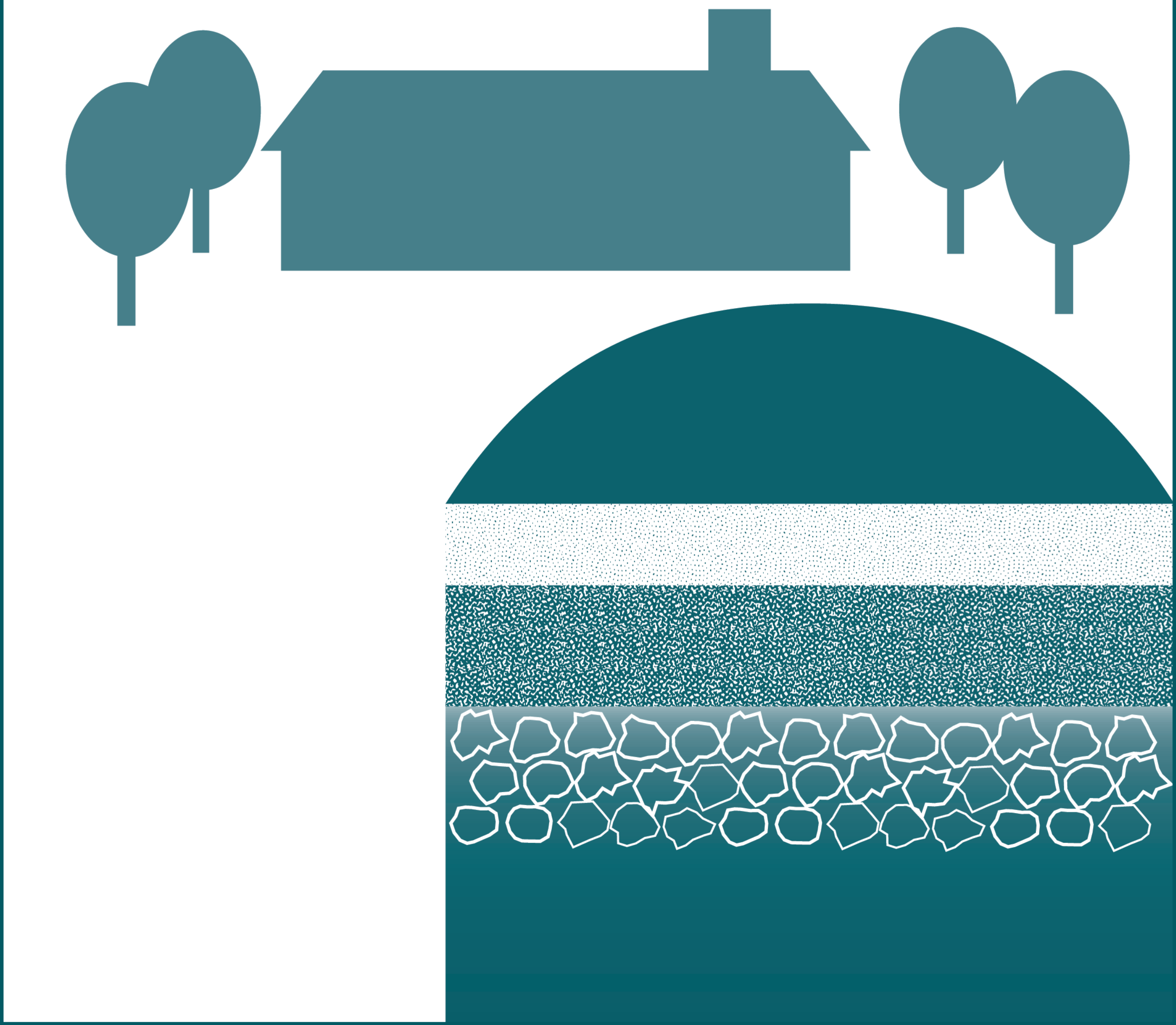
OHIO STATE UNIVERSITY EXTENSION

Bulletin 813

Mound Systems for Onsite Wastewater Treatment

Siting, Design and Construction in Ohio



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Mound Systems for Onsite Wastewater Treatment

Siting, Design and Construction in Ohio

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Based on: *Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual* by Professor James Converse, Biological Systems Engineering, and Professor E. Jerry Tyler, Soil Science, College of Agricultural and Life Sciences, University of Wisconsin-Madison.

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Bulletin 813

Mound Systems for Onsite Wastewater Treatment

Protecting public health and water quality is the goal of an onsite wastewater treatment system. Many treatment technologies are available to meet this goal. The selection of an appropriate technology is dictated by site and soil conditions. A mound system is one type of onsite treatment technology.

Ohio's current Household Sewage Disposal Systems regulations (OAC 3701-29) set minimum soil depth for onsite wastewater treatment. An assessment of soil depth throughout Ohio is presented in Ohio State University Extension Bulletin 896, *Suitability of Ohio Soils for Treating Wastewater*. Deep, permeable soils suitable for leach field systems represent only 16% of Ohio's land area. Soil with depths of 1–3 feet are suitable for mound systems and are present on more than 53% of Ohio's land area. Figure 1 illustrates the mound system in relation to ground surface and limiting conditions.

Many mound systems have been installed and are operating in Ohio. Ohio's Household Sewage Disposal Systems regulations (OAC 3701-29) contain minimum standards for mound systems.

This bulletin describes the procedures for siting, design, construction, management and maintenance of mound systems. In conjunction with this publication, two other OSU Extension bulletins should be used in siting and designing a mound system:

- Bulletin 829, *Mound System: Pressure Distribution of Wastewater—Design and Construction in Ohio*
- Bulletin 905, *Soil and Site Evaluation for Onsite Wastewater Treatment*

The bulletins mentioned above, including Bulletin 896, are available for purchase through your local OSU Extension office or from CFAES Publications at **estore.osu-extension.org**.

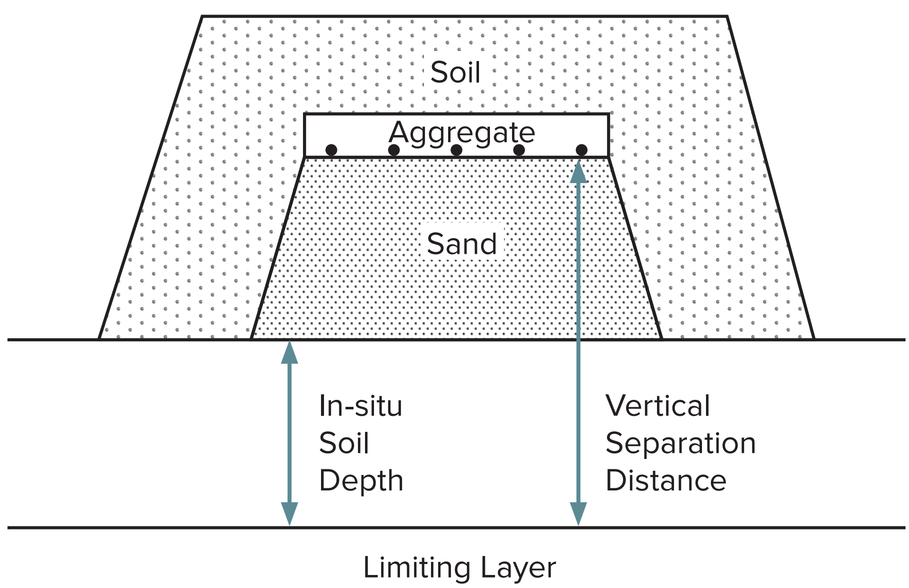


Figure 1. Cross section of mound system in relation to ground surface and limiting conditions (after Converse and Tyler, 1990, Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual, *University of Wisconsin-Madison).*

Where Should Mound Systems Be Used in Ohio?

A mound system is constructed with sand placed on top of natural, in-situ soil. Treatment occurs as the wastewater flows over biofilms that colonize the sand and the soil aggregates as shown in Figure 2. The sand and soil depths added together are considered the vertical separation distance (VSD). Mound systems can be used in areas of Ohio with seasonal high water tables, shallow depths to a restrictive soil layer or bedrock. A minimum depth of unsaturated and permeable soil is a prerequisite for a mound system. Table 1 lists the minimum soil depths required for different limiting conditions for mound systems. The table also presents the minimum vertical separation distance.

Table 1. Depth of in-situ soil to limiting condition and vertical separation distance (VSD) for mound systems.

Limiting Condition	In-situ Soil Depth (inches)	Vertical Separation Distance (inches)
Fractured/Karst Bedrock	12	36
Ground water or aquifer	12	36
Highly weathered soils on the low lime till plains	12*	24
Other limiting conditions	12*	18

*Note: Under Ohio's Household Sewage Disposal Systems regulations, 8 inches are permitted. However, Ohio State research shows pathogen removal requires at least 12 inches of unsaturated soil. Application of undisinfected wastewater to very shallow soil is not recommended.

A mound system must be positioned in the landscape along the contour of the lot. Separation distances of 50 feet from drinking wells and 10 feet from property lines are required for the mound system, as shown in Figure 3. Mounds are long and narrow to insure that wastewater can infiltrate the soil beneath and move away from the mound without surfacing. Ideally the mound should be as long and narrow as possible along the contour, but no shorter than is prescribed for the design linear loading rate. Constructing a mound shorter and wider than recommended will result in surfacing of partially treated wastewater.

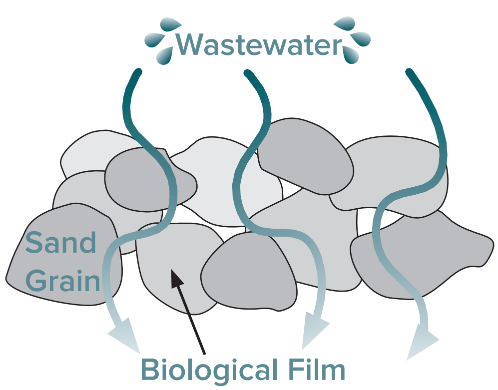


Figure 2. Wastewater flows over biofilms.

