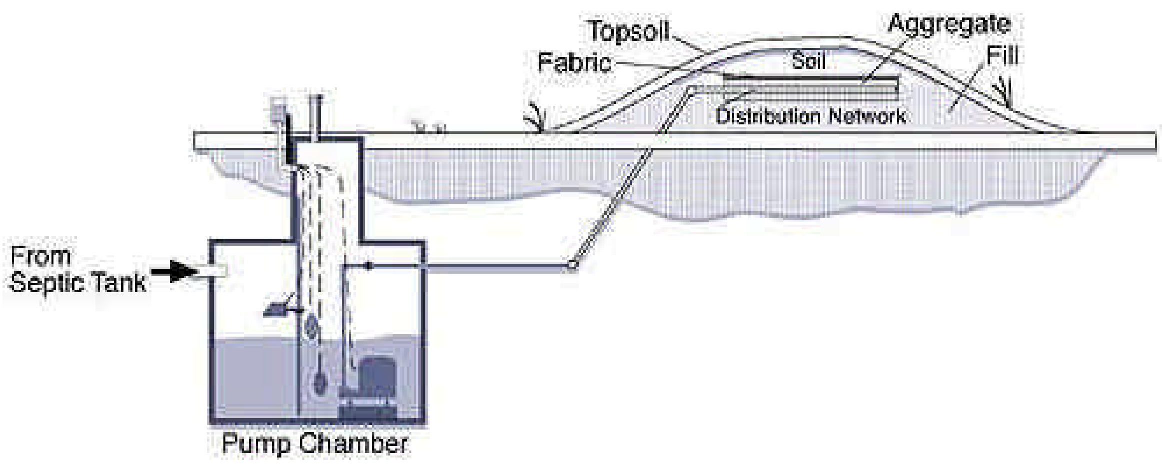
Pressure Mound Systems

Technical Guidance for Site Suitability, Design, Construction
and Operation and Maintenance



DEQ
Michigan Department of Environmental Quality
Water Division
Land Division and Local Health Department Support Program

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PREFACE

The technical guidance contained in this document has been developed for statewide application pursuant to R 560.424(2) of the Michigan Department of Environmental Quality Administrative Rules, "On-site Water Supply and Sewage Disposal for Land Divisions and Subdivisions." This technical guidance represents minimum standards for application of the described alternative method of sewage treatment and disposal for a development site less than one acre, subdivision lots, and site condominium units. The Michigan Department of Environmental Quality supports application of this technical guidance at the full discretion of the local health department having jurisdiction.

The standards may be used as minimums at the local level as written or modified to reflect more stringent requirements deemed necessary based on local conditions. Please note that pursuant to R 560.424(3), the specific alternative must be provided for under the regulations of the city, county, or district health department having jurisdiction and formal authorization must be granted by the Michigan Department of Environmental Quality.

R 560.424. Alternative methods of sewage treatment and disposal.
Rule 424. (1) The department may approve an alternative treatment and subsurface disposal system for a development site less than 1 acre in size or a lot deemed suitable or not suitable for a conventional subsurface sewage system.
(2) The department of environmental quality shall provide technical guidance in defining minimum site suitability and design and long-term operation and maintenance requirements considered essential for the proper functioning of specific alternative systems.
(3) The owner may utilize an alternative system if the specific alternative is provided for under the regulations of the city, county, or district health department having jurisdiction and if the department of environmental quality has authorized the alternative system's use.

TABLE OF CONTENTS

DEFINITIONS

Alternative System: A treatment and disposal system that is not a conventional system and provides for an equivalent or better degree of protection for public health and the environment than a conventional system.

Approved: A written statement of acceptability issued by the local health officer or the Department of Environmental Quality.

Basal Area: The effective in situ soil surface area available to transmit the treated effluent from the sand fill media into the original receiving soils.

Conventional System: An on-site sewage treatment system consisting of a watertight septic tank and a subsurface soil absorption system with non-uniform distribution of the effluent to subsurface soil trenches or an absorption bed.

Cover Material: The material used to cover a mound system, usually selected on its availability, cost, and ability to support vegetation, transfer oxygen, and shed water.

Distribution Cell Area: The area within the mound where the effluent is distributed into the fill material.

Effluent: Liquid discharged from a septic tank or other on-site sewage system component.

Excessively Permeable Soils: Soil that contains a high percentage of coarse to very coarse sands (2.0 mm and larger) and often including fine gravels and/or cobbles. Water passes through the soil very rapidly (i.e., soil permeability < 3 minutes/inch) and internal free water is very rare.

Greenbelt Area: The area measured horizontally downslope from the edge of the mound fill, which is maintained undisturbed prior to during and after construction so as not to impede lateral movement of effluent.

High Groundwater Elevation: The uppermost part of the soil or underlying material wholly saturated with water. The term includes perched and apparent conditions that are seasonally saturated for a time period in excess of two weeks, or permanently saturated.

Hydraulic Linear Loading Rate: The volume of effluent applied per day per linear foot of system along the natural ground contour.

Influent: Wastewater flowing into an on-site sewage system component.

In Situ Soil: Soil present in the natural or original position.

Limiting Layer: High groundwater elevation, soils with an expected permeability above 60 minutes/inch, or bedrock.

Original Grade: The natural land elevation which exists immediately prior to the construction of the mound system.

Permeable Soil: Soils with a textural classification, according to the U.S. Department of Agriculture Soil Conservation Service classification system, of silt loams, and some silty clay loams that are well structured with expected permeability less than or equal to 60 minutes/inch.

Permeability: The ability of soil to transmit liquids through pore spaces in a specified direction, e.g., horizontally or vertically.

Pressure Distribution: A system of small diameter pipes uniformly distributing effluent throughout a trench, bed, or chamber.

Pressure Mound System: An alternative method of on-site sewage treatment and disposal in which a specified sand fill media is laid on top of a properly prepared original soil surface. The pressure distribution system and wastewater distribution cells are then placed entirely within the filter media at such a level that the desired vertical separation to provide the necessary treatment exists. The fill material provides a measurable degree of wastewater treatment and allows effluent dispersal into the natural soil environment for final treatment.

Pump Chamber: A watertight tank or compartment following the septic tank or other pretreatment process that contains a pump, floats, and volume for storage of effluent.

Reserve Area: An area of land with site conditions deemed suitable for the installation of a replacement system upon failure of the initial system.

Sand Fill: Sand meeting specific criteria regarding particle size and installation technique to ensure adequate wastewater treatment.

Sanitary Sewage: Water and contaminants discharged from sanitary conveniences, including bathroom, kitchen, and household laundry fixtures of dwellings, office buildings, industrial plants, commercial buildings, and institutions. Commercial laundry wastes and industrial and commercial processes are not considered sanitary sewage.

Septic Tank: A watertight pretreatment receptacle receiving the discharge of sanitary sewage from a building sewer or sewers designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic/facultative digestion of the organic matter prior to discharge of the liquid.

Slowly Permeable Soil: Soils with a textural classification according to the U.S. Department of Agriculture Soil Conservation Service classification system of silt loams and some silty clay loams that are well structured with expected permeability above 60 minutes/inch.

Soil Compaction: An increase in the soil bulk density and decrease in soil porosity by the application of mechanical forces to the soil that results in a soil that retains less water and resists root penetration. Soils with high clay content are more easily compacted than sandy soils.

Soil Loading Rate: The allowable application rate to the basal area required for absorption of effluent based upon soil texture for a given soil structure.

Soil Mottling (also known as redoximorphic features): Spots or blotches of contrasting colors, such as, but not limited to, gray or brown or gray and brown colors in close proximity, that are formed in the soil matrix by the processes of reduction, translocation, and oxidation of iron and manganese compounds in soils that have been periodically saturated.

