SUBSURFACE SOIL ABSORPTION OF WASTEWATER
MOUND SYSTEMS

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I. Introduction

A. Description

A mound system is a subsurface soil absorption system that is elevated above the natural soil surface in a suitable fill material. Trenches or beds are constructed in the fill maintaining one to two feet of fill material between the bottom of the seepage area and the natural soil. Septic tank effluent is pumped or siphoned into the gravel area through a pressure distribution network. The system is covered with a finer textured soil material. See Figure I. A-1.

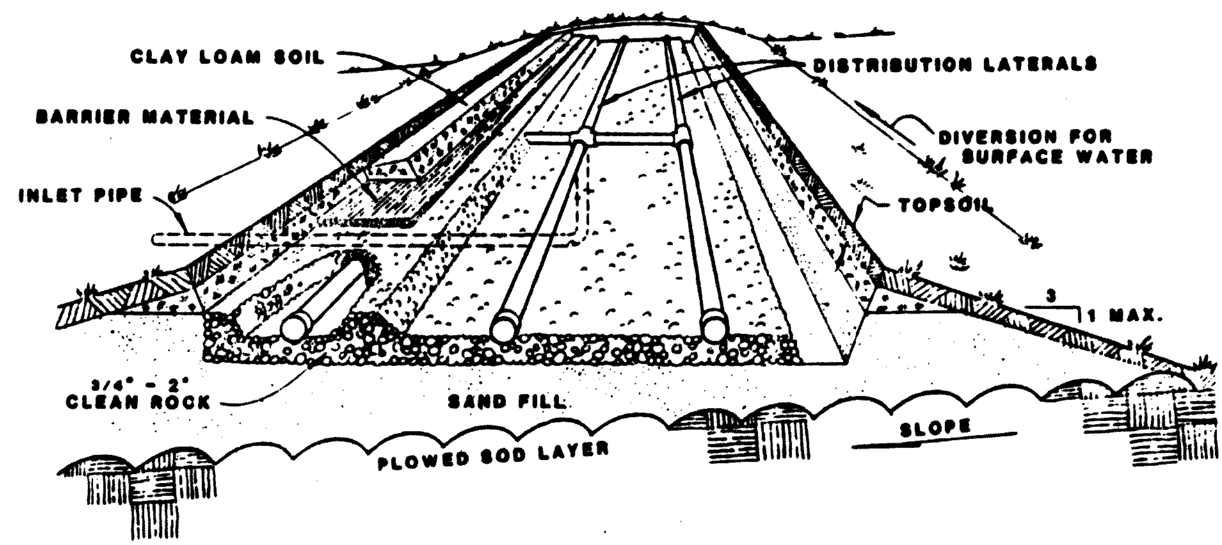


Figure I. A-1: Mound System Schematic

B. History

1, NODAK System

The mound system was originally developed in North Dakota in the late 1940's where it became known as the NODAK System (Witz, et.al, 1974). It was conceived to overcome problems with subsurface disposal on farmsteads located on slowly permeable and high water table soils. The absorption bed was constructed in a gravelly fill placed over the original soil after the topsoil had been removed.

2. Wisconsin Mound

Monitoring of NODAK Systems revealed that the gravelly fill was too coarse to provide adequate filtration to protect the groundwater where shallow soil existed and that surface seepage would occur during wet periods where the systems were constructed over slowly permeable soils. Changes in design were made to overcome these problems, the principal ones being: (1) to leave the topsoil in place but plowing it prior to placement of the fill, (2) to use a medium sand texture fill, and (3) to use pressure distribution to uniformly apply the effluent over the seepage area (Univ. Wis, 1978).

3. Other Mounds

Largely independent from the development in Wisconsin, other states developed similar mounds, notably Pennsylvania ("elevated sand mounds"), and Minnesota ("gopher mound"), but these designs have been abandoned since in favor of the Wisconsin design.

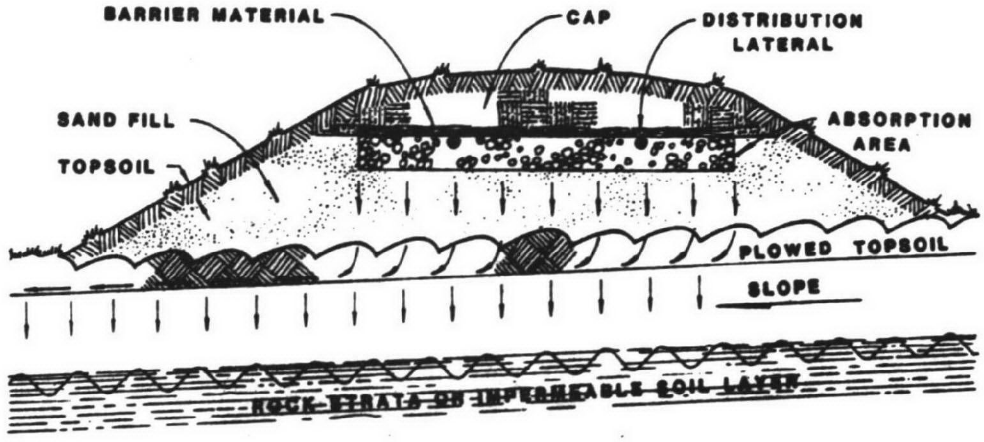
II. A. Functions

1. Absorption

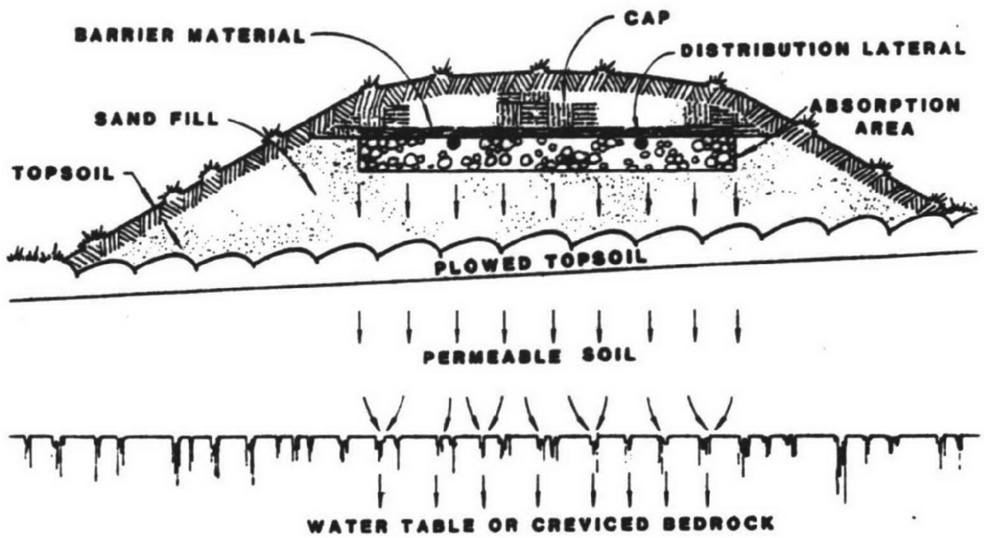
In slowly permeable soils, the primary function of the mound is absorption of the wastewater into the natural soil. By elevating the seepage area above the natural soil surface, several advantages result:

- Absorption into the topsoil

The topsoil is usually more permeable than the subsoil because of greater soil flora and fauna activity. Conventional systems are installed below the topsoil losing the benefit of the greater permeability. Once into the topsoil, it can move laterally until absorbed by the subsoil. See Figure II. A-1(a). (Transpiration by plants may also remove significant amounts of water during the growing season, but the mound is designed to function solely by absorption.)



