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3A-1 General Information

A. Concept

Sanitary Sewer Systems are essential to the public health and welfare in areas of concentrated population and development. Every community produces water-borne wastes of domestic, commercial and industrial origin. The Sanitary Sewer performs the needed function of collecting these wastes and conveying them to points of approved discharge or disposal. The use of uniform and adequate sanitary sewer design criteria is essential for public safety and proper wastewater treatment, maintenance and control.

B. Conditions

1. **Design.** The design for sanitary facilities should be in conformance with the following:

   a. Requirements and Standards of the Iowa Department of Natural Resources.

   b. "Recommended Standards for Sewage Works Great Lakes-Upper Mississippi River Board of State Sanitary Engineers." (Ten State Standards).

   c. Urban Standard Specifications for Public Improvements.

   d. Jurisdictions Plumbing Code.

   e. In case of a conflict between the above design standards, the most restrictive requirement applies.

2. **Construction standards.** Construction standards should be the most recent revision of the Urban Standard Specifications for Public Improvements together with the latest addenda. All details, materials, and sewer appurtenances should conform to these standards.

3. **Project submittals.** A construction permit issued by the Iowa Department of Natural Resources (IDNR) is required for the construction, installation or modification of any disposal system or part thereof or any extension or addition thereto. A permit to construct minor sewer extensions may be obtained from a local public works department when the Department's permitting authority has been delegated to the local public works department under section 455B.45 of the Code of Iowa.

   DNR construction permit are normally not be required for the following sewers:

   a. Storm sewers that transport only surface water runoff.

   b. Any new disposal system or extension or addition to any existing disposal system that receives only domestic or sanitary sewage from a building, housing or occupied by fifteen persons or less.

c. Replacement of previously approved construction where the replacement is done with the exact same methods, materials, capacities and design considerations. However, if there is any change, the proposed construction will require a construction permit.

d. Sanitary sewer service connections, defined as any connection from a single property unit to an existing sanitary sewer.

Engineering services to obtain a construction permit and complete the approved construction should be performed in three stages:

a. Engineering report or facilities plan (not required for minor sewer extensions).

b. Preparation of construction plans, specifications and contractual documents.

c. Construction inspection, administration, compliance and acceptance.

All reports, plans and specifications should be prepared in conformance with Chapter 114 of the Code of Iowa.

Engineering reports or facilities plans should be submitted to the Department at least 90 days prior to the date upon which action by the Department is desired, or in accordance with the Iowa Operation Permit or other schedules. The final plans and specifications should not be prepared until the engineering report has been approved. This enables the Department to review the concept and design basis, make appropriate comments, and indicate to the applicant the general acceptability of the proposal before additional expenses are incurred for developing final plans and specifications. After the engineering report has been approved, the final plans and specifications should be submitted in accordance with 400--24.2(455B) of the Iowa Administrative Code or in accordance with the Iowa Operation Permit or other schedules. These plans and specifications should be prepared in accordance with the approved engineering report or facilities plan. Any changes from the approved report must receive prior approval from the IDNR before incorporation into the plans and specifications.

An application for a permit to construct should follow the Department of Natural Resources Rules and Regulations.

3B-1 Flow Determination

A. Sanitary sewers

1. **Discharge (Q) average daily flow (minimum)**

   Area x Area Density x Rate = Average Daily Flow **Equation 1**

   Number of Units x Unit Density x Rate = Average Daily Flow **Equation 2**

2. **Discharge (Q) peak sewer flow (minimum)**

   Average daily flow times ratio of peak to average daily flow (See Figure 1 for ratio). NOTE: Population values shown in Figure 1 are based on the area that discharges into the sewer.

3. **Design density and rate**. See Table 1.

B. Footing drain inflow

If a proposed sewer is to serve an older developed area with existing footing drain inflow, special design information should be obtained from the Jurisdiction. If no information is available, the designer should use a minimum of 1,000 gpcd for footing drain inflow.

C. Area

Gross area should be used in determining design flows and include streets, alleys, school grounds, parks, and similar dedicated open space.

