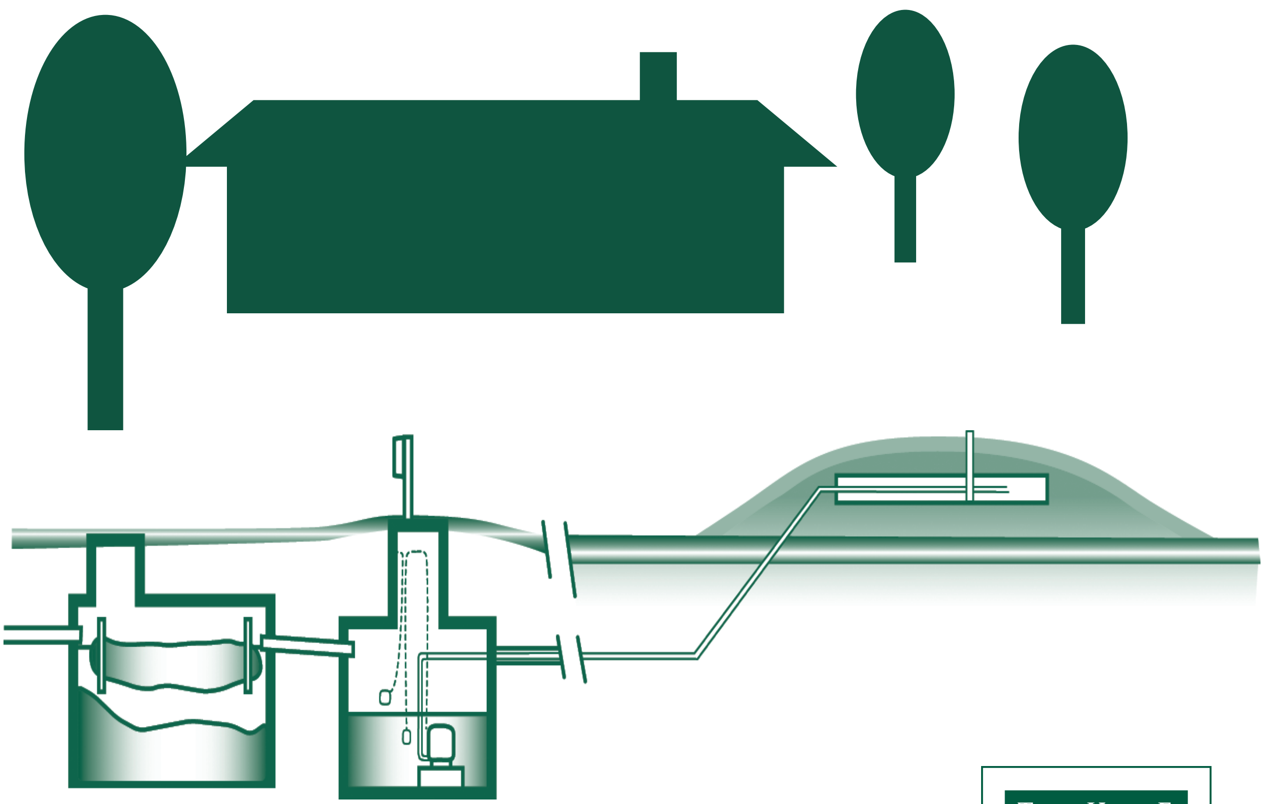
Bulletin 829

Mound System: Pressure Distribution of Wastewater

Design and Construction in Ohio



THE OHIO STATE UNIVERSITY EXTENSION

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Bulletin 829

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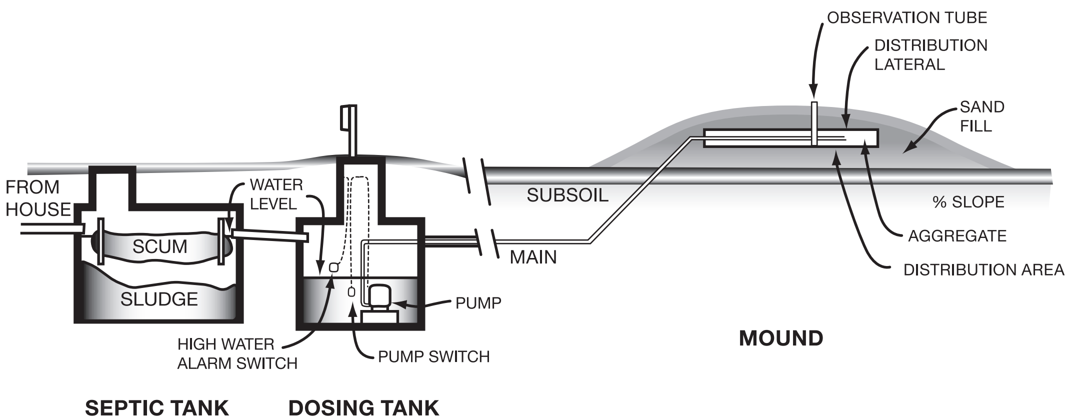
About this bulletin

The mound system is a soil absorption system constructed above grade that uses sand fill to enhance septic tank effluent treatment before the wastewater is dispersed to the natural soil at the site. Sites not suited for a conventional subsurface soil absorption system may be suitable for a mound system. Detailed information on mound systems is presented in Bulletin 813, Mound System for On-site Wastewater Treatment: Siting, Design, and Construction in Ohio. Copies of Bulletin 813 are available through Ohio county Extension offices or on the website *setll.osu.edu*.

This bulletin examines the dosing tank and distribution system that convey the septic tank effluent into the mound for treatment and dispersal. The discussions on design and construction are intended to enable engineers, soil scientists, sanitarians and installers to design, construct and inspect pressure distribution systems for mounds.

How mound systems work

Septic tank effluent is distributed in the mound through a series of perforated pipes buried in a layer of gravel above the sand fill (Figure 1) or in chambers set on top of the sand fill. A pump placed in a dosing tank is used to deliver the septic tank effluent across the top of the sand fill in the mound. Pressure distribution systems for mounds consist of five components: 1) lateral pipes with equally spaced shielded holes drilled into the top of the pipe; 2) manifold and main connected to the laterals; 3) dosing tank to collect septic tank effluent to be pumped to the mound; 4) pump to pressurize the system; and 5) controls and power supply to operate the pump.



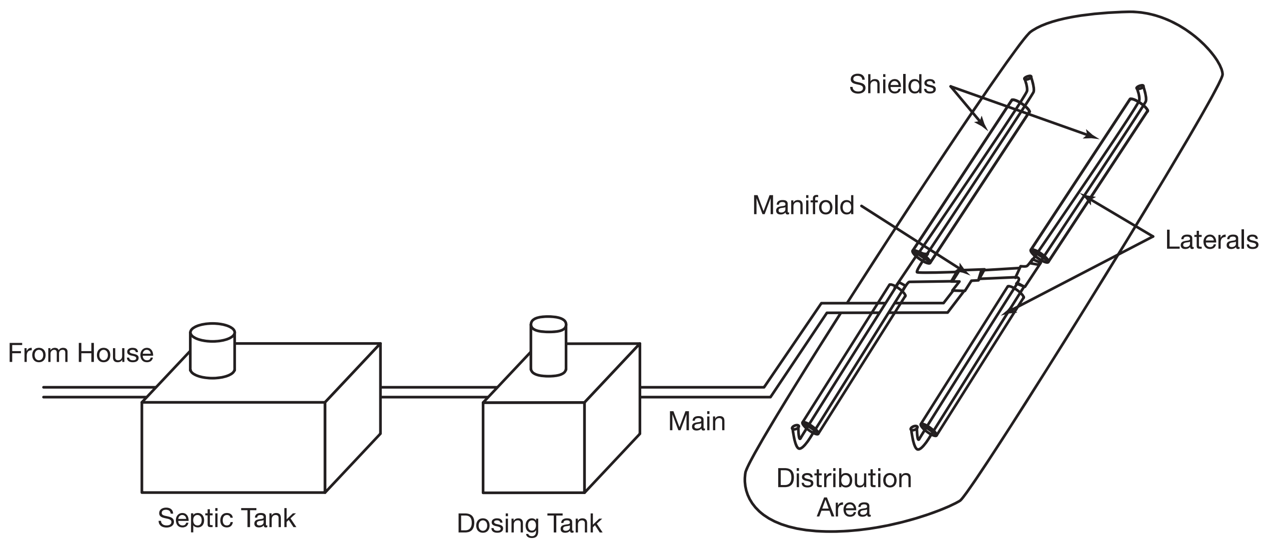


Figure 1. Mound system components.

How to use this bulletin

The steps to design and construct the five components of a pressure distribution system will be presented in this bulletin. To illustrate the steps, an example pressure distribution system for a mound will be presented in the series of figures, calculations and tables that follow. A shaded example across the bottom of the pages will help illustrate the steps.

What are the lateral pipes?

Pressure distribution networks with laterals and manifolds are used to provide relatively uniform distribution of wastewater effluent over the entire distribution area simultaneously during each dose (Figure 2). Uniform distribution of the septic tank effluent is especially important in mound systems. Uneven distribution of septic tank effluent can result in localized overloading and short-circuiting through the mound. Surface seepage in one area of a mound may be caused by uneven distribution (Figure 3).

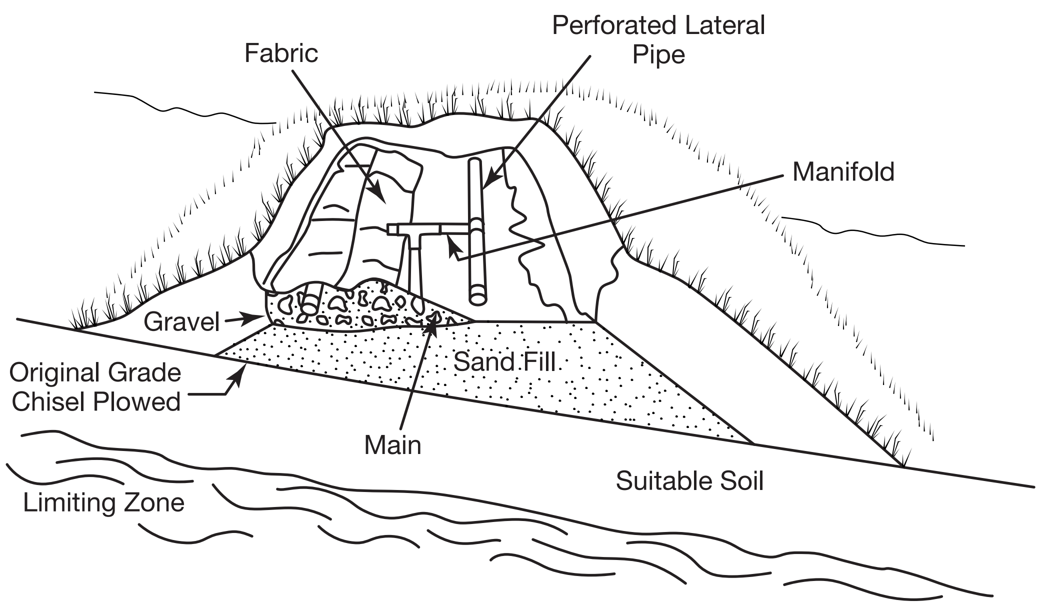


Figure 2. Mound with pressure distribution system.