(a)



(b)

Figure II. A-1: Schematic of water movement from a mound system. (a) slowly permeable soils; (b) permeable soils over high water tables or shallow porous bedrock.

- Less restrictive clogging mat

  Pressure distribution appears to reduce the severity of the clogging mat in coarse, textured soils such as the sandy fill material.

- Construction damage minimized

  Smearing and compaction of the wetter subsoil during construction is avoided since excavation in the natural soil is not necessary.

2. Treatment

In shallow permeable soils, the primary function of the mound is to provide additional unsaturated soil material to adequately treat the wastewater before it reaches the groundwater. See Figure II. A-1(b).

B. Treatment Effectiveness

Several years of monitoring of laboratory models and full-scale field systems have demonstrated that mound systems consistently remove all waste contaminates of concern except for nitrogen (Univ. Wis., 1978). There is some evidence that some nitrogen removal does occur in mound systems (Harkin, et.al, 1979). To maintain this treatment level, approximately 2 ft. of natural unsaturated soil is required below the fill material.

C. Application

Mounds are used in slowly permeable soils and permeable soils with shallow water tables or shallow creviced or porous bedrock where conventional trench or bed systems are unsuitable. Site criteria for mounds are summarized in Table II. C-1. These represent current practice for small systems and can be expected to become broader as experience is gained. Larger systems require more detailed hydrogeologic site investigations.

III. Design

Mound design is based on: (1) the estimated peak daily wastewater volume, (2) the fill characteristics, and (3) the natural soil characteristics. Mounds must be designed to accept the peak daily wastewater flow without surface seepage or encroachment of the zone of saturation into the fill material.

A. Wastewater Characteristics

1. Volume

The peak daily wastewater volume is used to size the system.

TABLE II. C-1
SITE CRITERIA FOR MOUND SYSTEMS

Item	Criteria
Landscape Position	Well-drained areas, level or sloping. Crests of slopes or convex slopes most desirable. Avoid depressions, bases of slopes and concave slopes unless suitable drainage is provided.
Slope	0 to 6% for soils with percolation rates slower than 60 min/in.[a]
	0 to 12% for soils with percolation rates faster than 60 min/in.[a]
Typical Horizontal Separation Distances from Edge of Basal Area	
Water Supply Wells	50 to 100 ft
Surface Waters, Springs	50 to 100 ft
Escarpments	10 to 20 ft
Boundary of Property	5 to 10 ft
Building Foundations	10 to 20 ft (30 ft when located upslope from a building in slowly permeable soils).
Soil	
Profile Description	Soils with a well-developed and relatively undistrubed A horizon (topsoil) are preferable. Old filled areas should be carefully investigated for abrupt textural changes that would affect water movement. Newly filled areas should be avoided until proper settlement occurs.
Unsaturated Depth	20 to 24 in. of unsaturated soil should exist between the original soil surface and seasonally saturated horizons or pervious or creviced bedrock.
Depth to Impermeable Barrier	3 to 5 ft[b]
Percolation Rate	0 to 120 min/in. measured at 12 to 20 in.[c]

[a] These are present limits used in Wisconsin, established to coincide with slope classes used by the Soil Conservation Service in soil mapping. Mounds have been sited on slopes greater than these, but experience is limited.

[b] Acceptable depth is site dependent.

[c] Tests are run at 20 in. unless water table is at 20 in., in which case test is run at 16 in. In shallow soils over pervious or creviced bedrock, tests are run at 12 in.

For systems to serve single family residences the peak volume is estimated from the size of the home, typically by the number of bedrooms. Common practice is to use 150 gpd per bedroom. For large cluster systems serving five houses or more, the peak volume is based on the maximum population to be served. Fifty to 75 gal per capita per day plus a factor for infiltration for extensive collection systems is used.

2. Pretreatment

Septic tank treatment is sufficient for mound systems. Further treatment is not beneficial.

B. Fill Selection

The fill material must be selected before sizing of the mound can be done because the material's infiltrative capacity determines the required absorption bed area. Medium textured sands, sandy loams, soil mixtures, bottom ash, strip mine spoil and slags are being used or are being tested (Converse, et.al, 1978). To keep costs of construction to a minimum, the fill should be selected from locally available materials. Commonly used fill materials and their respective design infiltration rates are presented in Table III. B-1.

TABLE III. B-1

COMMONLY USED FILL MATERIALS AND THEIR DESIGN INFILTRATION RATES

Fill Material	Characteristics	Design Infiltration Rate gpd/ft^2
Medium sand*	>25% 0.25-2.0mm <30-35% 0.05-0.25mm < 5-10% 0.002-0.05mm	1.2
Sandy loam	5-15% clay content	0.6
Sand/Sandy loam mixture	88-93% Sand 7-12% Finer grained material	1.2
Bottom ash	--	1.2

* Equivalent to 85% by weight between 10 and 60 mesh

C. Location

1. Area Required

Mounds designed for 3-bedroom homes require 2200 ft^2 to 3500 ft^2 of area depending on the permeability of the natural soil. Therefore, lots no smaller than one-half acre are necessary to maintain sufficient set back distances. Larger lots are preferable.

2. Slope

Gently sloping sites are preferred sites for mounds to promote lateral movement of liquid away from the mound. Crests of slopes are ideal because flow will occur in both directions from the divide. Slopes greater than 15 percent should not be used because of the danger of surfacing at the downslope perimeter or toe of the mound. The trenches or beds should be curved to follow the contour. However, concave slopes should be avoided because the flow from the mound may converge downslope and result in surface seepage.