D. Density table

Table 1: Minimum Values

LAND USE	AREA DENSITY	UNIT DENSITY	RATE
Low Density (Single Family) Residential	10 people / AC	3.3 people / unit	100 gpcd*
Medium Density (Multi-Family) Residential	12 to 15 people / AC 6.0 people / duplex	3.3 people / unit	100 gpcd*
High Density (Multi-Family) Residential	20 to 75 people / AC	2.5 people / unit	100 gpcd*
Office & Institutional	5,000 gpd / AC (IDNR)	Special Design Density	
Commercial & Light Industrial	5,000 gpd/AC (IDNR)	Special Design Density	
Industrial	10,000 gpd/AC (IDNR)	Special Design Density	

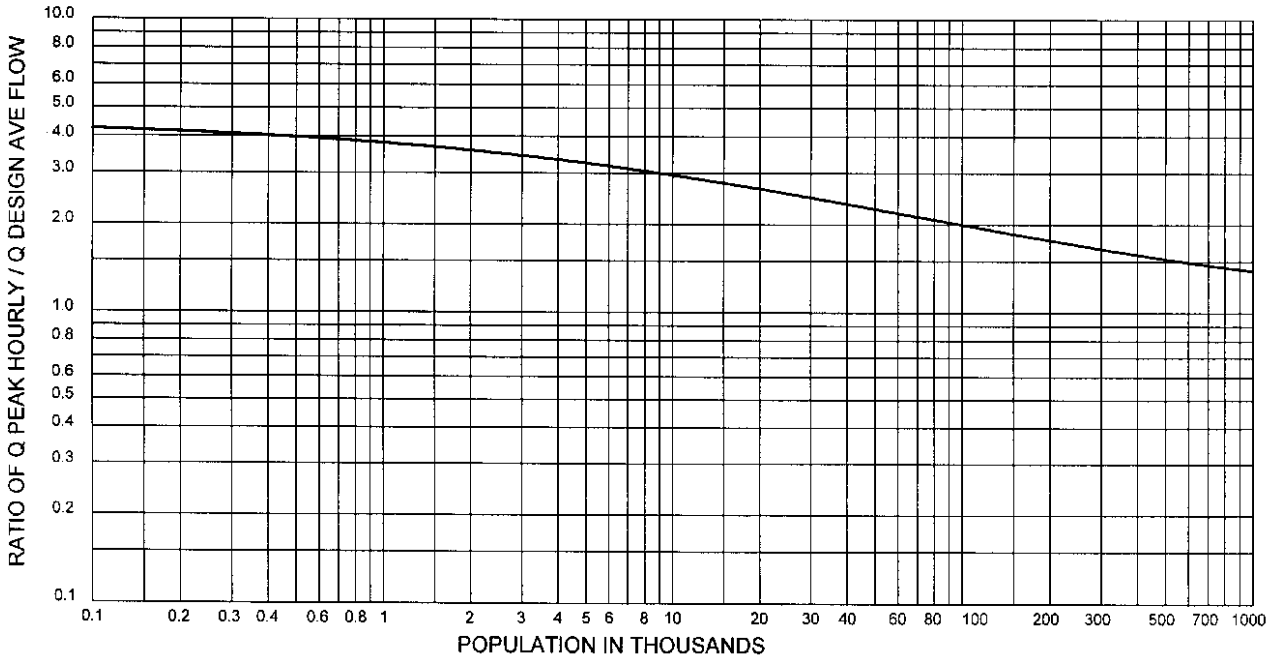
* Iowa Department of Natural Resources (IDNR) - Dry Weather Flow - One hundred gallons per capita per day (gpcd) should be used in design calculations as the minimum average dry weather flow. This 100 gpcd value may, with adequate justification, include maximum allowable infiltration for proposed sewer lines.

Note: If the Project Engineer uses values different from the above table, approval by the Jurisdictional Engineer is required.

E. Special design densities

Special design densities should be subject to approval by the Jurisdiction Engineer based on methodology provided by the Project Engineer.

