PRESSURE MANIFOLD DESIGN
FOR GROUND ABSORPTION SEWAGE SYSTEMS

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Large subsurface wastewater systems are being used more frequently as alternatives to discharging systems for may public and private facilities.

Dosing effluent periodically and uniformly throughout the drain field improves absorption field performance and increases field longevity (Otis et al. 1977, Harget et al. 1982). Low-pressure distribution of effluent in small diameter, perforated laterals has become a popular design alternative for achieving uniform distribution. Over 2,000 low-pressure pipe systems are now in use at single-family homes in North Carolina. A comprehensive design and installation manual for residential low-pressure pipe systems is available (Cogger et al. 1982). Design criteria and a simplified design procedure have also been published (Otis 1982). Available information, however, does not adequately address some key design parameters for the more extensive low-pressure pipe networks being planned and installed in North Carolina.

Pressure distribution manifolds feeding conventional gravity drain lines is another alternative being used in North Carolina to improve the distribution of effluent in large subsurface fields. This method is applied where soil conditions are favorable for conventional trenches and where the length of drain pipe required and degree of field slope would make it difficult to achieve uniform distribution between laterals in a low-pressure pipe network. Design criteria for such systems have not been previously available.

This paper sets forth some critical design parameters for pressure manifolds and laterals in large conventional and low-pressure pipe ground absorption sewage systems. The justification for these design parameters is presented elsewhere (Berkowitz, 1985)

PRESSURE MANIFOLDS FOR CONVENTIONAL DRAIN FIELDS

The traditional approach to dividing effluent between conventional trenches is with a gravity distribution box. While relatively simple in concept and design, distribution boxes have proven to be generally ineffective in uniformly distributing effluent, especially when the number of trenches to be dosed is large (Mitchell, 1983).

Pressure manifolds can be designed to more effectively split flow between separate conventional trenches while still under pressure from the dosing tank. Schematics are presented below of pressure manifolds designed for level (Fig. 1) and sloping (Fig. 2) sites.

Pressure manifolds must be installed level, although some deviations many not seriously impair flow uniformity. Protective accessible boxes are recommended to be constructed around pressure manifolds installed above the drain field on sloping sites. Note that precautions against freezing may be necessary in cold

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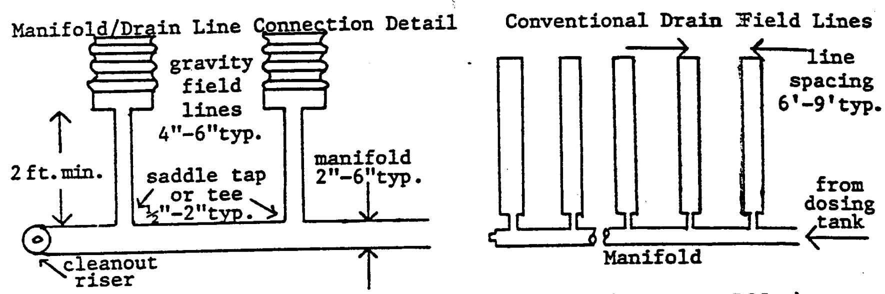

Fig. 1 Pressure Manifold For Level Site (1 ft. = .305 m)