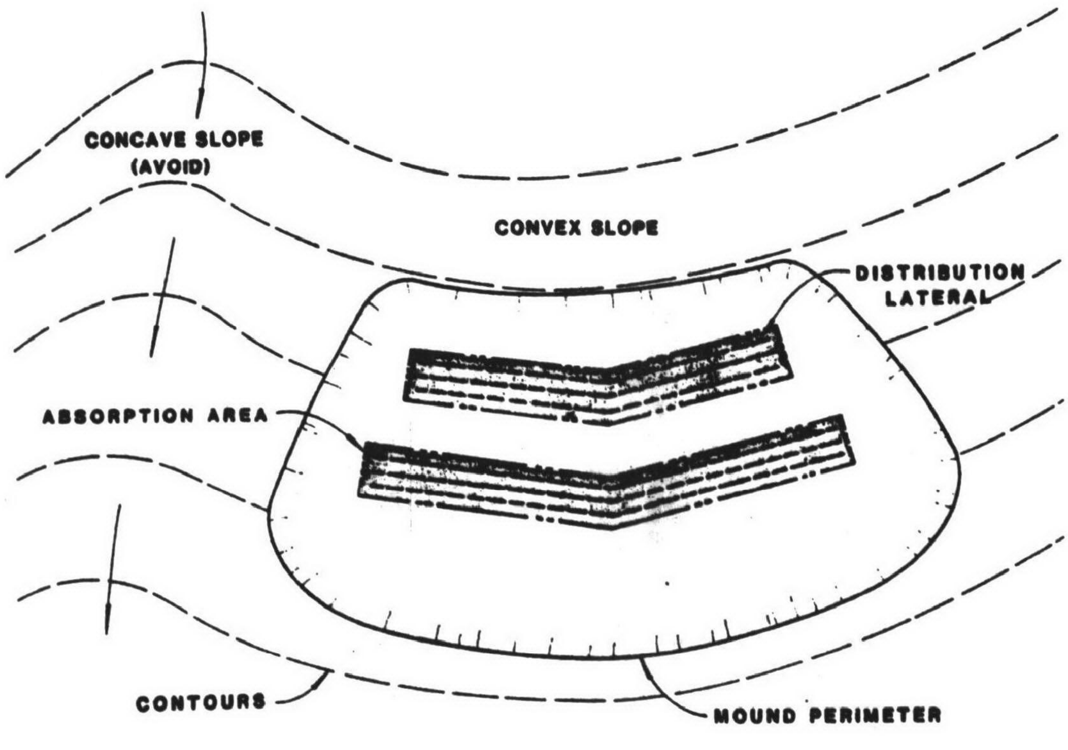


FIGURE III. C-1: Mound Orientation on a Complex Slope

3. Trees

If desired, large trees should be preserved. The mound need not have exposure to the sun or wind to function properly. It is designed to function by subsurface absorption only. However, trees that are within the mound perimeter may die if their trunks are partially buried. If it is necessary to remove the trees, they should be cut off at ground level and the stumps left in place so damage is not done to the natural soil.

D. Sizing

1. Geometry

The shape of the mound is largely dictated by the characteristics of the site. It is important that the system be laid out such that the water table or zone of saturation does not rise up into the fill material during wastewater application. Therefore, the following must be considered:

- Soil permeability

  If the soil is slowly permeable (slower than 60 to 90 min/in), the absorption area within the mound should be a narrow trench 5 ft or less in width oriented with its long axis perpendicular to the natural ground slope. If the percolation rate is faster than 40 to 60 min/in, beds may be used instead of trenches to reduce the mound's length. However, elongated beds with the long axis perpendicular to the natural ground slope are preferred to square beds.

- Unsaturated depth

  In permeable soils with water tables at 1 to 2 ft, beds no wider than 10 to 15 ft should be used within the mound. If the water table is greater than 3 ft below the surface, square beds are acceptable. In slowly permeable soils, perched water table or saturated soil conditions may occur during wet periods. The soil must be carefully examined for any evidence of this. (See "Site Evaluation for Onsite Treatement and Disposal Systems.")

- Layering within the soil profile

  The soil profile must be carefully examined for layers which may impede the vertical movement of liquid. If found, long narrow trenches oriented perpendicular to the natural ground slope rather than beds should be used.

- Bedrock or very slowly permeable barriers

  Usually the natural surface topography conforms to the topography of the bedrock surface. For large mound systems (>1000 gpd), this should be confirmed. If they do not conform, the mound should be oriented relative to the bedrock surface rather than the ground surface. However, plowing of the natural soil should still follow the surface contours.

Example: A large mound is to be used to dispose of sanitary wastes from an industrial firm. The available site has a shallow depth to bedrock. Borings indicate that the surface and bedrock topography differ. The primary concern is movement of the liquid away from the site which will occur in the saturated zone at the bedrock surface. The secondary concern is seepage at the based of the mound due to movement along the fill/soil interface. Since this movement will be parallel to the surface slope, the natural soil will be plowed along the surface contours (See Figure III. D-1).

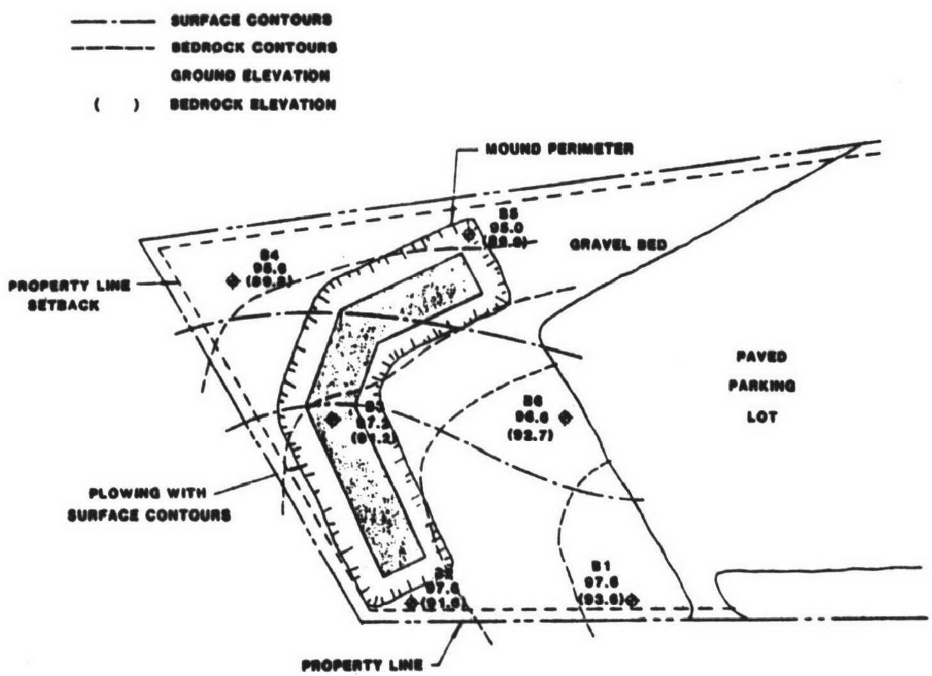


FIGURE III. D-1: Mound Orientation Conforming to Shallow Barriers to Flow

- Small lots

  If the site is too small to fit a single trench or bed along the contour, multiple trenches or beds may be used. The absorption areas may be tiered down on more steeply sloping sites to reduce the amount of fill necessary (See Figure III. D-2). In areas with slowly permeable soils, tiering may not be possible because the zone of saturation may rise up into the fill material.