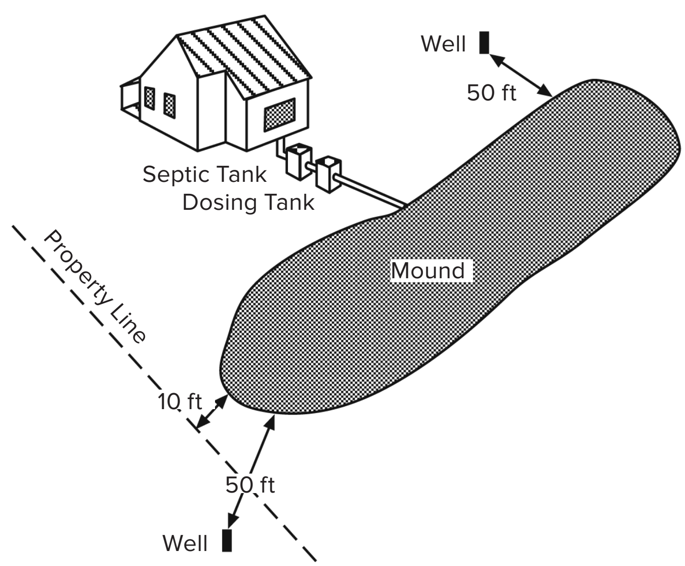


Figure 3. Separation distances for a mound system.

What Are the Components of a Mound System?

The most important component of a mound system is the natural, in-situ soil on the site. A layer of sand placed on top of the soil treats the wastewater to remove pollutants. Soil of at least 12 inches in depth removes pathogens from the wastewater to protect the public health. Therefore, the sand and soil work together to treat and disinfect the wastewater before it enters groundwater.

A mound system consists of a septic tank, a dosing tank, distribution pipes and a mound, as shown in Figure 4. The septic tank allows the solids in wastewater to settle and degrade. The septic effluent is filtered by an effluent filter and discharged to a dosing tank. The dosing tank is equipped with a pump to deliver the septic tank effluent through the distribution system to the mound. The distribution system normally consists of small diameter pipes and allows for even wastewater application under low pressure on the mound.

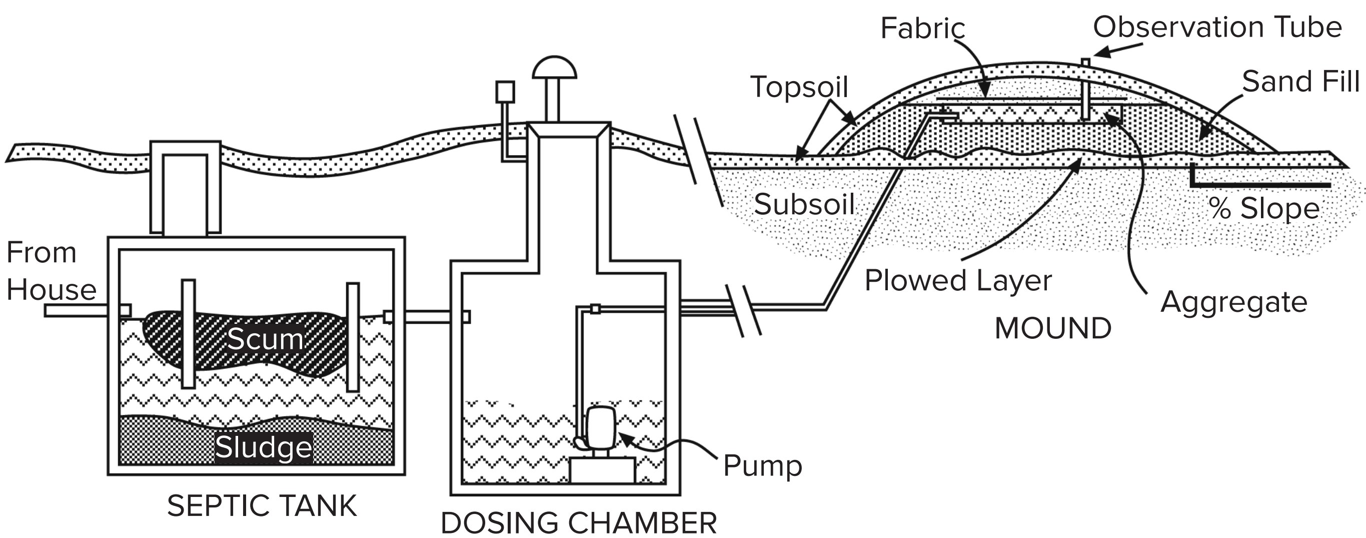


Figure 4. Schematic of a mound system (after Converse and Tyler, 1990).

How Are Mound Systems Designed?

Designing the mound component is described here in a 15-step process. The wastewater distribution design steps are described in OSU Extension Bulletin 829, *Mound System: Pressure Distribution of Wastewater—Design and Construction in Ohio*. The configuration of the mound is based on the volume of the wastewater to be treated, the characteristics of the natural soil and the depth to the limiting condition.

The following pages describe the design process and work through an example of a system for a three-bedroom home.

Mound System Design Example

Step 1. Evaluate Site Location for Mound System

A mound system is proposed for treatment and disposal of domestic wastewater for a three-bedroom residence. On a site that meets the recommended soil and site criteria, establish the contour of the lot and mound area. Stake out the mound so that the absorption bed runs parallel to the contour. Mounds must be on the contour to maintain constant mound height and to ensure even distribution of effluent. Mound systems should be installed 50 feet or more from existing wells, and more than 10 feet from the property line. Paint lines between stakes in case stakes are disturbed.

A summary of the soil and site information is given below. Confirm the described soil and site description prior to designing a mound system for the site.

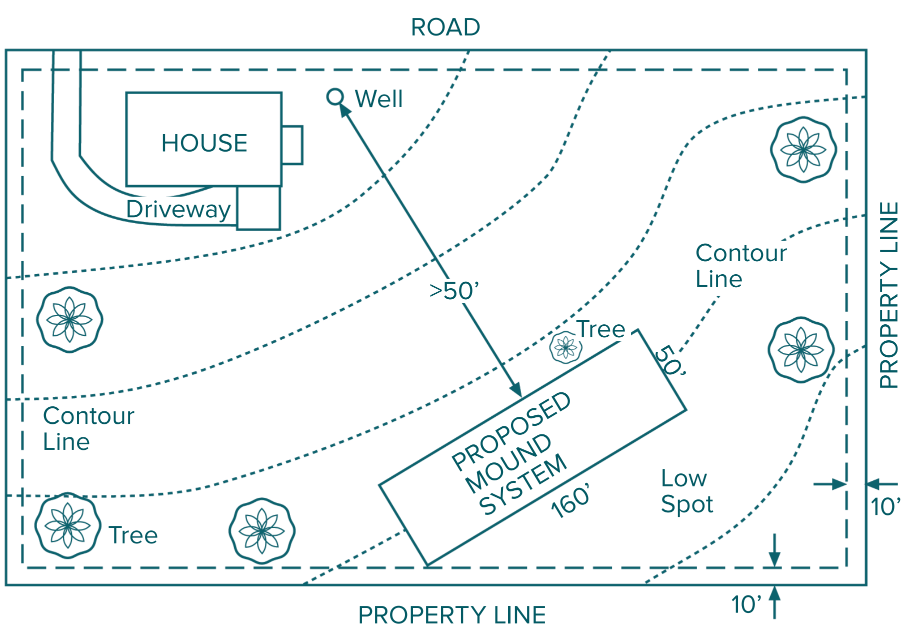
1. Soil Profile (summary of three soil excavations based on shallowest values):

- *a. 0–10 inches: silt loam texture; moderate (grade 2) granular to blocky structure; friable consistence*
- *b. 10–26 inches:* ***silty clay loam*** *texture; moderate (grade 2) blocky structure; friable consistence*
- *c. 26 inches: fractured bedrock*

2. Site slope is 12%.

3. The area available is 160 feet along the contour, and 50 feet along the slope. Three medium-sized trees are in the mound area.

4. Depth to liming condition is 26 inches due to bedrock creating a restrictive layer.



Step 2. Determine Design Wastewater Loading Rate

The design daily wastewater volume, based on Ohio's Household Sewage Disposal Systems regulations (OAC 3701-29), is 120 gallons/bedroom/day.

Newly constructed mound system to serve three-bedroom house.

Design Wastewater Loading Rate:

For a three-bedroom residence, design wastewater loading rate is:

120 gallons/day/bedroom x 3 bedrooms = 360 gallons/day (gpd)

Step 3. Select Linear Loading Rate

Selection of the linear loading rate is a very important step in designing a mound system. The linear loading rate determines the length of the mound along the contour, and it controls the landscape hydraulic loading. Based on the soil and site evaluation conducted by a qualified professional and in accordance with OSU Extension Bulletin 905, *Soil and Site Evaluation for Onsite Wastewater Treatment*, identify the nature of the limiting condition. For sites with a limiting condition from 12 to 24 inches, use Table 2 to select a linear loading rate. For deeper soils, the nature of the limiting condition can allow for shorter systems. Figure 5 shows how the treated effluent moves away from a mound system with different limiting conditions. For sites with water tables or restrictive soil layers, use Table 3 for the linear loading rate. Since the treated wastewater can move vertically through semipermeable layers, use Table 4 for sites with compacted glacial till. For sites with very permeable sand and gravel or fractured bedrock use Table 5.

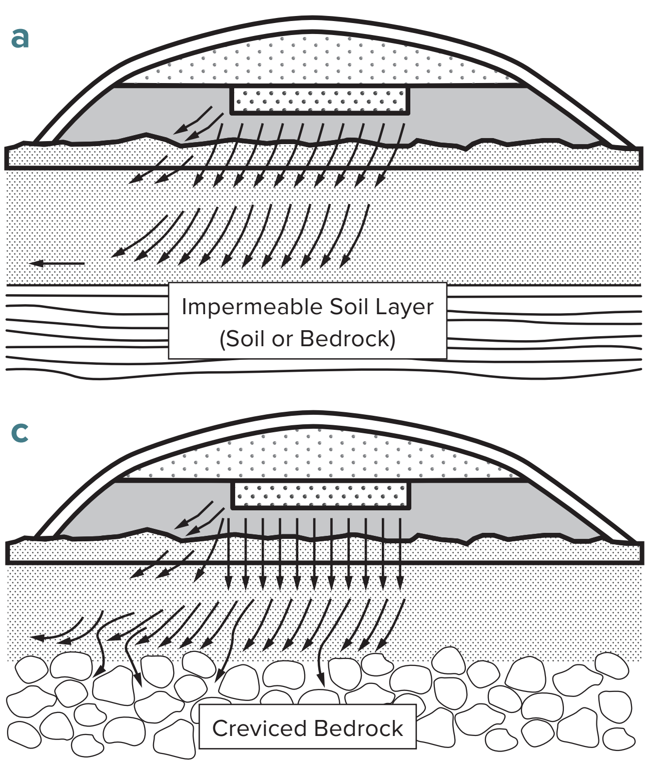


Figure 5. Effluent movement within and away from the mound system under four types of soil profiles (after Converse and Tyler, 1990).