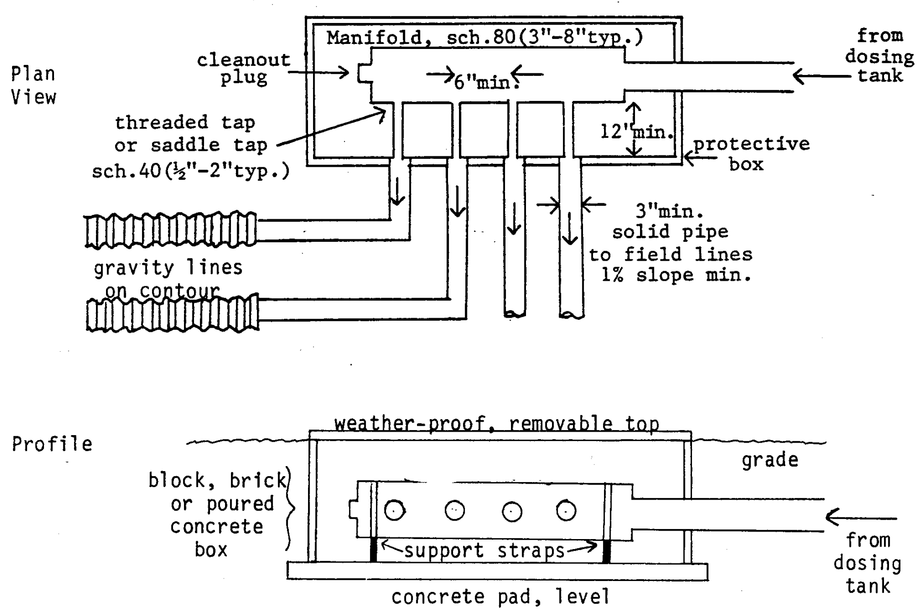

Fig. 2 Pressure Manifold For Sloping Sites

regions if the system is subject to extended periods of disuse unless provisions are made to drain out the manifolds, since they will normally remain about half-full between dosing cycles.

Design criteria for pressure distribution manifolds and laterals are presented in Table 1. Shown are the maximum number to taps by differently sized laterals which can be made out of manifolds of varying sizes, while maintaining no more than a five-percent difference between flow rates into each lateral. An important further assumption is that 1 to 4 feet of pressure head are available at the lateral outlets. Design criteria are presented both for manifolds with lateral taps in one side and for manifolds with lateral taps in adjacent sides.

Recommended design steps utilizing these criteria are as follows:

1. Select Drain Field Configuration: Determine the required field size, number of laterals to be dosed for each pressure manifold, and desired lateral and tap spacing.

2. Choose Lateral Tap Size: For pump dosed systems, pick the largest pressure tap that can be adequately pressurized by a reasonable sized pump. Use the orifice equation[1] to compute required flow per tap, assuming at least 2 feet of pressure head to each lateral opening. Taps less than one-half-inch nominal size is not recommended. For siphon-dosed systems, select a tap size large enough to handle the maximum siphon discharge rate with the head available between the siphon outlet and the pressure manifold, while still maintaining a sufficient pressure head at the minimum siphon discharge rate.

3. Select Manifold Size: Given the desired lateral tap size and spacing, select from Table 1 the minimum size of manifold from which at least the desired number of taps can be made while staying within the five-percent flow variation limit. Selecting the next larger sized manifold will yield an even greater degree of flow distribution uniformity.

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[1] Orifice equation: $Q = 13\,(d^2)(h^{1/2})$

where Q = flow from orifice, gallons per minute
d = diameter of orifice, inches
h = pressure head, feet

Table 1: Pressure Distribution Manifolds for Conventional Septic Systems; Manifold and Lateral Tap Size Criteria[a]

Tap Separation Distance (Feet)	Manifold Size (Inches)	Lateral Taps out of <u>One Side</u> of Manifold Lateral Tap Size (inches)						Lateral Taps out of <u>Both Sides</u> of Manifold Lateral Tap Size (inches)					
		½	¾	1	1 ¼	1 ½	2	½	¾	1	1 ¼	1 ½	2
		Maximum Number of Taps						Maximum Number of Tap Pairs					
0.5[b]	2	4	2					2					
	3	9	5	3	2			4	2				
	4	16	9	5	3	2		7	4	2			
	6	40+	21	12	7	5	3	18	10	6	3	2	
	8		38	22	12	9	5		17	10	6	4	2
3.0[c]	2	8	2					2					
	3	14	12	3	2			6	2				
	4	21	18	6	3	2		16	5	3			
	6	38	30	26	8	5	3	20+	19	7	3	2	
6.0[c]	2	5	4					4					
	3	9	7	6	2			7	3	2			
	4	14	11	9	4	2		10	9	3			
	6	27	20	17	14	7	3	19	15	13	4	3	
9.0[c]	2	4	3	3				3					
	3	7	6	5	2			6	5	2			
	4	12	9	7	6	3		8	7	6	2		
	6	22	16	13	11	10	4	15	12	10	5	3	

[a]Assumptions:	1 to 4 feet (.3 to 1.2 meters) head at lateral outlets; 5% maximum flow differential maintained between laterals; Hazen-Williams "C" factor of 140; taps are of Schedule 40 PVC and manifolds are of Schedule 80 PVC, with the following actual inside diameters:									
	----nominal pipe size (inches)----									
	½	¾	1	1 ¼	1 ½	2	3	4	6	8
	----actual inside diameter: inches (millimeters)----									
Taps	.622(19)	.824(25)	1.049(42)	1.38(42)	1.61(49)	2.067(63)				
Manifolds						1.94(59)	2.90(88)	3.83(117)	5.76(176)	7.63(232)

[b]Use for pressure manifold distribution box designed for sloping lots, located above highest field line.

