Indiana State
Department of Health

Environmental Public Health
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Elevated Sand Mound Design Manual

This manual supplements the provisions of ISDH Rule 410 IAC 6-8.3, *Residential On-Site Sewage Systems*, and ISDH Rule 410 IAC 10.1, *Commercial On-Site Sewage Systems*. It provides additional information on the procedures for the design of elevated sand mound systems for one and two family dwellings. It also applies to commercial facilities with daily wastewater flows that do not exceed 750 gallons for which review has been delegated in writing to the local health department. It does not include design criteria for systems which deviate from those documents, such as Type II mounds. Prior to elevated sand mound system design, the provisions of Residential Rule 410 IAC 6-8.3 or Commercial Rule 410 IAC 6-10.1, whichever is applicable, must be followed to determine site suitability for the application of this technology.

The intention of this manual is for the on-site system designer to be able to design an entire residential or small commercial elevated sand mound system when starting at the beginning and proceeding through this manual. This manual is divided into four sections:

The first section in this manual assists the designer in determining the actual size of the elevated sand mound for a project. A minimum amount of information is necessary to ensure accuracy of the design. This information includes:

- ✓ ***The Daily Design Flow (DDF) is expressed as gallons per day (gpd.) For residential systems, it is determined by the number of bedrooms (and bedroom equivalents) in the home [Rule 410 IAC 6-8.3-12]; for commercial systems, it is reported in the technical data sheet provided by the department for each commercial system.***
- ✓ ***The Soil Loading Rate (SLR) expressed as gallons per square foot per day (gpd/ft²)to be used for system design for the site [For residential systems: Table V, Rule 410 IAC 6-8.3-72(b)(7); for commercial systems: Table VI, Rule 410 IAC 6-10.1-80(b)(7)], and***
- ✓ ***The percent slope in the area proposed for the system.***

Section 1: Elevated Sand Mound Sizing

(a) Aggregate Bed

(1) The **size** of the aggregate bed shall be determined from the following:

(A) The minimum area of the aggregate bed shall be calculated as:

$$\text{minimum aggregate bed area (ft}^2\text{)} = \frac{\text{Daily Design Flow (DDF)}}{1.2\ \text{gpd/ ft}^2}$$

(B) The dimensions of the aggregate bed shall be as long and narrow as site conditions permit.

(C) The maximum width of the aggregate bed (in feet), is calculated as:

$$\text{maximum bed width} = 0.83\sqrt{\frac{(\text{DDF})(\text{SLR})}{3}}$$

where 0.83 is a conversion factor expressed in ft^2/gpd, DDF is daily design flow in gallons (not to exceed 1500), and where SLR is the soil loading rate.

(D) The minimum bed width shall not be less than four (4) feet and the maximum bed width shall not be more than ten (10) feet. Any bed width value from the bed width equation which is outside of these parameters must be adjusted to the minimum or maximum bed width.

(E) The minimum length of the aggregate bed is calculated as:
min. length (L) = min. aggregate bed area / max. aggregate bed width (AB).

(F) The depth of the aggregate bed shall be at least the sum of:
- (i) The depth of the aggregate below the pressure distribution lateral (a minimum of 6 inches);
- (ii) the outside diameter of the pressure distribution lateral; and
- (iii) at least two (2) inches of aggregate above the pressure distribution lateral.

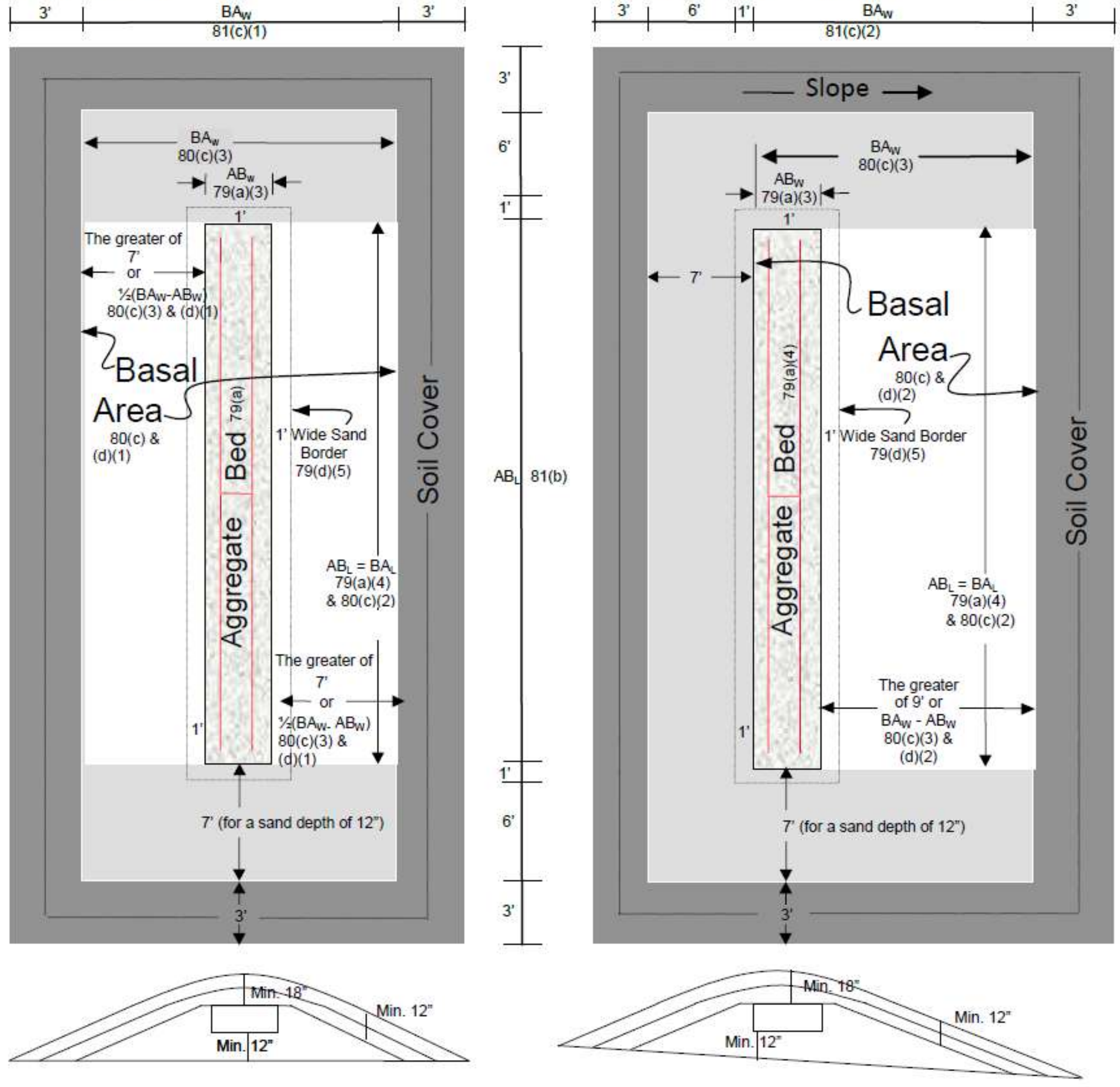
(2) The **location** of the aggregate bed shall be:
(A) for sites with slopes of one-half (1/2) percent or less, in the center of the basal area; and
(B) for sites with slopes greater than one-half (1/2) and less than or equal to six (6) percent, at the upslope side of the basal area**.**