Timer-Controlled System: A pressure distribution system where a pump's "on" and "off" times are preset, discrete time periods.

Uniform Distribution: A method of distribution that results in equal distribution of the effluent throughout the distribution network. This will help assure a vertical unsaturated flow regime.

Vertical Separation: The total depth of unsaturated soil that exists between the infiltrative surface of a distribution cell and a limiting layer.

INTRODUCTION

When properly sited, designed, constructed, operated and maintained pressure mounds provide a proven effective alternative method of on-site treatment. A pressure mound system relying on subsurface distribution to in situ soils can be an effective solution where site conditions are not suitable for conventional treatment and disposal systems. Typical situations where mound systems might be applied include:

- **Permeable or slowly permeable soils with a high groundwater elevation.**

  Where permeable or slowly permeable soils with a high groundwater elevation prevent the installation of a conventional treatment system, a mound may be an acceptable alternative to provide for final treatment and disposal. Utilizing a mound with pressure distribution of effluent to promote unsaturated flow along with elevating the infiltrative surface to provide vertical separation maximizes final treatment efficiency.

- **Slowly permeable soils without high groundwater.**

  Slowly permeable soils are most effective for final treatment and disposal where the natural soil profile is maintained in an undisturbed condition. Utilizing a mound system with pressure distribution for these sites offers a number of advantages as opposed to attempts to construct a conventional below grade final treatment and disposal system including:

  - Damage to the natural soils during construction including compaction and smearing is minimized.
  - Treated effluent is discharged and dispersed into the uppermost soil horizons, which are typically more permeable.
  - The mound sand fill media provides additional treatment, which minimizes clogging of the slowly permeable soils while maintaining their hydraulic conductivity.
  - Utilizing pressure distribution promotes unsaturated flow resulting in more efficient treatment, extended life of the system and improves overall hydraulic performance by minimizing groundwater mounding.

- **Excessively permeable soils or creviced bedrock.**

  Excessively permeable natural soils or shallow soils over creviced bedrock present distinct concerns related to contamination of groundwater supplies or surface waters. In conjunction with a comprehensive evaluation of site specific environmental and/or public health concerns, mounds may be evaluated as a potential treatment alternative to minimize adverse impacts.

SITE SUITABILITY

Those sites meeting the following criteria for the initial, replacement, and greenbelt areas may be considered for pressure mounds:

- Soils - undisturbed natural soils only. Historical agricultural activities are not generally considered as disturbance.

- Soil texture and structure - the most limiting horizon encountered in the upper 18 inches must be a suitable soil texture and structure as shown in Table 1.

- Permeability of uppermost soil horizon - soils with an estimated permeability of 60 minutes/inch or less based on soil texture and structure.

- Depth to high groundwater elevation - 18 inches minimum from the undisturbed natural ground surface. The depth to high groundwater elevation shall be confirmed by a soil profile with 6 inches or more of soil without mottling (a.k.a. redoximorphic features) below the “A” horizon (topsoil) or groundwater monitoring in accordance with R 560.423 of the Michigan Department of Environmental Quality Administrative Rules, “On-site Water Supply and Sewage Disposal for Land Divisions and Subdivisions.”

- Depth to creviced bedrock - 24 inches.

- Slope - natural ground slope should be $\leq$ 25 percent in mound area to promote safety of workers during construction.

SITE EVALUATION AND PLANNING

A critical step in the successful application of mound technology is the site evaluation and planning process. This step provides the site specific information necessary to evaluate overall site suitability and is used as the foundation for actual design.

Prior to completing the site evaluation, available site specific information related to soils, slopes, etc., should be reviewed in detail. For the majority of counties, USDA soil surveys are a valuable resource in this regard. This information will provide general guidance as to the potential for application of mound technology. After a thorough review of this information, preliminary site plans can be developed and a site evaluation conducted.

For each lot where a mound is intended, a minimum of three soil profile evaluations are considered sufficient to delineate the area under investigation for initial, replacement systems, and greenbelt areas and to establish consistency. Soil evaluations should be completed during those time periods where soils are sufficiently dry to avoid damage to the absorption area. In areas of complex soils, additional evaluations may be necessary. Soil evaluations should be completed by observation of shallow soil pits of adequate size, depth, and construction to safely enter and exit the pit and complete a soil profile description. All of the following shall be accurately reported by a competent soil consultant for each soil horizon or layer:

- Thickness
- USDA soil textural class
- Presence of soil mottles or redoximorphic features
- Soil structure - grade and shape
- Occurrence of saturated soil, groundwater, bedrock, or disturbed soils

Site planning for development sites less than one acre, subdivision lots, or site condominium units must also consider the following features:

- Property lines and lot lines
- Slope
- Required setback distances
- Existing or proposed structures
- Existing or proposed wells
- Surface waters

For projects involving multiple lots or units, overall planning should also consider and mitigate any negative impacts from other off-lot development activities, including grading, road construction, and surface water drainage.

DESIGN

Sufficient design detail must be provided for a development site less than one acre, subdivision lot, or site condominium unit to assure that adequate, suitable area is available for construction of initial and reserve mound systems and required greenbelt areas. These areas must be at locations that are readily accessible for construction and for future maintenance and repair. A proper design must allow for the home and any proposed improvements while maintaining required setbacks. The following design criteria are recommended:

Design Flows - For design purposes an allowance of 150 gallons per day per bedroom is suggested. This figure provides an adequate factor of safety necessary to promote satisfactory long term function of the distribution cell and mound.

Distribution Cell Sizing - The absorptive bottom area in the distribution cell should be designed to provide the minimum required by the city, county, or district health department having jurisdiction. The maximum loading rate should never exceed 1.0 gallon per day per square foot. More conservative loading rates will provide a higher factor of safety. Horizontal separation between distribution cells shall be based on allowable soil loading rate with a minimum of three feet.

Reserve Area - Reserve area with suitable site conditions must be set aside and protected for future use. The reserve area shall include a basal area, sized in accordance with Table 1, which is totally separate from the basal area of the initial mound.

Mound Orientation - The absorptive area should be long and narrow with the long dimension running parallel to the contour for a sloping site.

Soil Loading Rate - The minimum mound basal area required for absorption of effluent is based upon soil texture for a given soil structure. Table 1 suggests recommended maximum soil loading rates based upon the most limiting soil texture and structure encountered in the upper 18 inches of the soil profile. The basal area for sloping sites (i.e., those with slopes $\geq$ 2 percent) includes the area under the distribution cell and area downslope only. On flat sites (i.e., those with slopes $\leq$ 2 percent) the minimum required basal area includes that under the distribution cell and either side of it. Generally, the minimum required basal area will be found to be less than the actual area filled after accounting for required depth of fill and side slopes.

Hydraulic Linear Loading Rate - The hydraulic linear loading rate is the volume of effluent applied per day per linear foot of system along the natural ground contour. From a hydraulic standpoint, a long and narrow mound design is most efficient and better promotes aerobic conditions under the distribution cell. Table 1 suggests recommended maximum hydraulic linear loading rates based upon the most limiting soil texture and structure encountered in the upper 18 inches of the soil profile.

Setbacks - Table 2 summarizes minimum horizontal isolation distances which should be maintained from the toe of the mound fill.

Depth of Fill - The depth of fill must be such that the bottom of the distribution cell is isolated $\geq$ 3 feet above established high ground water elevation or limiting layer. Limiting layer includes soils with an expected permeability above 60 minutes/inch based on soil texture and structure. The minimum depth of fill at the outer edge of the distribution cell area shall be 12 inches. The approved plan shall indicate the location of a suitable benchmark to be used by the contractor during construction to judge that the required depth of fill has been provided.