[c]Use for pressure manifold on flat lots, located adjacent to end of each field line.

PRESSURE MANIFOLDS
FOR LOW-PRESSURE PIPE DRAIN FIELDS

Low-pressure systems involve distributing effluent throughout the nitrification field within a pressurized manifold and small diameter lateral network. Effluent enters the nitrification trenches from orificies drilled into the distribution laterals (Fig. 3).

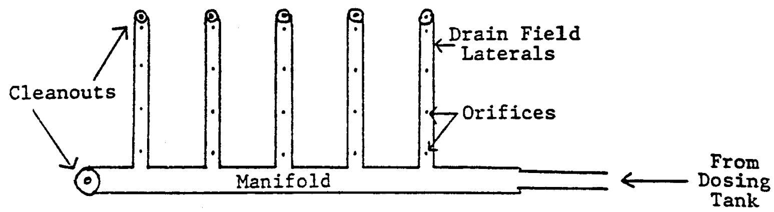

Fig. 3 Low-Pressure Pipe Drain Field

Pressure is generally maintained between 2 and 5 feet in the laterals to facilatate uniform distribution while minimizing scour outside of the orifices.

Critical design parameters for laterals are pipe diameter, lateral length, orifice size, and orifice spacing. In most low-pressure pipe applications in North Carolina, orifices range from 1/8-inch to 1/4-inch, with 5/32-inch orifices now recommended as the minimum size to use. Curves were developed which relate maximum lateral length to pipe diameter, orifice size, and spacing, based on yielding no more than a ten-percent difference between flow rates from each orfice (Fig. 4).

Critical design decisions for low-pressure system manifolds involve selecting the manifold diameter needed relative to the diameter of the laterals served and determining the maximum number of laterals which can be fed off a common supply manifold. Manifold design criteria are presented for the condition that the nitrification field is level and the manifold and laterals are on the same level (e.g.; laterals tee directly off from the manifold). Lateral spacing is assumed to be 5 feet, the most frequently used spacing for low-pressure pipe systems in North Carolina. Results are presented in Fig. 5 showing the maximum number of laterals of different sizes which can be supplied by a common manifold at varying mean lateral flow rates, while maintaining no more than 15-percent difference between flow rates into each lateral.

Results shown in Fig. 5 indicate that relatively few laterals can be served by small manifolds. It is uncertain, however, whether these criteria can be considered directly transferable to the more popular design whereby laterals are above the manifold, connected by short risers which tee off of the manifold and are elbowed or teed into each lateral. Under these conditions, more laterals than shown in Fig. 5 may in fact be fed by a common manifold while still maintaining relatively uniform flow distribution. Further research in this area is needed.