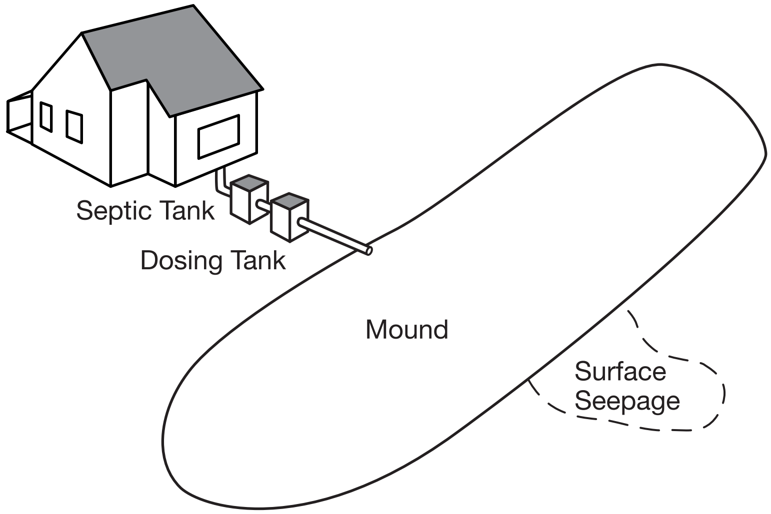


Figure 3. Indication of distribution failure in the mound system.

Pressure distribution systems are carefully designed so that the volume of septic tank effluent flowing out of each hole of the distribution pipe is nearly identical. The pipe diameters and hole diameters must be carefully sized to achieve uniform distribution.

A perforated lateral begins at the manifold and ends with a drain hole and turn up. In a pressure distribution system, 1 to 1 ½ inch diameter pipes are used as laterals to distribute the wastewater. The 4-inch perforated pipe, used in conventional soil absorption systems, is not suitable because it is too large and the holes are not appropriately sized and spaced to provide even effluent distribution.

Schedule 40 PVC pipe and fittings are used in pressure distribution systems. Holes are drilled perpendicular to the pipe in a straight line along the top of the pipe. A sharp drill bit will drill a more uniform perforation than a dull drill. Any burrs or rough edges must be removed from the holes so they do not collect debris and clog. Slide a rod or small diameter pipe along the inside of the lateral pipe to remove burrs. Upon installation, the pipe must be clean and clear of debris and PVC cuttings that can clog holes. During construction, protect the ends of pipes to keep rodents and their food and nesting material out of pipes. Duct tape works well for this.

The steps presented herein can be used to design pressure distribution systems where each lateral is at the same elevation. Developing a pressure distribution system for a series of laterals at different elevations is more involved and is not presented in this bulletin.

The pipe diameter, hole diameter and hole spacing are determined for each pressure distribution system. The sizing of the distribution pipe network is presented in the next five steps along with an example.

Step 1: Configure the distribution area

Establish dimensions of mound from estimated daily flow rate and soil conditions (Figure 4) described in Ohio Extension Bulletin 813, Mound Systems for On-Site Wastewater Treatment: Siting, Design, and Construction in Ohio. Copies of Bulletin 813 are available from Ohio county Extension offices.

Design Example

Dimension of the distribution area: 4 ft wide × 90 ft long

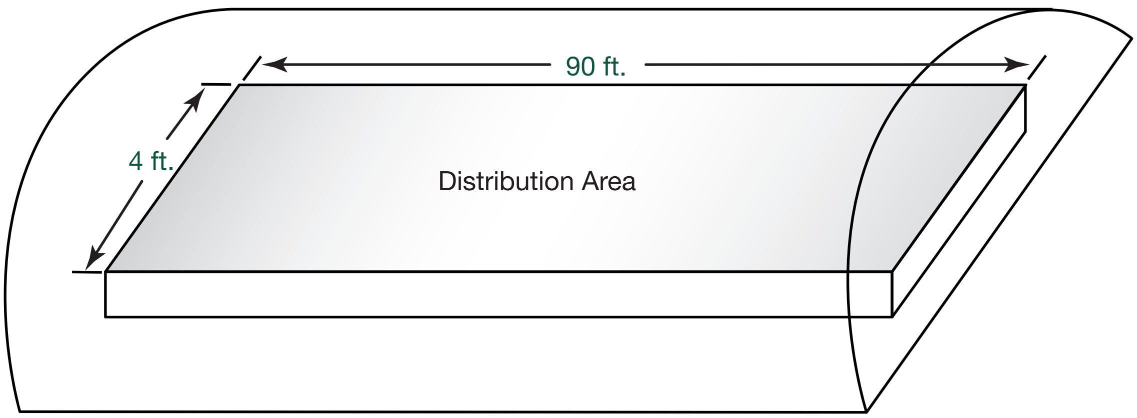


Figure 4. Distribution area for mound system.

Selected Parameter

(1) Width of distribution area: 4 ft

(2) Length of distribution area: 90 ft

Step 2: Length of laterals and distance between laterals

Determine the length of laterals and the distance between laterals (Figure 5). All lateral lines are to be on the same elevation to avoid uneven distribution. The lateral length is measured from the distribution manifold to the end of the lateral. A center manifold is preferred because it minimizes pipe length. For a center manifold it is approximately half the length of the distribution area. Figure 6 illustrates some possible manifold positions. The goal is to keep lateral lines short. Consider split manifolds shown in Figure 6 to keep lines short on long mounds.

Design Example

Length of laterals = Distribution area length / 2

Length of laterals = 90 ft / 2 = 45 ft

Distance between lateral = 2 ft

Total lateral number = 4 with center manifold connection

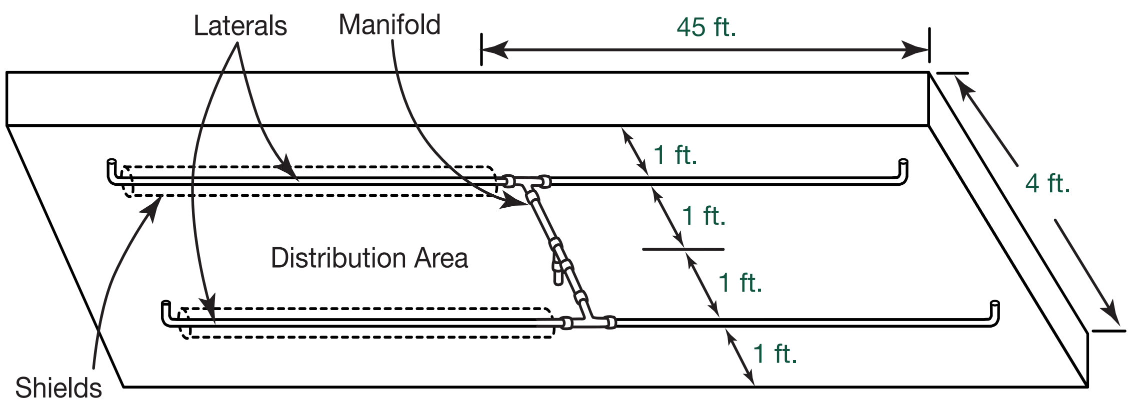


Figure 5. Network configuration for distribution area.

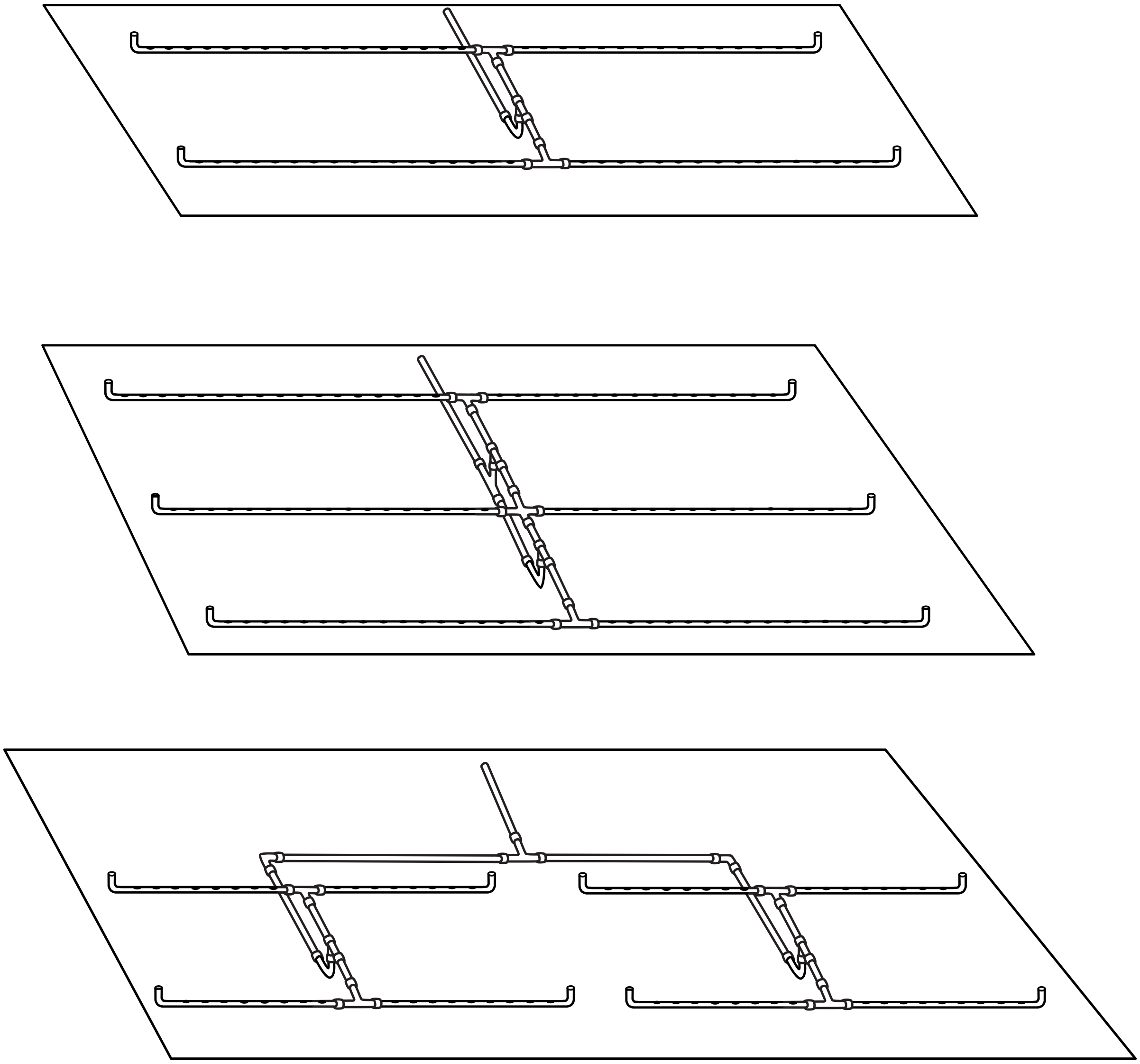


Figure 6. Alternative manifold designs for distribution system.

Selected Parameter

(3) Length of laterals: 45 ft

(4) Distance between laterals: 2 ft with center manifold

(5) Total lateral number: 4

Step 3: Hole spacing and number in the laterals

Determine hole spacing and number of holes, which can be calculated by maximum coverage area per hole. For example, **6 ft²/hole** is recommended for sand infiltration for all pressure distribution application. Hole spacing should be **less than 4 feet.** The higher the hole density, the more uniform the wastewater distribution. The holes should be staggered between adjacent laterals, if possible (Figure 7). A hole should always be drilled on the bottom at the end of the pipe to facilitate draining after a dose (Figure 7).

Select hole diameter. For mound systems meeting siting criteria in Bulletin 813, **¼-inch holes** are sufficient. Larger holes require larger pipe diameters and pumps. Smaller holes may clog. Use shields over each hole when using gravel. For example, shield with a 4-inch perforated pipe placed in a gravel bed.