2. Absorption Area

The absorption trench or bed within the mound is sized on bottom area only using the estimate peak daily wastewater flow and the design infiltration rate of the selected fill material.

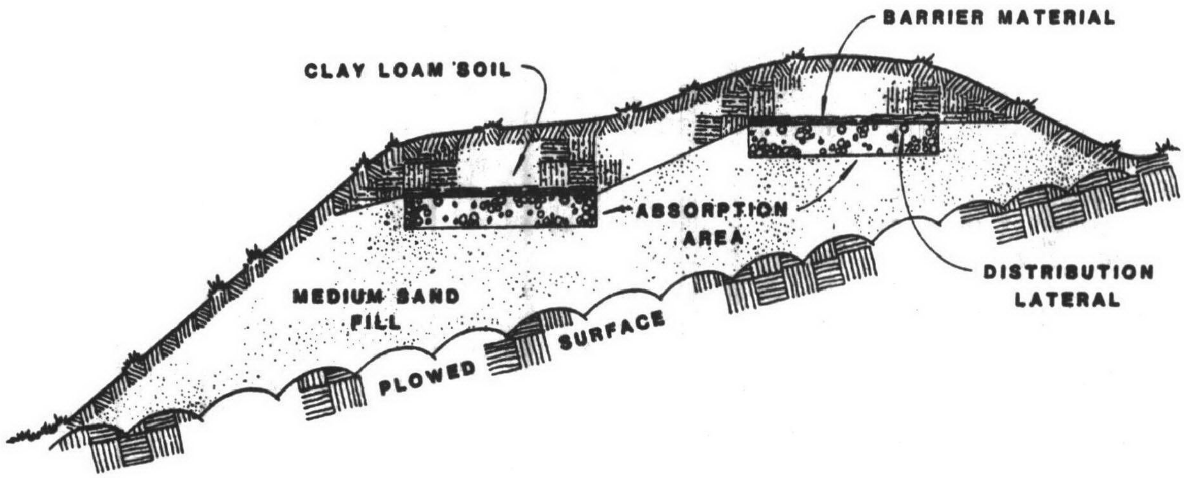


FIGURE III. D-2: Tiered Mound on a Sloping Site

3. Mound Basal Area

The basal area or the fill-natural soil interface of the mound must be sufficiently large to absorb all of the applied wastewater. Once into the topsoil, the liquid can move laterally out beyond the perimeter of the mound until absorbed by the subsoil. On level sites, the entire fill-natural soil interface can be used in determining the necessary area since lateral flow can occur in all directions. On sloping sites, only the area immediately below and downslope from the absorption area is considered. Infiltration rates for the natural soil used in design are presented in Table III. D-1. The soil horizon with the lowest permeability within the upper 24 inches should be used in this sizing. Dimensions of other mound components are shown in Figure III. D-3.

TABLE III. D-1

INFILTRATION RATES FOR DETERMINING MOUND BASAL AREA (U.S. EPA, 1980)

Natural Soil Texture	Percolation Rate* min/in	Infiltration Rate gpd/ft^2
Sand, Sandy loam	0-30	1.2
Loams, Silt loams	31-45	0.75
Silt Loams, Silty clay loams	46-60	0.5
Clay loams, Clay	61-120	0.25

* Measured at 12 to 20 in

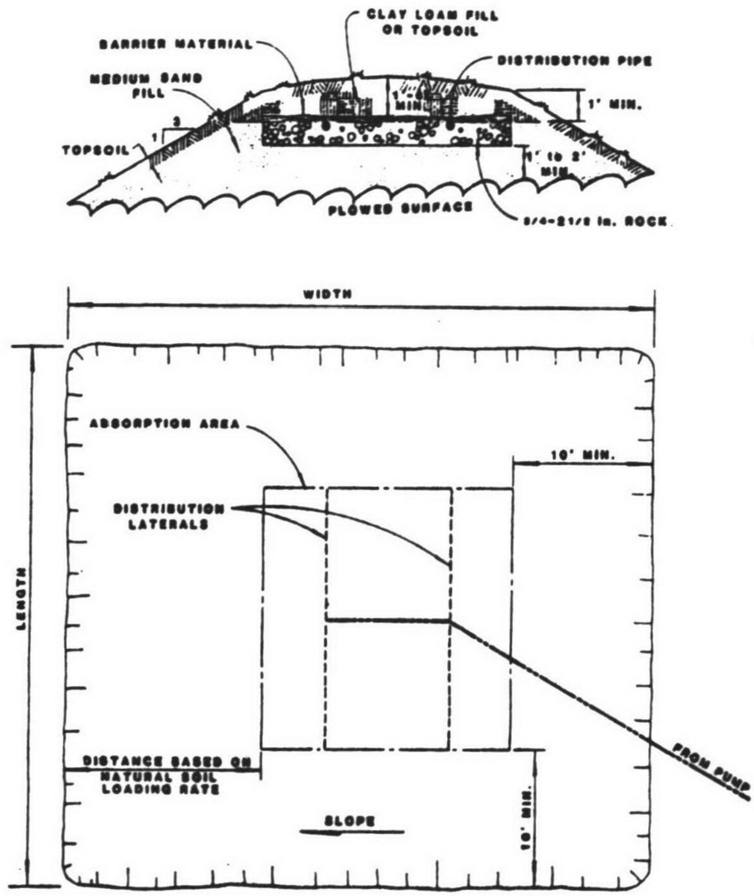


FIGURE III. D-3: Mound Dimensions

Example: A mound is to be built for a three-bedroom home on a lot with a shallow water table. The soil is a silty clay loam with a percolation rate of 60 min/in. A level and a sloping site may be used for the mound site. Compare the dimensions of the perimeter to mounds designed for each site.