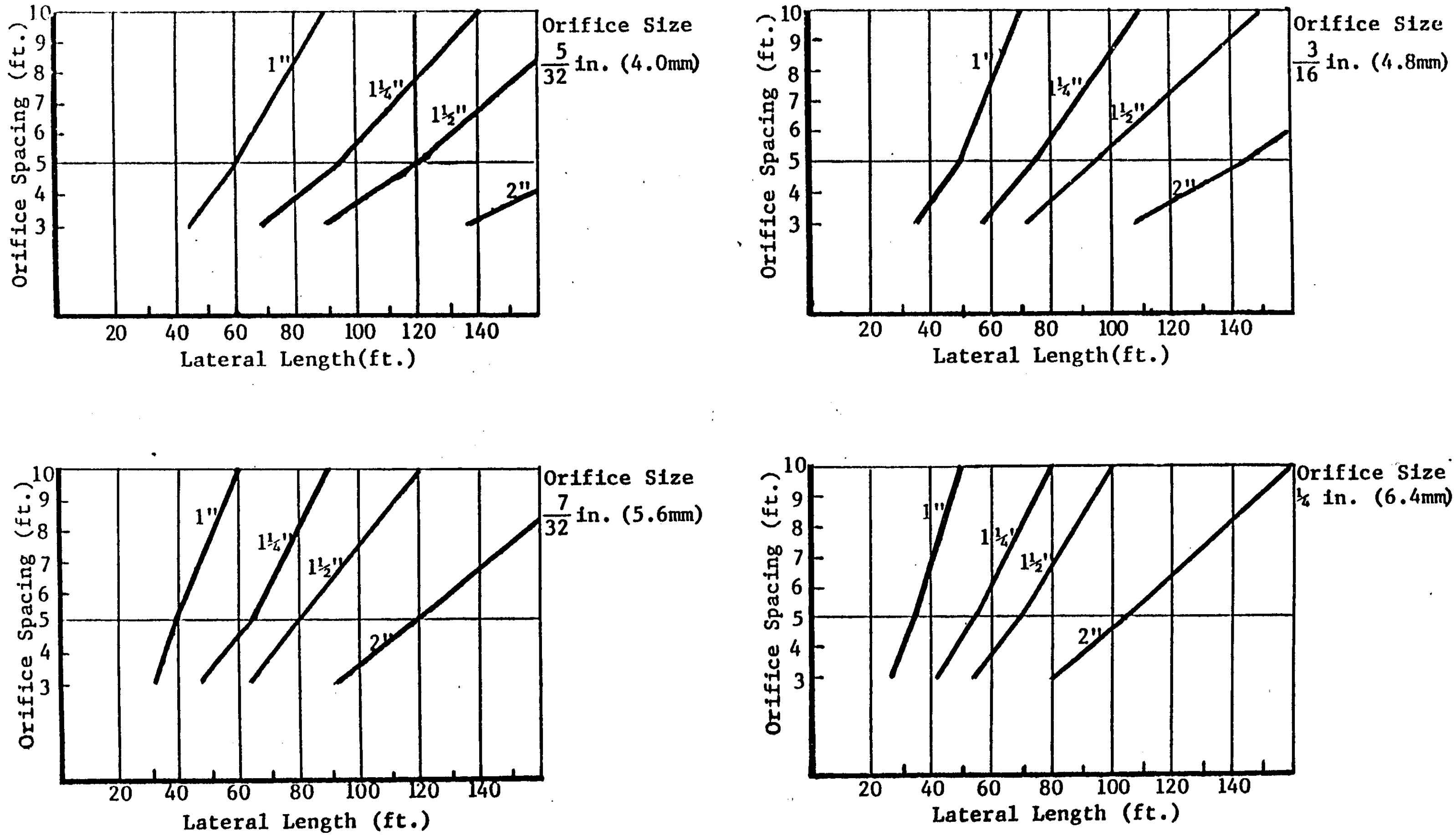

Fig. 4 Maximum Length of Different Sized Laterals For Low-Pressure Pipe Systems With Varying Orifice Sizes and Spacings (1 ft. = .305 m)