Linear Loading Rate:

The soil evaluation revealed a limiting condition of fractured bedrock at a depth of 26 inches on a 12% slope. Also in the profile is silty, clay loam. Use Table 5 to determine the linear loading rate for the soil characteristics at the most restrictive layer. For silty, clay loam with blocky structure and grade 2 consistence, use a linear loading rate of 7 gals/day/linear foot.

Table 2. For 12–24 inches of infiltration distance to a limiting condition, use the hydraulic linear loading rates to match the most restrictive soil in the profile for the given landscape slope.

SOIL CHARACTERISTICS			HYDRAULIC LINEAR LOADING RATE (GPD/FT)		
Texture	Structure		Infiltrative Distance (12–24 inches)		
	Shape	Grade	Slope 0%–4%	Slope 5%–9%	Slope >10%
Coarse Sand, Sand, Loam Coarse Sand, Loam Sand (COS, S, LCOS, LS)	--	0SG	5.0	6.0	7.0
Fine Sand, Very Find Sand, Loam Find Sand, Loam Very Find Sand (FS, VFS, LFS, LVFS)	--	0SG	4.5	5.0	6.0
Clay Sandy Loam, Sandy Loam (CSL,SL)	--	0M	3.5	4.1	6.0
	Platy (PL)	1	3.5	4.1	5.0
		2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	4.5	5.0	6.0
		2,3	4.5	5.0	6.0
Fine Sandy Loam, Very Fine Sandy Loam (FSL, VFSL)	--	0M	2.3	2.7	3.2
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	3.5	3.8	4.1
		2,3	3.8	4.1	4.4
Loam (L)	--	0M	2.3	2.7	3.2
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	3.5	3.8	4.1
		2,3	3.8	4.1	4.4
Silt Loam (SIL)	--	0M	2.5	2.7	2.9
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	2.7	3.0	3.5
		2,3	3.0	3.5	3.8
Sandy Clay Loam, Clay Loam, Silty Clay Loam (SCL, CL, SICL)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	2.5	2.7	2.9
		2,3	2.9	3.0	3.5
Sandy Clay, Clay, Silty Clay (SC, C, SIC)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1			
		2,3	2.5	2.7	2.9

Table 3. For seasonal water table, solid rock or impermeable soil layers as limiting conditions, 24–48 inches beneath the infiltrative surface, use the hydraulic linear loading rates to match the most restrictive soil in the profile at the landscape slope.

SOIL CHARACTERISTICS			HYDRAULIC LINEAR LOADING RATE (GPD/FT)		
Texture	Structure		Infiltrative Distance (24–48 inches)		
	Shape	Grade	Slope 0%–4%	Slope 5%–9%	Slope >10%
Coarse Sand, Sand, Loam Coarse Sand, Loam Sand (COS, S, LCOS, LS)	--	0SG	6.0	7.0	8.0
Fine Sand, Very Find Sand, Loam Find Sand, Loam Very Find Sand (FS, VFS, LFS, LVFS)	--	0SG	5.5	6.0	7.0
Clay Sandy Loam, Sandy Loam (CSL,SL)	--	0M	4.0	4.6	7.0
	Platy (PL)	1	4.0	4.6	6.0
		2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	5.5	6.0	7.0
		2,3	5.5	6.0	7.0
Fine Sandy Loam, Very Fine Sandy Loam (FSL, VFSL)	--	0M	2.6	3.0	3.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	4.0	4.3	4.6
		2,3	4.3	4.6	4.9
Loam (L)	--	0M	2.6	3.0	3.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	4.0	4.3	4.6
		2,3	4.3	4.6	4.9
Silt Loam (SIL)	--	0M	3.0	3.2	3.4
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	3.0	3.3	4.0
		2,3	3.3	4.0	4.3
Sandy Clay Loam, Clay Loam, Silty Clay Loam (SCL, CL, SICL)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	3.0	3.2	3.4
		2,3	3.4	3.3	4.0
Sandy Clay, Clay, Silty Clay (SC, C, SIC)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1			
		2,3	3.0	3.2	3.4

Table 4. For semipermeable soil layers and fractured compacted till as limiting conditions, greater than 24 inches beneath the infiltrative surface, use the hydraulic linear loading rates to match the most restrictive soil in the profile at the landscape slope.

SOIL CHARACTERISTICS			HYDRAULIC LINEAR LOADING RATE (GPD/FT)		
Texture	Structure		Infiltrative Distance (>24inches)		
	Shape	Grade	Slope 0%–4%	Slope 5%–9%	Slope >10%
Coarse Sand, Sand, Loam Coarse Sand, Loam Sand (COS, S, LCOS, LS)	--	0SG	8.0	9.0	10.0
Fine Sand, Very Find Sand, Loam Find Sand, Loam Very Find Sand (FS, VFS, LFS, LVFS)	--	0SG	7.5	8.0	9.0
Clay Sandy Loam, Sandy Loam (CSL,SL)	--	0M	6.0	6.6	9.0
	Platy (PL)	1	6.0	6.6	8.0
		2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	7.5	8.0	9.0
		2,3	7.5	8.0	9.0
Fine Sandy Loam, Very Fine Sandy Loam (FSL, VFSL)	--	0M	4.6	5.0	5.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	6.0	6.3	6.6
		2,3	6.3	6.6	6.9
Loam (L)	--	0M	4.6	5.0	5.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	6.0	6.3	6.6
		2,3	6.3	6.6	6.9
Silt Loam (SIL)	--	0M	5.0	5.2	5.4
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	5.0	5.3	6.0
		2,3	5.3	6.0	6.3
Sandy Clay Loam, Clay Loam, Silty Clay Loam (SCL, CL, SICL)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	5.0	5.2	5.4
		2,3	5.4	5.3	6.0
Sandy Clay, Clay, Silty Clay (SC, C, SIC)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1			
		2,3	5.0	5.2	5.4

Table 5. For fractured bedrock and sand and gravel layers* as a limiting condition greater than 24 inches beneath the infiltrative surface, use the hydraulic linear loading rates to match the most restrictive soil in the profile at the landscape slope.

SOIL CHARACTERISTICS			HYDRAULIC LINEAR LOADING RATE (GPD/FT)		
Texture	Structure		Infiltrative Distance (24–48 inches)		
	Shape	Grade	Slope 0%–4%	Slope 5%–9%	Slope >10%
Coarse Sand, Sand, Loam Coarse Sand, Loam Sand (COS, S, LCOS, LS)	--	0SG	9.0	10.0	11.0
Fine Sand, Very Find Sand, Loam Find Sand, Loam Very Find Sand (FS, VFS, LFS, LVFS)	--	0SG	8.5	9.0	10.0
Clay Sandy Loam, Sandy Loam (CSL,SL)	--	0M	7.0	7.6	10.0
	Platy (PL)	1	7.0	7.6	9.0
		2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	8.5	9.0	10.0
		2,3	8.5	9.0	10.0
Fine Sandy Loam, Very Fine Sandy Loam (FSL, VFSL)	--	0M	5.6	6.0	6.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	7.0	7.3	7.6
		2,3	7.3	7.6	7.9
Loam (L)	--	0M	5.6	6.0	6.7
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	7.0	7.3	7.6
		2,3	7.3	7.6	7.9
Silt Loam (SIL)	--	0M	6.0	6.2	6.4
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	6.0	6.3	7.0
		2,3	6.3	7.0	7.3
Sandy Clay Loam, Clay Loam, Silty Clay Loam (SCL, CL, SICL)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1	6.0	6.2	6.4
		2,3	6.4	6.3	7.0
Sandy Clay, Clay, Silty Clay (SC, C, SIC)	--	0M			
	Platy (PL)	1,2,3			
	Prismatic/Blocky/Granular (PR/BK/GR)	1			
		2,3	6.0	6.2	6.4

*Highly permeable material does not count as a part of the vertical separation distance.

Step 4. Select Sand Fill Loading Rate

The selection of sand fill material is critical to the long-term performance of the mound system. The purpose of the sand fill is to accept effluent from the distribution system and partially treat the wastewater before infiltration in to natural soil. A suitable sand is one that can be loaded at a reasonable rate and will provide satisfactory treatment. Generally, the finer the sand the better the treatment and the slower the wastewater infiltration into the absorption bed. Too coarse a sand will allow effluent to pass through the mound with little removal of impurities. Too fine a sand cannot be loaded at an acceptable rate and may cause severe clogging of the sand, which results in failure of the mound system.

Following the USDA Soil Textural Classification, a coarse sand is suitable. However, this is subject to the following two conditions: (1) no more than 20% by weight is gravel (>2 mm), and (2) no more than 5% by weight is silt and clay (<0.053 mm). Request a sieve analysis report on a proposed sand from the aggregate supplier to check these criteria.

Concrete sand is produced by many sand and gravel quarries in Ohio and generally meets the criteria for the very coarse and very fine fractions. The fine aggregate specified by the Ohio Department of Transportation will meet the mound sand requirements.

The specification is detailed in Section 703.02 of Aggregate for Portland Cement Concrete, Office of Construction Administration, 2002 Construction and Material Specifications. Although mason sand is also commonly available, it is a finer sand than concrete sand and is not recommended. Limestone sand is not suited although it may meet size requirements. Limestone sand can dissolve over time, reducing the system's useful life.