Figure 1: Ratio of Peak to Average Daily Sewage Flow



Q Peak Hourly: Maximum Rate of Wastewater Flow (Peak Hourly Flow)
Q Design Ave: Design Average Daily Wastewater Flow

Source: Q Peak Hourly/Q Design Ave $= \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$

(P = Population in Thousands)

Fair, G.M. and Geyer, J.C. "Water Supply and Wastewater Disposal" 1st Ed., John Wiley & Sons Inc., New York (1954). p 136

3C-1 Facility Design

A. Capacity of pipe

Pipe sizes 15 inches and smaller should carry the peak flow at a depth of no more than 0.67 of the pipe diameter. Pipe sizes greater than 15 inches should carry the peak flow at a depth of no more than 0.75 of the pipe diameter. See Figure 1 to determine full flow values. To calculate .67 full and .75 full, multiply the full flow values from Figure 1 by 0.79 and 0.91 respectively.

B. Velocity within pipe

Minimum at peak flow = 2 fps

Maximum at peak flow = 15 fps

C. Pipe material

Contact the Jurisdictional Engineer or refer to www.iowasudas.org for materials allowed by each jurisdiction.

D. Manning's

(n) for approved pipe materials

"n" = 0.013 smooth wall pipe

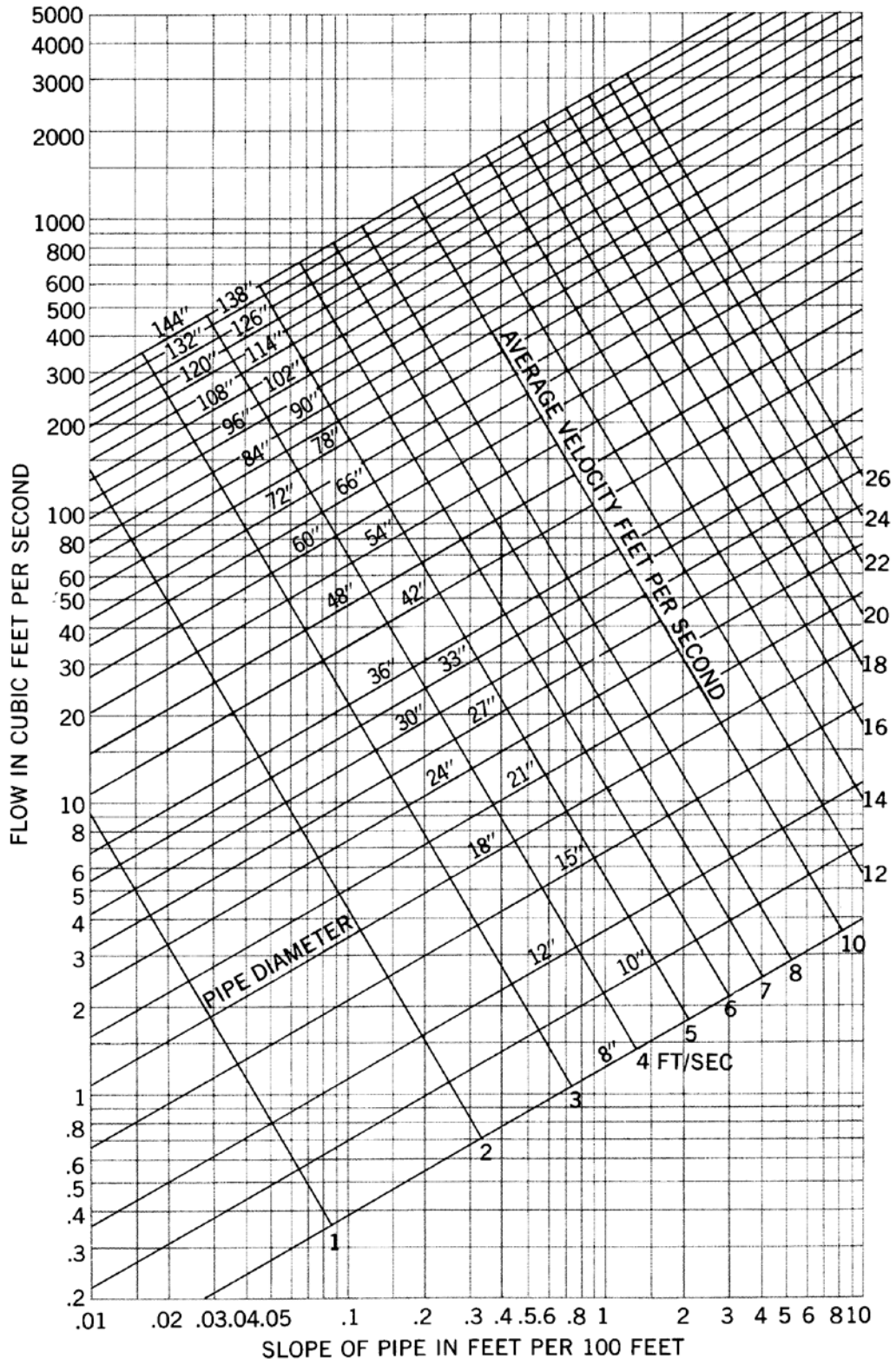
E. Minimum grade

Public sewers should have a sufficient grade to maintain 2 fps at peak flow (see Figure 1). Minimum grade on building sanitary sewer stubs should be 1/8 inch per foot.

F. Size of sewer pipe

Gravity sanitary sewers should not be less than 8 inches in diameter. Minimum size of building sanitary sewer stub should be 4 inches in diameter for residential and 6 inches in diameter for commercial. The size will increase based on the proposed number of fixtures that the sewer stub serves.

Figure 1: Flow for Circular Pipe Flowing Full (Based on Manning's Equation n=0.013)



G. Crossings and clearances

1. **Storm sewers.** Sanitary sewer crossings of storm sewers should have no less than 6 inches of clearance. Special structural support will be required if there is less than 18 inches clearance. The minimum horizontal clearance should be 5 feet. Clearance refers to the distance from the outside of the sanitary sewer pipe to the outside of the storm sewer pipe.

2. **Protection of water supplies:** (from Iowa DNR's *Iowa Wastewater Facilities Design Standards*, Chapter 12, Section 12.5.8)