Final Cover - The settled depth of final cover at the outer edge of the distribution cell should be a minimum of 12 inches and the top of the mound graded to promote positive drainage. Final cover over the mound should support the growth of a suitable vegetative cover while shedding rainfall and promoting aeration of the mound. Final cover should have a texture no heavier than sandy loam.

Side Slopes - The final side slope of the mound surface should be 4:1 or flatter.

Greenbelt Area - On sloping sites (i.e., those with slopes $\geq$ 2 percent) it can be expected that flow will move laterally down gradient. So as to not to adversely impede this lateral movement, a suitable downslope greenbelt area shall be provided. The greenbelt area is to be measured from the toe of the mound and located within property boundaries. The minimum required greenbelt area varies based on soil texture as indicated in Table 1.

Pressure Distribution System - Pressure distribution of effluent is required in the distribution cell to promote maximum achievable treatment, and is critical from a hydraulic standpoint, especially where slowly permeable soils are encountered. Pressure distribution system design should generally comply with currently accepted design practice including the following features:

- Septic tank effluent filters or screen pump vaults are necessary.
- Small frequent doses to the mound by means of time dosing to promote unsaturated flow and enhanced treatment and hydraulics are required. Design shall provide uniform doses with no more than 0.5 gallons per orifice per dose.
- Distribution cell area per orifice shall not exceed 12 ft^2.
- To reduce orifice plugging, high head pumps are recommended.
- Orifice shields should be provided.

- Provisions for flushing must be incorporated at the ends of all laterals.

- Geotextile fabric which prevents the downward migration of fine materials but allows for free passage of air and water should be placed over the stone in the distribution cell prior to placement of final cover.

Sand Fill Requirements - It is important that the specification of the sand fill material be closely controlled from both a performance and longevity standpoint. From a treatment standpoint, the mound functions in a similar fashion to a sand filter sand fill should be clean and meet the Michigan Department of Transportation 2NS gradation without excessive fines. A qualitative field check to assess the cleanliness of sand delivered to the construction site should be conducted. (See Appendix A.)

Observation Ports - At least one observation port to gauge ponding depth in the distribution cell is necessary. Where the distribution cell is divided into multiple zones, at least one per zone is required.

SITE PREPARATION AND CONSTRUCTION

Ultimate success or failure of a mound also relies on a clear communication and understanding of basic site preparation and construction principles. Critical issues include:

- Proper procedures must be followed to protect the mound area including required greenbelt area during and after construction. After establishing a suitable location for the mound and replacement area including greenbelt area, it should be suitably fenced or otherwise unmistakably identified to prevent further disturbance until actual construction can occur. Site planning resulting in a location for the mound that is isolated from other anticipated home construction activities is encouraged.

- Soil smearing and compaction, which can reduce infiltration capacity will occur if soils are worked on when wet. Construction activities should be scheduled only when soils are sufficiently dry. Acceptable soil moisture content of the soils to a depth of one foot should be evaluated by rolling a sample of soil between the hands. If the soil can be rolled into a 1/4 inch or smaller "wire" it is considered too wet and should be allowed to dry before preparing.

- Excess vegetation should be removed from the mound basal area. Trees should be cut flush to the ground and other vegetation over six inches in length should be mowed and cut vegetation removed. Where an excessive number of stumps and large boulders are encountered, the absorption area should be enlarged or an alternate site should be selected.

- The entire basal area of the mound should be suitably prepared by roughening in a ridge and furrow fashion with ridges following the contours. Methods that can be considered for roughening include chisel teeth fastened to the backhoe bucket, plowing with a multiple bottom agricultural chisel plow, or moldboard plow. Rototilling is not acceptable. Sand fill material should be applied immediately after roughening and prior to any subsequent precipitation.

- Cleanliness of sand fill should be field checked prior to installation. Placement of fill material then is to be accomplished from the end and upslope sides utilizing a tracked vehicle or equipment with adequate reach to minimize soil compaction. A minimum of six inches of fill material should be maintained below the tracks to minimize compaction. Wheeled vehicles should be prevented from travel over the mound basal area and downslope greenbelt area. Total depth of fill shall be established based on a benchmark provided by the design consultant on the approved plan.

- Final grading of the mound area should divert surface water drainage away from the mound. Sod the entire mound area or seed and mulch.

OPERATION AND MAINTENANCE

The system owner is responsible for assuring the continuous operation and maintenance of the system. Deed advisories need to be recorded to communicate to the system owner and subsequent future owners the importance of routine and regular maintenance activities. It is suggested that a maintenance inspection be conducted on an annual basis by a trained maintenance provider. The local health department or other management entity may require oversight of the on-site system by a properly certified operator. In such cases, the operator must be responsible for the continuous operation and maintenance of the system and must submit appropriate records routinely to the local health or other appropriate jurisdiction.

Routine and preventative maintenance aspects are:

- Scum and sludge levels in the septic tank as well as the pump chamber need to be inspected routinely on an annual basis and tanks pumped as necessary. Depending on tank size and usage, pumping will typically be required at intervals exceeding every 3 to 5 years.

- Periodic inspections of system performance are required. Liquid levels in the observation ports should be checked and examinations made for any seepage around the toe of the mound. The pressure distribution system should be assessed and laterals flushed as necessary. It is recommended that mounds be visited at least once per year. A suggested maintenance visit checklist is attached (Appendix C).

- A good water conservation plan within the house or establishment will help assure that the mound system will not be hydraulically overloaded.

- Avoid traffic in the initial and replacement mound areas and downslope greenbelt area. No vehicular traffic or livestock should be permitted. With lawn care equipment, such as a riding lawn mowers or tractor, it is important not to travel on the mound or the downslope area when the soil is saturated. Winter traffic on the mound should be avoided to minimize frost penetration in colder climate areas and to minimize compaction in other areas.

Owner’s Manual - A user’s manual needs to supplement the construction plan and must be submitted to the local health department for final approval. A copy of this manual must be provided to the property owner after completion of the mound system. The manual needs to contain the following as a minimum:

1. As-built drawings of all system components and their location are to be provided. The location of the reserve area also needs to be clearly defined and its importance communicated to the owner.

2. Specifications for all electrical and mechanical components.

3. Names and phone numbers of local health authority, component manufacturer, or management entity to be contacted in the event of an alarm, or other problems, or failure.

