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SANITATION AND SEWAGE DISPOSAL FOR COUNTRY HOMES

BY

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SANITATION AND SEWAGE DISPOSAL FOR COUNTRY HOMES.

Introduction.—The demand for modernly equipped farm homes at a moderate cost is becoming an urgent one. Farmers throughout Missouri are striving to keep abreast of the times in modern methods of agriculture. Likewise they are seeking the latest and best practices in every line of activity pertaining to the industry of farming.

They are demanding that their homes be equipped with the same modern conveniences that the people of the city enjoy, and it is the call from them for information on modern farm sanitation that has led to the publication of this bulletin.

The greater part of the bulletin is devoted to the subject of modern sewage disposal plants for isloated houses. A portion has been given to the discussion of sewage disposal methods now employed on the farm, and still another portion to country plumbing.

It is the purpose of this bulletin to present several specific designs and to call attention to the necessity of home sanitation in a general way.

Sewage Defined.—Sewage is composed of the liquid and solid waste matter that flows through a sewer. The character of the foul matters thus carried off may be fecal, excretory, or of the nature of slop water.

The term as defined here may allude to the contents of the privy vault, dry earth closet, slop water basin, cesspool or the septic tank. Sewage may mean the contents of the cesspool, septic tank, etc., or it may refer to the waste material after its final deposit in a stream, ditch or upon a field. The term generally applied to sewage as it flows from the sewer to the final place of disposal is **effluent**, and should this word be found in subsequent pages of this bulletin it will be thus defined.

METHODS OF DISPOSAL.

The methods of sewage disposal may be conveniently divided into two general classes, namely: Water-Carriage Systems and Dry Sewage Systems. The latter will be taken up and discussed first, inasmuch as it is the one in more general use at the present time in rural communities.

Dry Sewage Methods.

Under this head two subdivisions of the subject will be made. They are **privy vaults** and **earth closets.** Both of these methods, though crude, can be made healthful and sanitary if proper care is taken in regard to their arrangement, location, and operation.

The Privy Vault.—The privy vault is the method most commonly used at the country home. This system will continue to be used for a long time on account of its cheapness and economy. Some suggestions are offered by which its sanitary conditions may be improved.

The privy vault as ordinarily constructed consists of a small frame building erected over a pit which receives the refuse or fecal matter. For a time such a receptacle is satisfactory, but unless properly cared for it becomes a nuisance, obnoxious both to sight and smell, as well as a menace to health. This obnoxious condition of privies can be avoided by a generous use of lime and an occasional removal of the waste from the pit.

Water Supply Contamination.—Occasionally a privy vault will be found near a well, cistern, or other source of water supply. This may become polluted, due to the seepage of the sewage through the ground. Furthermore this sewage waste may be so clarified by passing through the porous earth that by the time it reaches the neighboring source of water supply it will be clear and apparently pure. Expericence has taught us, however, that this water often contains disease germs which we have no means of detecting until we have been poisoned by them and have perhaps developed a case of serious illness.

Privy Vault Dangers.—Two of the common causes of the spread of typhoid fever are the contamination of the water supply, and the transmission of the disease by the ordinary house-fly. Instance after instance could be given where cases and even epidemics of typhoid fever have been caused by the pollution of wells or cisterns from neighboring privies which in some cases were located several hundred feet distant. The water in the wells was apparently pure and sparkling, yet it contained the germs of disease. Frequently a well or spring is polluted from a nearby brook or gully leading from a neighboring farm where recently there may have been a typhoid patient. Instances are on record where typhoid bacteria were transmitted a mile or two by this method. Hence too much precaution cannot be taken in the protection of the home water supply.

The privy vault often becomes a fly breeding place, and should therefore be as far as possible from the house. That flies do transmit disease, notably typhoid fever, there is no longer any doubt, and the privy vault should, as far as possible, be inaccessible to them. This may be accomplished by the use of screens. Another effective and inexpensive remedy for keeping the flies away from the closet is by a generous use of dry air-slaked lime applied daily.

Some precautions should be observed in connection with the building of privy vaults. Generally they should not be within one hundred feet of any source of water supply. Do not leave the excreta accessible to flies. Do not neglect the frequent removal of the waste material from the vault. If possible select the location of the privy vault so that the liquid waste will drain away from the premises into a ditch or gully rather than to have it pass near the cistern.

Earth Closets.—In connection with dry sewage systems we have the earth closet which is perhaps little used in this country, although employed to quite an extent in England. The earth closet is simple and cleanly and in many respects an entirely satisfactory substitute for the privy.