Figure 1, Plan View of Sand Mound (Based on Minimum Dimensions), presents a visual depiction of the location of the aggregate bed within the basal area.

(3) The **design** of aggregate bed shall comply with the following:
(A) The bottom of the aggregate bed shall be level along its length and width.
(B) Aggregate used in the aggregate bed shall comply with the requirements of 410 IAC 6-8.1-68.
(C) The aggregate bed shall be installed in INDOT Specification 23 sand in the basal area [For residential systems, see Table XV, Rule 410 IAC 6-8.3-80(j); for commercial systems, see Table XVI, Rule 410 IAC 6-10.1-88(j)].
(D) A one (1) foot wide border of INDOT Specification 23 sand, level with the top of the aggregate bed, shall surround the aggregate bed. (See *Figure 1, Plan view of Elevated Sand Mounds*)

Figure 1
Plan View of Sand Mound
(Based on Minimum Dimensions)

(Slope ≤ 1/2%)	(1/2% < Slope ≤ 6%)



Legend: AB = Area of the Aggregate Bed, AB_L = Length of the Aggregate Bed, AB_W = Width of the Aggregate Bed, BA = Area of the Basal Area, BA_L = Length of the Basal Area, BA_W = Width of the Basal Area. Schematic is for a sand depth of 12 inches below the aggregate bed, and an aggregate bed depth of 6 inches below the laterals, plus the diameter of the laterals, plus 2 inches above the laterals.

(b) Basal Area

(1) The dimensions of the basal area and sand mound shall be as long and narrow as site conditions permit [For residential systems, see Rule 410 IAC 6-8.3-79(a)(2) and 80(a); for commercial systems, see Rule 410 IAC 6-10.1-87(a)(2) and 88(a)].

(2) Numerical dimensions provided in this section for basal area and sand mound sizes are rounded up to the nearest whole number. Numerical dimensions for the soil material cover from the edge of the basal area to the edge of the sand mound are based on a final grade of three-to-one (3:1) (on level sites). The plan views and numerical dimensions are for a simple slope (i.e., slopes that form a plane). Sand mounds sited on complex slopes are more difficult to design and construct on contour.

(3) The **size** of the basal area shall be determined from the following:

(A) The **minimum size** of the basal area shall be calculated as:

$$\text{minimum basal area (ft}^2\text{)} = \frac{\text{design daily flow}}{\text{soil loading rate}} = \frac{\text{DDF}}{\text{SLR}}$$

using the soil loading rate [see Rule 410 IAC 6-8.1-72(b)(7), Table V, for residential systems and Rule 410 IAC 6-10.1-80(b)(7), Table VI for commercial systems].

(B) The **length** (L) of the basal area shall equal the length of the aggregate bed.

(C) The minimum **width** of the basal area shall be calculated as the **GREATER** of:

(i) $$\text{Width (ft)} = \frac{\text{minimum basal area in ft}^2}{\text{length of aggregate bed in ft}}$$

OR

(ii)

Slope	**Min. Basal Area Width**
0% ≤ slope ≤ ½%	Agg Bed width + 14 ft.
½% < slope ≤ 6%	Agg Bed width + 9 ft.

The dimension determined from (i) or (ii) shall maintain a minimum sideslope grade of three-to-one (3:1).

See *Table 4 - Elevated Sand Mound Dimensions for Common Sizes* in the appendix

(4) The **location** of the basal area within the sand mound shall be:

(A) on sites with slopes of one-half (1/2) percent or less, the area under the aggregate bed and extending an equal distance from each side along the length of the aggregate bed;

(B) on sites with slopes greater than one-half (1/2) percent and less than or equal to six (6) percent, the area under the aggregate bed and extending directly downslope from the aggregate bed.

Figure 1, Plan View of Sand Mound (Based on Minimum Dimensions), presents a visual depiction of the location of the basal area within the sand mound.