4. Information on the periodic maintenance of the mound system, including electrical/mechanical components.

5. Information on what activities can or cannot occur on and around the mound, reserve area, and greenbelt area.

6. A standard homeowner “Do’s and Don’ts” list for proper system operation.

7. Information regarding suitable landscaping and vegetation for the mound and surrounding areas.

APPENDIX A

Figure 1
Typical Mound System Components

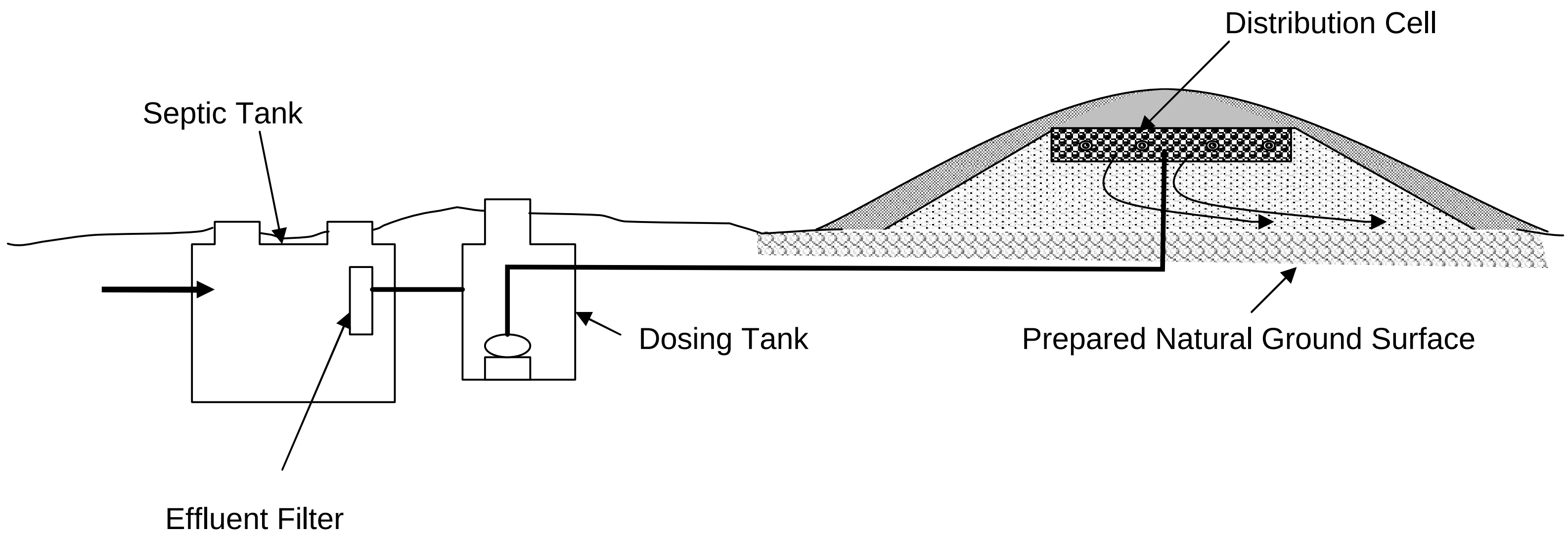


Figure 2
Typical Site Plan

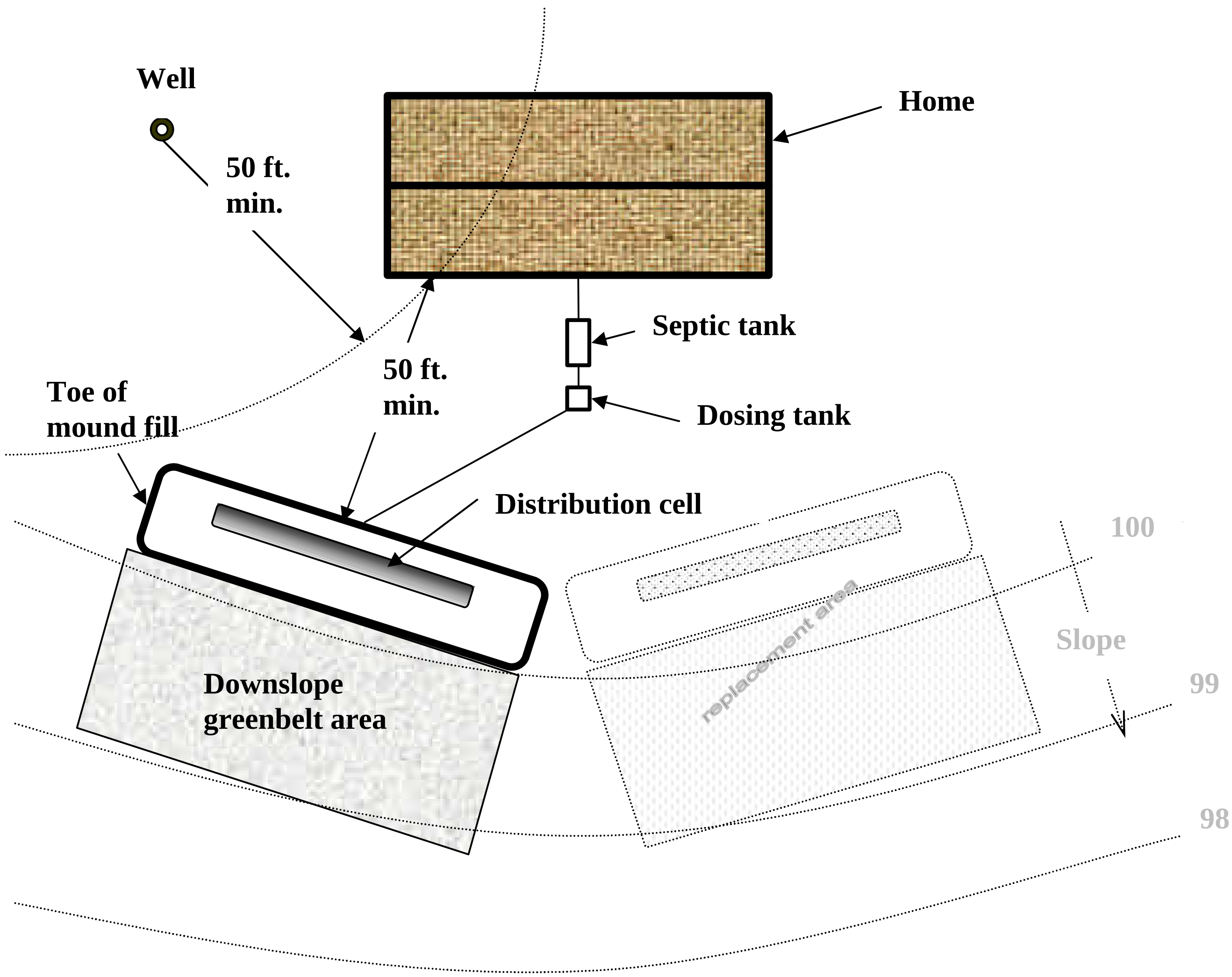
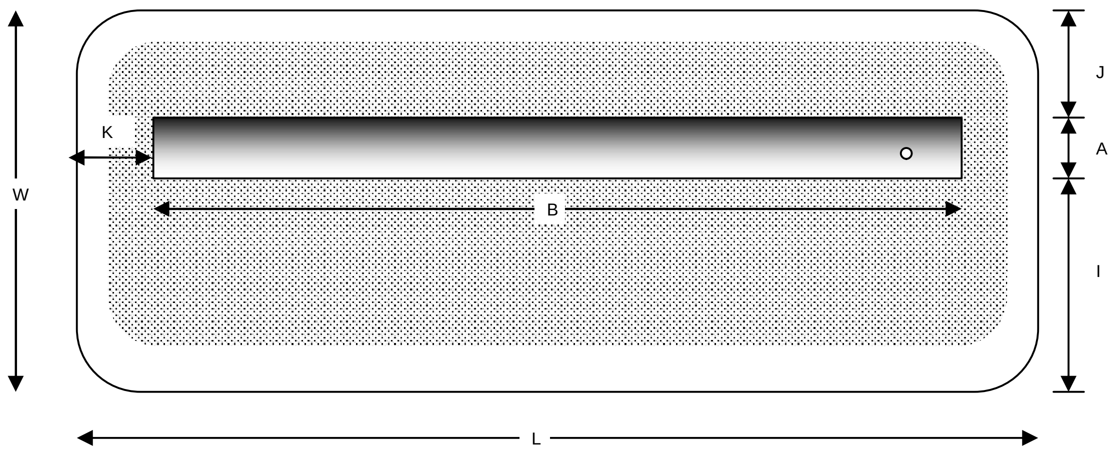
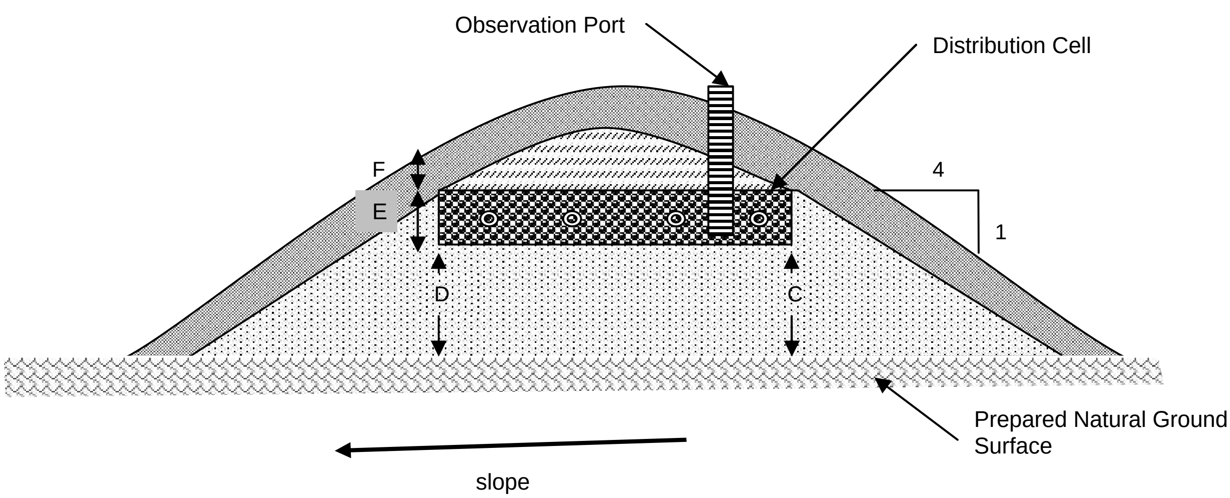


