

# MANHOLE SIZING RECOMMENDATIONS

## Introduction

Round manholes are the most widely used maintenance utility structures that provide access to pipelines for inspection and cleanout. Manholes are used for connecting two or more converging storm or sanitary sewers, permitting pipe size changes, accommodating abrupt changes in alignment or grade and allowing for direct surface flow interception. The largest impact on the size of these structures is the diameter and angle of entrance of the intersecting pipe.

This document provides a guideline for sizing round manhole structures for various sizes and angles of incoming pipe.

## Sizing Considerations

Two main criteria in designing manholes are that they must be large enough to accept the maximum pipe size, and the minimum structural leg width between pipe holes must be maintained.

The minimum pipe opening is assumed to be the pipe's inside diameter plus the wall thickness. The minimum structural leg is, as a practical minimum, 6 inches. Anything less than this width may allow cracking, which can lead to leakage, structural distress or durability concerns.

A typical additional over-sizing of no more than 6 inches larger than the outside diameter of the pipe is used for the cutout. The final cutout or opening, therefore, includes all of these design provisions with respect to all other pipe openings, relative pipe elevations and vertical clearances.

The type of pipe entering the structure, and the connection method (boot, compression or mortar) must be known to accurately determine the required holes size and consequently, the manhole size.

When possible, avoid pipes entering into structure joints and corners, as this may compromise the structural integrity and watertightness of the structure. However, this practice may be necessary for certain installations and should be left to the discretion of an experienced precast concrete manufacturer.

Always consult your local precast concrete manufacturer and connector supplier for exact design requirements and product specifications.

## Design Method

The following method can be used to determine minimum manhole size for as many as three incoming pipes. (For installations where more than three pipes enter a manhole, the design equations in the Appendix must be used.)

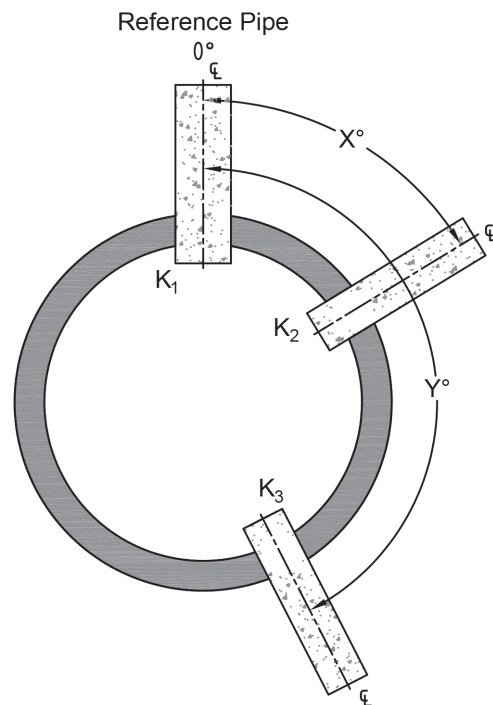
**Note:** Always consult your local precast concrete manufacturer for exact design requirements and manhole size availability. Additionally, when pipe-to-manhole connections use resilient rubber connectors, additional manhole sizing considerations may be required to meet structural and sealing performance expectations.

The formulas are:

- **One Pipe:**  $180^\circ > K$
- **Two Pipes:**  $180^\circ > X^\circ > (K_1 + K_2) / 2$
- **Three Pipes:**  $180^\circ > X^\circ > (K_1 + K_2) / 2$  and  $X^\circ + (K_2 + K_3) / 2 < Y^\circ < 360^\circ - (K_1 + K_3) / 2$

Where **K** represents the **K Factor** that can be found in the tables that follow for different types of pipe.

$X^\circ$  and  $Y^\circ$  are the angles between the pipes



## RCP AND HDPE PIPE 'K' FACTOR

Pipe Diameter (inches)	Manhole Diameter						
	48 in	60 in	72 in	84 in	96 in	108 in	120 in
72	-	-	-	-	154	120	102
66	-	-	-	-	129	106	92
60	-	-	-	142	112	95	83
54	-	-	-	119	98	84	74
48	-	-	131	102	86	75	66
42	-	154	109	88	75	66	58
36	-	118	91	76	65	57	51
33	180	106	84	70	60	53	47
30	136	96	76	64	55	49	44
27	117	86	69	58	51	45	40
24	103	77	63	53	46	41	36
21	90	69	56	48	41	37	33
18	79	61	50	43	37	33	29
15	68	53	44	37	33	29	26
12	59	46	38	32	28	25	23

## PVC AND DUCTILE IRON PIPE "K" FACTOR

Pipe Diameter (inches)	Manhole Diameter						
	48 in	60 in	72 in	84 in	96 in	108 in	120 in
64	-	-	169	117	97	83	73
60	-	-	140	107	90	78	69
54	-	-	124	98	83	72	64
48	-	142	104	85	73	63	57
42	-	115	89	74	63	56	50
36	135	95	76	64	55	48	43
30	105	79	64	54	47	41	37
24	83	64	52	44	39	34	31
20	70	55	45	38	33	30	27
18	64	50	41	35	31	27	25
16	58	46	38	32	28	25	22
14	53	42	34	29	26	23	20
12	47	37	31	26	23	20	18
10	42	33	27	23	21	18	16
8	37	29	24	21	18	16	14
6	31	25	21	18	15	14	12

## CORRUGATED METAL PIPE 'K' FACTOR

Pipe Diameter (Inches)	Manhole Diameter						
	48 in	60 in	72 in	84 in	96 in	108 in	120 in
72	-	-	-	141	111	94	83
66	-	-	-	121	99	85	75
60	-	-	138	106	89	77	68
54	-	-	116	93	79	69	61
48	-	134	100	82	70	61	55
42	-	110	86	72	62	54	48
36	128	92	74	62	53	47	42
33	113	84	68	57	49	44	39
30	101	76	62	52	46	40	36
27	91	69	57	48	42	37	33
24	81	63	51	44	38	34	30
21	72	56	46	39	34	30	27
18	63	50	41	35	30	27	24
15	55	43	36	31	27	24	21
12	47	37	31	26	23	20	18
10	42	33	28	24	21	18	16

### Design Tables

Since the wall thickness for the design of reinforced concrete pipe and high-density polyethylene pipe are similar, a standard precast concrete C-wall pipe thickness was used for the development of the tables for these products. For inlet pipes, which have greater total outside diameters than standard ASTM C76 C-wall pipes, you must use the design equations in the Appendix to determine the acceptable manhole diameter.