The excreta should be received in a box or pail made to fit closely beneath the seat. The seat may be like that of an ordinary water closet. Each time the closet is used a small amount of dry earth is added. The action of dry earth is to deordorize and render harmless the waste matter of the closet. The receptacle should be emptied frequently. The out-house or closet should be well lighted and ventilated, and preferably plastered on the inside. With proper attention, this closet need not be built far from the dwelling house.

The earth used in such a closet should be dry, and if possible, porous and of a loamy nature. A very sandy soil is useless. Ashes are entirely satisfactory for this purpose. Authorities on the subject of sanitation recommend the "Dry Closet" rather than the "Privy Vault," because it is far more sanitary and becomes less of a nuisance.

Regarding earth closets, Gerhard states the following in the annual report of the State Board of Health of Maine:

"All that is needed is a common closet, a supply of dry earth, a water tight receptacle beneath, and a convenient way of disposing of its contents at quite frequent intervals. The receptacle should be wholly above the ground, and may consist of a metallic lined box, or half of a kerosene barrel with handles on it for removal, or better still, a galvanized iron pail. The receptacle may be removed through a door in the back of the closet or in front of the seat, or by having the seat hinged and made to open backward it may be removed in that way.

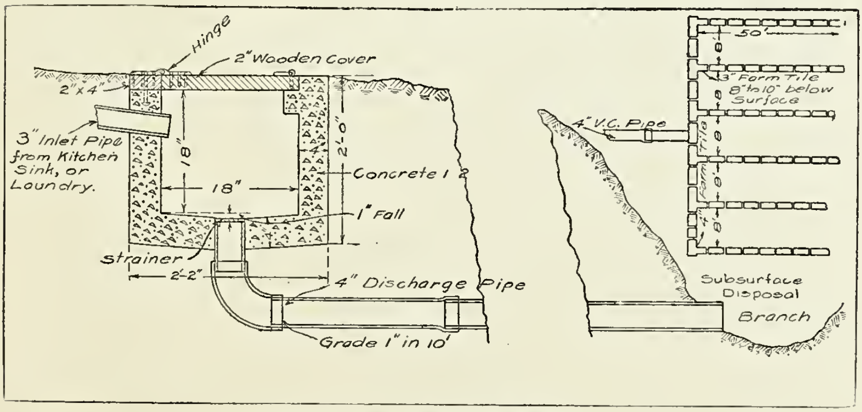
"The earth used should be common garden or field loam finely pulverized. Road dirt does well, but sand is not suitable. Coal ashes are also good. Whichever is used should be dry and screened through a sieve with about one-fourth inch meshes. The dry earth may be kept in a box set where it can be filled from the outside of the closet, or it is quite convenient to have one-half of the seat hinged, and beneath it a small compartment to hold the supply of earth. In this box there may be a small tin scoop which may be used for sprinkling over the refuse a pint or more of earth each time the closet is used. The main thing is to use enough earth to completely absorb all liquids. This last requirement of course precludes the throwing of slops into the closet."

A CONCRETE SLOP WATER DISPOSAL BASIN.

The Tank.—Fig. 1 shows an arrangement for the disposal of slop water from the kitchen or laundry. In many farm houses where it is impracticable to install a complete sewage system, such a convenience as the concrete basin shown will greatly reduce the labor of disposing of house slops. It is entirely sanitary, and may be used satisfactorily either winter or summer.

The basin tank for receiving the slops is made of concrete. The mixture should be in the proportion of 1:2:4, that is, one part of cement,

FIG. 1.



Slop Water Disposal Basin.

two parts of sand, and four parts of broken stone. The thickness of the walls should be four inches. The side walls should be vertical and the bottom should slope with a one-inch fall toward the center.

The size of the tank is 18″ wide x 18″ long x 18″ deep. A three-inch inlet pipe connects the tank to the kitchen sink or laundry. To aid in the escape of offensive gases from the tank the wooden cover is perforated with several holes. This does not entirely prevent the escape of gases through the opening of the sink, but if the tank and pipes are flushed occasionally little difficulty will arise from the escape of gas through the sink into the house.

A four-inch discharge pipe connects the tank to a ditch located at a distance not less than from fifty to one hundred feet from the house.

In case the ditch cannot be given sufficient slope for readily discharging the waste matter as it comes from the concrete tank it will be better to use the subsurface or underground method of dispósal which will be described later.