Figure 3
Mound Plan View and Cross Section



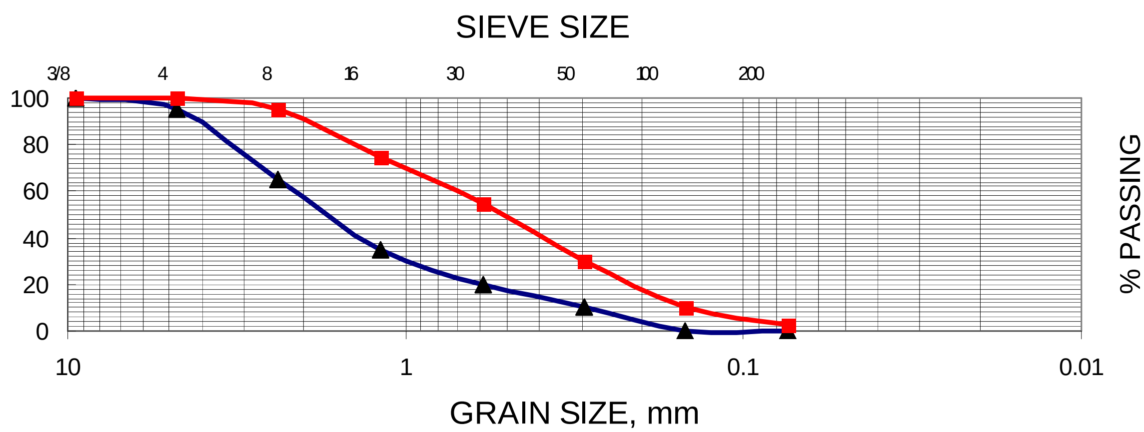


<u>Legend</u>

A - Distribution cell width
B - Distribution cell length
C - Up slope fill depth under distribution cell
D - Downslope fill depth under distribution cell
E - Distribution cell depth
F - Depth of final cover
I - Distance from edge of distribution cell to downslope edge of fill
J - Distance from edge of distribution cell to up slope edge of fill
K - Distance from end of distribution cell to edge of fill
L - Overall mound fill length
W - Overall mound fill width

Figure 4
MDOT 2NS Sand Specification

Sieve Size	Grain Size (mm)	Percent Passing %	Percent Passing %
3/8	9.52	100	100
4	4.76	95	100
8	2.38	65	95
16	1.19	35	75
30	0.59	20	55
50	0.297	10	30
100	0.149	0	10
200	0.074	0	3



Procedure for
Qualitative Field Test of Sand Cleanliness

Sand fill materials for mound construction should be obtained from a supplier that has documented through sieve analysis that the 2NS specification is met. As results of sieve analyses will typically vary over time, it is recommended that a qualitative field assessment of the cleanliness of the sand delivered to the construction site also be conducted. The following procedure is suggested:

1. Fill a quart jar one half full of the sand fill material to be tested.

2. Add water to fill the jar.

3. Shake the jar contents vigorously after which it should be allowed to settle for 30 minutes.

4. If after settling a perceptible layer of fines greater than 1/8 inch in thickness has accumulated on the surface, the fill material should not be considered clean enough and an alternate source should be explored.