   a. Wells: Sewers constructed of standard sewer materials shall not be laid within 75 feet of a public well or 50 feet of a private well. Sewers constructed of water main materials may be laid within 75 feet of a public well and within 50 feet of a private well but no closer than 25 feet to either.

   b. Horizontal Separation of Gravity Sewers from Water Mains: Gravity sewer mains shall be separated from water mains by a horizontal distance of at least 10 feet unless:

      1) the top of a sewer main is at least 18 inches below the bottom of the water main, and
      2) the sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.

      When it is impossible to obtain the required horizontal clearance of three feet and a vertical clearance of 18 inches between sewers and water mains, the sewers must be constructed of water main materials meeting both a minimum pressure rating of 150 psi and the requirements of Sections 8.2 and 8.4 of the "Iowa Standards for Water Supply Distribution Systems." However, a linear separation of at least 2 feet shall be provided.

   c. Separation of Sewer Force Mains from Water Mains: Sewer force mains and water mains shall be separated by a horizontal distance of at least 10 feet unless:

      1) the force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of Section 8.2 and 8.4 of the "Iowa Standards for Water Supply Distribution Systems" and
      2) the sewer force main is laid at least 4 linear feet from the water main.

   d. Separation of Sewer and Water Main Crossovers: Vertical separation of sanitary sewers crossing under any water main should be at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, the sewer may be placed not closer than 6 inches below a water main or 18 inches above a water main. The separation distance shall be the maximum feasible in all cases.

      When the sewer crosses over or is less than 18 inches below a water main one full length of sewer pipe of water main material shall be located so both joints are as far as possible from the water main. The sewer and water pipes must be adequately supported and have watertight joints. A low permeability soil shall be used for backfill material within 10 feet of the point of crossing.

   e. Exceptions: Should physical conditions exist such that exceptions to b through d above are necessary, the design engineer must detail how the sewer and water main are to be engineered to provide protection equal to that required by these sections.