(5) The **design** shall meet the following:

(A) The design shall be for:

(i) A site with a slope one-half (1/2) percent or less; OR

(ii) A site with a slope greater than one-half (1/2) and less than or equal to six (6) percent.

(B) A site where the area within the sand mound perimeter will be plowed parallel to the contour of the site.

(C) The long axis of the basal area and sand mound shall be oriented parallel to the contour of the absorption field site.

(D) The minimum depth of the INDOT Spec. 23 sand under the aggregate bed shall be twelve (12) inches.
(E) The INDOT Spec. 23 sand shall have a minimum final grade on all sides of three-to-one (3:1).
(F) The soil material cover shall have a minimum final grade on all sides of three-to-one (3:1).

(c) Dimensions of the Elevated Sand Mound

(1) The **minimum length** of a sand mound shall be the sum of the following:
(A) The length of the aggregate bed (L).
(B) Plus fourteen (14) feet, representing the two side-slopes of INDOT Specification 23 sand at both ends of the aggregate bed [including the one (1) foot level borders], and shall maintain a minimum sideslope grade of three-to-one (3:1).
(C) Plus a minimum of six (6) feet, representing the soil material cover at both ends of the aggregate bed.

(2) The **minimum width** of the sand mound shall be the sum of the following:
(A) On sites with <u>slopes one-half (1/2) percent or less</u>, the minimum width of a sand mound is the sum of the following:
(i) The width of the aggregate bed (AB).
(ii) Plus the greater of either:
a) the total width of basal area minus the width of aggregate bed; or
b) fourteen (14) feet.
The dimension from (a) or (b) shall maintain a minimum sideslope grade of three-to-one (3:1).
(iii) Plus a minimum of six (6) feet, representing the soil material cover on both sides of the aggregate bed.
(B) On sites with <u>slopes greater than one-half (1/2) percent and less than or equal to six (6) percent</u>, the minimum width of a sand mound shall be the sum of the following:
(i) The width of the aggregate bed (AB).
(ii) Plus seven (7) feet, representing the side-slope of INDOT Specification 23 sand on the upslope side of the aggregate bed [including the one (1) foot level border], and shall maintain a minimum sideslope grade of three-to-one (3:1).
(iii) Plus the greater of either:
a) the total width of basal area minus the width of aggregate bed; or
b) Nine (9) feet,
representing the side-slope of INDOT Specification 23 sand on the downslope side of the aggregate bed [including the one (1) foot level border] and shall maintain a minimum sideslope grade of three-to-one (3:1),
(iv) Plus a minimum of six (6) feet, representing the soil material cover on both sides of the aggregate bed.

The second section in this manual assists with the design of the pressure distribution network for an elevated sand mound. A minimum amount of information is necessary to ensure accuracy of the design. This information includes:

- ✓ ***The diameter of the effluent force main, and***
- ✓ ***The dimensions of the proposed elevated sand mound aggregate bed.***

Section 2: Effluent Force Main and Pressure Distribution Network

(a) The design of the pressure distribution network shall comply with the requirements of Rule 410 IAC 6-8.3-82 for residential systems, Rule 410 IAC 6-10.1-90 for commercial systems, and the following:

(1) The **effluent force main** leading up to the pressure distribution network shall approach the sand mound as follows:

(A) On sites with slopes of one half (1/2) percent or less, from either end.

The effluent force main must be positioned to minimize disturbance of the basal area plow layer. Therefore:

i) The effluent force main from the dosing tank to the elevated sand mound should not extend into the basal area plow layer.

ii) A vertical effluent force main segment should be installed to the center of the pressure distribution network piping located in the aggregate bed area. The vertical effluent force main will be connected to a horizontal effluent force main segment at the base of the aggregate bed elevation.

iii) A horizontal effluent force main segment should be installed parallel to the distribution laterals to the point of connection to the distribution network manifold.

(iv) The effluent force main must drain between doses unless it is installed below the frost line and is designed so that no effluent remains in any portion of the effluent force main located above the frost line. [See Rule 410 IAC 6-8.3-76(d), Table VIII, for residential systems and Rule 410 IAC 6-10.1-84(d), Table IX, for commercial systems.

(B) On sites with slopes greater than one half (1/2) percent and less than or equal to six (6) percent, from the upslope side.

The effluent force main must be positioned to minimize disturbance of the basal area plow layer. Therefore:

i) Installation of the effluent force main through the downslope basal area plow layer and the down slope dispersal area must be avoided.

ii) The preferred route of installation is from the upslope side of the basal area plow layer. If an upslope delivery is not possible the effluent force main may be installed at the end of the basal area plow layer.

iii) For an upslope effluent force main installation, the effluent force main segment from the dosing tank to elevated sand mound should not extend into the basal area plow layer.

iv) For upslope effluent force main installations, a vertical effluent force main segment should be connected directly to the pressure distribution network manifold. For end effluent force main installations, the vertical effluent force main segment should be connected to the manifold between the pressure distribution laterals. The vertical effluent force main will connect to a horizontal effluent force main segment at the base of the aggregate bed elevation.

v) The effluent force main must drain between doses unless it is installed below the frost line and is designed so that no effluent remains in any portion of the effluent force main located above the frost line. [See Rule 410 IAC 6-8.3-76(d), Table VIII, for residential systems and Rule 410 IAC 6-10.1-84(d), Table IX, for commercial systems.