The wooden cover is hinged as shown to a 2″ x 4″ piece of wood which is bolted to the concrete in a manner as indicated in the drawing. The cover rests on a concrete projection at the side, and for convenience in opening, a ring is attached. A strainer should be provided in the bottom of the tank as shown in Fig. 1. This strainer is to prevent the entrance of solid matter into the discharge pipe which might thus become choked.

Construction.—Excavate to a depth of two feet below the ground surface. The finished size of the excavation is to be 2′-2″ wide x 2′-2″ long x 2′ deep. Locate the inlet and the outlet pipes according to the measurements indicated on the drawing, Fig. 1, giving each pipe sufficient fall to provide for a ready drainage of the slop. Use the earth as one side of the form, the other side of the form being constructed of one-inch lumber properly braced. First lay the side walls, and after about thirty-six hours remove the forms. Then lay the concrete in the bottom and carefully plaster the inside throughout. If crushed rock cannot be had, creek sand and gravel may be used with entirely satisfactory results. The concrete should be rammed into place.

Disposal of the Outflow.—The discharge from the above slop basin may be emptied directly into a running stream, or into a ditch some fifty to one hundred feet from the house. It will soon be purified and no offensive odors will form from it. The respective sizes of the inlet and discharge pipes should be three inches and four inches. They should be vitrified clay pipe with cemented joints. The slop tank should be fifteen to twenty feet from the house. The slope of the inlet pipe should be greater than the slope of the outlet pipe. A slope of one foot in fifty feet for the outlet pipe is desirable in order that it may be cleansed by the velocity of flow.

Subsurface Disposal of the Waste.—It is not possible in every case to dispose of the waste water as explained above. Should the ground be very flat, no ditch being available, other methods of disposal must be resorted to; chief among them being **subsurface** irrigation or disposal. In a subsurface disposal system a 3″ open-jointed drain tile is used, laid with ¼ to ½ inch open joints, and to a slope of one inch in twenty-five feet. It is very essential that the tile be laid to a uniform slope. If possible the ditch should be excavated eight to twelve inches below the pipe and filled with sand, gravel, cinders, or other porous material, to aid in the immediate filtration of the waste water.

The tile should be laid from eight to twelve inches below the surface of the ground. It is essential that the drain tile be as near the surface of the ground as possible in order that the waste water may be purified by the oxygen which is present in the surface layers of the earth. At a greater depth this purifying process is greatly retarded due to the absence of oxygen. Should the ground be of a compact or clay nature, a greater length of drain tile will be necessary, as also there will be greater need for the porous material beneath the tile.

The approximate cost of such a slop water disposal system is given below. If the waste water is emptied into a ditch or running stream the cost of slop basin will be $5.85 as shown below. If the subsurface disposal scheme is used, then an addtional 50 feet of 3″ pipe drain tile will be required. Fifty feet of drain tile at three cents per foot will add $1.50 to the cost, making a total cost of $7.35.

Approximate Cost—Labor not Included.

Cement, two sacks at 40c	$ .80
Hinges	.25
Ring	.10
Sixty-five feet of vitrified clay pipe at 6c	3.90
Wooden cover	.25
4″ elbow	.35
3″ elbow	.30
Total	$5.85

CESSPOOLS.

The general definition of a cesspool is a tank into which the house sewage is discharged, said tank retaining the solid and sometimes the liquid matter until removed. There are two types of cesspools, viz., **leaching** and **tight** cesspools.

The leaching cesspool is built of loose brick or stone without the use of cement or mortar. Through the crevices in the side of the cesspool the liquids leach out into the surrounding soil leaving the solid matter to remain in the cesspool until removed by pumping or by similar means.

The tight cesspool is built of brick or concrete, it being essential that the cesspool be water tight. The liquid is removed by being drained out through a drain pipe. The solids are removed as in the leaching cesspool.

The writer quotes from the following authorities in regard to the unsanitary conditions of cesspools.

"Sparkling water may not be pure. It may contain typhoid germs. The filtration of sewage effluent does not purify it although it may clarify it. It requires the action of oxygen and light to render sewage harmless." —Burton T. Ashley.

"It is hopeless to depend upon the purifying influence of intervening soil to protect the wells from cesspool fouling, because soil filtration, in order to be effective must be intermittent."—Mason.

"The cesspool is a relic of medieval shiftlessness and carelessness for which no excuse can be offered."—Dr. Bashore.

"The privy or cesspool is walled with loose stone so that the liquid waste may leak through them into the surrounding soil. The result of this is a gradual increasing pollution of the soil and often a neighboring spring or well becomes so contaminated as to spread disease."—Prof. Merriman.

THE SEPTIC TANK.