3. **Sewer crossing under a waterway:** (from Iowa DNR's *Iowa Wastewater Facilities Design Standards*, Chapter 12, Section 12.5.11)

   The top of all sewers entering or crossing streams shall be at a depth below the natural bottom of the stream bed sufficient to protect the line. One foot of cover over the top of the line is required where the sewer is located in rock or cased and three feet of cover is required in other material. In major streams, more than the three feet of cover may be required.

   In paved channels, the top of the sewer line should be placed below the bottom of the channel pavement. Sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be so located that they do not interfere with the free discharge of flood flows of the stream. Sewers located along streams shall be located outside of the stream bed.

   Sewers entering or crossing streams shall be constructed of cast or ductile pipe with mechanical joints or shall be so otherwise constructed that they will remain water tight and free from changes in alignment or grade. Sewer systems shall be designed to minimize the number of stream crossings. The stream crossings shall be designed to cross the stream as nearly perpendicular to the stream flow as possible. Construction methods that will minimize siltation shall be employed. Material used to backfill the trench shall be stone, course aggregate, washed gravel, or other materials which will not cause siltation. Upon completion of construction, the stream shall be returned as near as possible to its original condition. The stream banks shall be seeded and planted, or other methods employed to prevent erosion. The design engineer shall include in the project specifications the method or methods to be employed in the construction of sewers in or near streams to provide adequate control of siltation.

4. **Aerial crossings:** (from Iowa DNR's *Iowa Wastewater Facilities Design Standards*, Chapter 12, Section 12.5.12)

   Support shall be provided at all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent overturning and settlement.

   Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers.

   For aerial stream crossings the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 50-year flood.

5. **Drainage courses.** Consideration should be given to providing additional depth below the streambed or erosion protection in the case of potentially erodable drainage courses.

H. Depth of sewer

Gravity sewers should be deep enough to serve basements, assuming a 2% grade plus adequate allowance for pipe fittings on house sewers (absolute minimum of 1%). They should have a minimum depth to the top of pipe of 8 feet unless the sewer can serve existing basements at a lesser depth. For those structures with no basements or when a high ground water table is encountered, depths less than 8 feet may be allowed. In either case, the sewer should be well below the frost line at all points and lower than any water lines placed in the same street. Insulation should be provided for sewers that cannot be placed at a depth sufficient to prevent freezing. For sewers greater than 12 feet deep as measured at the building line, provide risers on service stubouts. Maximum depth of sewer should not exceed depth recommended by manufacturer.

I. Location of sanitary sewers

1. **Sanitary sewers in street right of way**

   a. Sanitary sewers parallel to the right of way may be placed in the center of the street or behind the back of curb. Contact Jurisdiction for allowable location.

   b. Sanitary sewers perpendicular to the street should follow IDNR clearance requirements between storm sewer, water mains, and other utilities.

2. **Sanitary sewers outside of street right of way**

   a. Sanitary sewers will be placed in a sanitary sewer public easement. Public Sanitary sewer easements should have a minimum total width of 20 feet or two times the depth of the sewer, whichever is greater, with the sanitary sewer centered in the easement. Additional width may be required by the Jurisdictional Engineer to insure proper access for maintenance equipment.

   b. Provisions must be made to provide public access to the sanitary sewer easements from public streets.

J. Alignment of sewers

Sewers less than 24 inches in diameter should be straight between manholes. Bends may be allowed in sewers 24 inches and greater but must be straight between the bends. Jurisdictional Engineer may approve exceptions.

K. Sewer linings for ductile iron pipe

If ductile iron pipe is used for sanitary sewer pipe material, the pipe must be lined for sulfate protection. Allowable linings include calcium aluminate cement, polyethylene, ceramic epoxy, or coal tar epoxy.

