too deep in the tank, it will scour out into the tile lines and tend to clog them. A handy device for cleaning the tank is a 2-inch pipe with cistern pump installed on top to pump the sludge out.

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

The effect of the use of household chemicals on the action of a septic tank is also sometimes questioned. It is probable that an unusual amount of waste of an acidic or alkaline nature discharged into the tank would interfere with the natural decomposition by killing the bacteria which carry on the action, but the amounts of such chemicals commonly used in domestic processes are too small to be the cause of trouble.

Never use disinfectants when cleaning the septic tank. Such materials destroy bacterial life which is the chief agent in decomposing sewage.

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Cooperative Extension Work in Agriculture and Home Economics, University of Minnesota, Agricultural Extension Division and United States Department of Agriculture Cooperating, Paul E. Miller, Director. Published in furtherance of Agricultural Extension Acts of May 8 and June 30, 1914. 25M-1-46