Sand specifications are also given in terms of effective size and uniformity coefficient. When using these criteria, select a sand with an effective size in the range of 0.15–0.30 mm, and with a uniformity coefficient of less than 6. For more infromation on sand analysis, see OSU Extension fact sheet AEX-757, *Sand Size Analysis for Onsite Wastewater Treatment Systems*.

When using a sand that meets the guidelines above, the recommended design **sand fill loading rate is 1.0 gpd/ft^2** if the wastewater is typical domestic septic tank effluent. If the effluent is from a commercial establishment, the wastewater quality should be evaluated and the sand fill loading rate should be adjusted accordingly. When treating higher strength wastewater, the sand fill loading rate should be reduced, or use pretreatment to achieve a waste strength comparable to domestic effluent prior to distribution to the sand fill material.

Sand Fill Loading Rate:

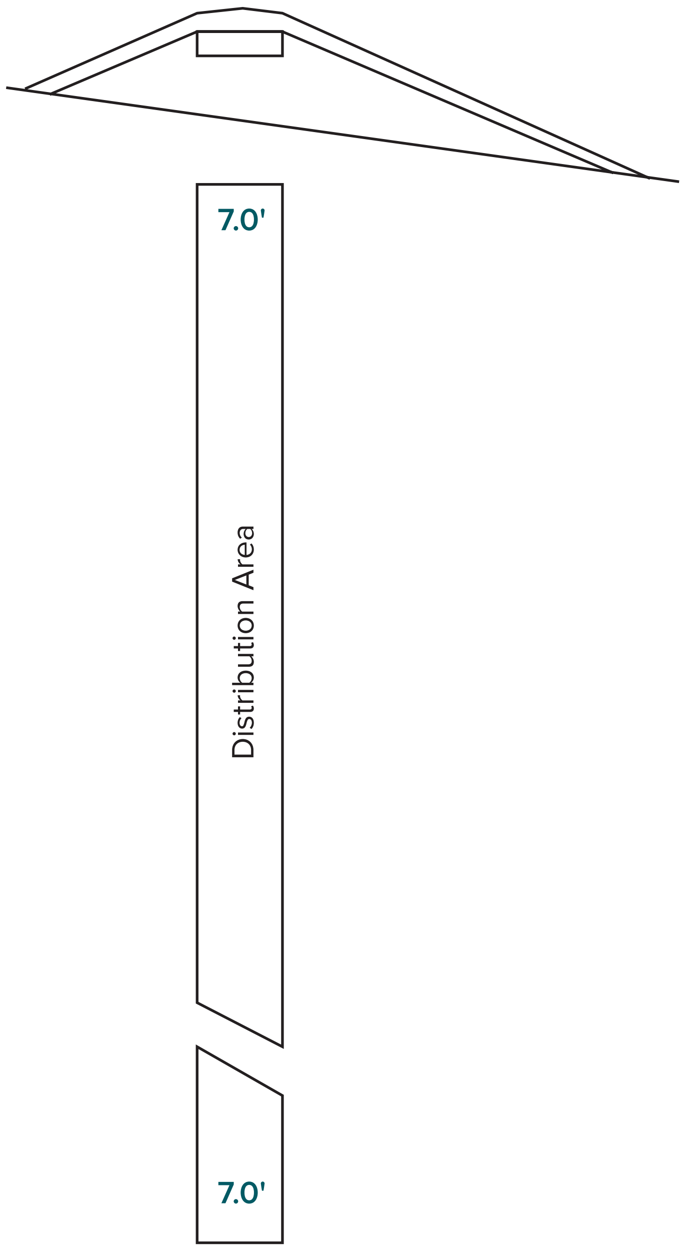
Sand Fill Loading Rate = 1.0 gpd/ft^2

Step 5. Determine Distribution Area Width

Distribution Area Width = (Linear Loading Rate)/(Sand Fill Loading Rate)

Side View

Top View



Distribution Area Width:

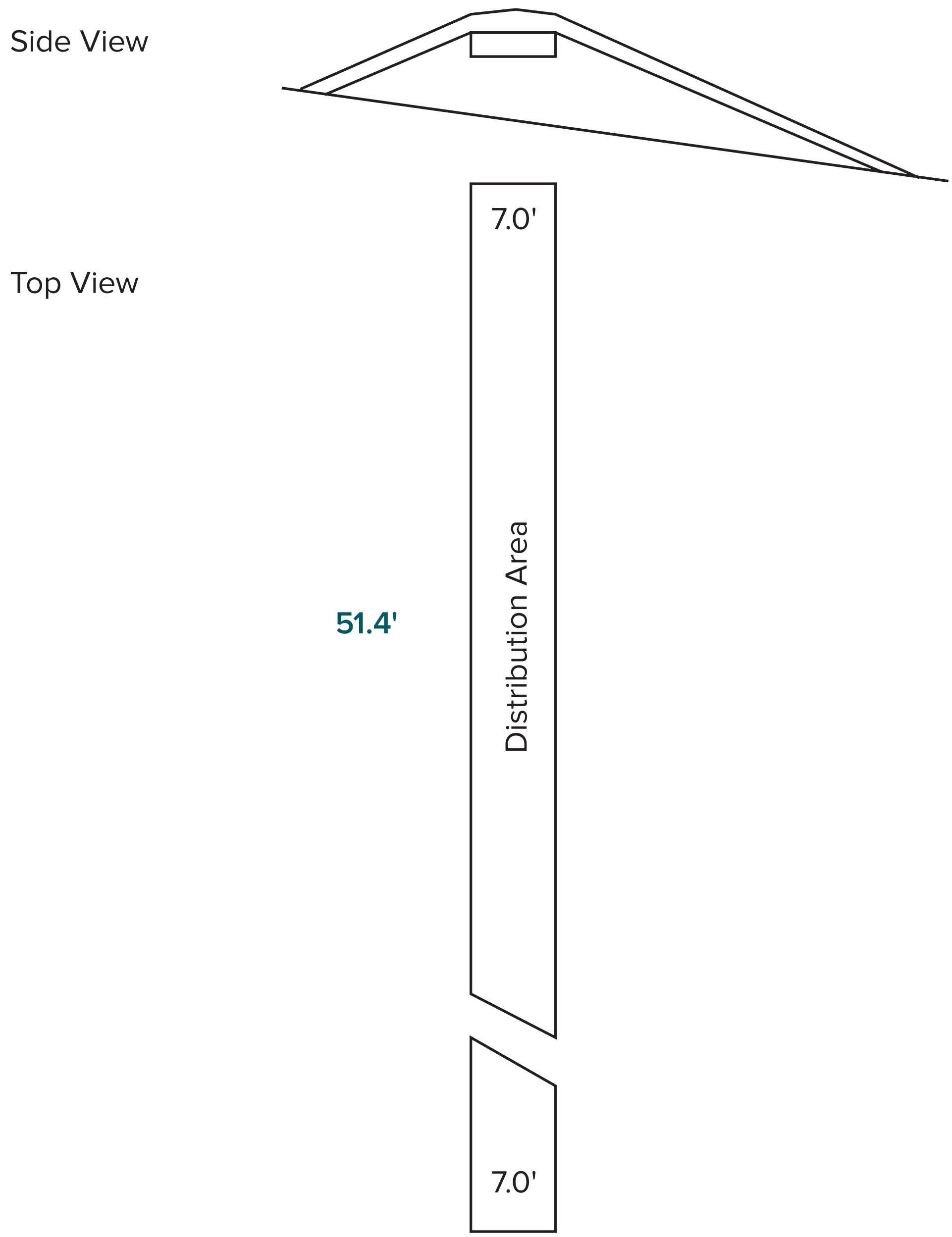
Distribution Area Width = (Linear Loading Rate) / (Sand Fill Loading Rate)

= (7.0 gpd/ft) / (1.0 gpd/ft^2)

= 7.0 ft

Step 6. Determine Distribution Area Length

Distribution Area Length = (Design Wastewater Loading Rate)/(Linear Loading Rate)



Distribution Area Length:

Distribution Area Length = (Design Wastewater Loading Rate) / (Linear Loading Rate)

= (360 gpd) / (7 gpd/ft)

= 51.4 ft

Step 7. Select Soil Infiltration Loading Rate

The wastewater moves down through the sand layer by gravity. When the sand-treated septic tank effluent reaches the sand/soil interface, it cannot move as quickly into the soil. The wastewater begins to spread out in the downslope direction. The area that the wastewater spreads out on the sand/soil interface is called the soil infiltration area. It is necessary to use the soil infiltration loading rate to determine the size of the soil infiltration area. The nature of the top 6 inches of the surface soil horizon determines the soil infiltration loading rate from Table 6. Use the least permeable layer of soil in the top 6 inches.