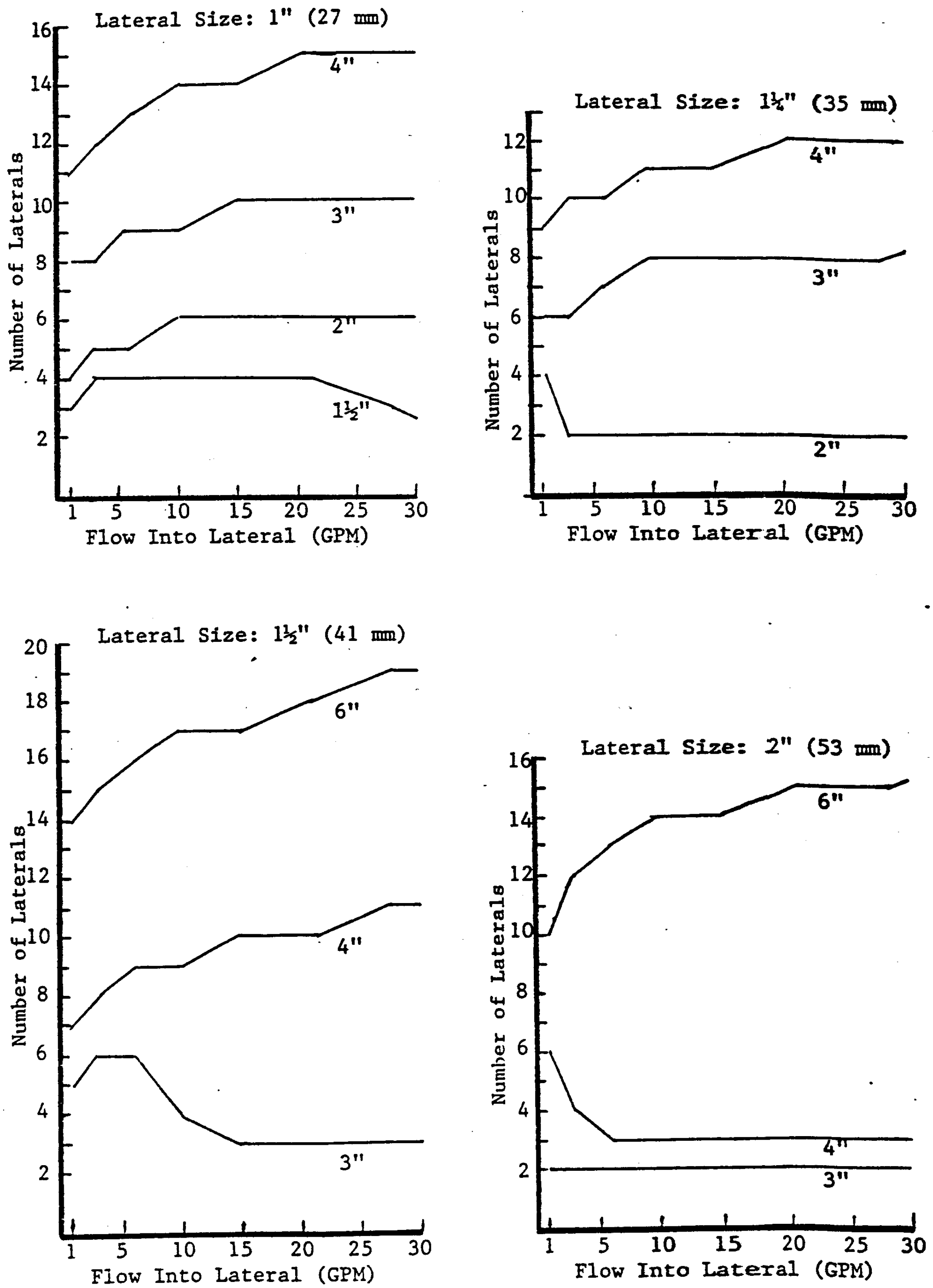

Fig. 5 Maximum Number of Different Sized Laterals For Low-Pressure Pipe Systems With Varying Sizes of Manifolds and Varying Rates of Flow Into Lateral (1 GPM = .0631 l/sec)

Recommended design steps using these criteria are as follows:

1. Select Drain Field Configuration: Determine the desired field size configuration, lengths of laterals, and location of supply manifolds.

2. Choose Orifice Size and Spacing: For pump dosed systems, select the largest orifice size and shortest orifice spacing resulting in a total number of orfices which can be adequately pressurized by a reasonably sized pump. Use the orifice equation to compute required flow per orifice, assuming at least 2 feet of pressure head at each orifice. Taps less than 5/32-inch and spacing greater than 10 feet are not recommended. For siphon-dosed systems, select an orifice size and spacing so that there are enough orifices of sufficient size to handle the maximum siphon discharge rate with the head available between the siphon outlet and the drain field, while still maintaining a sufficient pressure head at the minimum siphon discharge rate.

3. Choose Lateral Diameter: Given the desired lateral length and orifice size and spacing, select from Fig. 4 the minimum size of lateral from which at least the desired size and spacing of orifices can be used while staying within the 10-percent flow variation limit.

4. Select Manifold Size: Given the desired lateral size and lateral design flow rate, select from Fig. 5 the minimum size of manifold from which at least the desired number of laterals can be dosed while staying within the 15-percent flow variation limit.

5. Optimize Design: Repeat steps 1 through 4 above until a practical, workable manifold and lateral network design is obtained.

REFERENCES

1. Berkowitz, S. J. 1985. Pressure manifold design for large subsurface ground absorption sewage systems. In: On-Site Wastewater Treatment: Proceedings of the fourth national symposium on individual and small community sewage systems. Dec. 10-11, 1984. New Orleans. American Society of Agricultural Engineers.

2. Cogger, C., B. L. Carlile, D. Osborne and E. Holland. 1982. Design and installation of low-pressure pipe waste treatment systems. UNC Sea Grant College Pub. UNC-SG-82-03. 31p.

3. Mitchell, D. 1983. Nonuniform distribution by septic tank systems. 1982 southeastern on-site sewage treatment conference. N. C. Div. Of Health Services, Raleigh, NC 37-45.

4. Otis, R. J. 1982. Pressure distribution design for septic tank systems. Jour. Of the Env. Eng. Div., ASCE 108(1): 123-140.

5. Otis, R. J., J. C. Converse, B. L. Carlile and J. E. Witty. 1977. Effluent distribution. Home Sewage Treatment. ASAE Pub. 5-77. St. Joseph, Mich. 61-85