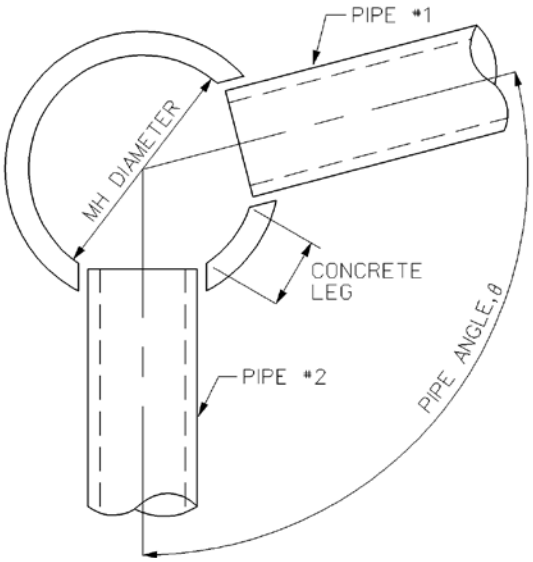
L. Manholes

1. **Access to manholes.** Manholes in street right of way must be located in areas which allow direct access by maintenance vehicles. Areas outside the street right of way should be subject to the approval of the Jurisdictional Engineer.

2. **Standard manhole.** The minimum size for a manhole is 48 inches in diameter. Check manhole size according to Section 3C-1. Most Jurisdictions require eccentric manholes with the manhole opening over the centerline of the pipe or on an offset not to exceed 12 inches. The remaining Jurisdictions allow for concentric manholes. Check with Jurisdictional Engineer regarding use of eccentric and concentric manholes and built-in steps.

3. **Special manholes.** For square or rectangular manholes, the manhole openings should be over the centerline of the pipes or on an offset not to exceed 12 inches. The distance from the centerline of the manhole opening to the face of the inside manhole wall should not exceed 30 inches to better facilitate video inspection and maintenance equipment. This may require more than one manhole opening.

4. **Manhole locations**
    a. Manholes should be installed:
        1. at the end of each sewer line
        2. at all changes in pipe size, grade or alignment, and at bends
        3. at all sewer pipe intersections
        4. at intervals not exceeding 400 feet for sewers 24 inches or less or at intervals not exceeding 500 feet when adequate cleaning equipment is available. Spacing of manholes over 500 feet may be permitted in sewers larger than 24 inches if the owner has adequate cleaning equipment.
    b. Cleanouts may be substituted, with Jurisdictional approval, for mains shorter than 150 feet.
5. **Minimum manhole drop**
    a. Change in alignment – 0 to 45 degrees – None
    b. Change in alignment across manhole – greater than 45 degrees - 0.10 feet (minimum), 0.25 feet (preferred)
6. **Dissimilar pipe sizes.** Change in pipe size - match eight-tenths full points.
7. **Maximum manhole drop.** A drop connection is required when the invert to invert drop is greater than 2 feet, except when the eight-tenths points match exceeds 2 feet.
8. **Manhole frames and covers.** Bolt-down covers are required on manholes subject to inundation such as in flood plains, detention areas, and storm water easement areas subject to "major storms."
9. **Manhole coatings.** Exterior waterproof coating (bituminous) is not required unless specified by the Jurisdiction. Interior coatings should be required if sulfate protection is necessary. Drop sections should be coated along with the manhole to protect against sulfate.
10. **Manhole sizes.** When utilizing circular precast manholes, it is necessary to determine the diameter required to maintain the structural integrity of the manhole. As a general rule, a minimum concrete leg of 6 inches should remain between the manhole blockouts for adjacent pipes. Determining the required manhole diameter to provide this minimum distance may be done as follows:
    a. Determine the diameters of, and the angle between, the two pipes in question. If more than two pipes connect at the manhole, the adjacent pipes with the critical configuration (i.e. smallest angle and largest pipes) should be selected. If the critical configuration is not apparent, calculations may be required for all adjacent pipes.



b. Determine the blockout diameter. The blockout is the opening provided in the manhole for the pipe. Blockout dimensions are based on the outside diameter of the pipe, plus an additional distance to accommodate the integrally cast gasket for sanitary sewer pipe. For storm sewer, a circular or doghouse type opening is provided with additional clearance to allow for the insertion of the pipe and sufficient space to accommodate placement of concrete grout in the opening. Typical blockout dimensions for various pipe sizes and materials are given in Table 1.