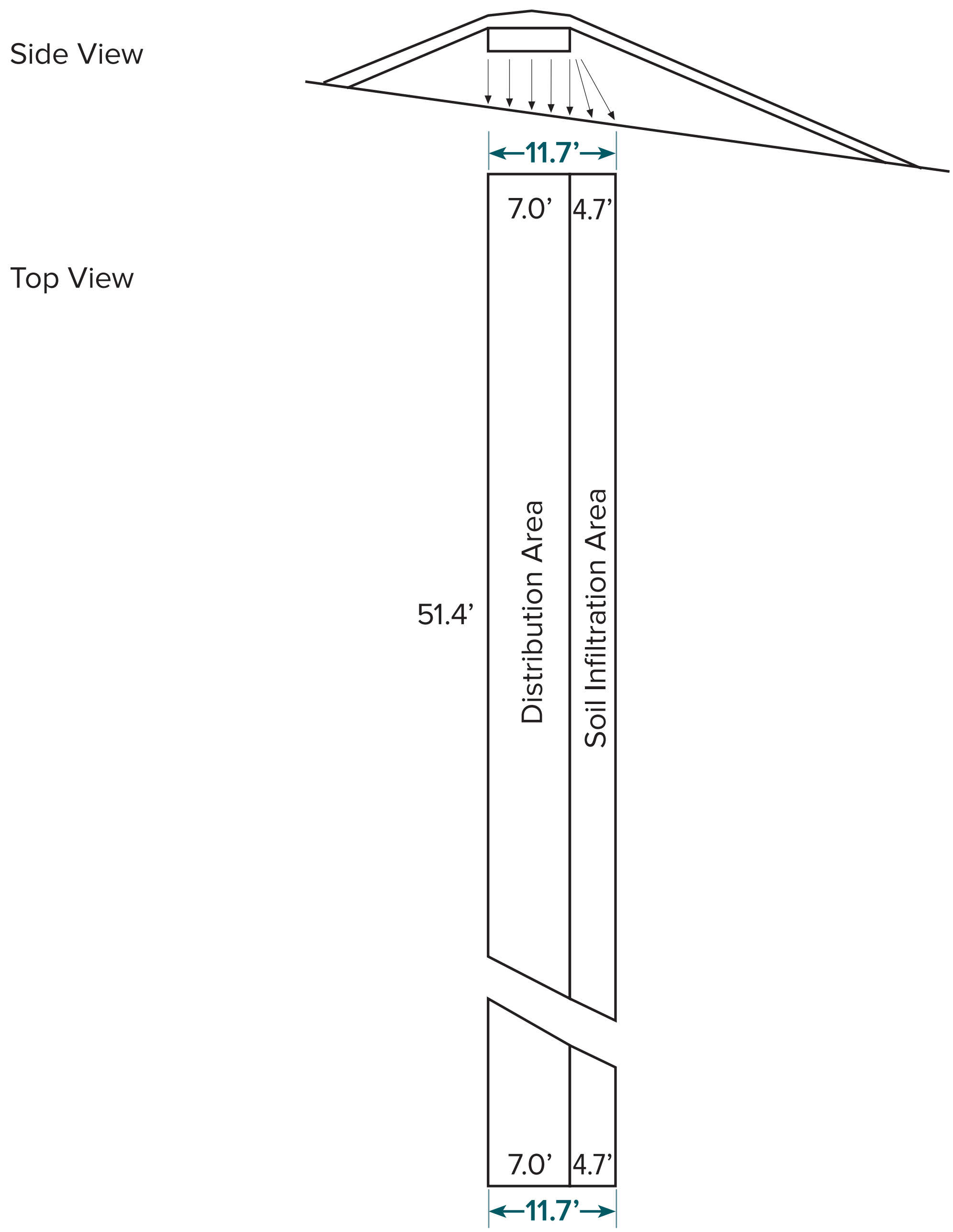
Table 6. Soil infiltration loading rates.

SOIL CHARACTERISTICS			SOIL INFILTRATION LOADING RATE (GPD/FT^2)
Texture	Structure		$CBOD_5$
	Shape	Grade	>25mg/L (septic tank effluent)
Coarse Sand, Sand, Loam Coarse Sand, Loam Sand (COS, S, LCOS, LS)	--	0SG	0.8
Fine Sand, Very Find Sand, Loam Find Sand, Loam Very Find Sand (FS, VFS, LFS, LVFS)	--	0SG	0.4
Clay Sandy Loam, Sandy Loam (CSL,SL)	--	0M	0.2
	Platy (PL)	1	0.2
		2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0.4
		2,3	0.6
Fine Sandy Loam, Very Fine Sandy Loam (FSL, VFSL)	--	0M	0.2
	Platy (PL)	1,2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0.2
		2,3	0.4
Loam (L)	--	0M	0.2
	Platy (PL)	1,2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0.4
		2,3	0.6
Silt Loam (SIL)	--	0M	0
	Platy (PL)	1,2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0.4
		2,3	**0.6**
Sandy Clay Loam, Clay Loam, Silty Clay Loam (SCL, CL, SICL)	--	0M	0
	Platy (PL)	1,2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0.2
		2,3	0.4
Sandy Clay, Clay, Sandy Loam Clay (SC, C, SIC)	--	0M	0
	Platy (PL)	1,2,3	0
	Prismatic/Blocky/Granular (PR/BK/GR)	1	0
		2,3	0.2

Step 8. Determine Soil Infiltration Area Width

Infiltration Area Width = (Linear Loading Rate/Soil Infiltration Loading Rate)

The infiltration area width should be outlined on the site and protected from construction traffic and equipment. (Note: The infiltration area width is normally less than the mound side widths, which are required to provide a mound side slope no steeper than 3:1.)



Soil Infiltration Loading Rate:

The soil evaluation revealed silt loam with blocky structure and grade 2 consistence. From Table 6, use a soil infiltration loading rate of 0.6 gal/day/ft^2.

Soil Infiltration Area Width:

Infiltration Area Width = (Linear Loading Rate) / (Soil Infiltration Loading Rate)

= (7.0 gpd/ft) / (0.6 gpd/ft^2)

= 11.7 ft

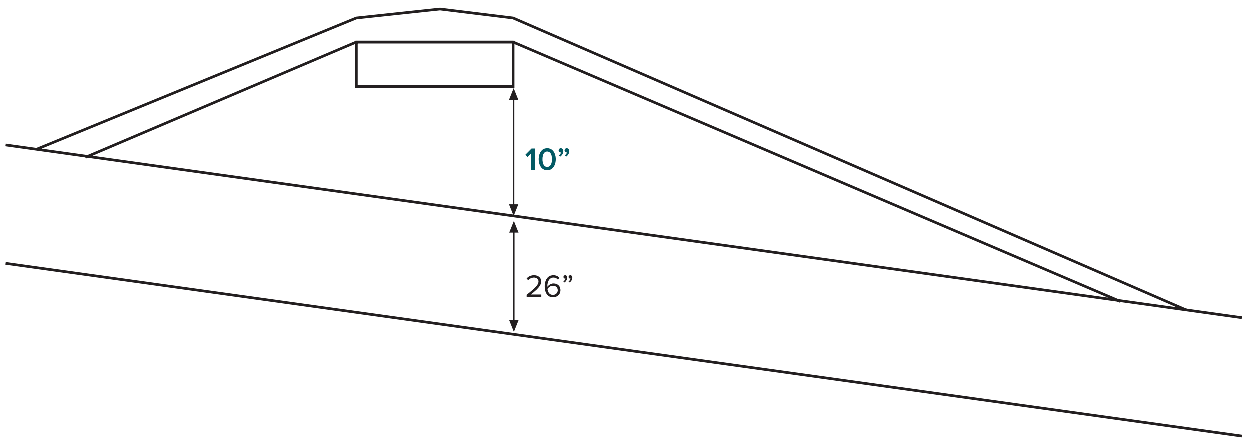
The infiltration area width is 11.7 - 7.0 = 4.7 feet wider than the distribution area width.

Step 9. Determine Mound System Sand Fill Upslope Depth

Ohio's Household Sewage Disposal Systems regulations require a minimum vertical separation distance based on the risk to public health. Mound systems treating septic tank effluent must have a minimum of 6 inches of sand depth. Soils over fractured bedrock present the highest risk for well water contamination. Isolated homes present a low risk of contaminating neighbors' wells. Minimum vertical separation distances for mound systems range from 18 to 36 inches.

$$\text{Mound Sand Fill Upslope Depth} = \left(\text{Minimum Vertical Separation Distance}\right) - \left(\text{Depth of Suitable Soil to Limiting Condition}\right)$$

Side View



Mound Sand Fill Upslope Depth:

$$\text{Mound Sand Fill Upslope Depth} = \left(\text{Minimum Vertical Separation Distance}\right) - \left(\text{Depth of Suitable Soil to Limiting Condition}\right)$$

= 36 inches - 26 inches

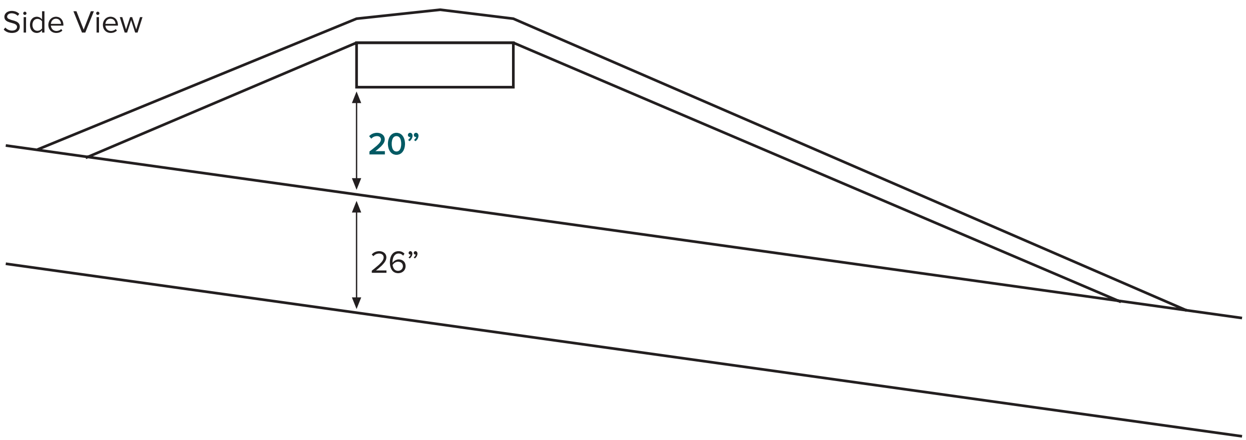
= 10 inches

Step 10. Determine Mound System Sand Fill Downslope Depth

The bottom of the distribution area must be constructed level. Therefore, the sand fill will be deeper on the downslope side of the distribution area.

$$\text{Mound Sand Fill Downslope Depth} = \left(\text{Mound Sand Fill Upslope Depth}\right) + [(\text{Site Slope}) * (\text{Distribution Width})]$$

Side View



Mound Sand Fill Downslope Depth:

The site slope is 12% in this design example.

$$\text{Mound Sand Fill Downslope Depth} = \left(\text{Mound Sand Fill Upslope Depth}\right) + [(\text{Site Slope}) * (\text{Distribution Width})]$$

= (10 inches) + [(0.12) * (7.0 feet)]

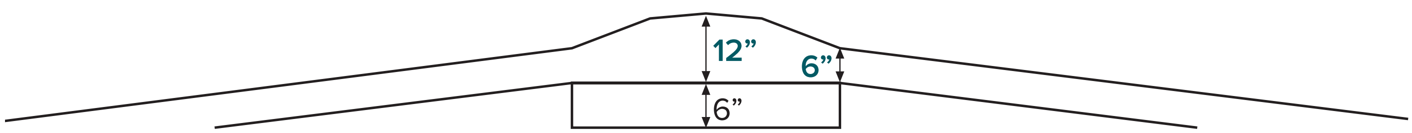
= (10 inches) + [(0.12) * (84.0 inches)] = 20.0 inches

Step 11. Distribution Area Aggregate Depth, Cover Depth and Mound Cap Depth

Clean, washed coarse aggregate protects the distribution system. At least 3 inches of aggregate is used as a base beneath the distribution laterals, and at least 1 inch of aggregate should cover the laterals. Therefore, the total aggregate depth should be 6 inches.