Design flow

$Q = 3 \text{ bedrooms} \times 150 \text{ gpd/bdrm} = 450 \text{ gpd}$

Absorption area required (medium sand fill to be used: 1.2 gpd/ft^2 infiltration rate)

$$\text{Area} = \frac{450 \text{ gpd}}{1.2 \text{ gpd/ft}^2} = 375 \text{ ft}^2$$

Absorption area dimensions (10 ft max trench width due to high water table)

$$\text{Length} = \frac{375 \text{ ft}^2}{10 \text{ ft}} = 37.5 \text{ ft} \Rightarrow 38 \text{ ft}$$

Dimensions: 10 ft x 38 ft

<u>Mound perimeter dimensions</u> (From Table III. D-1 select 0.5 gpd/ft^2 for natural soil infiltration rate)

- Level site: Assume lateral flow is equal in all directions. Therefore, entire basal area can be used for absorption.

  Absorption area perimeter = 2 x 10 ft + 2 x 38 ft = 96 ft

  $$\text{Lateral flow/ft of bed perimeter} = \frac{450 \text{ gpd}}{96 \text{ ft}} = 4.7 \text{ gpd/ft}$$

  $$\text{Distance to mound perimeter} = \frac{4.7 \text{ gpd/ft}}{0.5 \text{ gpd/ft}^2} = 9.4 \text{ ft}$$

  In this case, this distance is measured from the center line of the bed since the soil immediately below the bed is also used for absorption. However, a minimum distance from the perimeter to the absorption area sidewall is 10 ft to maintain at least a 3:1 slope (See Figure III. D-3).

  Mound dimensions:

  Width = 10 ft + 10 ft + 10 ft = 30 ft
  Length = 10 ft + 38 ft + 10 ft = 58 ft
  => 30 ft x 58 ft

- Sloping site: Lateral flow is assumed to be parallel to the slope only. Therefore, only the area below the absorption area and downslope from it is considered.

  $$\text{Lateral flow/ft of bed} = \frac{450 \text{ gpd}}{38 \text{ ft}} = 11.8 \text{ gpd}$$

  $$\text{Distance to mound perimeter} = \frac{11.8 \text{ gpd}}{0.5 \text{ gpd/ft}^2} = 23.6 \text{ ft} \Rightarrow 24 \text{ ft}$$

  In this case, this distance is measured from the upslope sidewall of the absorption area. A 10 ft min distance to the upslope and sideslope mound perimeters is required to maintain at least a 3:1 slope (See Figure III. D-3).

  Mound dimensions:

  Width = 10 ft + 24 ft = 34 ft
  Length = 10 ft + 38 ft + 10 ft = 58 ft
  34 ft x 58 ft

  Although the mound on the level site is smaller, the sloping site is preferred because of better subsoil drainage.

4. Mound Height

- Fill depth

The depth of fill under the absorption area is determined by the degree of treatment required. The combined depth of fill and natural soil should be a minimum of 3 ft. In areas of permeable soils with shallow creviced bedrock, a combined minimum depth of 4 ft.is common because of the greater risk of contaminating ground water used for water supply. On sloping sites, the depth of fill below the absorption area increases downslope. To prevent uneven settling of the absorption area, the mound should be designed to limit the depth of fill under the downslope portion of the bed to 3 1/2 ft. To meet this requirement, tiering of the absorption area may be necessary.

- Trench or bed depth

A minimum depth of 6 in. of aggregate is used below the distribution pipe to provide some water storage during peak flows. An additional 2 in. of aggregate is placed above the pipe to protect and insulate the pipe.

- Mound cap

The cap provides frost protection and promotes runoff. It is a finer textured material such as a silt loam or clay loam to promote runoff and at the same time, retain more water for a good vegetative cover. The cap depth should be 1 1/2 to 2 ft. above the top of the aggregate in the center of the mound and a minimum of 1 ft. at the edge of the absorption area in areas of severe winters. An additional 4 in. to 6 in. of good top soil should cover the entire mound.

5. Side slopes

Side slopes should be no greater than 3:1 for stability and maintenance. A minimum distance from the sidewalls of the absorption area to the mound perimeter of 10 ft. is common practice. The length of the downslope may be greater due to basal absorption area requirements.

D. Distribution

1. Method

Although both gravity and pressure distribution networks have been used in mound systems, the pressure networks have been shown to be superior (Converse, et. al, 1978, Univ. Wis, 1978). They ensure unsaturated flow is maintained and prevent short circuiting through the fill material by applying the wastewater uniformly over the entire absorption area. It is important that the network is designed such that the manifold drains between dosings. Drainage can be either out the laterals or back into the lift station. The method used depends on the relative elevations of the dosing tank and the distribution laterals. Pressure networks can be designed for simultaneous loading of each absorption area but dual systems pressurized by duplex pumping units or alternating siphons are preferred to ensure equal division of flow. For design of these networks, see "Distribution Networks for Subsurface Soil Absorption Systems". Also, see Converse (1978), EPA (1980) and Otis (1981).

2. Dose volume

Frequent small doses of wastewater ensure unsaturated flow through the fill but too frequent dosing can lead to more severe clogging. Dosing frequencies of 2 to 4 times daily should be employed.

E. Porous Media

Any durable material that performs the necessary functions of providing access to the infiltrative surface, water storage, support of the absorption area sidewalls and dissipating the energy in the influent can be used. Gravel or crushed rock is most common. Recommended sizes range from 3/4 to 2-1/2 in. The smaller size is preferred. The rock should be free from fines, durable and resistant to slaking and dissolution. A hardness of 3 or greater on Moh's scale of hardness is suggested. Rock that can scratch a copper penny without leaving any residual rock meets this criterion.

F. Barrier Material

To maintain the porous nature of the media, a barrier material must be placed over the media to prevent backfilled material from filling the voids. The material should be porous to water vapor and resistant to rapid decay. A 6 to 9 in. layer of uncompacted marsh hay or synthetic drainage fabric is recommended.

G. Inspection Vents

Inspection vents provide limited access into the absorption area to observe the depth of ponding which is a measure of the system's performance. They extend vertically from the gravel-fill interface to 6 to 12 in. above finished grade. The pipe is open at the bottom and perforated within the gravel layer. A vent cap or threaded plug is used to cover the open end.

IV. Construction

Proper construction is extremely important if the mound is to function as designed. Detailed construction procedures are outlined by Converse (1978).

A. Machinery

Small track type tractors are recommended for working the fill over the site. Wheeled tractors are difficult to maneuver in the uncompacted fill. The narrow tires also have the tendency to spin, penetrating the fill and disturbing the plowed soil

B. Site Preparation

1. Vegetative Cover

Excess vegetation should be cut and removed. Trees should be cut at ground surface and the stumps left in place.

2. Staking

The mound is staked out in the proper orientation and the ground elevation shot along the upslope edge of the absorption area. This elevation is necessary to establish the elevation of the bottom of the absorption area. It should be tied to a bench mark established at the site.