Design Example

Required hole numbers = Total distribution area, ft² (width, ft × length, ft) / Maximum coverage area per each hole (6 ft²/hole)

Total distribution area, ft ² (width, ft × length, ft) = 4 ft × 90 ft = 360 ft²

Required hole numbers = 360 ft² / (6 ft²/hole) **= 60 holes**

Hole spacing, ft = Lateral length, ft / Number of holes in each lateral

Number of holes in each lateral = Required number of holes / Lateral numbers
= 60 holes / 4 = **15 holes**

Hole spacing, ft = 45 ft / 15 = **3 ft**

∴**Checking:** 3 ft hole spacing is less than 4 ft, so OK!

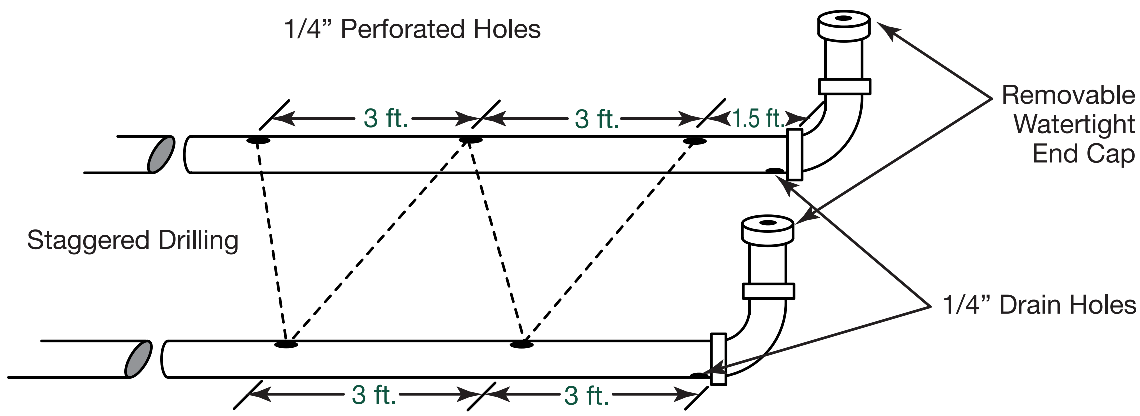


Figure 7. Hole spacing in distribution system.

Selected Parameter

(6) Hole diameter: ¼ inch

(7) Total number of holes: 60 holes

(8) Number of holes per lateral: 15 holes

(9) Hole spacing: 3 ft

Step 4: Lateral diameter

Determine lateral diameter. The lateral diameter selection is based on the hole size, hole spacing and lateral length. Graphs, such as the one in Figure 8, have been developed to help in selecting minimum lateral diameters between 1 and 1 ½ inch. Select the pipe diameter indicated between the lines on the graph.

Design Example

Diameter from Figure 8 = 1.5 inch based on hole spacing 3 ft and 45 ft lateral length

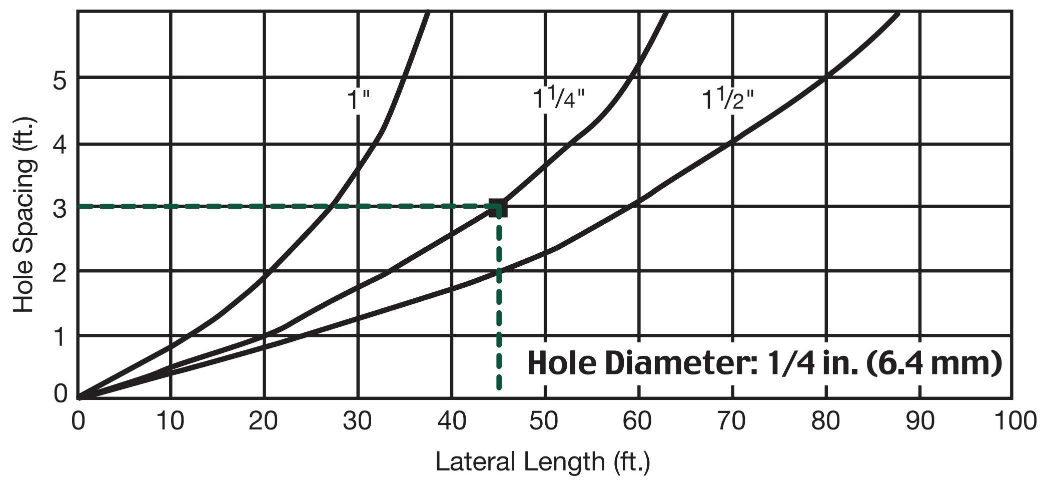


Figure 8. Minimum lateral diameters of plastic pipe for lateral lengths versus spacing for ¼ inch hole diameter (after Otis, 1982).

Selected Parameter

(10) Lateral diameter: 1.5 inch

Step 5: Pressure head

Select a pressure head to be maintained at the end of each lateral. The head should be between **2 feet and 4 feet.** Using the selected head and the hole diameter, the flow rate per hole can be determined from Table 1. By multiplying the flow rate per hole by the number of holes in the lateral, the lateral flow rate can be calculated.

Design Example

Flow rate per hole for ¼ **inch** at head **4 ft** from Table 1 = **1.47 gpm/hole**

Numbers of holes per lateral = **15 holes**

Flow rate per lateral = Flow rate per hole × Numbers of holes per lateral

= 1.47 gpm/hole × 15 holes = **22.1 gpm**

Table 1. *Flow rate per hole for 1/4 inch holes and various network pressures (after Otis et al. 1978).*

Head (feet)	Pressure (psi)	Gallon per minute (gpm)
1	0.434	0.74
2	0.867	1.04
3	1.301	1.28
4	1.734	1.47

Selected Parameter

(11) Head at end of lateral: 4 ft

(12) Flow rate per hole: 1.47 gpm

(13) Flow rate per lateral: 22.1 gpm

About manifold and main

The manifold and main pipes connect the mound to the dosing tank. The manifold is piping that connects the laterals and distributes the septic tank effluent to each lateral. The main delivers the septic tank effluent from the dosing tank to the manifold. Manifold and mains are usually PVC pipe with appropriate ell or tee fittings joined with solvent cement.

The connections between the manifold and the laterals, and the manifold and the main, affect the design of the system. Connections can be made at the center of the pipes. In addition, the relative elevation of the connections determines how the system drains. Figure 9 illustrates connection between manifold and laterals connected at the same elevation with tees at center connection as shown in Figure 9 (a), and connection between the manifold and main with ell fitting, as shown in Figure 9 (b), the manifold volume is part of the delivery pipe system because it drains back to the dosing tank.

The main should be sloped back to the dosing tank without the pipe sagging so that it drains back to the tank between doses as shown in Figure 10. This prevents freezing for shallow pipe placement in cold weather and biofilm formation inside of pipe.

The manifold should be the same diameter as the main. The size and position of the manifold and main are determined for each pressure distribution system. The sizing and connections of the manifold and main are presented in steps 6 through 7 along with an example.

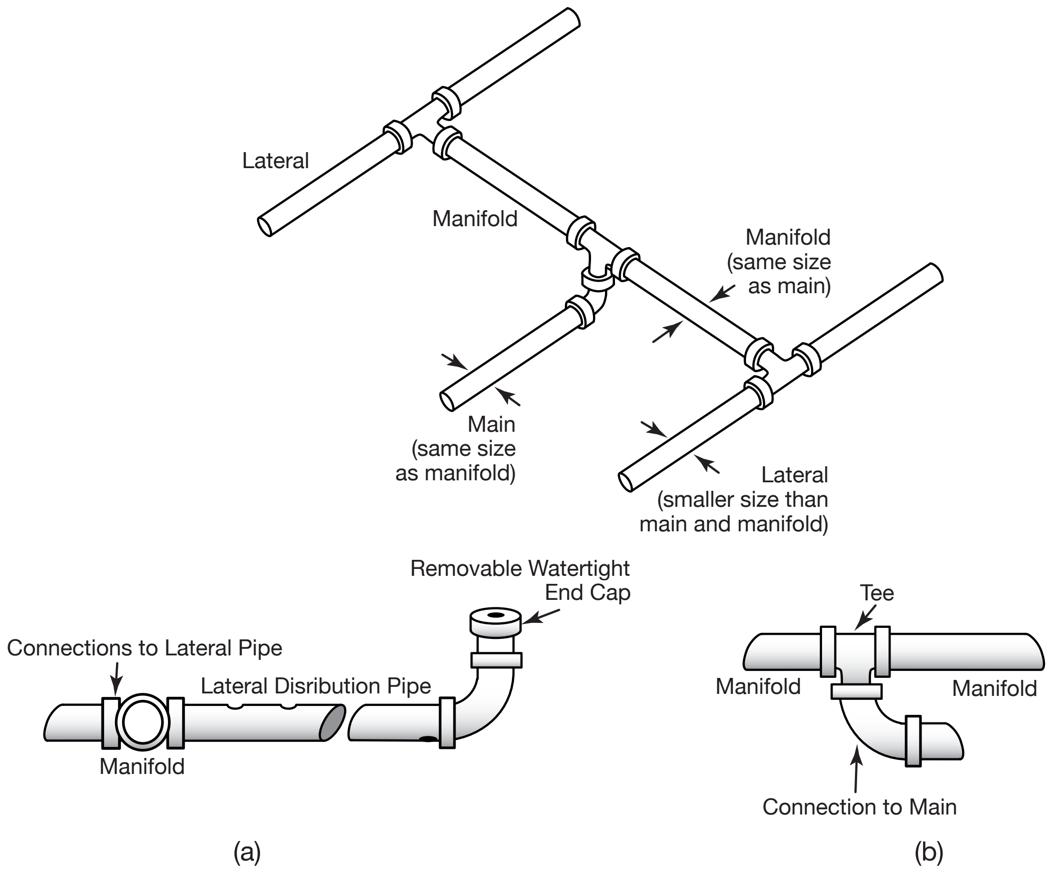


Figure 9. Examples of manifold to lateral connections: (a) center connection with tee and (b) ell fitting connection between the manifold and main.

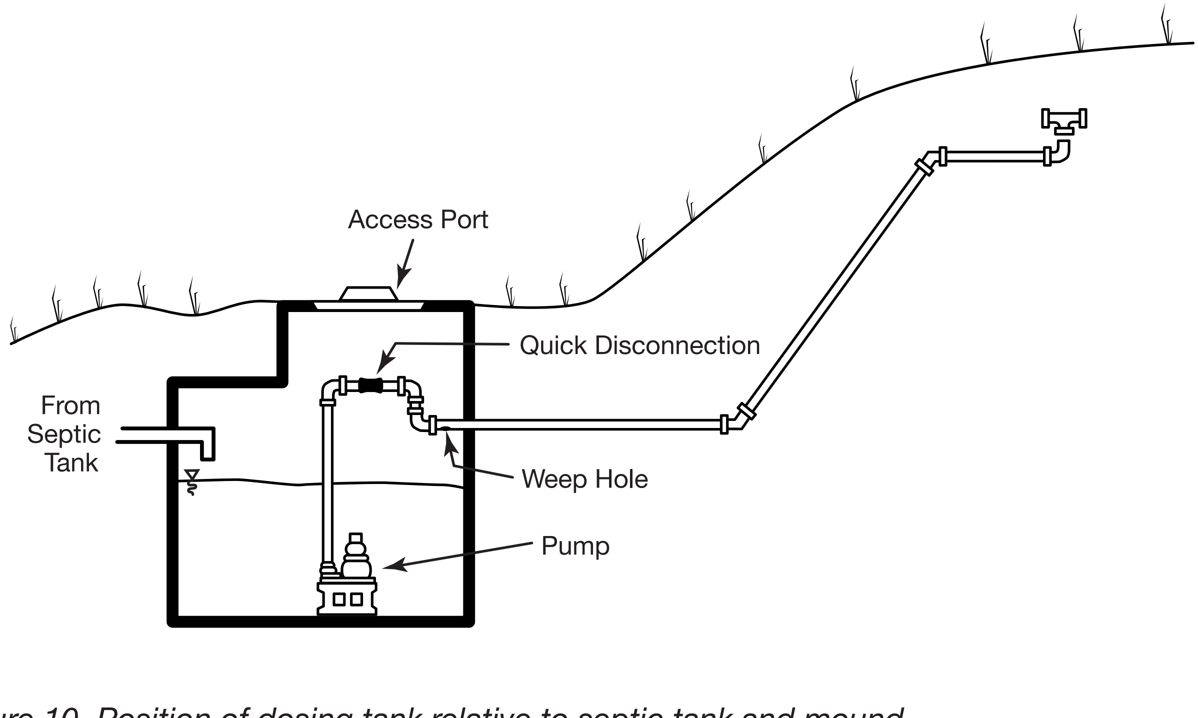


Figure 10. Position of dosing tank relative to septic tank and mound.