(2) A **manifold** shall comply with the requirements of Rule 410 IAC 6-8.3-82(g) for residential systems, or Rule 410 IAC 6-10.1-90(g) for commercial systems, and be installed between the effluent force main and the pressure distribution laterals as follows:

(A) The manifold pipe for an elevated sand mound:

(i) with a design daily flow of seven-hundred and fifty (750) gallons per day or less, shall have a diameter of two (2) inches; or

(ii) with a design daily flow of greater than seven-hundred and fifty (750) gallons per day, shall have the same diameter as the effluent force main, or a diameter of two (2) inches, whichever is greater.

(B) The manifold shall be located within the aggregate bed.

(3) The **pressure distribution laterals** shall comply with the requirements of Rule 410 IAC 6-8.3-82(h) for residential systems, or 410 IAC 6-10.1-90(h) for commercial systems, and meet the following requirements:

(A) Each pressure distribution lateral connects to the manifold.

(B) The design head must be two and one-half (2.5) or three (3) feet.

(C) The diameter of the pressure distribution laterals shall be determined from *Table 1, Pressure Distribution Lateral Diameter for Elevated Sand Mounds*.

Table 1
Pressure Distribution Lateral Diameter for Elevated Sand Mounds *

Lateral Length, L (ft.)	L ≤ 25 ft.	25 ft. < L ≤ 40 ft.	40 ft. < L ≤ 55 ft.
Diameter (in.)	1 in.	1 1/4 in.	1 ½ in.

* Distribution lateral diameters for ¼ in. holes spaced at 3 ft. on centers.

(D) Pressure distribution laterals shall be laid out as shown in Figure 2, Plan View of Pressure Distribution Laterals in an Aggregate Bed of an Elevated Sand Mound as follows:

(i) The separation distance between laterals shall be no less than twenty-four (24) and no more than thirty-six (36) inches.

(ii) Laterals shall be located no less than twelve (12) and no more than eighteen (18) inches from the sides of the aggregate bed along the length of the lateral.

(iii) Holes in pressure distribution laterals shall be one-quarter (1/4) inch in diameter and spaced at three (3) feet on centers.

(iv) The first hole shall be eighteen (18) inches from the center of the manifold.

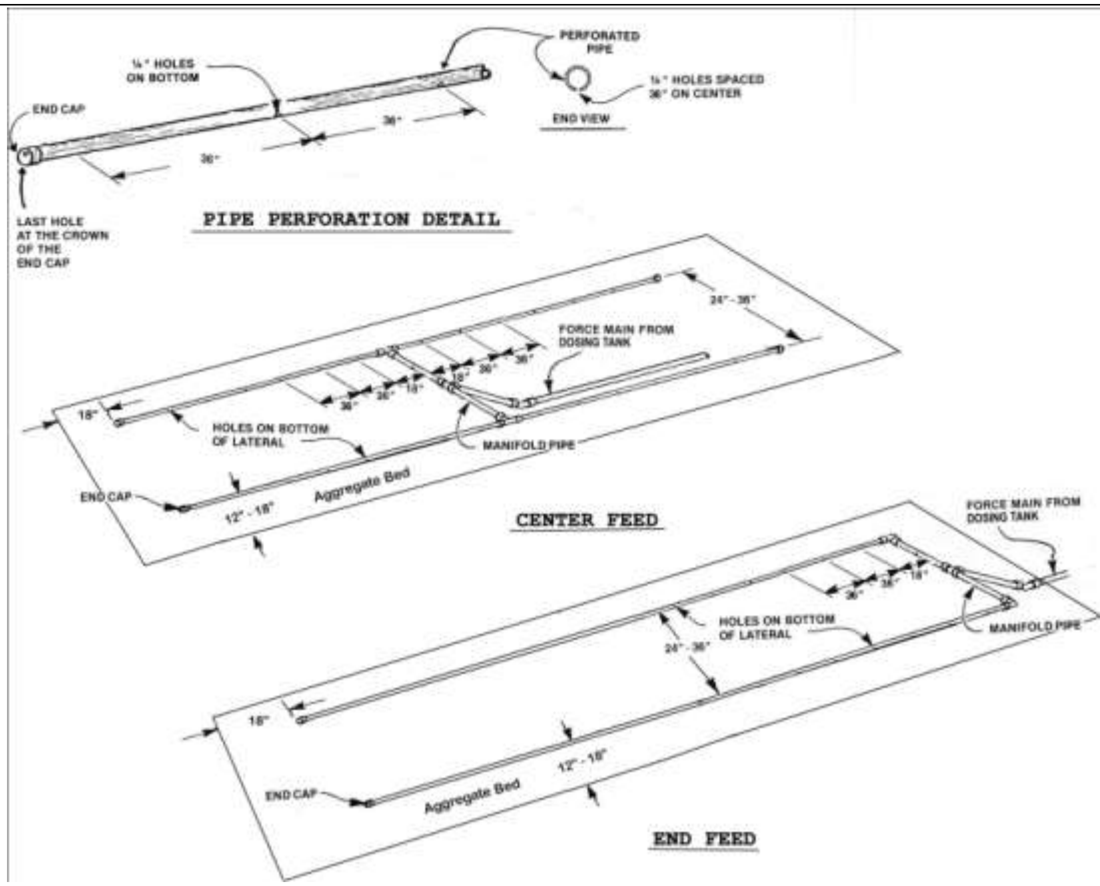
(v) The end cap hole shall be eighteen (18) inches from the end of the aggregate bed.

(vi) The spacing for the last hole in the lateral before the endcap shall be at no less than eighteen (18) inches and no more than thirty-six (36) inches.

(vii) Laterals connected by center feed manifolds shall be attached using a cross-tee fitting or two (2) tee fittings located side-by-side.

(viii) Laterals connected by end feed manifolds may be attached using 90˚ elbows or tee fittings.