Figure 5 – Observation Port Example Details

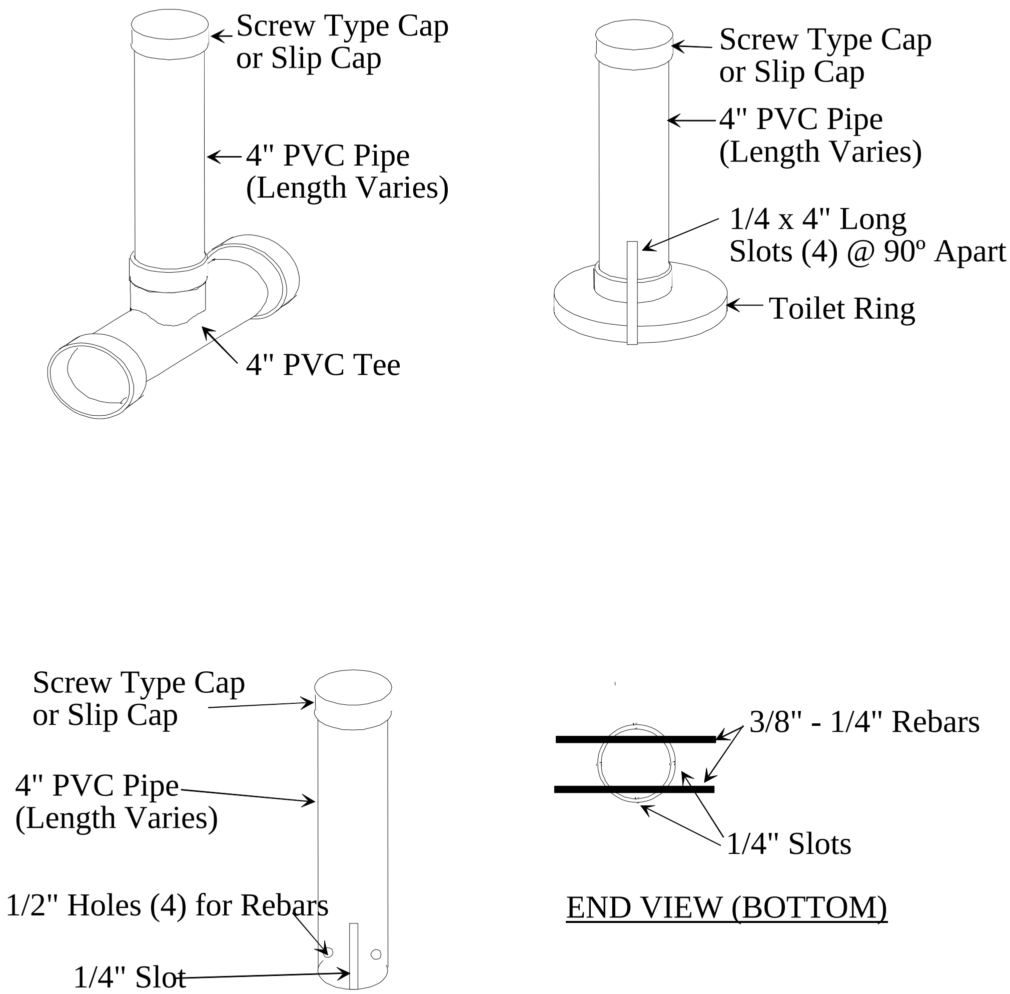


Table 1
Allowable Soil Loading Rates

SOIL STRUCTURE* → / SOIL TEXTURE* ↓	MAXIMUM SOIL LOADING RATE GPD/FT^2					MAX. HYDRAULIC LINEAR LOADING RATE, GPD/LF					REQUIRED DOWNSLOPE GREENBELT** (SLOPE > 2%, FEET)
	BK/GR			PL	M	BK/GR			PL	M	
	1	2	3			1	2	3			
COARSE SAND / MEDIUM SAND	1.0	1.0	1.0	0.5	0.5	5.0	5.0	5.0	2.5	2.5	NR
FINE SAND / LOAMY SAND	0.4	0.5	0.6	0.4	0.4	3.5	4.0	4.5	2.0	2.0	10
VERY FINE SAND / SANDY LOAM	0.3	0.4	0.5	U	0.2	3.0	3.5	4.0	U	1.0	20
LOAM / SANDY CLAY LOAM	0.2	0.25	0.3	U	0.2	2.5	3.0	3.5	U	U	30
CLAY LOAM / SILTY CLAY LOAM	0.15	0.2	0.25	U	U	1.8	2.5	3.0	U	U	40
SILTY CLAY/ SANDY CLAY / CLAY	UNSUITABLE										

* MOST LIMITING LAYER IN UPPER 18 INCHES
** MEASURED FROM TOE OF MOUND FILL

TABLE LEGEND

BK = BLOCKY	1 = WEAK
GR = GRANULAR	2 = MODERATE
PL = PLATY	3 = STRONG
M = MASSIVE	U = UNSUITABLE

Table 2
Minimum Horizontal Isolation Distances

From Toe of Mound Fill To:	Minimum Horizontal Isolation Distance (feet)
Private individual well	50
Surface waters	100
Basement foundation walls	50*
Top of drop-off	20
Property lines	10
Footing drains installed in water table without direct connection to surface water	25
Footing drains installed in water table with direct connection to surface water	50
Drains designed to lower the water table	100

*The downslope edge of the greenbelt area may be located within 25 feet of the foundation walls.

APPENDIX B

Design Example

Site Criteria

1. Soil Profile:

   A. 0-8 in. - Dark grayish brown medium sand, weak granular structure.

   B. 8-29 in. - Yellowish brown medium sand, single grain with common fine distinct light brownish gray iron oxide depletions evident below 18 inches.

   C. 29-32 in. - Reddish brown clay loam, massive with many fine distinct greenish gray iron oxide depletions.

2. Slope: 4%

3. This is a site for a proposed 3 bedroom home.

Step 1. Evaluate the quantity and quality of wastewater generated.

For this example, it is intended to serve a three bedroom home and the designer has proposed to discharge domestic septic tank effluent to the mound. Design flows are established based on an estimate of 150 gallons per day (gpd) per bedroom, which equates to a design flow rate of 450 gpd. Using a design flow of 150 gpd/bedroom provides for a factor of safety resulting necessary to promote greater system performance and longevity.

Step 2. Evaluate the soil profile and site description for maximum soil loading rate and hydraulic linear loading rate.

From the soil profile description there are indications of a seasonal high groundwater elevation at 18 inches. The most limiting soil horizon in the upper 18 inches from a texture and structure standpoint is brown medium sand with weak granular structure. Using Table 1, the soil loading rate and linear loading rate are selected.

Soil Loading Rate (SLR) = 1.0 gpd/ft^2
Linear Loading Rate (LLR) = 5.0 gpd/lineal foot

Step 3. Select the sand fill loading rate and calculate the distribution cell width (A).

The maximum sand fill loading rate for septic tank effluent is 1.0 gpd/ft^2. For this example the maximum rate will be used. Use of this rate is based on the assumption that the sand fill under the distribution cell will meet the requirements of Figure 4 and that a factor of safety has been provided in design flows as discussed in Step 1. The width of the distribution cell (A) can then be calculated as follows:

A = Linear Loading Rate ÷ Sand Fill Loading Rate
= 5.0 gpd/ft. ÷ 1.0 gpd/ft^2
= 5.0 ft.

Step 4. Determine the distribution cell length (B).

B = Design Flow ÷ Linear Loading Rate
= 450 gpd ÷ 5.0 gpd/ft.
= 90 ft.

Step 5. Determine the soil infiltration area width (IW).

The soil infiltration width represents the width required to absorb the effluent into the natural soil. To provide a factor of safety, it is based on the most limiting horizon in the upper 18 inches. For this example, the most limiting horizon is medium sand which has a maximum soil loading rate of 1.0 gpd/ft^2.

IW = Design flow ÷ (soil loading rate x B)
= 450 ÷ (1.0 x 90)
= 5 ft.

For this example, the infiltration width and distribution cell width (A) are equal. For other situations where the most limiting horizon is less permeable, it will be found that the infiltration width will exceed width of the distribution cell. The infiltration width defines the minimum overall dimensions of the basal area and is important when evaluating the adequacy of the mound fill area and horizontal spacing when using multiple distribution cells.

Step 6. Determine mound fill depth (C) at the upslope edge of the distribution cell.

In this case, the depth of fill (C) at the upslope edge of the distribution cell will be the fill required to elevate the stone three feet above high groundwater elevation, which is 1.5 ft.

Step 7. Determine the mound fill depth (D) at the downslope edge of the distribution cell.

For a 4% slope, the following can be used:

D = C + 0.04(A)
= 1.5 + 0.04(5)
= 1.7 ft.

Step 8. Determine mound depths (E) and (F).

E = 1.0 ft. (total depth of stone)

F = 1.0 ft. (minimum amount of final cover)

Step 9. Determine the downslope width (I).

Using a recommended side slope of 4:1 the calculations is as follows:

Downslope correction factor = 100 ÷ [100-(side slope x % ground slope)]
= 100 ÷ [100-(4 x % slope)]
= 100 ÷ [100-(4 x 4)]
= 1.19

I = 4(D+ E+ F) x downslope correction factor
= 4(1.7 +1.0+ 1.0)(1.19)
= 17.6 ft.

Step 10. Determine the upslope width (J).

Using a recommended side slope of 4:1 the calculations is as follows:

Upslope correction factor = 100 ÷ [100+(side slope x % slope)]
= 100 ÷ [100+(4 x % slope)]
= 100 ÷ [100+(4 x 4)]
= 0.86

J = 4(C+ E+ F) x upslope correction factor
= 4(1.5 +1.0+1.0)(0.86)
= 12.0 ft.

Step 11. Determine the end slope length (K).