The modern septic tank, sometimes called a scum tank or putrefaction tank, consists essentially of a water tight chamber of suitable capacity, through which the sewage flows slowly, and almost continuously, the inlets and outlets being submerged to prevent an undue disturbance of the surface scum.

Countless numbers of bacteria harbored in the surface scum and living upon the solids in the sewage, cause its liquefaction. All solids settle to the bottom of the tank from which they are removed at frequent intervals.

Septic Tank Effluents.—While the liquid waste from the septic tank contains but little solid matter, it is highly charged with putrescible matter in solution, and the liquid gives off bad odors, particularly on warm or damp days. It cannot be sufficiently emphasized that the septic tank process is only a preliminary process of sewage treatment, that the waste from septic tanks are neither clarified, nor purified, that they contain all the dissolved organic substances which are the chief causes of contamination of lakes and streams, and that a further purification in most cases is necessary.

Operation of Septic Tanks.—No septic tank shows good results when first put in operation. It is necessary that the process be carried on for several weeks before it becomes efficient. The claims that all suspended impurities are liquefied and that there will be no increase in the deposit of solids or in the scum in a septic tank have not been realized. On an average only from thirty to fifty per cent of the suspended solid matter is destroyed, partly by liquefaction and partly by changing them into gas.

Capacity of Septic Tanks.—The capacity of the septic tank should be made in size about three-fourths the daily volume of the sewage. Otherwise the tank acts as a mere settling chamber. On the other hand the tank should not be too large, as the sewage remains too long in the tank. By the use of two tanks in series the capacity of each tank may be reduced.

Open and Closed Septic Tanks.—For isolated buildings it is preferable to use covered tanks, notwithstanding the fact that open tanks have been found to be quite satisfactory. Reasons for this are: that bad odors are confined within the tank; the sewage scum is concealed from sight; the surface of the sewage in the tank is protected from wind, rain and snow; but most important of all, the probable infection of food in the house by flies is prevented.

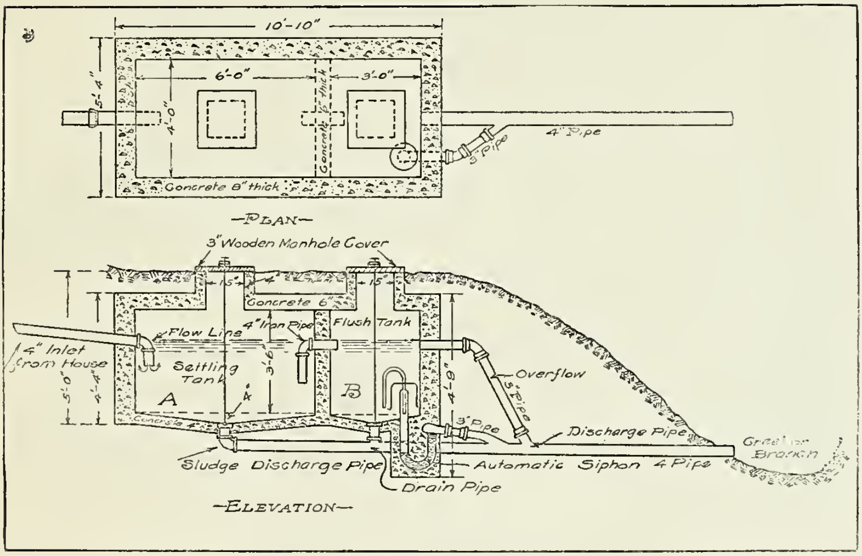
Small Concrete Septic Tank.—Fig. 2 shows a concrete septic tank which is designed large enough to provide for the sewage disposal of a family of six.

The tank operates as follows: Sewage enters tank "A" through a four-inch inlet pipe from the house. A heavy scum will form over the surface of the liquid, and beneath this scum the sewage is liquefied by the action of the bacteria which develop or grow in the surface scum. For the successful growth or culture of these bacteria, the scum must not be frequently broken or disturbed, hence the inlet pipe is made to discharge below the surface of the liquid. For the same reason the overflow pipe from tank "A" to tank "B" is extended below the surface to about the middle of tank "A" where the liquefaction of the sewage is most complete.

In the sludge discharge pipe provision is made for cleaning out the sludge from the settling tank without putting it out of service, and, furthermore, provision is made for the discharge of the contents of the tank during a time when it may be found necessary to repair the siphon.

After passing through the flush tank the sewage may be discharged directly into a creek or a running stream. Under most conditions, if a running stream were not available, the effluent may be discharged into a ditch or other drainage branch which should be seventy-five or one hundred yards from the house. No offense from odor will ordinarily be given from such a system of disposal, as there will usually be enough rain during the year to flush the small creek or ditch into which the waste enters.