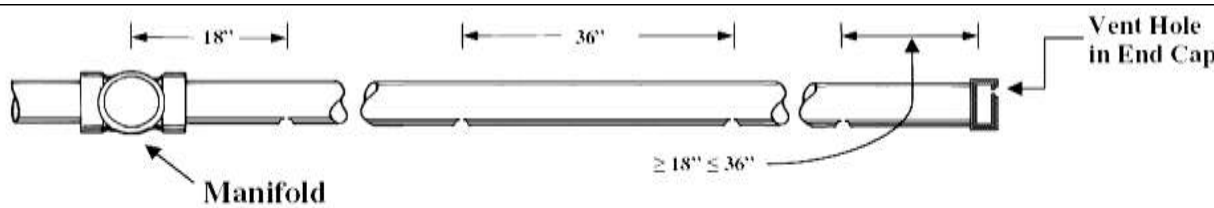
Figure 2 – Plan View of Pressure Distribution Laterals in an Aggregate Bed of an Elevated Sand Mound



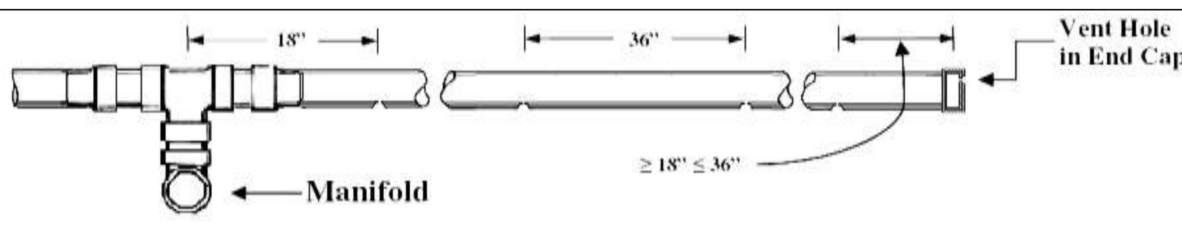
(G.) Determine the positioning of the ¼-inch holes in the pressure distribution lateral. Draw a pressure distribution lateral and identify the location of the holes (in feet) along the length of the distribution lateral, including the end cap hole. (Figure 2)

Figure 3

Manifold Cross Tee Connection & Lateral Hole Location



Manifold Tee-To-Tee Connection & Lateral Hole Location



(b) Design check of Pressure Network design

(1) Calculate the total number of feet of pressure distribution lateral pipe used in the system.

(2) Use *Table 2 - Pipe Volume (gal/ft) for Various Diameter Pipes* to determine the volume (in gallons) for the pressure distribution laterals used in the system. Total Volume of pressure distribution laterals = the volume per foot (*Table 2*) times the total number feet of pressure distribution lateral pipe in the system.

Table 2
Pipe Volume (gal/ft) for Various Diameter Pipes

Pipe Diameter (in)	1	1 1/4	1 1/2	2*	3*	4*
Volume (gal/ft)	.045	.078	.106	.174	.384	.650

*These diameters and pipe volumes are for calculating the total volume of the effluent force main. They are not used for calculating volumes of pressure distribution laterals.

(3) The **dose volume** shall be calculated as follows:

(A) If the effluent force main and manifold do not drain to the dosing tank, the controls for the pressure distribution network shall be set to deliver one-quarter (1/4) of the design daily flow (Dose = 1/4 DDF).

(B) If the effluent force main and manifold drain to the dosing tank, the controls for the pressure distribution network shall be set to deliver one-quarter (1/4) of the design daily flow (DDF) plus the volume of the effluent force main (Dose = 1/4 DDF + drain back). The volume of the effluent force main is calculated the same way as the volume of the laterals [See Subsection (b)(2), above].

(C) The dose volume (1/4 DDF) must be at least 7 times the volume of the pressure distribution laterals.

The third section in this manual assists with the proper size of an effluent pump for an elevated sand mound project. There is a minimum amount of information necessary to ensure accuracy of your design. This information includes:

- ✓ ***Length of the effluent force main,***
- ✓ ***The static head loss,***
- ✓ ***The friction loss for the effluent force main, and***
- ✓ ***The gallon per minute requirement for the proposed pressure distribution network.***

Section 3: Correct sizing of the Effluent Pump

(a) Determine the Total Discharge Rate (**TDR**) of the pump in Gallons per Minute **(GPM)** and the Total Dynamic Head **(TDH)** requirements for the Pressure Distribution Network

(1) Determine the TDR:
The total discharge rate of the pump is the total number of one-quarter (1/4) inch holes in all laterals (including the holes in the end caps) multiplied by one and twenty-eight hundredths (1.28) gallons per minute (gpm) for 3 feet of design head.

(2) Determine the size of the **effluent force main**. The effluent force main shall not be less than one and one-half (1 ½) inches nor more than four (4) inches. The effluent force main diameter is dependent on total discharge rate (GPM). From *Table IX – Friction Losses in Plastic Pipe*, select a pipe diameter that will have a low friction loss at the calculated total discharge (flow) rate. (Note: The manifold can be no smaller than the effluent force main. The typical practice is to size the manifold the same as the effluent force main.)

(3) Determine the **Total Dynamic Head**. Total Dynamic Head is the sum of Static head, Friction loss head and Design / Residual head.

(A) **Elevation / Static Head:** The elevation difference in the pressure distribution system, *typically* measured from "pump off" elevation to the manifold elevation in the elevated sand mound.