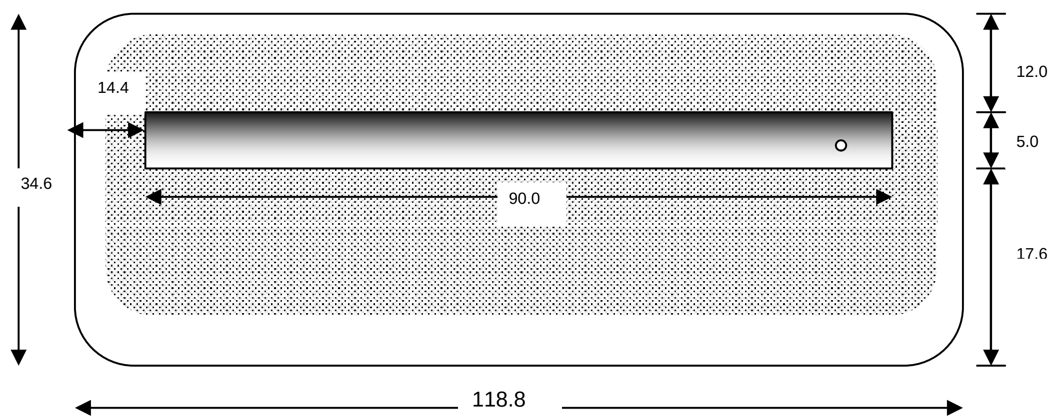
Using a recommended side slope of 4:1 the calculations is as follows:

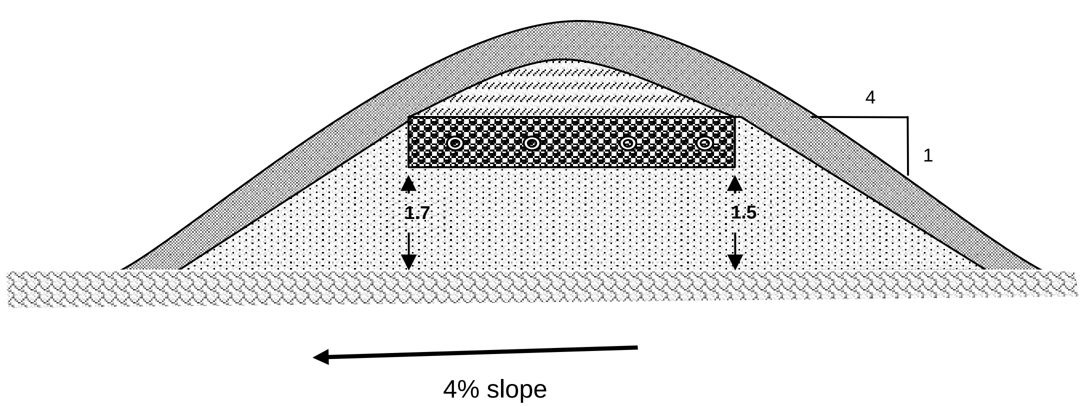
K = 4[(C+D)/2 +E +F]
= 4[(1.5 +1.7)/2 + 1.0 +1.0]
= 14.4 ft.

Step 12. Determine the overall width (W) and length (L) of the mound fill.

W = A + I + J
= 5 + 17.6 +12.0
= 34.6 ft.
L = B + 2K
= 90 + 2(14.4)
= 118.8 ft.

The calculated dimensions are summarized on the following plan view and cross section:





APPENDIX C

Mound Maintenance Visit Checklist

General Observations

Mound Appearance (check items that may apply)

☐ Erosion has occurred
Explain____
☐ Greener vegetation visible in spots
Explain____

Toe of Slope Wetness
☐ Soil at downslope toe is soggy
☐ Water at surface of downslope toe
☐ Sewage odor around wet spots

General Condition
☐ Attractive, well groomed, completely sodded
☐ Mostly vegetated, evidence of mowing
☐ Overgrown with weeds
☐ Overgrown with brush

Observation Tube in Stone Bed

☐ Observation tube is present
☐ Depth of ponding in tube____________

Other Observation Tubes

Describe and note distance to water below soil surface:
____
____

Pump Chamber

Appearance: (Note any apparent problems or concerns)
____
____

☐ Water level normal

Pump operation is:
☐ Demand (float) controlled
☐ Timer controlled

Number of floats: ________

☐ Check float operation and desirable function of each (first visit only)

If timer is present, note settings
________ On time
________ Off time

Flush Laterals

☐ Access is provided to ends of lines
☐ Have to dig up ends of lines (recommend addition of sumps for access)

Perform flush of each line by opening the end of one lateral at a time. Have helper turn pump on while you observe end of line. Note what flushes out of each line. Provide sketch to identify laterals.

Lateral #1 ____

Lateral #2 ____

Lateral #3 ____

Lateral #4 ____

Lateral #5 ____

Lateral #6 ____

After flushing all lines, make head measurement at the end of the line farthest from the pump. Note head and compare with previous records (if available) of how residual head in the system is supposed to be set. If head is more than 20 percent above previous value, bottle brush the lines – or otherwise clean – and measure head again.

Note final head: ___________ ft.

APPENDIX D

Mound Design Worksheet

Site Criteria

1. Soil Profile

    ____
    ____
    ____

2. Slope: __________%

3. This is a site for a proposed _______ bedroom home.

Step 1. Evaluate the quantity and quality of wastewater generated.

Daily Flow = # of bedrooms x 150 gpd/bedroom
= (______ x 150) gpd
= ______ gpd

Step 2. Evaluate the soil profile and site description for maximum soil loading rate and hydraulic linear loading rate.

Seasonal High Groundwater Elevation = ______ inches

Depth to Limiting Layer = ______ inches

Limiting Layer texture, structure, grade ______, ______, ______

Using Table 1 the soil loading rate (SLR) and linear loading rate (LLR) are selected.

Soil Loading Rate (SLR) = ______ gpd/ft^2
Linear Loading Rate (LLR) = ______ gpd/lineal foot

Step 3. Select the sand fill loading rate and calculate the distribution cell width (A).

The <u>maximum</u> sand fill loading rate for septic tank effluent is 1.0 gpd/ft^2. For this design the following rate will be used ______ gpd/ft^2. The width of the distribution cell (A) can then be calculated as follows:

A = Linear Loading Rate ÷ Sand Fill Loading Rate

= ______ gpd/ft. ÷ ______ gpd/ft^2
= ______ ft.

Step 4. Determine the distribution cell length (B).

B = Design Flow ÷ Linear Loading Rate
= ______ gpd ÷ ______ gpd/ft.
= ______ ft.

Step 5. Determine the soil infiltration area width (IW).

The soil infiltration width represents the width required to absorb the effluent into the natural soil. To provide a factor of safety it is based on the most limiting horizon in the upper 18 inches. For this design the most limiting horizon is ______ with a ______, which has a maximum soil loading rate of ______ gpd/ft^2.

IW = Design flow ÷ (soil loading rate x B)
= ______ ÷ ______
= ______ ft.

For situations where the most limiting horizon is slowly permeable it will be found that the infiltration width will exceed width of the distribution cell. The infiltration width is important when evaluating the adequacy of the overall mound fill area and horizontal spacing when using multiple distribution cells.

Step 6. Determine mound fill depth (C) at the upslope edge of the distribution cell.

In this case, the depth of fill (C) at the upslope edge of the distribution cell will be the fill required to elevate the stone three feet above high groundwater elevation or limiting layer, which is ______ feet.

Step 7. Determine the mound fill depth (D) at the downslope edge of the distribution cell.

For a given slope, the following can be used:

D = C + (slope x A) Note: express slope as decimal, i.e., 4% = 0.04
= ______ + (______ x ______)
= ______ ft.

Step 8. Determine mound depths (E) and (F).

E = ______ ft. (total depth of stone)
F = ______ ft. (amount of final cover)

Step 9. Determine the downslope width (I).

Using a recommended side slope of 4:1 the calculations is as follows:

Downslope correction factor = 100 ÷ [100-(side slope x % ground slope)]
= 100 ÷ [100-(4 x ______ % slope)]
= 100 ÷ [100-(4 x ______)]
= ______

I = 4(D+ E+ F) x downslope correction factor
= 4(______ +______ + ______)(______)
= ______ ft.

Step 10. Determine the upslope width (J).