Table 1: Manhole Blockout Sizes

Pipe Dia.	**Manhole Blockout, in**			
	RCP		*PVC*	*DIP*
	Sanitary (gasketed)	*Storm (non-gasketed)*		
8”	N/A	N/A	12”	12”
10”	N/A	N/A	14”	14”
12”	24”	21”	16”	16”
14”	N/A	N/A	16”	18”
15”	26”	24”	19”	N/A
16”	N/A	N/A	N/A	20”
18”	30”	28”	22”	23”
20”	N/A	N/A	N/A	24”
21”	35”	31”	25”	N/A
24”	38”	35”	28”	29”
27”	42”	38”	31”	N/A
30”	44”	42”	35”	36”
33”	47”	47”	N/A	N/A
36”	52”	48”	42”	41”
42”	59”	57”	N/A	N/A
48”	66”	64”	N/A	N/A
54”	72”	71”	N/A	N/A
60”	79”	78”	N/A	N/A

c. Determine the diameter of the manhole required to provide the minimum concrete leg dimension. This diameter may be calculated with the following equation:

$$MH_d = \frac{BO_1 + BO_2 + 2CL}{\theta \times \left(\pi / 180\right)}$$ **Equation 1**

Where:

MH_d = Manhole Diameter, inches
BO = Blockout Diameter, inches
CL = Minimum Concrete Leg Length, inches (6 inches)
θ = Angle between pipe centerlines, degrees

d. Round the minimum manhole diameter calculated, up to the next standard manhole size (48 inches, 60 inches, 72 inches, 84 inches, 96 inches, 108 inches, or 120 inches)

e. Verify that the manhole diameter calculated is sufficient for the largest pipe diameter (See Table 2).

Table 2: Minimum Manhole Diameter Required for Pipe Size

Pipe Dia.	**Minimum Manhole Diameter Required for Pipe**		
	RCP	*PVC*	*DIP*
8”	N/A	48”	48”
10”	N/A	48”	48”
12”	48”	48”	48”
14”	N/A	N/A	48”
15”	48”	48”	N/A
16”	N/A	N/A	48”
18”	48”	48”	48”
20”	N/A	N/A	48”
21”	48”	48”	N/A
24”	48”	48”	48”
27”	60”	48”	N/A
30”	60”	60”	60”
33”	60”	N/A	N/A
36”	60”	60”	60”
42”	72”		
48”	84”		
54”	96”		
60”	96”		

M. Sewer services

1. Each structure or complex under one ownership should be served by a separate service line connected to a public or private sanitary sewer. The service should be perpendicular to the sewer line where possible, with tee or wye connections to the public sewer.

2. Sewer services must meet all the Jurisdiction's requirements.

3. Unless individual onsite treatment systems are allowed, all platted lots of a proposed subdivision are to have separate sewer services for each owner and be adjacent to a public sanitary sewer main without crossing any adjacent properties. Additional sewer services will be required for each additional principal structure on a given lot.

4. Sewer services across one property to provide service to an adjacent property should be avoided. If a condition exists that requires crossing an adjacent property, the following should be met:

    a. A private utility easement is provided that is 10 feet wide (minimum) or two times the depth, whichever is greater.

    b. The Jurisdictional Engineer determines that a sewer main extension will not be necessary and in all likelihood no future development of abutting properties will benefit from a main extension.

5. Connect sewer services to sewer mains. Connections directly to manholes will require Jurisdiction's approval. Individual single family residential services will not be connected to a manhole unless at terminal manholes which cannot possibly be extended in the future. Any service line connections to manholes require approval from the Jurisdiction. The services may not enter the manhole at greater than 2 feet above the invert of the outlet. Sewer flow channels in the manhole bottom must be provided for all services. Commercial and multi-family sewer services can be connected, with Jurisdictional approval, to a manhole on the collector sewer if flows are large enough to keep the manhole clean.

O. Force mains

1. **Minimum velocity:** 2 fps at minimum pumping condition.

2. **Air release valves:** Should be located at high points to control the excess accumulation of sewage gases.