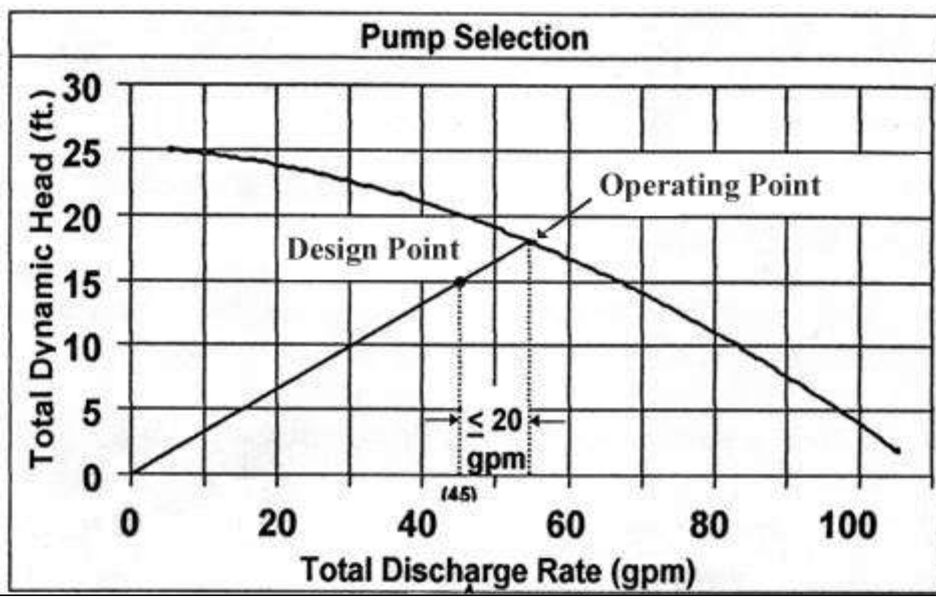
(B) **Friction Loss Head:** The amount energy spent as the effluent flows through the effluent force main. The length and diameter of the effluent force main is needed as well as the TDR of the pressure distribution network. *Table IX – Friction Losses in Plastic Pipe* (See Appendix) can be used to determine the actual friction loss in the effluent force main.

(C) **Design/Residual Head: T**he constant operating head of the pressure distribution system. It is a constant requirement of 3 feet. This can be confirmed during inspection in the field.

(b) Plot the design point for the system on the pump curve. The design point is the intersection of the TDR and TDH requirements for the system.

(c) Confirm that the correct effluent pump is selected. See *Figure 4, Pump Selection for an Elevated Sand Mound*. Start by drawing a line from "0" through the design point of the system and intersecting the pump curve. Draw a vertical line down from that point of intersection to the total discharge rate (horizontal) axis. The design point GPM must be located under the pump curve and within 20 GPM of the point where the vertical line drawn intersects the horizontal axis.

Figure 4 - Pump Selection for an Elevated Sand Mound



The fourth section in this manual assists with the proper size of the dosing tank for an elevated sand mound project. A minimum amount of information is necessary to ensure accuracy of the design. This information includes:

- ✓ ***The daily design flow (DDF),***
- ✓ ***Cross section of the dosing tank, and***
- ✓ ***The volume per inch (gal/in) for the proposed dosing tank.***

Section 4: Dosing Tank Specifications and Volume

(a) The volume in gallons per inch of the dosing tank should be obtained from the tank manufacturer.

(b) Generate float settings on a cross-section drawing of dosing tank [See Appendix, Figure 6):

(1) Pump-OFF float set at a level to keep effluent pump submerged

(2) Pump-ON float set at a level to provide a dose volume is ¼ DDF + drainback, if applicable [See Section 2(b)(3) of this document].

Drainback = length of the effluent force main (in feet) times pipe volume (in gallons per foot). See *Table 2 - Pipe Volume (gal/ft) for Various Diameter Pipe.*

(3) The high-water alarm should be set to activate within 4 inches of the pump “on” level. Adequate freeboard shall be provided for proper operation of alarm float.

(A) All dosing tanks shall have a properly functioning high-water alarm.

(B) The alarm shall be audible and visible by the system users and must meet the requirements of the current Indiana Electrical Code. The alarm circuit should be provided with a manual disconnect in a watertight, corrosion-resistant outside enclosure.

(C) Alarm circuits shall be on a separate circuit from the pump and shall be supplied ahead of any overload or short circuit protective devices.

(D) Only switches comparable to mercury float level switches shall be used for controls and alarms.

(4) A minimum of 150 gallons of freeboard capacity in the tank should be provided between the high water alarm activation elevation and the invert elevation of the dosing tank inlet.

(c) Calculate the used volume in the dosing tank to insure proper tank capacity. This is the total volume calculated from the bottom of the tank to the level of the alarm float (from items 1 thru 3, above). This calculated volume plus the volume required for freeboard (item 4, above) must be less than the liquid capacity of the dosing tank below the inlet invert.