Step 6: Manifold length, size and connection

Determine the configuration of connection between the manifold and the laterals, and the manifold and the main (Figure 9). The point of the main/manifold connection determines the length of the manifold. The manifold length is measured from the main/manifold connection to the end of the manifold.

Design Example

From **Figure 9,**

Connection between the manifold and the laterals: center

Connection between the main and the laterals: tee-to-tee

Manifold length: **2 ft between the laterals**

Manifold size: **the same size as the main**

Selected Parameter

(14) Connection between the manifold and the laterals: center

(15) Connection between the main and the laterals: tee-to-tee

(16) Manifold length: 2 ft between the laterals

(17) Manifold size: the same size as the main

Step 7: Main diameter associated with the system flow rate

Determine the main and the manifold diameter. The main diameter is dependent on the system flow rate. From the head loss values given in Table 2, select a pipe diameter that will have a low head loss at the given flow rate. Note that the head losses listed in Table 2 are for a 100-foot piece of pipe. The manifold is same size as the main.

Design Example

Flow rate per lateral = Flow rate per hole × Numbers of holes per lateral
= 1.47 gpm/hole × 15 holes = **22.1 gpm**

System flow rate = Flow rate per lateral × Number of laterals
= **22.1 gpm × 4 laterals = 88.4 gpm**

From Table 2, main pipe size 3 or 4 inch available for 90 gpm (≈ 88.4 gpm) for this system. The 4-inch diameter pipe size has the lower head loss, therefore, it is selected the 4-inch diameter pipe.

Main and manifold size: **4 inch**

Selected Parameter

(18) System flow rate: 88.4 gpm

(19) Main size: 4 inch

(20) Manifold size: 4 inch

Table 2. *Head loss in schedule 40 plastic pipe (after Otis, et al. 1978).*

	Pipe Diameter (inches)						
Flow	1	1¼	1½	2	3	4	6
gpm	ft/100ft						
1	0.07						
2	0.28	0.07					
3	0.60	0.16	0.07				
4	1.01	0.25	0.12				
5	1.52	0.39	0.18				
6	2.14	0.55	0.25	0.07			
7	2.89	0.76	0.36	0.10			
8	3.63	0.97	0.46	0.14			
9	4.57	1.21	0.58	0.17			
10	5.50	1.46	0.70	0.21			
11		1.77	0.84	0.25			
12		2.09	1.01	0.30			
13		2.42	1.17	0.35			
14		2.74	1.33	0.39			
15		3.06	1.45	0.44	0.07		
16		3.49	1.65	0.50	0.08		
17		3.98	1.86	0.56	0.09		
18		4.37	2.07	0.62	0.10		
19		4.81	2.28	0.68	0.11		
20		5.23	2.46	0.74	0.12		
25			3.75	1.10	0.16		
30			5.22	1.54	0.23		
35				2.05	0.30	0.07	
40				2.62	0.39	0.09	
45				3.27	0.48	0.12	
50				3.98	0.58	0.16	
60					0.81	0.21	
70					1.08	0.28	
80					1.38	0.37	
90					1.73	0.46	
100					2.09	0.55	0.07
125						0.85	0.12
150						1.17	0.16
175						1.56	0.21
200							0.28
250							0.41
300							0.58
350							0.78
400							0.99

For pump selection

In mound systems, the pump delivers septic tank effluent to the mound situated at a higher elevation. The pump also pressurizes the lateral system to provide uniform distribution in the dosing application. Pumps appropriate for septic tank effluent, called effluent pumps, are designed to operate in the corrosive environment of a sewage system. Effluent pumps can also handle a small amount of solid material without damage.

The pump size is selected based on the system flow rate in gallons per minute (GPM) and the total dynamic head (TDH). The total dynamic head is determined by adding together:

- the elevation difference between the pump outlet and the laterals;
- the head losses in the pipe and fitting; and
- the desired head at the end of the laterals times 1.3 for network losses.

Using pump performance curves, select the pump that best matches the required flow rate at the operating head. Using the pump performance curve, determine if the pump will produce the flow rate at the required head. Do not choose the undersized pump. Pumps can be oversized but will be more costly.

Follow steps 8 through 13 to determine the pump size. They are presented here along with an example.

Step 8: Relationship between system flow rate and total dynamic head for pump selection

The needed pump capacity in gallons per minute is the system flow rate (determined when sizing the main). The system flow rate is the sum of the flows out of all the holes in the laterals. The pump size is selected based on the system flow rate in gallons per minute (GPM) and the total dynamic head (TDH)

Design Example

1) System flow rate (GPM)

2) Total dynamic head (TDH) = Static lift + Main pipe loss + Network loss

Selected Parameter

(18) System flow rate: 88.4 gpm

Step 9: Configuration of main pipes and static lift

Establish the relative positions of the mound and the dosing tank, both vertically and horizontally, as shown in Figure 11. Determine the elevation difference between the pump outlet and the laterals. This is called the static lift. Minimize 90° angle fittings. Choose where possible 2 × 45° angles to gradually move the wastewater from the pump to the laterals. 90° angle fittings make it difficult to clear the pipe if a clog occurs.

Design Example

Static lift (Elevation difference between the pump outlet and the laterals) = 10 ft

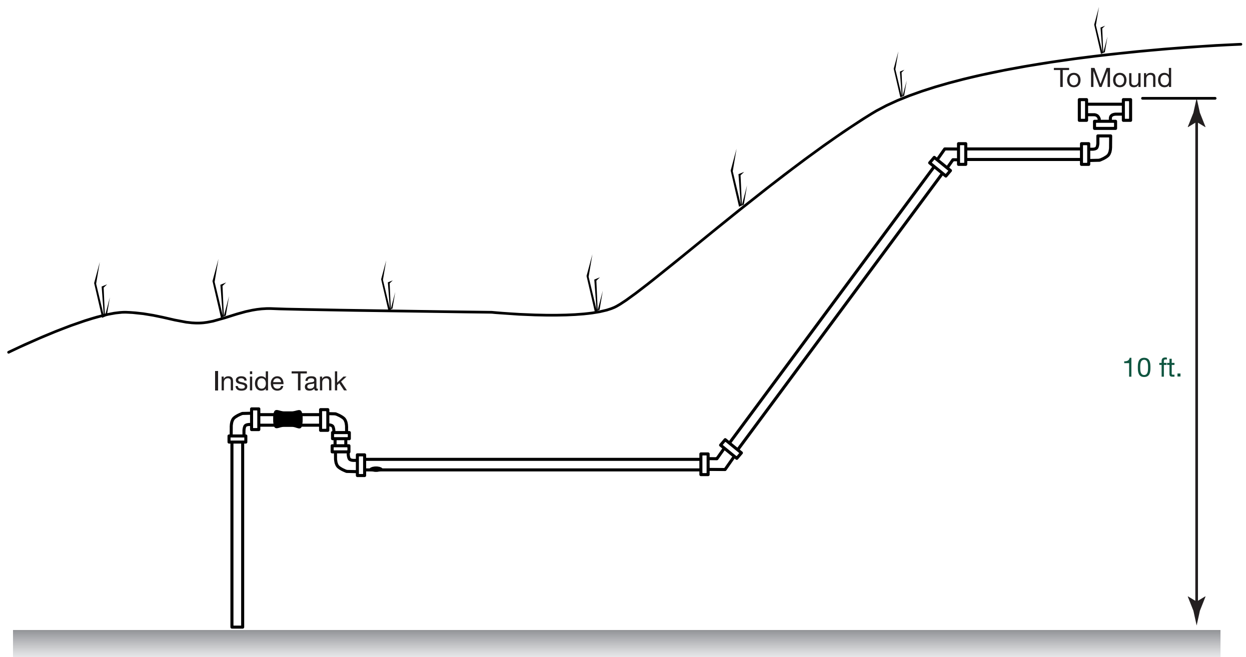


Figure 11. Elevation difference from dosing tank to mound.

Selected Parameter

(21) Static lift: 10 ft

Step 10: Head losses in the main pipe and fittings

Calculate the head losses in the main pipe and fittings. Determine the total length of the main pipe and the types and number of fittings, as illustrated in Figure 12. Add to the length of the main the equivalent lengths of pipe for each fitting, as presented in Table 3. Multiply the equivalent length of pipe by the head loss per 100 feet of pipe from Table 2. Then divide by 100 to get the head loss in the main pipe and fittings.

Design Example

Total equivalent length of pipe = Main pipe length + Sum of equivalent length of pipe for fitting (from Table 3 at 4 inch main diameter)

Main pipe length = 5 ft + 15 ft + 15 ft + 5 ft = **40 ft**

Equivalent length of pipe for 4 – 90° Std. Elbow = 4 elbow × 14 ft/elbow = **56 ft**

Equivalent length of pipe for 2 – 45° Std. Elbow = 2 elbows × 8 ft/elbow = **16 ft**

Quick disconnection coupling = **5.0 ft**

Equivalent length of pipe for tee = **22 ft**

Total equivalent length of pipe = 40 ft + 56 ft + 16 ft + 5 ft + 22 ft = **139 ft**

Head loss in 100 ft of 4 inch pipe at 90 gpm = **0.46 ft** (from Table 2, page 19)

$$\text{Head loss in 139 ft of 4 inch pipe} = \frac{0.46\text{ ft} \times 139\text{ ft}}{100\text{ft}} = \mathbf{0.64\text{ ft}}$$

Table 3. *Head losses through plastic fittings in terms of equivalent lengths of plastic pipe (after Clemons, 1991).*

	Nominal Size Fittings and Pipe—inches					
Type of Fitting	1 ¼	1 ½	2	2 ½	3	4
	Equivalent Lengths of Pipe—feet					
90° Std. Elbow	7.0	8.0	9.0	10.0	12.0	14.0
45° Std. Elbow	3.0	3.0	4.0	4.0	6.0	8.0
Std. Tee	7.0	9.0	11.0	14.0	17.0	22.0
Check Valve	11.0	13.0	17.0	21.0	26.0	33.0
Coupling or Quick Disconnect	1.0	1.0	2.0	3.0	4.0	5.0
Gate Valve	0.9	1.1	1.4	1.7	2.0	2.3

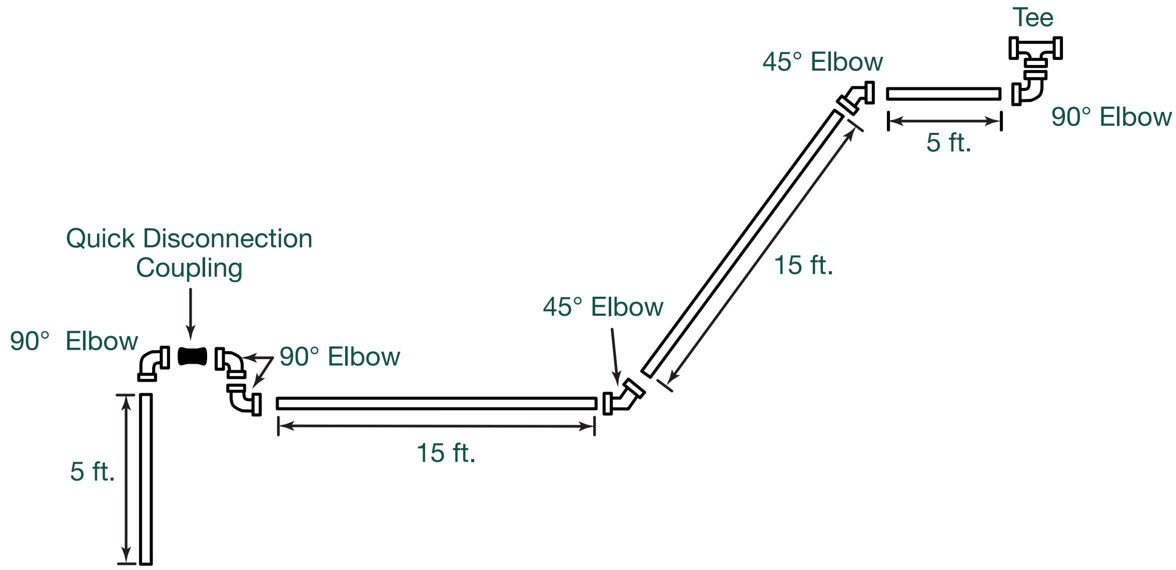


Figure 12. Main length and fittings from dosing tank to mound.