A distribution system cover of a 12-inch soil crown will help drain water from the top of the mound. The extra depth also provides additional frost protection.

To ensure proper mound system performance, 6 inches of settled soil cover is required for the mound side slope cap, providing frost and erosion protection. The soil cap can be one of the most expensive features among the construction materials. The preferred soil texture for the soil cap are sandy loam, loamy sand and silt loams. The soil must be adequate to support grass growth to prevent soil erosion. Clay subsoil may be amended with ⅓ compost peat or manure and ⅓ coarse sand to create a 6- to 12-inch cap suitable for grass growth. Do not compact the mound soil cap, because the microbial community treating wastewater in the mound and the grass growing on the mound need air. Natural settling of the soil cover and cap will occur over time.



Aggregate Depth in Distribution Area = 6 inches (3 inches of aggregate base, 2 inches for pipe depth and 1 inch aggregate above distribution system)

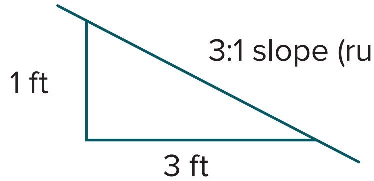
Distribution System Cover Depth = 12 inches

Mound Cap Depth = 6 inches

Step 12. Determine Upslope Width

The mound side slope should not be steeper than 3:1 (run:rise) for safe mowing as shown in Figure 6. Therefore, the mound footprint will be extended in all directions outside the distribution area.
The upslope width intersects the site slope. To adjust the upslope width, use an upslope width correction factor. The upslope width correction factor matches the percent slope of the lot. Upslope width correction factors are provided in Table 7 for various site slopes.

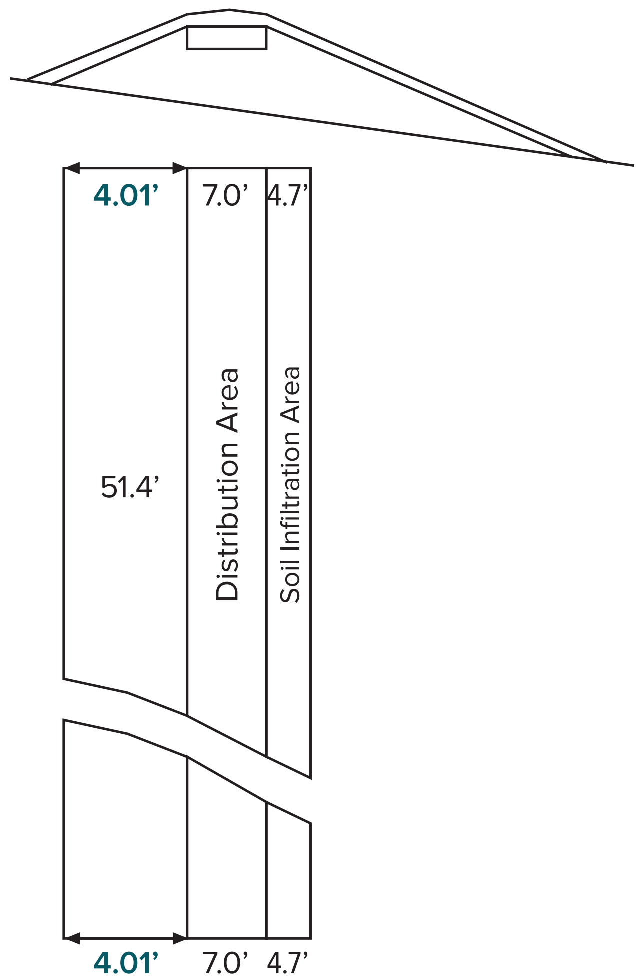
Figure 6. Mound side slope.



$$\text{Upslope Width} = 3 * \left(\begin{array}{l}\text{Mound sand fill}\\ \text{upslope depth}\end{array} + \begin{array}{l}\text{Aggregate}\\ \text{depth}\end{array} + \begin{array}{l}\text{Soil cover}\\ \text{depth}\end{array}\right) * \left(\begin{array}{l}\text{Upslope correction}\\ \text{factor}\end{array}\right)$$

Table 7. Upslope width correction factor.

% Slope for Site	Correction Factor
1	0.97
2	0.94
3	0.92
4	0.89
5	0.87
6	0.85
7	0.83
8	0.81
9	0.79
10	0.77
11	0.75
12	0.73
13	0.72
14	0.70
15	0.69



Upslope Width:

The recommended mound side slope is 3:1 in this design example and the lot slope is 12% while the corresponding upslope correction factor is 0.73.

$$\text{Upslope Width} = 3 * \left(\begin{array}{l}\text{Mound sand fill}\\ \text{upslope depth}\end{array} + \begin{array}{l}\text{Aggregate}\\ \text{depth}\end{array} + \begin{array}{l}\text{Soil cover}\\ \text{depth}\end{array}\right) * \left(\begin{array}{l}\text{Upslope correction}\\ \text{factor}\end{array}\right)$$

$$= (3) * (10 \text{ inches} + 6 \text{ inches} + 6 \text{ inches}) * (0.73)$$

$$= 48.18 \text{ inches}$$

$$= 4.01 \text{ ft}$$

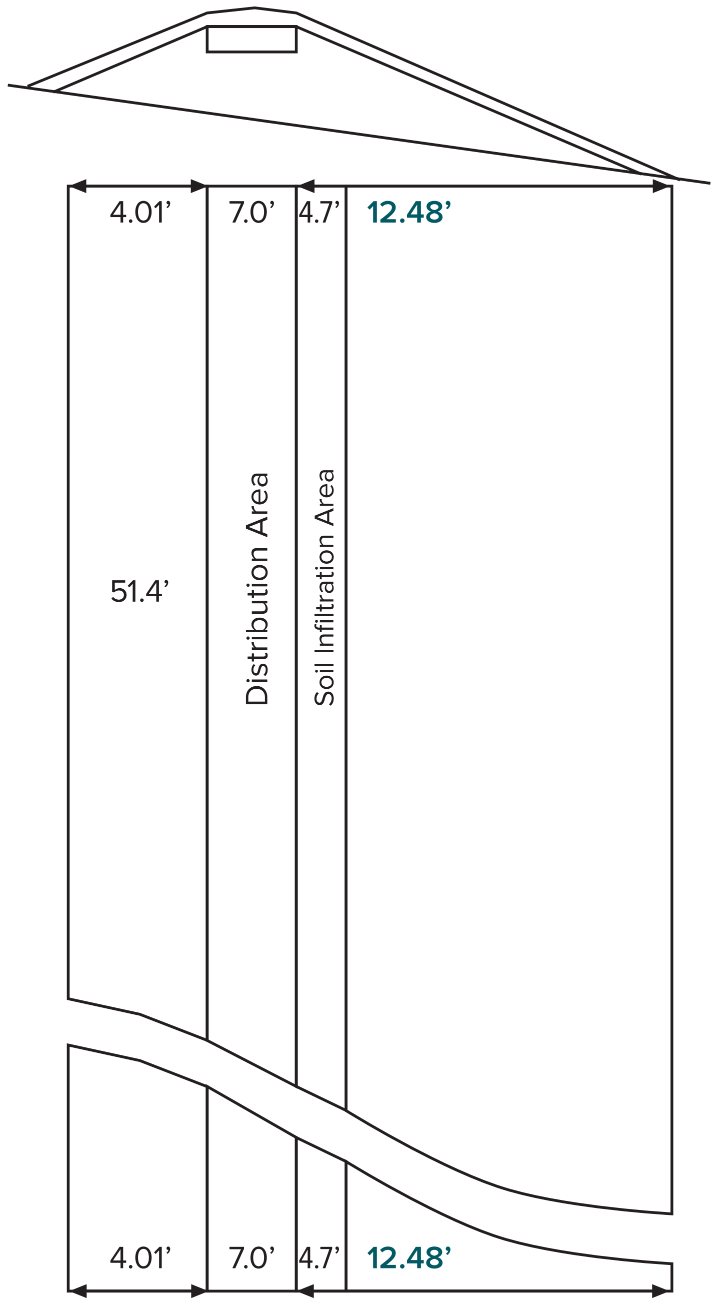
Step 13. Determine Downslope Width

The mound downslope side should also be no steeper than 3:1 (run:rise) for safe mowing. Since the site slopes away, a downslope width correction factor is required for the width adjustment. The downslope width correction factors are provided in Table 8 to match the % slope for the site.

$$\text{Downslope Width} = 3 * \left(\begin{array}{l}\text{Mound sand fill}\\\text{upslope depth}\end{array} + \begin{array}{l}\text{Aggregate}\\\text{depth}\end{array} + \begin{array}{l}\text{Soil cover}\\\text{depth}\end{array}\right) * \left(\begin{array}{l}\text{Downslope correction}\\\text{factor}\end{array}\right)$$

Table 8. Downslope width correction factor.