FIG. 2.



Small Concrete Septic Tank.

When the effluent is discharged direct into a running stream of sufficient flow the tank "B" may be omitted. If the waste is treated by subsurface irrigation, then the flush tank "B" should always be used in order to have the sewage delivered intermittently. If the flow be continuous upon the ground then sufficient time is not given to allow the air to enter the soil, and consequently it soon becomes water-logged.

A six-inch partition should separate settling tank "A" from flush tank "B." The liquefied sewage flows from tank "A" from flush from which it is removed by means of an automatic siphon, which is so designed that it will discharge when the sewage reaches a certain height in the flush tank. This siphon should be so arranged that it will discharge the liquid twice every twenty-four hours. This siphon action will take place when the tank is receiving a flow of three hundred and sixty gallons per day.

To provide for the entrance of air into tank "B," which is necessary for the successful operation of the siphon, and also to provide for an overflow of the sewage in case the siphon becomes clogged and refuses to discharge the contents of tank "B", an overflow pipe is connected to the main discharge pipe as shown in Fig. 2.

A valve is placed in the bottom of the flush tank "B" to provide for the removal of sediment which in time may collect there.

The cost of the above septic tank, not including labor, is as follows:

Cement, 22 sacks at 40c per sack	$ 8.80
175 ft., 4″ V. C. pipe at 8c per foot	14.00
10 ft., 3″ V. C. pipe at 6c per foot	.60
Automatic siphon	15.00
Incidentals	5.00
Total	$43.40

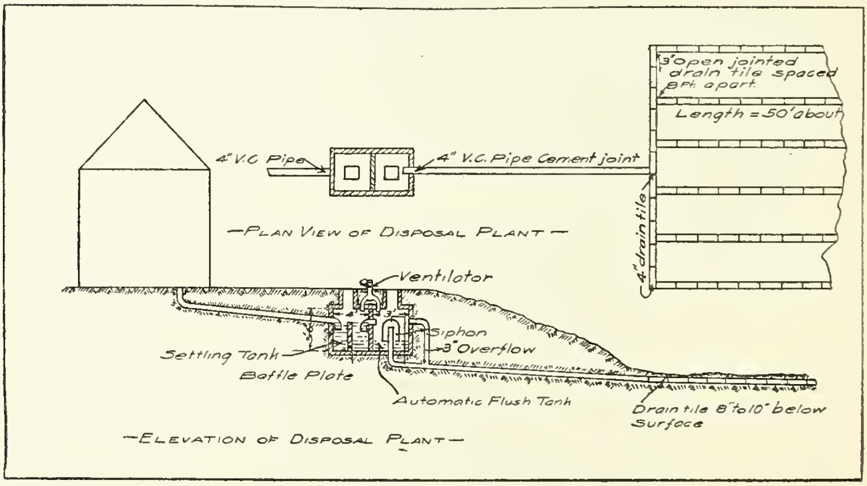
As will be noted above no estimate of the cost of sand or gravel has been made. In most farming communities this may be obtained from creeks or branches nearby at the expense of hauling.

SUBSURFACE DISPOSAL OF SEWAGE.

In septic tank disposal sewage systems, as in all others of whatever nature they may be, some provision must be made for the effluent after it leaves the tank. If it is allowed to flow out upon the ground continually a nuisance will soon be created, which may endanger health. In the absence of running streams into which to empty it, some other means of disposal must be resorted to. Perhaps the one of universal application is the **sub-surface disposal scheme.** This plan may be successfully used whether the ground be level or sloping. In fact it is about the only method that may be used in a flat country.

Subsurface disposal means the disposal of the liquid sewage through a system of open-jointed drain tile laid from eight to twelve inches below the surface of the ground. The open joints should be from one-fourth to one-half inch apart, covered with some material to prevent loose earth from falling back into the pipe during the backfilling of the ditch. The length of the drain pipe will depend upon the amount of sewage and character of the soil. An intermittent discharge is essential, hence the necessity of an automatic siphon. For the lateral drains a three-inch tile is ordinarily used.

FIG. 3.



Subsurface Disposal Plant.

It is evident that such a system of disposal requires the effluent to be a liquid, otherwise the drain tiles would soon become clogged and stop the operation of the plant.