3. Distribution Network Delivery Pipe

The delivery pipe from the dosing tank to the mound should be installed and stubbed off 12 in. below the ground surface. The backfill around the pipe should be compacted to prevent seepage along the trench. Extend the pipe several feet above the ground surface after the plowing is completed, but before the fill material is spread.

4. Plowing

The area within the perimeter of the mound is plowed to a depth of about 8 in. Plowing is done along the contour, throwing the soil upslope. Moldboard or chisel plows may be used. Rototilling is too damaging to the soil. Soil moisture during plowing must be below the plastic limit. Check by rolling a sample of soil taken from the plow depth between the hands. If it crumbles, plowing may proceed.

C. Fill Placement

1. Delivery

The fill should be spread over the area immediately after plowing. The delivered fill should be dumped around the upslope and side edges of the plowed area. Traffic on the plowed area and the downslope side should be avoided to prevent compaction of the topsoil.

2. Spreading

The fill is moved into place using a small track type tractor with a blade. A minimum of 6 in. of fill should always be under the tracks to prevent compaction of the natural soil.

D. Absorption Area

1. Forming

The absorption trench or bed is formed in the fill after all the fill is in place. The bottom of the area is hand-leveled to the elevation established prior to plowing.

2. Aggregate

The aggregate is laid in the absorption area to a minimum depth of 6 in. Care must be taken to avoid rutting of the bottom surface.

3. Distribution Network

The distribution network is assembled in place setting the manifold to ensure draining between doses. Additional rock is placed over the pipe and the aggregate covered with a suitable barrier material.

E. Cover Material

1. Cap

The finer textured cover material should be dumped on the upslope edge of the mound for spreading with the track type tractor. An additional 4 in. to 6 in. layer of good quality topsoil is placed over the entire mound.

2. Vegetation

The mound should be seeded and mulched or sodded immediately after construction to stabilize the side slopes. Moisture-tolerant shrubs can be planted around the mound perimeter and up the side slopes.

V. Operation and Maintenance

A. Routine Maintenance

A properly designed and constructed mound requires no more attention than a conventional trench or bed system.

B. Rehabilitation

Two different failure conditions may occur within the mound. Each usually can be corrected.

1. <u>Absorption Area Clogging</u>

Surfacing of septic tank effluent high on the sideslopes when the base of the mound remains dry indicates severe clogging of the absorption area within the mound. This may be caused by: (1) improper maintenance of the pretreatment unit, (2) hydraulic overloading, or (3) unusual wastewater characteristics. The cause must first be determined and corrected. Hydrogen peroxide then can be used to oxidize the clogging mat. If it is necessary to enlarge the mound, the cap can be removed, the absorption bed stripped out and additional fill added.

2. <u>Natural Soil Clogging</u>

If the fill-natural soil interface fails to accept all the wastewater, surfacing of the effluent will occur along the base of the mounds. Additional fill may have to be added down-slope. If this does not correct the situation, the mound should be elongated along the contour. If neither corrects the problem, the site may have to be abandoned.

VI. Questions

1. Which type of site would be best suited for a mound system: level, crested or sloping? Would it vary with soil permeability?

2. What additional considerations should be included in the site evaluation and design for large mound systems?

3. How might frozen soil conditions affect mound operation? Would this affect the design?

4. If mound failure were to occur, how would the cause of failure be diagnosed?

VII. References

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VIII. Problems

A. Problem Statements

1. Single-Family Home

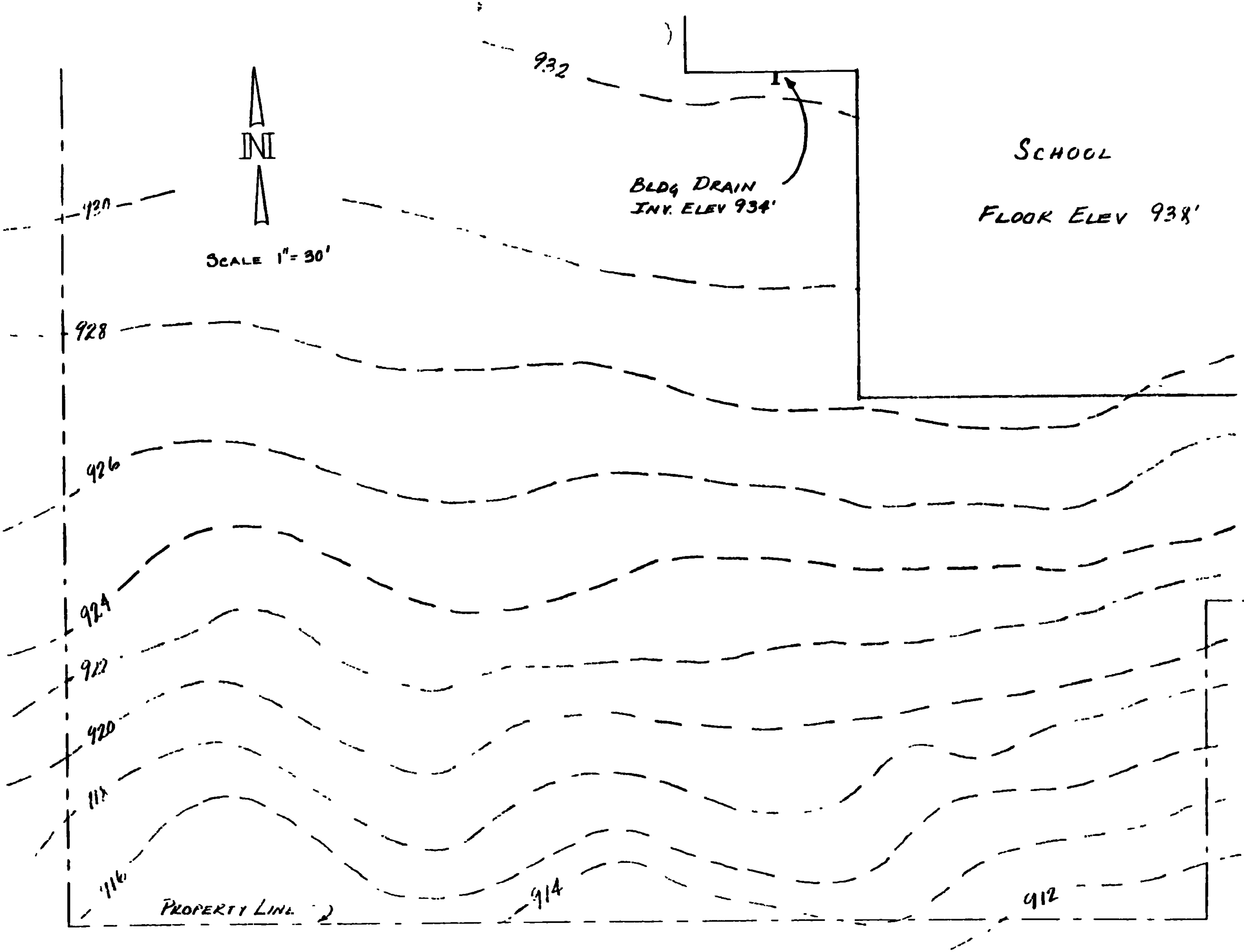
A 1-acre lot in an older subdivision has slowly permeable clay loam soils with distinct mottling at 28 in. Percolation rates are 90 min/in. The natural ground slope is 4 percent.