Appendix

Figure 5
Cross Sections of Elevated Sand Mounds for Level and Sloping Sites

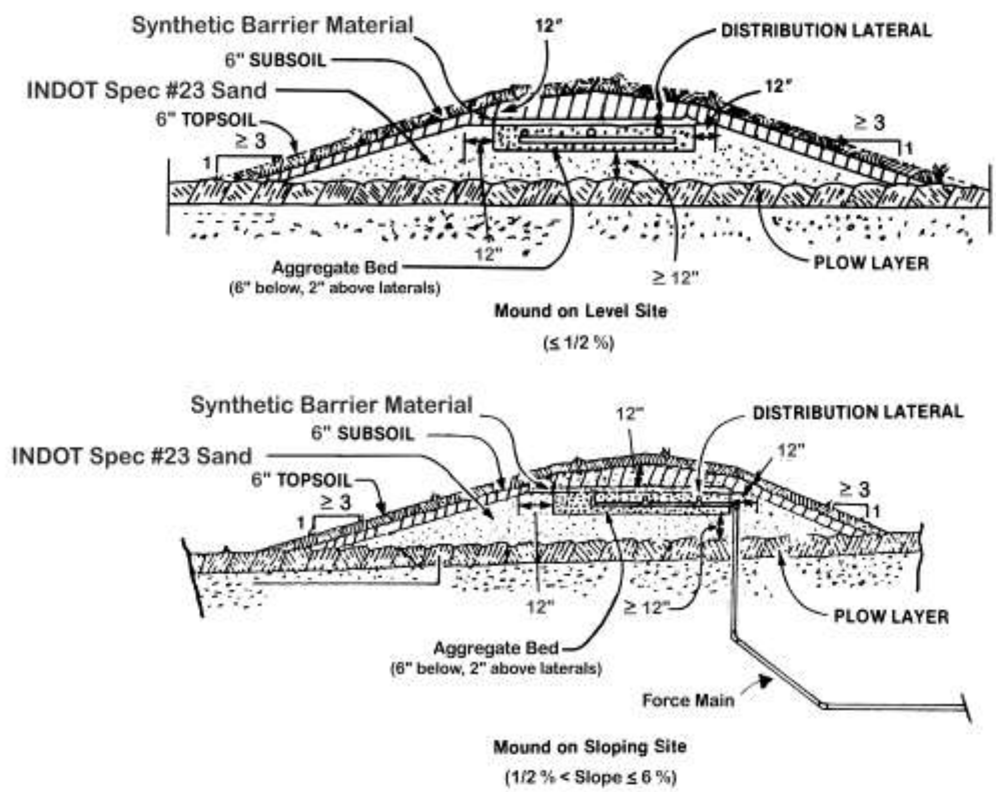


Table 3
INDOT* Specification 23 Sand

Sieve Sizes		Percent (%) Passing Sieve (by Weight)
3/8 in	(9.50 mm)	100
No.4	(4.75 mm)	95 – 100
No. 8	(2.36 mm)	80 – 100
No. 16	(1.18 mm)	50 – 85
No. 30	(600 µm)	25 – 60
No. 50	(300 µm)	5 – 30
No. 100	(150 µm)	0 – 10
No. 200	(75 µm)	0 – 3

* INDOT: Indiana department of transportation. The sand shall not have more than forty-five (45) percent retained between any two (2) consecutive sieves.

Table 4 Elevated Sand Mound Dimensions for Common Sizes (Based on Maximum Bed Width Formula and sand depth of 12 inches)[a]									
Number of Bedrooms & Equivalents	Daily Design Flow DDF (gpd)	Soil Loading Rate SLR (gpd/ft²)	Aggregate Bed			Basal Area[f]			
			Area (ft²)	Maximum Width (ft)[b]	Minimum Length (ft)[c]	Minimum Area (ft²)	Min. Width (ft) Slope ≤½% [d] (Centered Agg. Bed)	Min. Width (ft) Slope >½%[e] (Upslope Agg. Bed)	Minimum Length (ft)
1	150	0.25	125	4	32	600	19	19	32
1	150	0.50	125	4	32	300	18	13	32
1	150	0.60	125	4	32	250	18	13	32
1	150	1.20	125	6	21	125	20	15	21
2	300	0.25	250	4	63	1200	20	20	63
2	300	0.50	250	5	50	600	19	14	50
2	300	0.60	250	6	42	500	20	15	42
2	300	1.20	250	9	28	250	23	18	28
3	450	0.25	375	5	75	1800	24	24	75
3	450	0.50	375	7	54	900	21	17	54
3	450	0.60	375	7	54	750	21	16	54
3	450	1.20	375	10	38	375	24	19	36
4	600	0.25	500	5	100	2400	24	24	100
4	600	0.50	500	8	63	1200	22	20	63
4	600	0.60	500	9	56	1000	23	18	56
4	600	1.20	500	10	50	500	24	19	50
5	750	0.25	625	6	105	3000	29	29	105
5	750	0.50	625	9	70	1500	23	22	70
5	750	0.60	625	10	63	1250	24	20	63
5	750	1.20	625	10	63	625	24	19	63
6	900[g]	0.25	750	7	108	3600	34	34	108
6	900	0.50	750	10	75	1800	24	24	75
6	900	0.60	750	10	75	1500	24	20	75
6	900	1.20	750	10	75	750	24	19	75

[a]The sand mound should be designed as long and narrow as possible.

[b]Maximum width is rounded down to the nearest whole number.

[c] Minimum length is rounded up to the nearest whole number.

[d]The greater of BA Min. Area/BA Min. Length **or** Agg. Bed Width + 14'

[e]The greater of BA Min. Area/BA Min. Length or Agg. Bed Width + 9'.

[f]Sideslopes of the INDOT Spec 23 sand on each side of the aggregate bed must have a minimum grade of three-to-one 3:1)