The design tables for PVC and ductile iron pipe were based on the outside pipe diameters specified in the AWWA C150 standards for ductile iron pipe. Profile wall PVC pipe that does not conform to the maximum ductile iron outside diameters may need to use either the RCP/HDPE or corrugated metal tables depending on which is closer to its cross-sectional thickness.

The corrugated metal pipe tables were developed using a 0.064 wall thickness and a 0.5-inch corrugation pattern for all sizes. Since there are a great number of corrugation depths available for this product, the designer should adjust the design values in the table accordingly.

The equations presented in the Appendix of this document are simplified in the tables as previously noted for each pipe type. These tables are used to determine the minimum size manhole required for one, two and three pipes entering a single manhole structure at various angles. The "K" factors are based on the pipe diameter including its wall thickness and an appropriate supporting wall between the entering pipe for each manhole diameter. Maximum vertical cutoffs are limited to an 8-foot high riser.

### Example

**Given:** Two pipes entering a manhole: 42-inch RCP and 36-inch PVC at 115°

**Find:** Smallest size manhole

**Solution:** For two pipes  $180^\circ \geq 115^\circ > (K_1 + K_2)/2$

**Trial 1 (60-inch manhole)**  $K_1$  (42-inch RCP)=154 (from RCP Table)  
 $K_2$  (36-inch PVC)=95 (from PVC Table)

$$(154 + 95)/2 = 125 > 115$$

**Result: Not Acceptable**

**Trial 2 (72-inch manhole)**  $K_1$  (42-inch RCP)=109 (from RCP Table)  
 $K_2$  (36-inch PVC)=76 (from PVC Table)  
 $(109 + 76)/2 = 93 < 115$

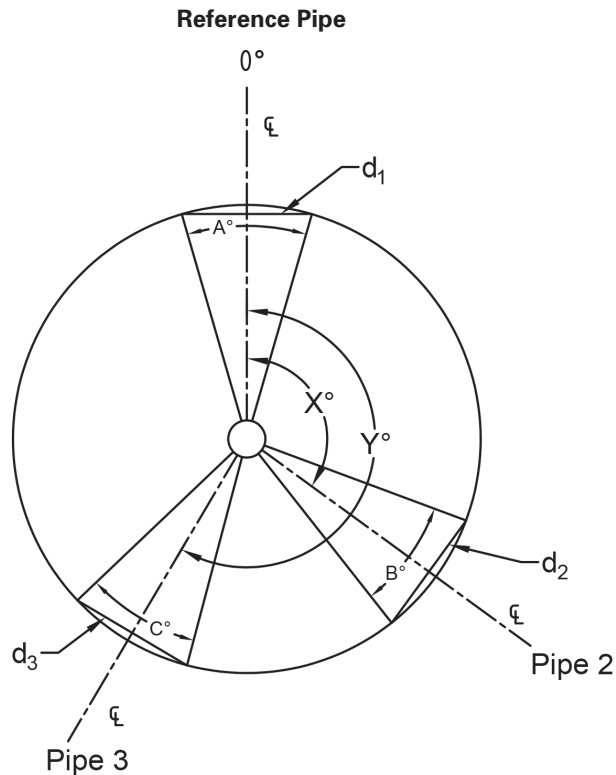
**Result: Acceptable**

### Summary

The procedures presented in this document provide a quick and easy solution for estimating the optimal size for manholes depending on the incoming pipe and type of connections being used. The ultimate design is the responsibility of the engineer, who must ensure the angles are correct. The contractor must also obtain these angles in the field. If the pipe is installed at angles other than normal or 90 degrees to the manhole, new calculations must be made.

## APPENDIX

The determination of acceptability of each entering pipe relative to all the other incoming pipe is based on the reference pipe, which is arbitrarily selected by the designer. For ease of design, it is best to use the largest pipe diameter as the reference pipe. The other incoming pipe are determined by their angle, x and y, to this reference pipe. The illustration below and corresponding equations are used for making these calculations:



## DESIGN PARAMETERS

Pipe Opening	Pipe Angle	Pipe Equation	Angle Range
Reference Pipe (d <sub>1</sub> )	0°	$A^\circ = 2\sin^{-1}\left(\frac{d_1}{r}\right)$	$A^\circ < 180^\circ$
Pipe 2 (d <sub>2</sub> )	X°	$B^\circ = 2\sin^{-1}\left(\frac{d_2}{r}\right)$	$X^\circ - \frac{B^\circ}{2} > \frac{A^\circ}{2}$
Pipe 3 (d <sub>3</sub> )	Y°	$C^\circ = 2\sin^{-1}\left(\frac{d_3}{r}\right)$	$Y^\circ - \frac{C^\circ}{2} > X^\circ + \frac{B^\circ}{2}$ and $Y^\circ + \frac{C^\circ}{2} < 360 - \frac{A^\circ}{2}$

Where: d<sub>n</sub> = [0.5 (pipe inside diameter) + pipe wall thickness + 3]

r: manhole inside radius

All units in inches