% Slope for Site	Correction Factor
1	1.03
2	1.06
3	1.10
4	1.14
5	1.18
6	1.22
7	1.27
8	1.32
9	1.37
10	1.43
11	1.49
12	1.56
13	1.64
14	1.72
15	1.82



Downslope Width:

The recommended mound side slope is 3:1 in this design example, and the lot slope is 12% while the corresponding downslope correction factor is 1.56.

$$\text{Downslope Width} = 3 * \left(\begin{array}{l}\text{Mound sand fill}\\\text{upslope depth}\end{array} + \begin{array}{l}\text{Aggregate}\\\text{depth}\end{array} + \begin{array}{l}\text{Soil cover}\\\text{depth}\end{array}\right) * \left(\begin{array}{l}\text{Downslope correction}\\\text{factor}\end{array}\right)$$

$= (3) * (20.0 \text{ inches} + 6 \text{ inches} + 6 \text{ inches}) * (1.56)$

$= 149.76$ inches

$= 12.48$ ft

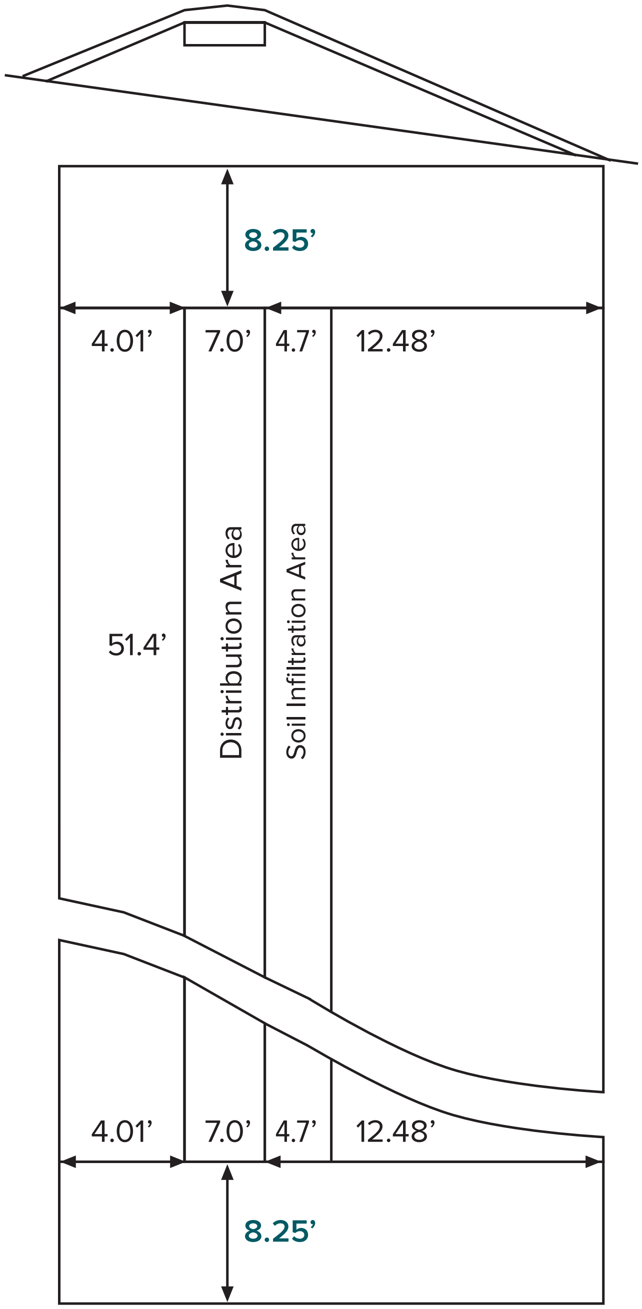
Step 14. Determine End Slope Length

The mound will slope off at both ends. By adding on the end slope length, the overall length of the finished mound can be outlined on the site. Be sure that design specifications require that all trees are cut off at the soil surface, but leave the roots undisturbed. If soil is mounded around the base of a tree, it will die.

End Slope Length = 3 * (Average depth of sand fill under absorption area + Aggregate depth + Mound cap depth)

Side View

Top View



End Slope Length:

The recommended mound side slope is 3:1 in this design example.

End Slope Length = 3 * (Average depth of sand fill under absorption area + Aggregate depth + Mound cap depth)

= (3) * [(10+20) / 2 inches + 6 inches + 12 inches]

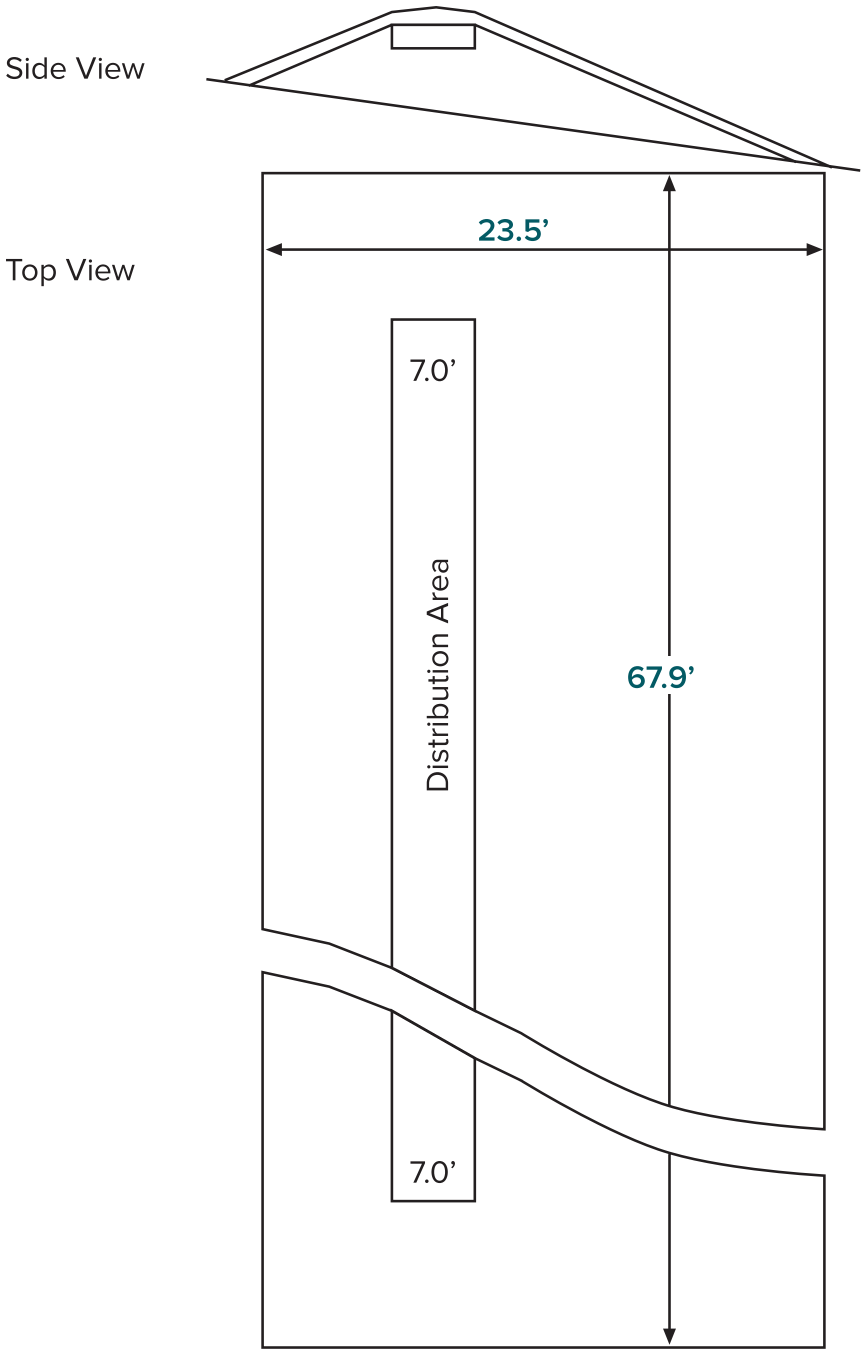
= 99 inches

= 8.25 ft

Step 15. Overall Mound System Length and Width

Overall Length = (Distribution area length) + (2) * (End slope length)

Overall Width = (Distribution area width) + (Upslope width) + (Downslope width)



Overall Length and Width:

Overall Length = (Distribution area length) + (2) * (End slope length)

= (51.4 ft) + (2) * (8.25)

= 67.9 ft

Overall Width = (Distribution area width) + (Upslope width) + (Downslope width)

= (7.0 ft) + (4.01 ft) + (12.48 ft)

= 23.5 ft

The overall dimensions of this mound system (67.9 ft by 23.5 ft) fit within the proposed site area (50 ft by 160 ft).

Distributing Septic Tank Effluent in Mound Systems

Septic tank effluent is distributed in the mound through a series of perforated pipes buried in a layer of gravel or a chamber above the sand fill. Uniform distribution of the septic tank effluent is important in mound systems. Uneven distribution of septic tank effluent can result in localized overloading, short-circuiting through the mound and even break-out at the slope or toe of the mound near the overload. Uniform distribution is achieved using a pressure distribution system. Pressure distribution systems should be carefully designed so that the volume of septic tank effluent flowing out of each hole is uniform across the system. The pipe diameters and hole diameters must be carefully sized to achieve uniform distribution. A pump placed in a dosing tank is used to deliver the septic tank effluent into the mound and pressurize the distribution network.

A pressure distribution network should be designed in accordance with OSU Extension Bulletin 829, *Mound System: Pressure Distribution of Wastewater—Design and Construction in Ohio*. Bulletin 829 explains 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 designers, contractors and health officials to properly design, construct and inspect pressure distribution systems for mounds.

Pressure distribution systems for mounds consist of five components:

1. lateral pipes with equally spaced holes and end turn ups to facilitate maintenance and monitoring of distal pressure
2. the manifold and main connected to the laterals
3. a dosing tank to accumulate septic tank effluent to be pumped to the mound
4. a pump to pressurize the system
5. control and power supply to operate the pump

How Should Mound Systems Be Constructed?

Because a large portion of mound system components are above-grade, mound systems are easier to construct than conventional soil absorption systems. The most important things for a contractor to remember are outlined in the following 11-step procedure.

Recommended Construction Procedures for Mound Systems

Step 1

Lay out the proposed mound system along the contour of the lot in the area specified by the detailed soil and site evaluation. According to the designs, outline and stake three areas:

- distribution area
- soil infiltration area
- overall footprint of the mound

Step 2

Determine the septic tank and dosing tank locations based on the site layout. The tanks should be installed to the side or upslope of the mound.