- Design a mound for a 4-bedroom home
- Sketch a plan and section of the mound showing all dimensions
- Would your design differ if the natural soil were a sandy loam? If the site were level?

2. Elementary School

A 600-student elementary school is to be built on a sloping property with limited space for a subsurface soil absorption system. The available area is shown with the natural topography on the attached plot plan. The soil is loam with creviced bedrock at 24 to 36 inches. Percolation rates are 35 min/in.

- Design a subsurface soil absorption system and lay it out on the plot plan. The school will not have a gymnasium and meals will be brought in.
- What are your concerns about the site? Do you desire any additional information?
- Indicate on your drawing the elevation of the bottom of the absorption area within the mound. What is the maximum depth of fill required below the area?
- Could you use dosing siphons? If so, does this affect the location of the system components? How?



N
SCALE 1"= 30'
932
BLDG DRAIN
INV. ELEV 934'
SCHOOL
FLOOR ELEV 938'
928
926
924
920
916
914
912
PROPERTY LINE

B. Solutions

1. Single-Family Home

- Design flow

  $Q = 4 \text{ bdrms} \times 150 \text{ gpd/bdrm} = 600 \text{ gpd}$

- Absorption area required (use medium sand fill)

  $\text{Area} = \frac{600 \text{ gpd}}{1.2 \text{ gpd/ft}^2} = 500 \text{ ft}^2$

- Absorption area dimensions

  A 5 ft maximum trench width is recommended for slowly permeable soils.

  Width = 5 ft

  $\text{Length} = \frac{500 \text{ ft}^2}{5 \text{ ft}} = 100 \text{ ft}$

- Fill depth

  Upslope edge of absorption area = 1 ft min

  Downslope edge of absorption area = 1 ft + 5 ft x 0.04 = 1.2 ft

- Bed depth

  A minimum depth of 6 in of rock below the pipe is recommended with additional 2 in covering the pipe. If 1-in distribution laterals are used, total bed depth (rock depth) will be 9 in.

- Mound cap depth

  Over the center of the bed a minimum depth of cover recommended is 1.5 ft of loamy soil and 4 to 6 in of topsoil. At least 1 ft of cover should be maintained at the edge of the absorption bed.

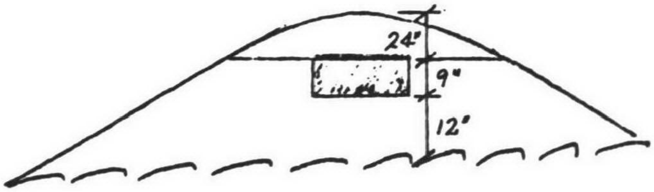
- Basal absorption area

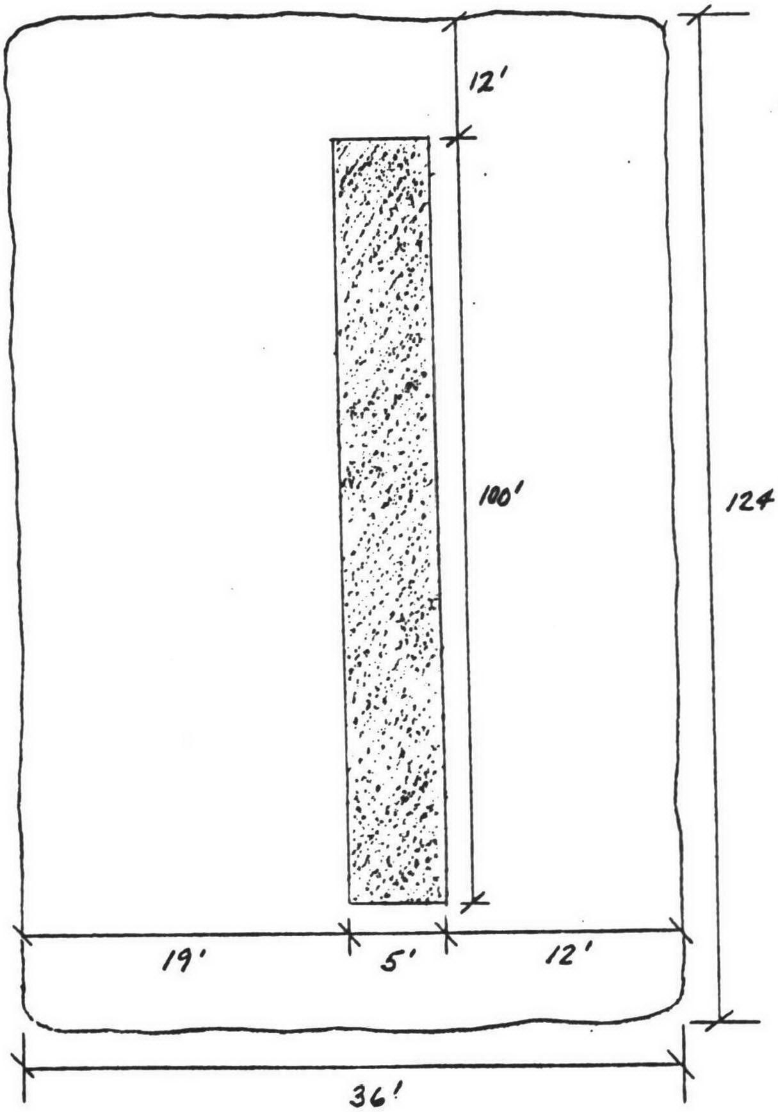
  From Table III. D-1, a natural soil infiltration rate of 0.25 gpd/ft^2 is determined.

  $\text{Basal area required} = \frac{600 \text{ gpd}}{0.25 \text{ gpd/ft}^2} = 2400 \text{ ft}^2$

  Area length (bed length) = 100 ft

  $\text{Area width} = \frac{2400 \text{ ft}^2}{100 \text{ ft}} = 24 \text{ ft}$





Mound for a 4-Bedroom Home in Clay Loam Soil
with Seasonally Parched Water Table (not to scale)

- Downslope length

Basal area width is measured from the upslope edge of the bed.