P. Siphons

In general, sanitary sewer siphons should be avoided and will only be accepted where no feasible alternative exists and where there will be sufficient flow in the sewer so that maintenance will be held to a minimum. All siphons should have a minimum of two barrels with a minimum pipe size of 6 inches diameter. Design provisions should be made for diversion of normal flow to either barrel for maintenance. Sufficient head should be provided to insure velocities of at least 3 feet/second for average flow.

3D-1 Pipe and Manhole Materials

Table 1: Sanitary Sewer Pipe Comparisons

Typical Application	Pipe Material	Size Range	Standard	Thickness Class (min.)	Pipe Stiffness (min.)	Joints
Gravity Flow	PVC Solid Wall	8" - 15"	ASTM D 3034	SDR 35	46 psi	Bell & Spigot
Gravity Flow	PVC Solid Wall	8" - 15"	ASTM D 3034	SDR 26	115 psi	Bell & Spigot
Gravity Flow	PVC Solid Wall	18" - 27"	ASTM F 679	SDR 35	46 psi	Bell & Spigot
Gravity Flow	PVC Truss	8" - 15"	ASTM D 2680	N/A	200 psi	Bell & Spigot
Gravity Flow	Corrugated PVC	8" - 36"	ASTM F 949	N/A	46 psi	Bell & Spigot
Gravity Flow	Closed Profile PVC	21" - 36"	ASTM F 1803	N/A	46 psi	Bell & Spigot
Force Main	PVC	4" - 12"	AWWA C 900	DR 18	150 psi	Bell & Spigot
Force Main	PVC	14” - 30”	AWWA C 905	DR 18	150 psi	Bell & Spigot
Gravity Flow	ES VCP	8" - 42"	ASTM C 700	N/A		Bell & Spigot
Gravity Flow	LRCP	18" - 144"	ASTM C 76	Class IV Wall B	4000 psi	Tongue & Groove
Gravity Flow	DI	8" - 54"	AWWA C151	Class 52	300 psi	MJ or Push on
Force Main	DI	4" - 64"	AWWA C151	Class 52	300 psi	MJ or Push on

Gravity mains greater than 36 inches in diameter will be lined reinforced concrete pipe or ductile iron. Force mains greater than 36 inches in diameter will be ductile iron.

Table 2: Manhole Types

Figure No.	Type	Description	Depth Restrictions
6010.301	SW-301	Circular Sanitary Sewer Manhole	N/A
6010.302	SW-302	Rectangular Sanitary Sewer Manhole	12’ max.
6010.303	SW-303	Sanitary Sewer Manhole Over Existing Sewer	N/A
6010.304	SW-304	Rectangular Base/Circular Top Sanitary Sewer Manhole	12’ min. - 22’ max.
6010.305	SW-305	Tee-section Sanitary Sewer Manhole	N/A

Table 3: Ring and Cover Types

Figure No.	Casting Type	Number of Pieces	Ring/ Cover	Bolted Frame	Bolted Cover (Floodable)	Gasket
6010.601	A	2	Fixed[2]	Yes	No	Yes[1]
6010.601	B	3	Adjustable[3]	No	No	Yes[1]
6010.601	C	2	Fixed[2]	Yes	Yes	Yes[1]
6010.601	D	3	Adjustable[3]	No	Yes	Yes[1]

[1] Machine bearing surfaces required.

[2] Typically used with non-paved or flexible surfaces, including HMA, seal coat, gravel, and brick.

[3] Typically used with PCC surfaces, including castings in concrete boxouts.

3E-1 References

1. "Design and Construction of Sanitary and Storm Sewers" ASCE Manual of Practice No. 37. (WPCF Manual of Practice 9)

2. "Design Manual Concrete Pipe", American Concrete Pipe Association

3. "Great Lakes Standard Sewage Works", (10 State Standards)

4. Iowa Department of Natural Resources Design Standards

5. Environmental Protection Agency Guidelines

6. "Handbook of Ductile Iron Pipe", Ductile Iron Pipe Research Association

7. "Water Supply and Wastewater Removal", Vol. 1, Fair, Geyer, and Okun

8. "Water Distribution", American Water Works Association