Selected Parameter

(22) Main pipe head loss: 0.64 ft

Step 11: Network losses

Determine the network losses by multiplying the desired head at the end of the laterals (from step 5) by 1.3 (multiplier related to the friction loss in the manifold and laterals which assumes that the laterals and manifold are sized correctly).

Design Example

Network loss = Head at end of laterals × 1.3
= 4 ft × 1.3 = 5.2 ft

Selected Parameter

(23) Network loss: 5.2 ft

Step 12: Total dynamic head (TDH)

Determine total dynamic head (TDH) by adding together the elevation difference (from step 9), the head loss in the main pipe and fittings (from step 10), and the network head losses (from step 11).

Design Example

Total dynamic head (TDH) = Static head + Main pipe loss + Network loss
= 10 ft + 0.64 ft + 5.2 ft = **15.84 ft**

Selected Parameter

(24) Total dynamic head (TDH): 15.84 ft

Step 13: Selection of pump

Determine pump curves to help select an appropriate pump. Three examples of pump curves are presented in Figure 13. Each pump will have a rating curve, which compares pump capacity (in GPM) to the head (in feet) provided by the manufacturer. Select a pump that will provide sufficient head for the capacity needed. Avoid selecting too large a pump, with the GPM versus TDH far below the curve. Large pumps are more expensive. The required TDH for the GPM should be on or just below the pump curve, within the middle two-thirds of the curve, for the most efficient operation.

Design Example

Pump (1) is undersized and Pump (3) is oversized, while Pump (2) is large enough to provide sufficient head at the necessary flow rate. **Select Pump (2)**

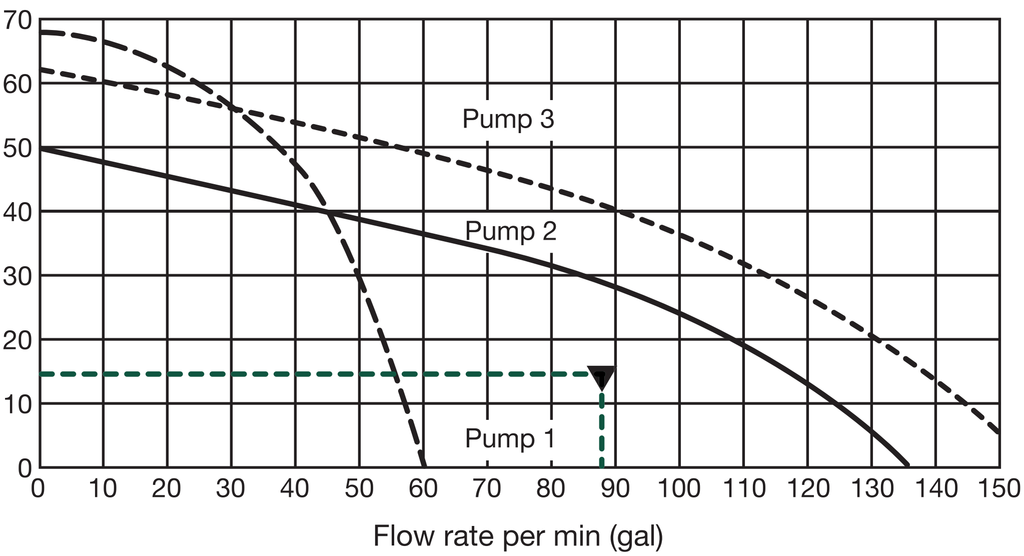


Figure 13. Example pump curves for three different pumps.

How to select a dosing tank

The dosing tank is placed between the septic tank and the mound to accumulate septic tank effluent to be periodically dosed to the mound (Figure 1). Once the accumulated effluent reaches a predetermined volume, the effluent is pumped to the laterals in the mound by an electrical control system. Proper dosing tank construction, placement and sizing must be considered to ensure reliable system operation.

The dosing tank construction requirements are the same as for septic tanks. The tank must be durable and watertight and must withstand the soil loads, which tend to push in on the walls. Since the environment in the tanks is very corrosive, no metal parts or fittings should be used. The major difference between a septic tank and a dosing tank is that the dosing tank volume will be lowered on a daily basis. Therefore, anchoring it against floatation is critical in areas with a high seasonal or permanent water table, which is where mound systems are often used. Common methods for anchoring can be used, such as a concrete anchor pad or deadmen anchors for fiberglass and plastic tanks. Placing 1 to 3 feet of soil cover over concrete tanks helps to anchor them against floatation.

Ensuring that the dosing tank is watertight is critical. In areas with a high seasonal or permanent water table, groundwater may leak into the dosing tank and overload the mound system. The seals around the pipes that enter and exit the dosing tank are especially vulnerable to leaks. If the pump is running more than the few minutes a day it takes to pump out the accumulated septic tank effluent, groundwater may be leaking into the septic tank or dosing tank. If groundwater infiltration is suspected, an event counter can document the number of times the pump comes on.

Dosing tanks can be round or rectangular as shown in Figure 14. A riser to the ground surface is needed for access to the pump. Make sure the riser is also watertight. Joints in risers can be a source of ground or surface water infiltration.

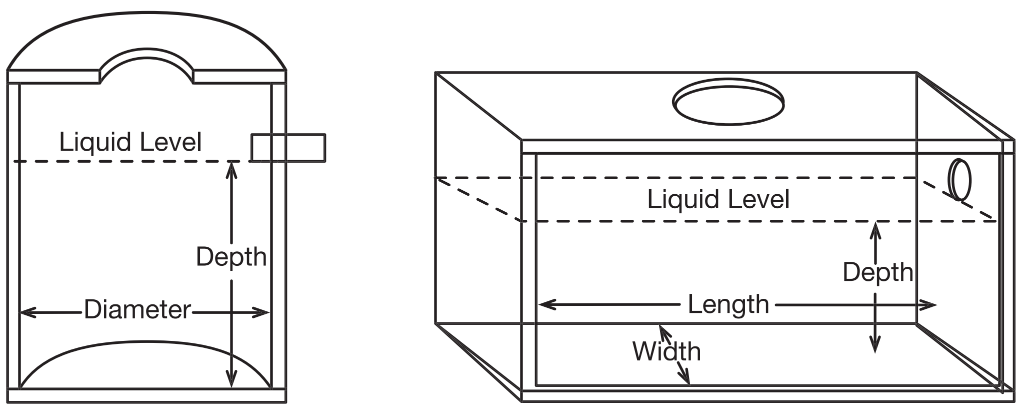


Figure 14. Styles of dosing tank: (a) round, (b) rectangular.

Never enter a dosing tank. Any work to replace pumps, switches or connections should be made from the outside. The sewage gases produced in the tank can kill a person in a matter of minutes. When working on a tank, make sure the area is well-ventilated and someone is standing by. Never go into a dosing tank to retrieve someone who accidentally fell in without a self-contained breathing apparatus. While waiting for help, the best thing to do is to put a fan at the top of the tank to blow in fresh air.

The pump in a dosing tank should be set several inches off the tank bottom to provide storage space for solids that may have carried over from the septic tank, as shown in Figure 15. A 6-inch concrete block makes a good pedestal for the pump. Whenever the septic tank is pumped to remove solids, the dosing tank should be pumped.

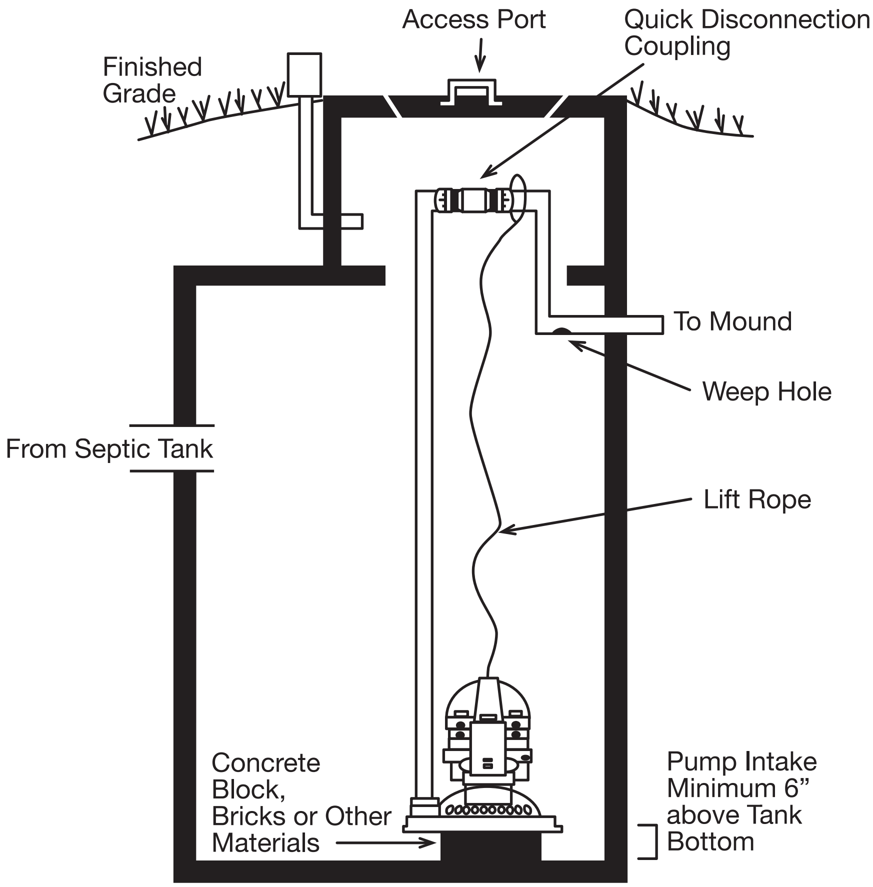


Figure 15. Cross section of dosing tank showing riser and pedestal for pump.

The minimum size of the dosing tank is the sum of the dosing volume, the volume of the delivery pipes, volume needed to keep pump submerged, and emergency storage volume in case of pump failure. The dose volume equals the delivery pipes plus 5 times the volume that will drain through the holes. A minimum of one-day emergency storage above the high water alarm should be provided. Appropriate dosing tank sizes are listed in Table 4. Avoid using a large tank as a dose tank because it is difficult to achieve adequate switch separation for pump control.