Length of downslope = 24 ft - 5 ft = 19 ft

- Mound dimensions

Length = 12 ft + 100 ft + 12 ft = 124 ft
Width = 12 ft + 5 ft + 19 ft = 36 ft

- Sideslopes/Upslope

A maximum side slope of 3:1 is recommended.

Slope length = 3.75 ft x 3 = 11.25 => 12 ft

2. Elementary School

- Design flow

Assume 10 gpd per student (Table III. A-2 "Onsite Wastewater Treatment: Septic Tanks")

Q = 500 students x 10 gpd/student = 5000 gpd

- Absorption area required (use medium sand fill)

$$\text{Area} = \frac{5000 \text{ gpd}}{1.2 \text{ gpd/ft}^2} = 4167 \text{ ft}^2$$

- Absorption area dimensions

The length of the absorption area in the mound will be limited by the site. Because of the steep slope, it is desirable to elongate the absorption area as much as possible. Maximum width of the slope is about 280 ft. Subtracting approximately 40 ft for sideslopes and property line setbacks, 240 ft remain for the bed.

$$\text{Bed width} = \frac{4170 \text{ ft}^2}{240 \text{ ft}} = 17.4 \text{ ft} \Rightarrow 18 \text{ ft}$$

- Depth of fill

Minimum depth of fill is 2 ft since creviced bedrock is within 2 ft of the ground surface.

Depth under downslope edge of bed = 2 ft + 18 ft x 0.15 (% slope)
= 4.7 ft

This difference in depths across the bed bottom is too great. Uneven settling may occur. Therefore, the bed will be divided into two 9' x 240' beds and tiered down the slope.

Depth under downslope edge of 9' bed = 2 ft + 9 ft x 0.15 (% slope)

= 3.35 ft <= OK

- Bed spacing

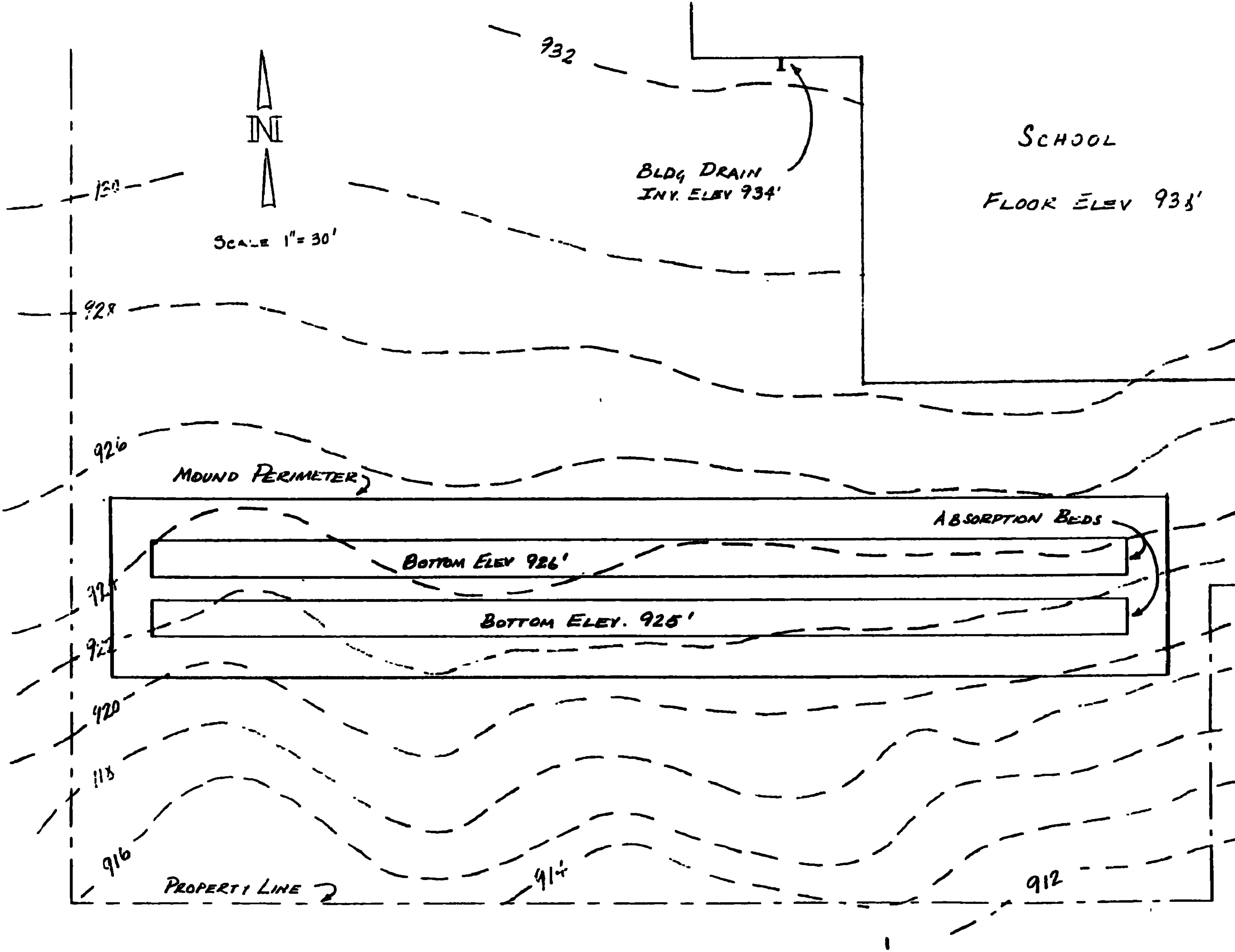
To limit hydraulic interference between the beds, the beds will be spaced sufficiently far apart so that the liquid from the upper trench is absorbed into the natural soil before the flow reaches the lower trench. A natural soil infiltration rate of 0.75 gpd/ft will be used (Table III, D-1)

Flow/linear ft of bed = 9 ft x 1.2 gpd/ft^2 = 10.8 gpd/ft

$$\text{Spacing} = \frac{10.8 \text{ gpd/ft}}{0.75 \text{ gpd/ft}^2} - 9 \text{ ft} = 5.4 \text{ ft} \Rightarrow 6 \text{ ft}$$

The remainder of the mound design follows the same procedures used in conventional mound design.

Dosing siphons can be used if the septic tank and dosing tank are constructed at a sufficent elevation above the distribution lateral inverts. Two siphons would be used, one for each bed. They will automatically alternate dosing.



N
Scale 1" = 30'
932
928
926
924
920
916
914
912
Bldg Drain
Inv. Elev 934'
School
Floor Elev 938'
Mound Perimeter
Absorption Beds
Bottom Elev 926'
Bottom Elev. 925'
Property Line