Using a recommended side slope of 4:1 the calculations is as follows:

Upslope correction factor = 100 ÷ [100+(side slope x % slope)]
= 100 ÷ [100+(4 x ______% slope)]
= 100 ÷ [100+(4 x ______)]
= ______

J = 4(C+ E+ F) x upslope correction factor
= 4(______+______+______)(______)
= ______ ft.

Step 11. Determine the end slope length (K).

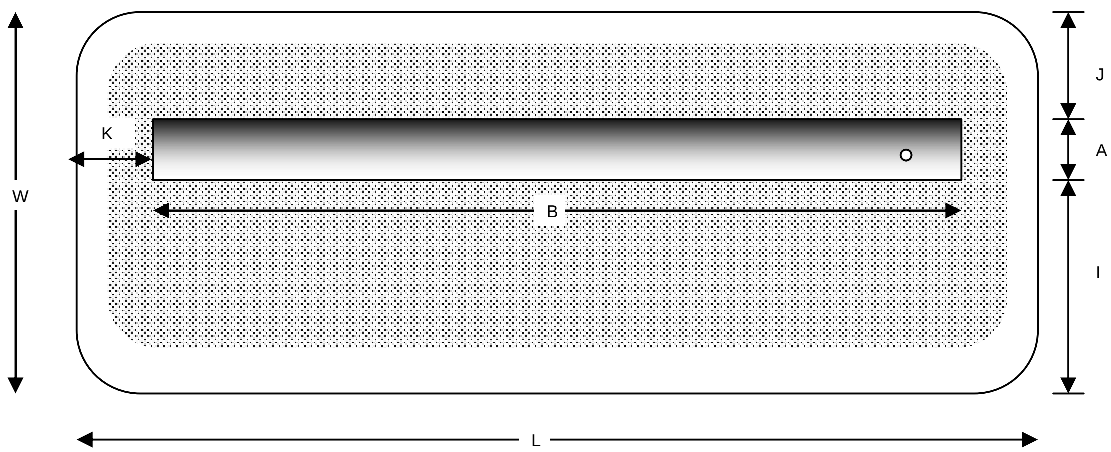
Using a recommended side slope of 4:1 the calculations is as follows:

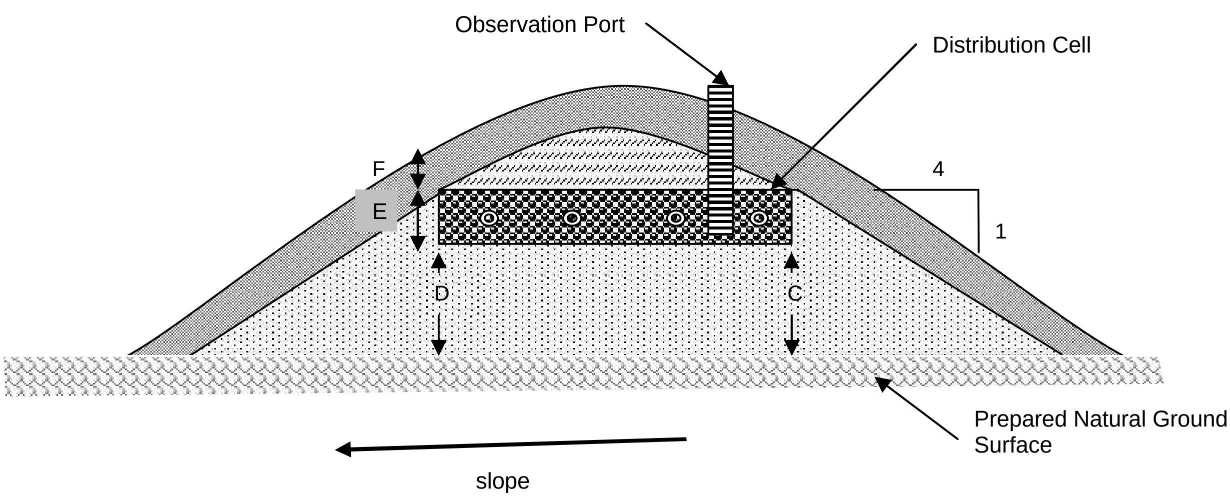
K = 4[(C+D)/2 +E +F]
= 4[(______+______)/2 +______+______]
= ______ ft.

Step 12. Determine the overall width (W) and length (L) of the mound fill.

W = A + I + J
= _______ + _______+ _______
= _______ft.

L = B + 2K
= _______ + 2(_______)
= _______ ft.





Mound Component Dimensions

A	Distribution cell width	
B	Distribution cell length	
C	Up slope fill depth under distribution cell	
D	Downslope fill depth under distribution cell	
E	Distribution cell depth	
F	Depth of final cover	
I	Distance from edge of distribution cell to downslope edge of fill	
J	Distance from edge of distribution cell to up slope edge of fill	
K	Distance from end of distribution cell to edge of fill	
L	Overall mound fill length	
W	Overall mound fill width	

APPENDIX E

Plan Submittal Checklist

In order to install a system correctly, it is important to develop overall plans that will clearly communicate how to install the system correctly. The following checklist may be used when preparing plans for review. The checklist is suggested as a general guide. Not all needed information may be included in this list. Additional information may be needed or requested to address unusual or unique characteristics of a particular project.

Forms and Fees

- ☐ Application form for submittal, provided by reviewing agency along with proper fees.

Soils Information

- ☐ Complete soil description for each soil boring described by a competent professional.
- ☐ The location of all borings and backhoe excavations must be identified on the plot plan.

Documentation

- ☐ Plans signed sealed and dated by licensed professional.
- ☐ Copy of mound design work sheet confirming basis of design and design calculations.

Plot Plan

- ☐ Dimensioned plans or plans drawn to scale (scale indicated on plans) with property boundaries clearly marked.
- ☐ Slope directions and percent in initial and replacement system area.
- ☐ Bench mark and north arrow.
- ☐ Setbacks indicated as per appropriate code.
- ☐ Two-foot contours or other appropriate contour interval within the system area.
- ☐ Location information; legal description of parcel must be noted.
- ☐ Location of any nearby existing system or well.

Plan View

- ☐ Dimensions for distribution cell(s).
- ☐ Location of observation pipes.
- ☐ Overall dimensions of mound.
- ☐ Pipe lateral layout, which must include the number of laterals, pipe material, diameter, length and number, location and size of orifices and orifice shields.
- ☐ Manifold and force main locations, with materials, length and diameter of each.

Cross Section of System

- ☐ Includes tilling requirement, distribution cell details, percent slope, side slope, and cover material.
- ☐ Lateral elevation, position of observation pipes, dimensions of distribution cell, and type of cover material and geotextile fabric.
- ☐ Sand fill specifications.

Tank And Pump Information

- ☐ All construction details including cross section of tanks.
- ☐ Size and manufacturer information for prefabricated tanks.
- ☐ Notation of pump model, pump performance curve, and summary of calculation for total dynamic head.
- ☐ Notation of high water alarm manufacturer and model number.
- ☐ Cross section of dose tank / chamber to include storage volumes; connections for piping, vents, and power, pump "off" setting , pump control timer settings and volume, high water alarm setting, location of vent and riser details.
- ☐ Tank leak testing requirements.

Detailed Specifications

- ☐ Detailed specifications for all materials and equipment.
- ☐ Detailed specifications describing all phases of site preparation and construction including provisions for protection of mound areas prior to construction and testing.

Inspections

- ☐ Inspection shall be made in accordance with requirements of the local health department. The inspection of the system installation and/or plans is to verify that the system at least conforms to specifications listed.
- ☐ Affidavit signed by designer attesting to compliance with approved plans and specifications.