Step 6

Bring in the mound sand to form the absorption area and cover the soil infiltration area. Two different methods can be used to bring in sand to shape the mound. The traditional approach uses a dump truck to deliver the sand to the upslope side of the mound. A backhoe moves the sand into the shape of the mound, covering the entire soil infiltration area. The alternative method is to use a truck equipped with a conveyor to place the sand over the soil infiltration area to the approach depth. This approach is especially suited to limited access sites. Paint marks on the ground outlining the soil infiltration area and paint stakes indicating the desired depth of sand in the absorption area guide the conveyor operator in placing the sand to shape the mound.

Step 3

Prepare the site for the mound. Trees should be cut off at the soil surface, but leave the roots undisturbed. Mow the grass to a maximum 2-inch height and remove the cuttings from the mound location. Construction should be delayed if the soil is too wet.

Step 4

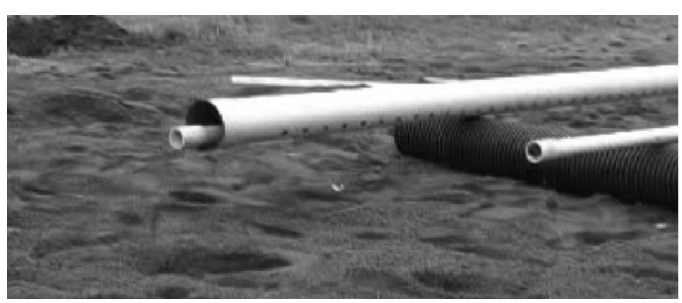
For the pressure pipe that delivers wastewater to the mound, dig a trench from the dosing tank to the side or upslope of the mound. The trench is for the pressure pipe bringing septic tank effluent into the center of the mound. The pressure pipe should be installed with an adequate slope so that the septic tank effluent drains back to the dosing tank after the pump shuts off. The trench should be adequately bedded and filled with granular backfill to reduce settling.

Step 5

Prepare the soil surface in the soil infiltration area. A chisel plow on a small tractor or special teeth fitted to the backhoe bucket can be used to scarify the soil surface. Scarifying the soil surface and breaking up the sod growing in the soil infiltration area will improve the contact of the mound sand with the natural soil. Avoid any traffic and equipment on the soil infiltration area or downslope of the mound. The soil infiltration area will be covered with a layer of sand that protects the soil under the mound from compaction during construction.

Step 7

Level off the sand surface in the absorption area. Cut off the distribution main at least 4 inches above the sand surface and remove all bits of plastic and rough spots that can accumulate debris and clog the pipe. Place some sections of 6-inch pipes across the top of the sand to support the layout of the distribution pipes. Lay out the main, manifold and laterals according to the designs. Cement all tees and joints to prevent leakages and pressure losses.



Step 8

The distribution orifices should be mechanically drilled at the shop. Hand drilling is discouraged. Mark the hole positions evenly on the top of the laterals according to the design calculations. Drill ¼-inch diameter holes with a sharp drill bit to help create clean holes and minimize rough edges. Drill ¼-inch diameter drain holes in the bottom at the end of laterals. Slide a smaller diameter pipe back and forth inside the distribution pipes to knock off any pieces of plastic extending down from the drill holes. The distribution system is typically constructed with small diameter pipes with small holes spaced evenly along the top of the pipes. The pipe size, hole size and hole spacing should be carefully calculated and linked. Consult with the designer before changes are made to make necessary adjustments during the construction.

Step 9

Install an observation port in the gravel down to the sand to serve as a window into the mound to check for ponding of wastewater on the sand surface. Three methods of stabilizing observation tubes are shown in Figure 7. Attach turn-ups to the end of each pipe with a removable cap to allow for flushing accumulated debris from the pipes. The turn-up is supported with gravel to accept the flushed wastewater and allow it to flow back into the mound for treatment. A valve box works well to house the turn-ups so they can be easily located and accessed for regular maintenance.

Step 10

Cover the distribution system with clean washed gravel. The holes on the top of the pipe need to be shielded so that they are not restricted by the gravel cover. A 4-inch perforated pipe slid over the distribution pipe makes an effective shield. Cover the gravel with construction fabric before placing the insulating layer of soil on the top of the mound. As an alternative to gravel cover, chambers can also be used to cover the sand and distribution pipes if the design specifies.

Step 11

Cover the sand and gravel with an insulating layer of soil. Deliver soil cover material to the upslope side of the mound and cover the mound working from the upslope side. Never allow any heavy equipment on the area downslope of the mound. The treated wastewater flows downslope through the soil. Heavy equipment will result in unnecessary soil compaction and lead to bleed-out at the toe or downslope of the mound. Properly grade the upslope side of the mound to divert surface runoff around the mound. Stay on the mound while shaping the downslope side to limit soil compaction. A small bulldozer works well to shape the mound. Seed the soil cover of the mound to limit soil erosion as soon as the construction is completed. If it is late in the season, additional erosion control measures may be necessary.

Step 12

Preparation of as-built drawings is required for good recordkeeping. The as-built drawings should include the actual mound system layout, elevations, benchmark and start-up date. Also include baseline tests of the pump/distribution system. The drawings should be kept for personal records with copies provided to the owner and the inspector.

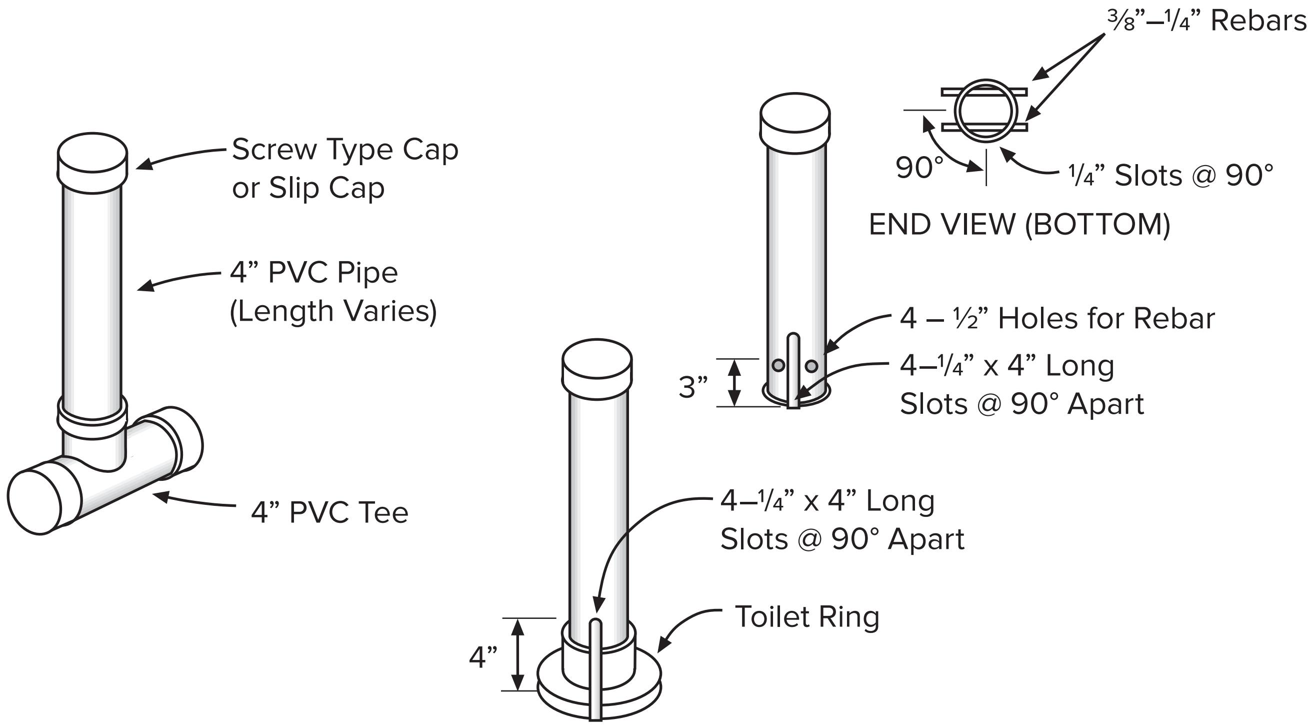


Figure 7. Three methods of stabilizing observation tubes (after Converse and Tyler, 1990).

How Are Mound Systems Maintained to Ensure Decades of Trouble-Free Operation?

Maintenance-free wastewater treatment systems do not exist. All onsite wastewater treatment systems require at least annual inspection and maintenance. Because mound systems have mechanical pumps and small diameter laterals, residential systems require semi-annual inspection. Each inspection and maintenance takes a trained professional approximately 30 minutes to complete. For systems with great distances between pumps and the mound, the necessary inspection and maintenance may take as long as hour one to complete.

Important inspection and maintenance steps include the following:

- Make sure no trees or shrubs are planted on the mound. Tree roots will clog the distribution pipes.
- Avoid sprinkler systems and irrigation on a mound. Plant ground-cover vegetation that can tolerate dry conditions, if necessary.
- Walk around the lot and look for landscape changes that can interfere with or damage the mound system.
- Walk downslope of the mound to check for signs of surfacing sewage.
- Locate and open up each inspection port to check for ponding.
- Activate the pump and check alarms.
- Open the valve box at the end of each lateral to open and flush the lines to remove debris that may clog holes in the small-diameter pipes (Figure 8).
- Conducted a pressure test for each line and compare it to the initial test to check for plugging or broken pipes.

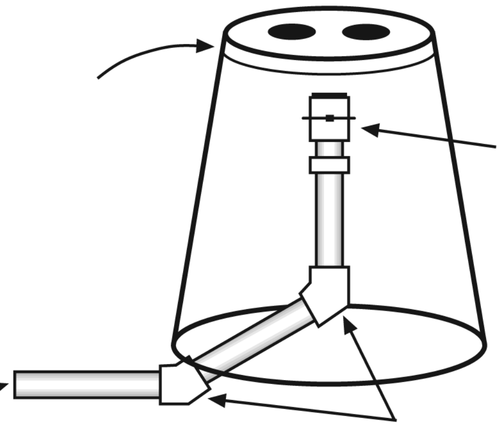


Figure 8. Valve to flush line at end of each lateral (not to scale).

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