Design of the Subsurface Disposal Plant.—Fig. 3 shows the arrangement of a typical subsurface disposal system. The plan view illustrates the method of arranging the drain tile. The distance of the septic tank from the house is about one hundred feet, and from the septic tank to the disposal field approximately one hundred feet. Local conditions will govern entirely as to the location of the tank and the disposal ground. In no case should the tank be closer to the house than one hundred feet.

Construction.—The pipe connecting the septic tank to the house should be a four-inch vitrified clay pipe, with bell and spigot joints carefully cemented. The four-inch pipe connecting the two tanks is to be arranged as shown in the drawing, Fig. 3.

The pipe line connecting the flush tank with the disposal ground is to be a four-inch V. C. pipe with cemented joints, and laid to a grade of at least one-fourth inch to the foot.

The main transverse drain tile should be four inches in diameter laid level with cemented joints. It is necessary that this tile be laid level in order to secure an equal distribution of the sewage to the laterals. The lateral drains should be three inches in size, laid in rows about fifty feet long and eight feet apart, and laid to the grade of one inch in twenty-five feet.

For a family of six people from 150 to 200 feet of drain tile will be necessary in a loose soil. In a compact clay soil, a much greater length will be needed, probably 300 to 400 feet.

Septic Tank.—The septic tank shown here consists of a settling tank and a flush tank provided with an automatic siphon. For the details of construction see Fig. 2.

Approximate Cost of Septic Tank.

Cement, 22 sacks at 40c	$ 8.80
100 ft. of 4″ V. C. pipe at 8c	8.00
10 ft. of 3″ V. C. pipe at 6c	.60
40 ft. of 4″ drain tile at 4c	1.60
150 ft. of 3″ drain tile at 3c	4.00
Automatic siphon	15.00
Incidentals	5.00
Total	$43.00

SURFACE DISPOSAL OF SEWAGE.

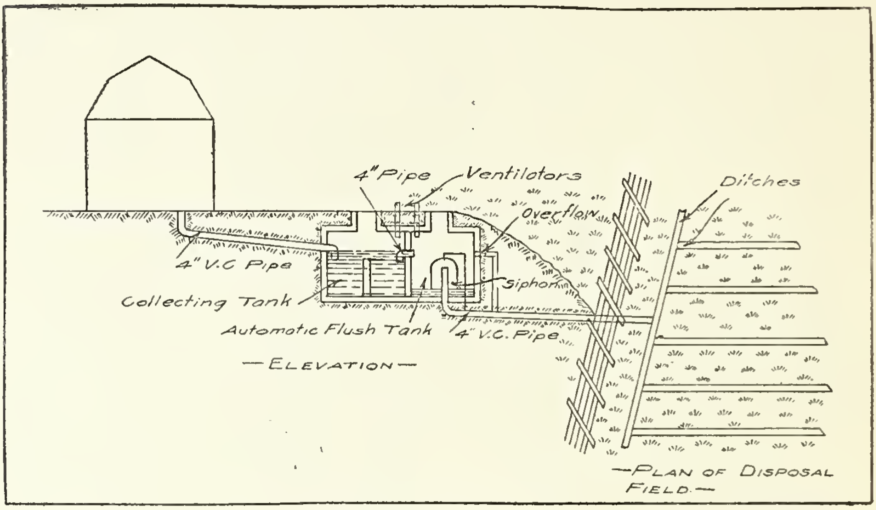
The surface disposal problem for sewage is solved in various ways. As in the case of the subsurface disposal scheme, it is essential that the sewage be discharged upon the surface of the ground intermittently. Such an arrangement gives time for the purification of the soil, which would soon become water-logged if the flow of sewage upon it were continuous.

Fig. 4 shows a typical surface disposal plant. The operation of the septic tank used is identical with that of Fig. 2, the only change being in the method of the final disposal of the discharged sewage. See Fig. 2 for the details of the construction of the septic tank.

The Disposal Field.—This plot of ground may be a small patch of cultivated land with a growing crop, such as corn, or it may be a piece of meadow or pasture land. A plot containing 2500 square feet will be ample to take care of the sewage from a family of six. This plot of ground should be at least 200 feet from the house or well, or any source of water supply. Upon reaching the disposal field the sewage empties into a ditch about one foot wide and four inches deep running at right angles to the disposal pipe from the septic tank.

Distributing Ditches.—The distributing ditches may be from four feet

FIG. 4.



Surface Disposal Plant.

to six feet apart, and four inches deep by eight inches wide. Their length will depend upon the size of the available disposal plot. There should be a sufficient number of ditches to quickly and equally distribute the sewage over the field.