[g]Commercial systems above 750 gpd are not reviewed by local health departments

Table 5 – Friction Losses in Plastic Pipe (per 100 feet of pipe) Pipe Diameter, Flow (gpm), Velocity (v)[2], and Friction Loss Head (H_f)[1]														
Flow (gpm)	1"		1 1/4"		1 1/2"		2"		2 1/2"		3"		4"	
Q	v	H_f	v	H_f	v	H_f	v	H_f	v	H_f	v	H_f	v	H_f
1	0.37	0.11												
2	0.74	0.38	0.43	0.10										
3	1.11	0.78	0.64	0.21	0.47	0.10								
4	1.49	1.31	0.86	0.35	0.63	0.16								
5	1.86	1.92	1.07	0.52	0.79	0.24								
6	2.23	2.70	1.29	0.71	0.95	0.33	0.57	0.10						
8	2.97	4.59	1.72	1.19	1.26	0.56	0.77	0.17						
10	3.71	6.90	2.15	1.78	1.58	0.83	0.96	0.25	0.67	0.11				
15	5.57	14.7	3.22	3.76	2.37	1.74	1.43	0.52	1.01	0.22				
20	7.43	25.2	4.29	6.42	3.16	2.96	1.91	.87	1.34	0.37	0.87	0.13		
25	9.28	38.6	5.37	9.74	3.94	4.46	2.39	1.29	1.68	0.54	1.09	0.19		
30			6.44	13.6	4.73	6.27	2.87	1.81	2.01	0.76	1.30	0.26		
35			7.51	18.2	5.52	8.40	3.35	2.42	2.35	1.01	1.52	0.35	0.88	0.10
40			8.59	23.6	6.30	10.7	3.83	3.12	2.68	1.28	1.74	0.44	1.01	0.12
45					7.09	13.5	4.30	3.85	3.02	1.54	1.95	0.55	1.13	0.15
50					7.88	16.5	4.78	4.68	3.35	1.93	2.17	0.67	1.26	0.18
60					9.47	23.6	5.74	6.62	4.02	2.72	2.60	0.94	1.51	0.25
70							6.70	8.86	4.69	3.67	3.04	1.25	1.76	0.33
80							7.65	11.5	5.36	4.69	3.47	1.59	2.02	0.42
90							8.60	14.3	6.03	5.83	3.91	1.99	2.27	0.52
100									6.70	7.13	4.34	2.42	2.52	0.63
125									8.38	10.9	5.43	3.72	3.15	0.96
150											6.51	5.16	3.78	1.34
175											7.60	6.90	4.41	1.79
200											8.68	8.93	5.04	2.27
225													5.67	2.84
250													6.30	3.37
275													6.93	4.13
300													7.56	4.87
325													8.19	5.70

[1] This figure is based on flows for PVC Schedule 40 pipe (flow coefficient: C-150). Other values for friction loss may be used if documentation from the pipe manufacturer is provided with the plan submittal. Calculations using the Hazen-Williams equation may be used if provided with the plan submittal.

[2] Flow velocity must be at least 2 fps; flow velocities above 5 fps should be avoided.

Figure 6
Dosing Tank for an Elevated Sand Mound

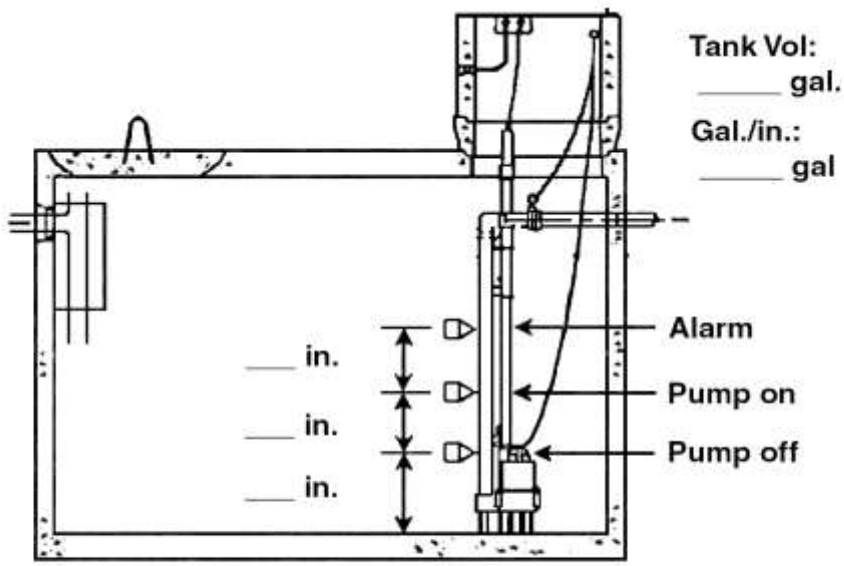


Table 6
Frost Penetrations in Indiana (in inches)

Adams	60	Allen	60	Bartholomew	48	Benton	60
Blackford	60	Boone	54	Brown	48	Carroll	60
Cass	60	Clark	36	Clay	54	Clinton	54
Crawford	36	Daviess	48	Dearborn	48	Decatur	48
DeKalb	60	Delaware	60	Dubois	42	Elkhart	60
Fayette	54	Floyd	36	Fountain	60	Franklin	48
Fulton	60	Gibson	42	Grant	54	Greene	54
Hamilton	54	Hancock	54	Harrison	36	Hendricks	54
Henry	54	Howard	60	Huntington	60	Jackson	48
Jasper	60	Jay	60	Jefferson	42	Jennings	48
Johnson	54	Knox	48	Kosciusko	60	LaGrange	60
Lake	60	LaPorte	60	Lawrence	48	Madison	60
Marion	54	Marshall	60	Martin	48	Miami	60
Monroe	48	Montgomery	60	Morgan	48	Newton	60
Noble	60	Ohio	42	Orange	42	Owen	54
Parke	60	Perry	36	Pike	42	Porter	60
Posey	42	Pulaski	60	Putnam	54	Randolph	54
Ripley	48	Rush	54	St. Joseph	60	Scott	36
Shelby	54	Spencer	36	Starke	60	Steuben	60
Sullivan	54	Switzerland	42	Tippecanoe	60	Tipton	60
Union	48	Vanderburgh	36	Vermillion	60	Vigo	60
Wabash	60	Warren	60	Warrick	36	Washington	36
Wayne	54	Wells	60	White	60	Whitley	60