Table 4. *Minimum dosing tank size for different sized homes (after Converse, 1978).*

Home size, No. bedrooms	Minimum dosing tank size, gallons
1	250
2	250
3	500
4	500
5	750

Step 14: Volume of pipe for calculation of dose volume

Determine volume of pipe: laterals that will drain through the holes and the volume of the delivery pipes, manifold and main that will drain back into the dose tank. Remember, this is determined by the style of manifold/lateral connections (Figure 9). In tee-to-tee connections, the manifold drains back to the dosing tank. Table 5 lists the pipe volume per foot of pipe for several diameters of pipe.

Design Example

For this tee-to-tee connections, the lateral volume drains through the holes and the manifold and main volumes drain back to the dosing tank.

Lateral diameter and total length = **1.5 inch** and **180 feet** (45 feet/lateral × 4 laterals)

Manifold and main diameter and total length = **4 inch diameter and 42 feet long**

Volume drains through the holes (for laterals) = [Total laterals length (feet) × 0.1 gal/ft]

= 180 ft × 0.1 gal/ft = **18 gal**

Volumes drain back to the dosing tank (laterals + manifold + main)

= 18 gal (lateral volume) + [manifold and main length(feet) × 0.65 gal/ft]

= 18 gal + (42 ft × 0.65 gal/ft) = **45 gal**

Table 5. *Pipe volumes in gallons per foot of pipe (after Clemons, 1991).*

Per size, inches	Volume in gallons per foot of pipe
1	0.04
1 ¼	0.07
1 ½	0.10
2	0.17
2 ½	0.24
3	0.38
4	0.65

Selected Parameter

(25) Volume drains through the holes (for laterals): 18 gal

(26) Volumes drain back to the dosing tank (laterals + manifold + main): 45 gal

Step 15: Dose volume

Determine dose volume. Dose volume is 5 times the volume that will drain through the holes plus volumes drain back to the dosing tank calculated by volume of the delivery pipes.

Design Example

Dose volume = [volume that drains through holes (gal) × 5]
+ [volume that drains back to dosing tank(gal)]
= [18 gal × 5] + 45 gal
= **135 gal**

Selected Parameter

(27) Dose volume: 135 gal

Step 16: Size of dosing chamber

Check the size of the dosing tank. The minimum size of the dosing tank may be calculated by storage volume resulting from placement of the pump with concrete block, sum of the dose volume, and one-day emergency storage volume in case of pump failure.

Design Example

Size of dosing chamber = storage space volume resulting from placement of the pump with concrete block and pipes (0.5 ft height)
+ sum of the dose volume
+ one-day emergency storage volume (360 gal)

= (based on tank dimension)
+ 135 gal
+ 360 gal
+ (based on tank dimension)
≈ **500 gal is enough**

Selected Parameter

(28) Size of dosing chamber: 500 gal

How to control and supply power of pump

The purpose of the dosing system is to pump a predetermined volume of septic tank effluent from the dosing tank to the mound. The pump must be turned on when enough septic tank effluent collects in the tank, and shut off when the effluent remaining keeps the pump submerged. The pump is usually controlled by float switches suspended in the tank, as shown in Figure 16. A third switch is used to trigger an alarm when the effluent collected in the dosing tank reaches twice the dose amount (emergency level). The settings for the switches are determined based on the dosing volume and the size and geometry of the tank. The procedure for setting the levels for the controls is presented in step 17, along with an example.

Float switch versus timers to control pumps

Float switches, as described in this bulletin, are a good choice for household systems where water is used nearly every day throughout the day. They are easy to install and inspect.

Electronic control panels are now available with timers to equalize flow to the mound throughout the day. Timers are a good choice for commercial systems that experience days with high flows over a few hours combined with days with extremely low flows. Dose tank sizing must be adjusted to store the high flows to be dosed to the mound over an extended period.

Step 17: Control switches setting

Simple float switches can signal the pump and alarm controls. The on switch is needed to turn the pump on and a second switch is placed below it to turn the pump off (Figure 16). The distance between the pump on and pump off switches yields the dose volume. The distance needed between the two switches depends on the size and shape of the dose tank. Sometimes a combination switch is used where the swing of the switch dictates the on and off level.

The gallons per inch in a circular tank (Figure 14(a)) can be determined by:

$$\frac{\pi}{4}(\text{Diameter (inches)})^2 \times \frac{1\text{ gal}}{231\text{ in}^3} = \frac{\text{Diameter (inches)} \times \text{Diameter (inches)}}{294} = \text{gal per inch of depth}$$

The gallons per inch a rectangular tank (Figure 14 (b)) can be determined by:

$$\text{Width (inches)} \times \text{Length (inches)} \times \frac{1\text{ gal}}{231\text{ in}^3} = \text{gal per inch of depth}$$

Design Example

The gallons per inch in a 72-inch diameter circular tank

$$= \frac{72\text{ inches} \times 72\text{ inches}}{294} = 17.7\text{ gal/inch}$$

$$\frac{\text{dose volume}}{\text{gal per inch}} = \text{switch separation}$$

$$\frac{135\text{ gal}}{17.7\text{ gal/inch}} = 8\text{ inches}$$

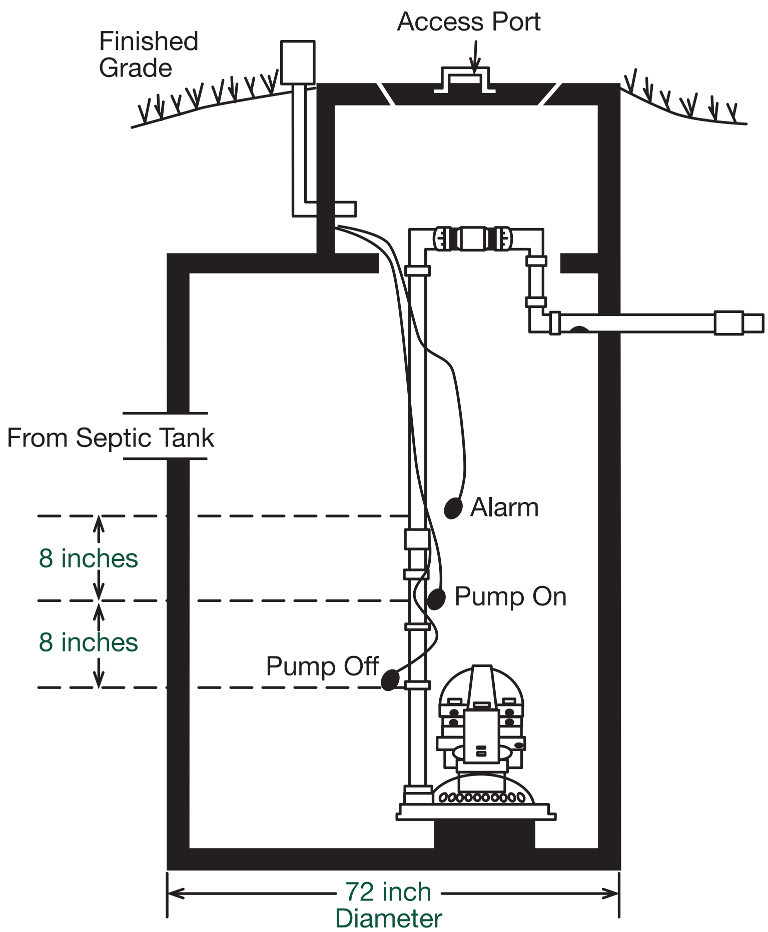


Figure 16. Water level controls used in dosing tank.

Selected Parameter

(29) Tank shape: Circular

(30) Tank diameter: 72 inch

(31) Switch separation: 8 inch

Electrical Power Supply and Controls

All wastewater distribution systems that utilize a pump require electrical power and control systems. Proper wiring materials and installation procedures are critical to the safety of the installer, sewage system user and all individuals involved in future repairs and maintenance. Adequate wiring ensures reliable pump and system performance. Follow a few basic guidelines to ensure safe and reliable operation at a reasonable cost. In all cases, installation procedures must follow the specifications of the National Electric Code or any other prevailing code. Contact local electrical inspection authorities for permits and inspection requirements. Work should be done by a qualified electrical installer.

Types of Materials for Outdoor Wiring

Electrically, there is no difference between wiring inside or outside a building. However, the materials and installation procedures are considerably different. Outdoor wiring must be able to withstand exposure to water, weather and corrosive environments. This is certainly the case for wiring septic system dosing tanks. While there are several types of systems for outdoor and underground wiring, based on what materials are used, each has specific applications.

Boxes and Panels

Outdoor equipment used in residential wiring must be weatherproof. The two most common types of weatherproof equipment are driptight and watertight. Driptight equipment seals against water falling vertically. Driptight boxes are usually used for control or circuit breaker panels. Watertight boxes seal against water coming from any direction. Individual junction boxes, switch boxes and receptacle boxes will usually be of the watertight type.

Driptight boxes are usually made of painted sheet metal and have shrouds or shields that deflect rain falling from above. An example of a driptight unit is shown in Figure 17. These boxes are not waterproof and should not be used where water can spray or splash on the unit.

Watertight boxes are designed to withstand temporary immersion or spray streams from any direction. They are commonly made of cast aluminum, zinc-dipped iron, bronze or heavy plastic and have threaded entries for watertight fittings and gasketed covers.

Be aware that the National Electric Code requirements state that all ground level outlets must be ground-fault circuit interrupter (GFCI) protected. Figure 18 shows a watertight switch box and receptacle.

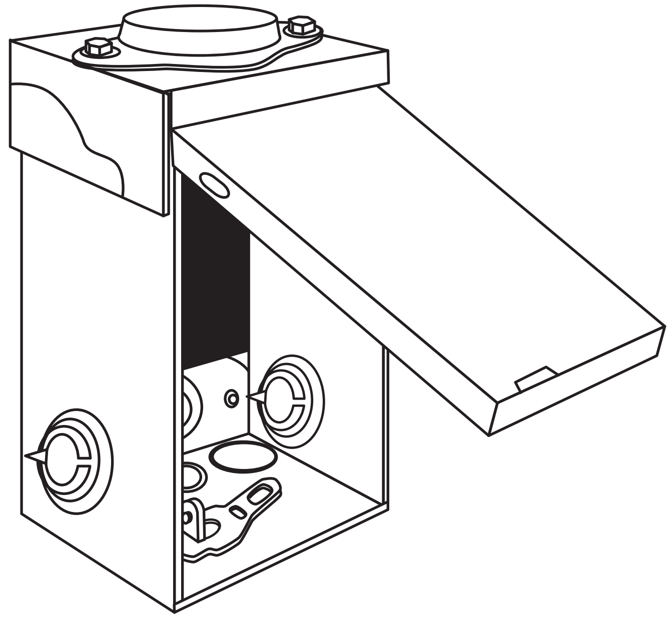


Figure 17. Weatherproof box (driptight) for outdoor wiring.

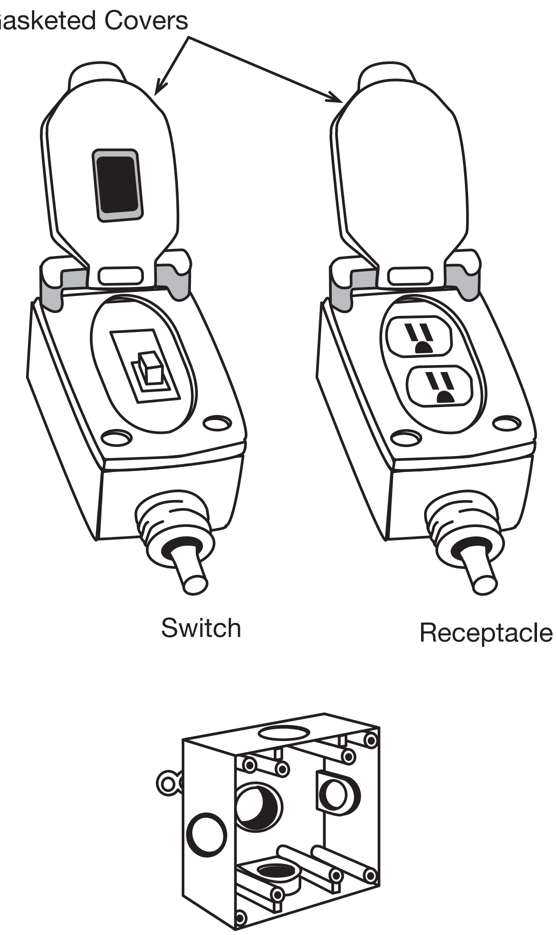


Figure 18. Weatherproof boxes (watertight) for wet locations.