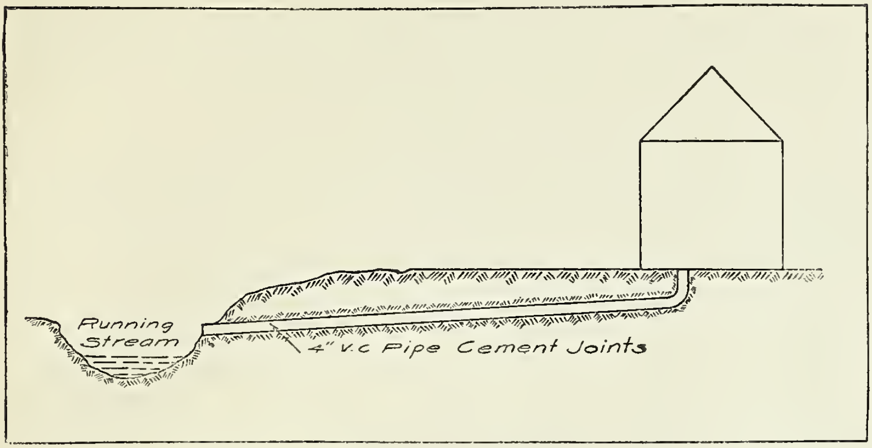
Estimated Cost.

Cement, 22 sacks at 40c	$ 8.80
100 ft. V. C. pipe at 8c	8.00
10 ft. V. C. pipe at 6c	.60
Automatic siphon	15.00
Incidentals	5.00
Total	$37.40

DIRECT DISPOSAL SYSTEM.

In some cases it may be advisable to dispose of the sewage directly into a running stream, but this plan is not to be generally recommended as the best. The danger is that the water farther down the stream sometimes used for drinking purposes may become contaminated, or the supply water for stock may be so fouled as to become unfit for use. If the flow of the stream be large, the dilution will be so great that little danger will occur from its contamination by the sewage of a single farm house. Disease germs may be transmitted for a distance of several miles, hence there is always danger in using for drinking purposes any water from a river into which sewage empties.

FIG. 5.



Direct Disposal Plant.

Fig. 5 shows an arrangement for the disposal of sewage direct into a stream. The discharge pipe should have a uniform slope of about one foot in twenty-five feet to insure its proper flushing.

Estimating the Cost.—The cost will obviously depend upon the distance of the house from a nearby creek. The disposal pipe should be a four-inch vitrified clay pipe and will cost eight cents per foot. The cost may be estimated for any specific design in hand from the general cost data given below, including cement, sewer pipe, drain tile, and concrete.

Cement 40c per sack, net.
Sewer pipe, 3″, 6c per foot.
Sewer pipe, 4″, 8c per foot.
Sewer pipe, 6″, 11c per foot.
Sewer pipe, 8″, 20c per foot.
Elbows, ¼, ⅛, and 1-16 bend.—
3″ 30c each.
4″ 35c each.
6″ 45c each.
8″ 60c each.
Y's and T's.—
3″ 35c each.
4″ 45c each.
6″ 70c each.
8″ 90c each.
Traps.—
3″ 65c each.
4″ 75c each.
6″ $1.00 each.
8″ $1.60 each.

Drain Tile.—
3″ 3c per foot.
4″ 4c per foot.
6″ 6c per foot.

Concrete.—On an average concrete for the above construction will cost from five to seven dollars per yard where it is necessary to hire all labor and buy all materials. One barrel of cement (about four sacks) will in general make one cubic yard of concrete consisting of a 1:2½:5 mixture.

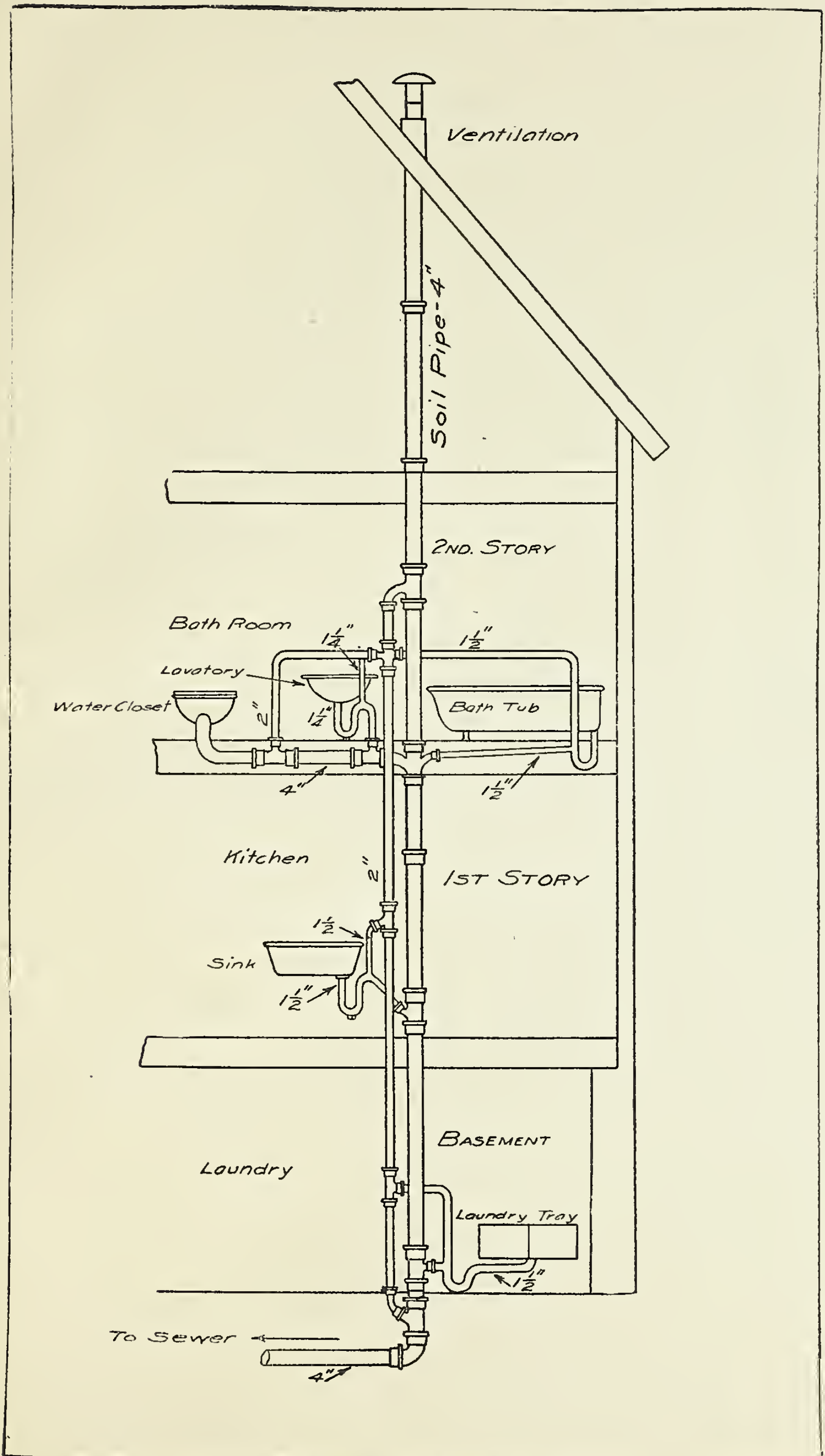
PLUMBING.

Fig. 6 shows the plumbing of the bath-room, kitchen and laundry of a modern house. The plumbing necessary for carrying the sewage to the main sewer outside of the house is also shown in the drawing. It will be noted that the system is fully vented so that no trouble will be had from the escape of sewer gas into the house.

The fixtures usually placed in the bath-room are the bath tub, wash basin, and the water closet; in the kitchen, a sink, and in the basement a laundry tray or tub.

The main ventilation or soil pipe, as it is commonly called, should pass upward through the roof to the open air. Its purpose is to relieve the gas pressure which might otherwise force the traps and enter the house. The top of the soil pipe should be covered with a cap to prevent the entrance of rain or snow.

FIG. 6.



Plumbing System for Sewage Disposal.

Cost.—The cost of the plumbing will depend upon the quality of the fixtures installed. For a two-story seven-room house fitted with first-class plumbing and fixtures throughout, the cost will be about $165. This cost item includes the following: Bath tub, wash basin, water closet, kitchen sink, laundry tub, a forty gallon hot water heater in the kitchen, all the necessary water piping to bath room, laundry and kitchen, and all the necessary drain tile and sewer pipe completely installed ready to connect with the main sewer located outside a few feet away from the house.

The expense item of $165 mentioned above includes the cost of both labor and material. We may add to this sum $50 for the septic tank and sewer pipe outside of the house, giving a total cost of $215. This estimate does not include the cost of a supply tank for water, nor the cost of putting in the water supply pipes. The water supply is described in a bulletin: "Water Supply for Country Homes," which may be obtained by addressing the Director, Missouri Engineering Experiment Station, Columbia, Missouri.