Wiring Materials

Two different methods, or a combination of the two, are common in outdoor wiring. One method is to place electrical wires inside a conduit. The other is to use cable. In either case, protection from physical damage, water and corrosion must be provided. Both approaches are illustrated in Figure 19.

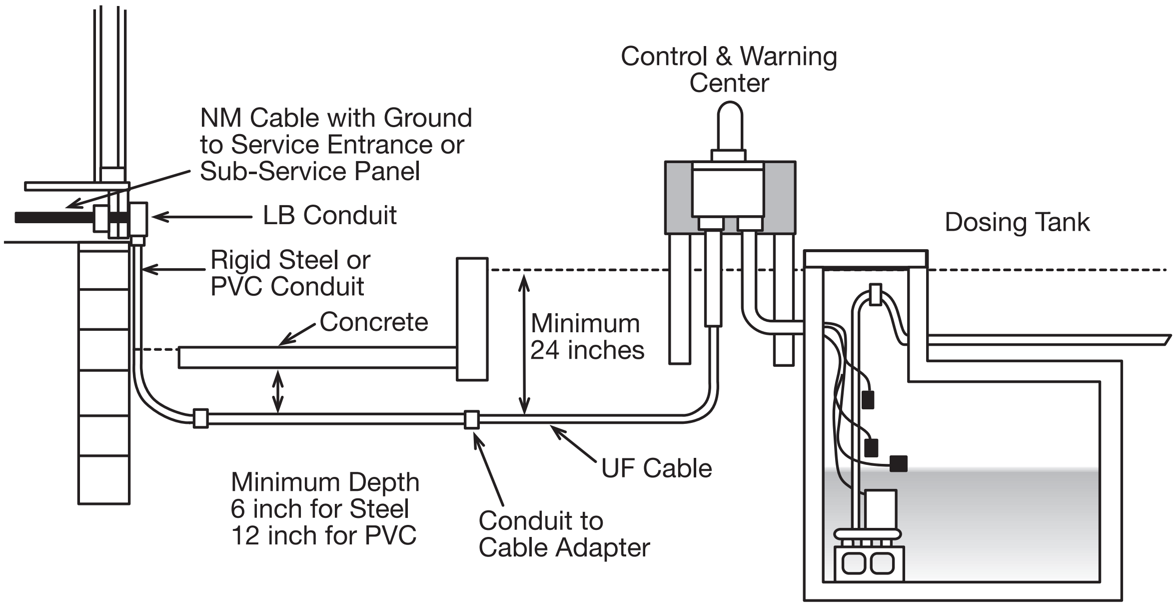


Figure 19. Power and control system for onsite wastewater system.

Running wire through sealed conduit provides physical, water and corrosion protection. Several kinds of conduit are acceptable for outdoor use. Rigid metal conduit made from aluminum or steel provides equivalent wire protection. However, aluminum conduit is not acceptable for installation where it is directly in contact with soil. Rigid PVC conduit made from polyvinyl chloride can be used above ground. High-density polyethylene conduit is suitable for underground installation. Do not use thinwall conduit (EMT) for underground or outdoor installation.

An underground feeder (UF) cable (Figure 20) can be buried without conduit protection. Physical protection for underground cable is highly recommended to reduce the risk of spading through the cable at a later time. A redwood board buried just above the cable is highly recommended to provide physical protection. Do not use nonmetallic (NM) cable (Figure 20) for underground installations. While it is an excellent material for interior wiring, it will not withstand the moisture conditions in the soil.

Combining the conduit and cable wiring methods is also an option. Conduit can be used around cable for physical protection. Conduit is particularly useful to protect cables where they enter and exit the soil. If conduit and cable are used in combination, as shown in Figure 19, appropriate connectors and bushings are needed for transitions from one system to the other. Minimum burial requirements apply to wire in conduit and cables. Table 6 lists the National Electric Code requirements for each type of installation.

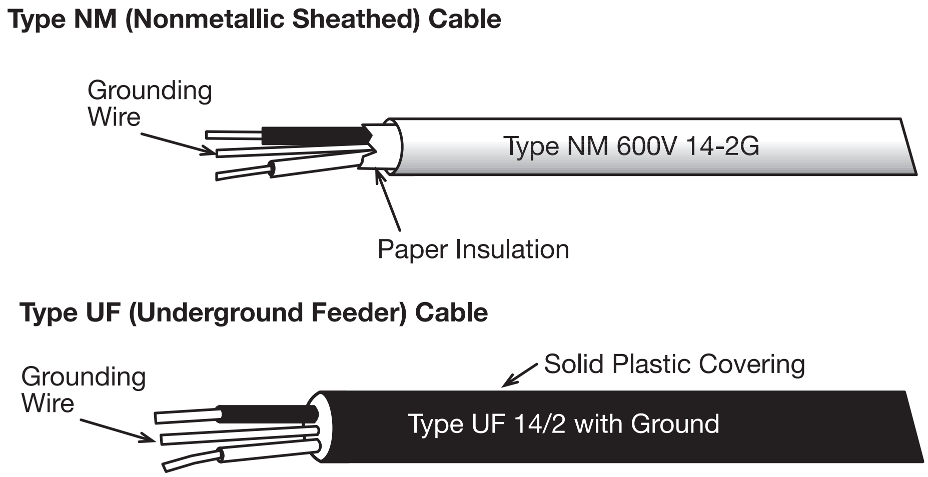


Figure 20. Example electrical cable types.

Table 6. *Required burial depths for branch circuits (after 2005 National Electric Code, Section 300.5).*

	Cable	Rigid Metal Conduit	Non-Metallic Conduit
Directly in soil	24 in.	6 in.	18 in.
Under residential drive	18 in.	18 in.	18 in.
Under 4 in concrete slab no vehicle traffic	18 in.	4 in.	4 in.

Control Switches for Pump

Control switches sense the water level in the dosing tank and signal the pump or alarm system. A failure of the control switches can cause sewage to back up into the home or come out the top of the dosing tank. Follow some simple guidelines to avoid control problems.

First, select the appropriate switches. Mercury float switches encased in plastic or neoprene are recommended. In Figure 21, one switch is used to start and stop the pump. In Figure 22, one switch is used to start and a different switch is used to stop the pump. In both cases, a separate switch is used to activate the alarm system if the liquid level rises too high in the tank. Some switches handle power to the pump directly, while others require a relay.

Second, if possible, make no electrical connections inside the dosing tank. This includes plug-ins, screw-type, twisted wire, boxes, relays or any other type of connection that requires movement to connect or operate. If connections or splices must be made, they should be located in a watertight, corrosion resistant junction box with watertight, corrosion-resistant fittings and a gasketed cover.

An alarm system is used to alert the homeowner to a pump malfunction by means of an audible and/or visual signal. Therefore, the alarm system must be powered in such a way that if the pump circuit fails the alarm will still operate. Provide a means to turn off the alarm without losing power to the pump.

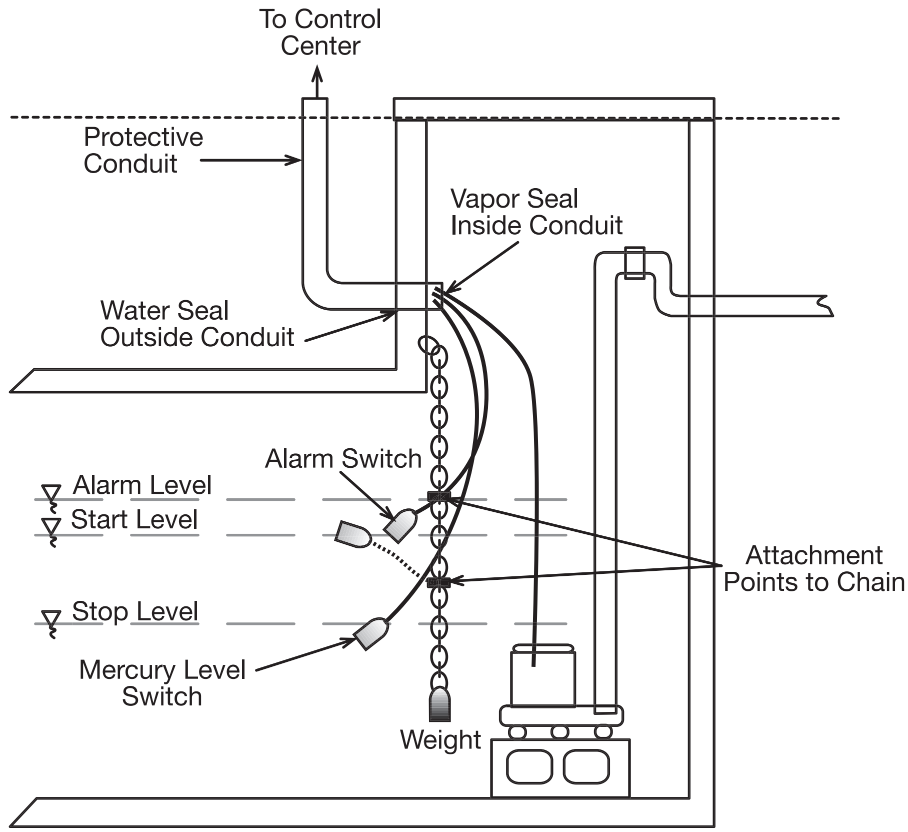


Figure 21. Two-switch control system for dosing tank.

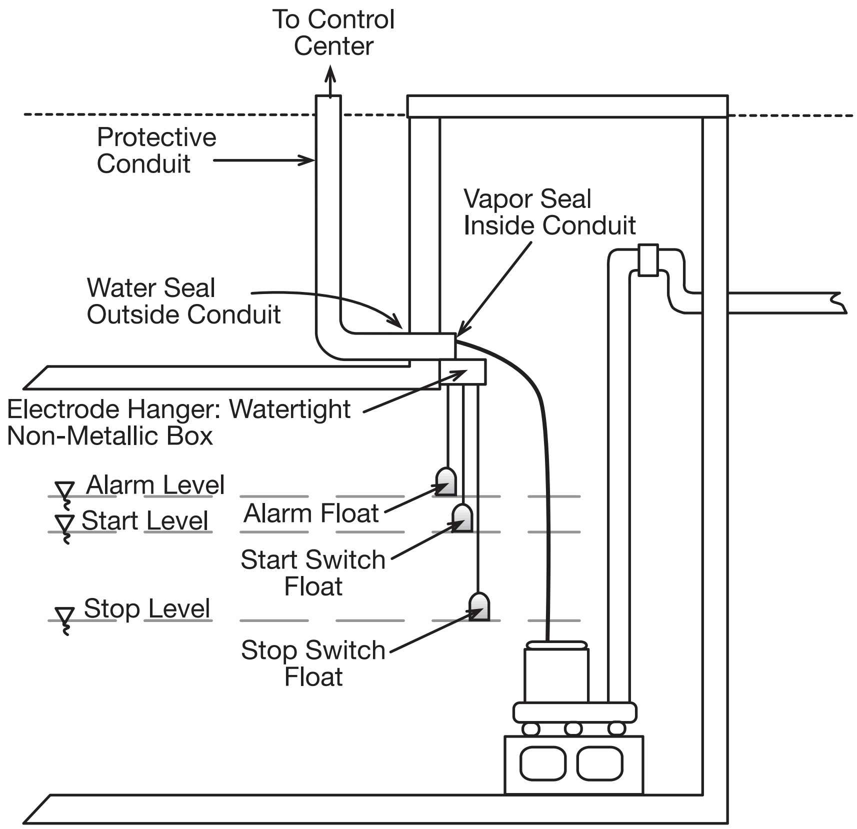


Figure 22. Three-switch control system for dosing tank.

Pump and Alarm Control Center

The cables that connect to the pump control switch, alarm switch and pump all originate from the pump and alarm control center. The center should either be inside a weatherproof box or on a post near the entrance port to the dosing tank. Locating the control and alarm center inside a nearby building (such as a basement or garage) is also acceptable, however access for service and inspection may be less convenient. Never place the control system inside the dosing tank or access passageway. The moisture in the dosing tank will cause the system to corrode and fail.

Locate the control center in a weatherproof enclosure mounted to a treated wood or steel post near the entrance to the dosing tank. A typical outdoor pump and alarm control centers are shown in Figure 23. It is important to use wire, connectors and weatherproof enclosures appropriate for outdoor use.

A pump motor relay with built-in motor overcurrent protection is shown in Figure 23. The pump motor start and stop switches control the relay coil current. Conduit is shown for physical protection of the conductors and cables entering and leaving the box.

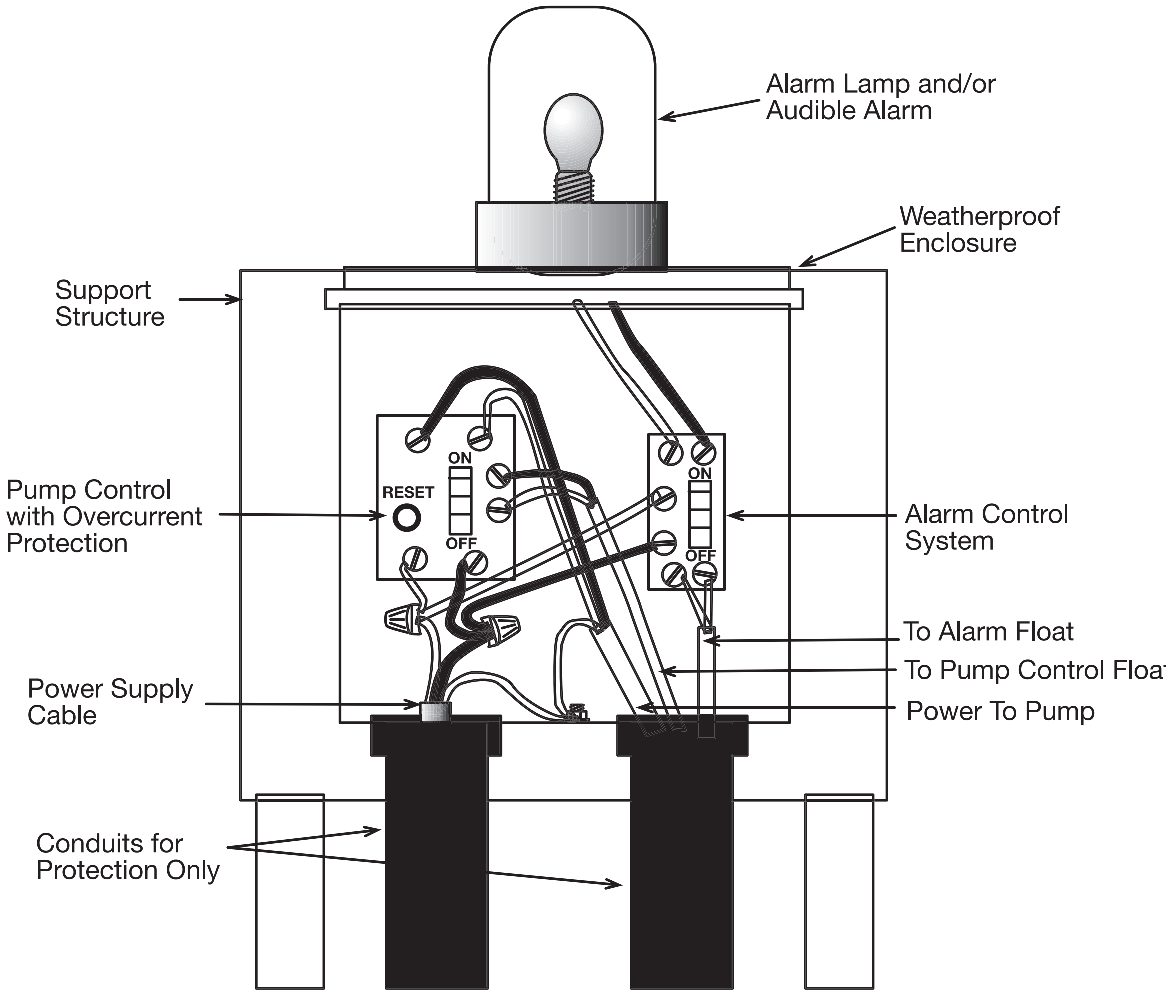


Figure 23. Outdoor control center with built-in pump control.

Wiring from the pump and alarm control center to the pump and switches

The power cable to the pump and float switch cables running from the control center into the tank should be run in conduit (metal or PVC) where physical protection is needed. The area around the conduit entering the tank should be sealed to prevent surface water from entering the tank through the conduit, as shown in Figure 23. If the conduit provides a continuous connection between the control center box and the tank, the conduit entrance to the box should be plugged with high quality electrical putty to prevent the movement of moisture and corrosive gases into the control box. Power cables used in these installations, such as Type SE, SJ or SOW, must be suitable for moist and corrosive environments. The power cable to the pump must have a grounding conductor (usually a green insulated wire) to ground the pump motor frame. Metallic conduit should not be used for equipment grounding to or within the tank. Since the pump is considered a motor load, it must have appropriate disconnecting means. The disconnect for units of 1 horsepower or greater (circuit breaker or switch) must be clearly marked and in sight of the pump location or lockable. This prevents inadvertent reactivation of the circuit during servicing of the unit. Under certain circumstances, for large pumps or long distances to the power source, 240 volt equipment may be desirable.

Power supply to the pump and alarm system control center

Power to the pump and alarm system control center, when located outside a building, will most frequently be supplied by an underground branch circuit from a nearby service entrance or sub-panel. Follow electrical code specifications for materials and burial depths as described earlier. Avoid routing buried wiring through existing or anticipated gardens or landscaping areas to minimize the chances of damage due to spading.

Power to the control center should be from a single individual branch circuit with no other loads. The circuit breaker or fuse supplying this circuit should be clearly marked at the service entrance location.

Maintaining pressure distribution system

Monitoring and maintenance for the pressure distribution system is required after operation.

- Collect baseline pressure head when system is new
- Check and clean the effluent filter in septic tank to keep small debris from clogging holes in pipes
- Look for water leaks into system
- Activate float and alarm switches every 6 months
- Flush lines every 6 months
- Conduct pressure test every 6 months
    - Pressure too high – clogging (Figure 24(a))
    - Pressure too low – leaks, breaks or pump wear (Figure 24(b))

If clogging becomes severe, clean laterals with a brush on a plumbing snake. If cleaning is not effective, lateral pipes may need to be replaced. By placing laterals in 4-inch shielding pipe, they can be cut at the manifold, slid out at the turn up and a new pipe can be slid in and glued into place.

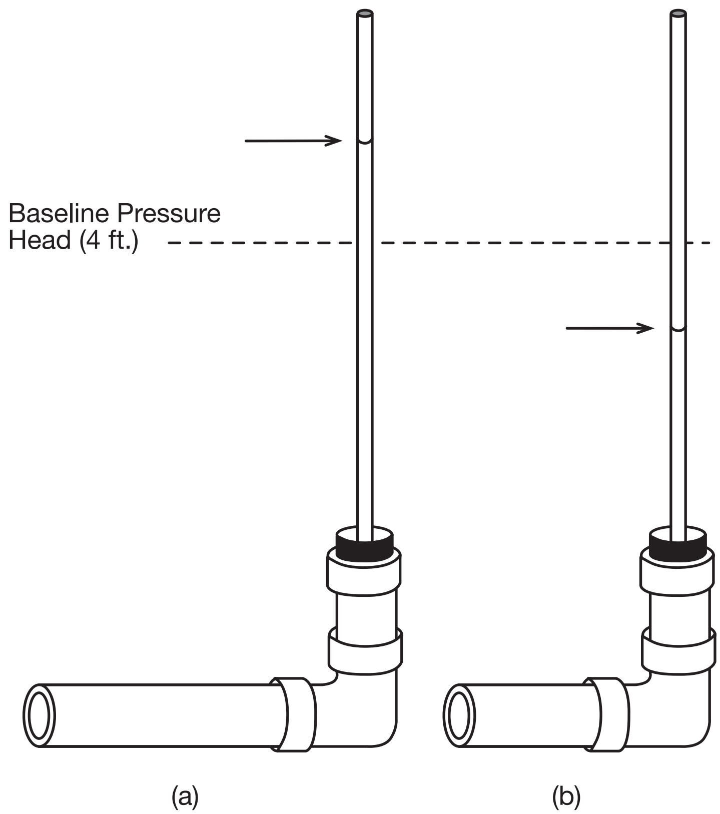


Figure 24. Pressure tests with clogging(a) and leaks(b) in the mound system.

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Summary of pressure distribution design

Investigation of soil suitability and information for household

↓

Step 1: Distribution area configuration
(Length and width)

↓

Steps 2-5: Lateral design
(Length, distance, size, hole numbers and space, head and flow rate)

↓

Steps 6-7: Manifold and main design
(Pipe size and length, connection method and system flow rate)

↓

Steps 8-12: Configuration of mains and total dynamic head
(TDH)

↓

Step 13: Pump selection by GPM/TDH

↓

Steps 14-16: Dosing chamber design
(Pipe volume, dose volume, and size of dosing chamber)

↓

Step 17: Pump installation in dosing tank with level switch
(Configuration of dosing chamber and installation of switch)

↓

Electrical system

Pressure distribution design worksheet

1. Information for household	
Bedrooms	
Persons	
Estimated daily wastewater flow	gal/day
2. Distribution area configuration	
Width of distribution area	ft
Length of distribution area	ft
3. Lateral design	
Length of lateral	ft
Distance between laterals	ft
Total numbers of laterals	
Manifold type	
Hole diameter	inch
Total number of holes in distribution area	
Number of holes per lateral	
Hole spacing in laterals	ft
Lateral diameter	inch
Head at end of lateral	ft
Flow rate per hole	gal/min
Flow rate per lateral	gal/min
4. Manifold and main design	
Connection between the manifold and lateral	
Connection between the main and manifold	
Length of manifold	ft
Manifold diameter	inch
Main diameter	inch
System flow rate (GPM)	gal/min
5. Configuration of mains	
Static lift	ft
Head losses in main and fittings	ft
Network loss	ft
Total dynamic head (TDH)	ft

6. Pump selection by GPM/TDH	
Pump capacity	
7. Dosing chamber design	
Volume drains through the holes (for laterals)	gal
Volumes drain back to the dosing tank (laterals + manifold + main)	gal
Dose volume	gal
Size of dosing chamber	gal
8. Pump installation in dosing tank with level switch	
Tank shape	
Tank diameter	inch
Switch separation	inch