



4C-1 Facility Design

A. General

Except for well systems, water mains and appurtenances, including hydrants and valves, should be provided along all streets including connections to and extensions from existing water systems.

The location and spacing of water main and their appurtenances is not only important for service and fire protection, but also maintenance requirements. Figures 1-3 show guidelines for the location of these facilities.

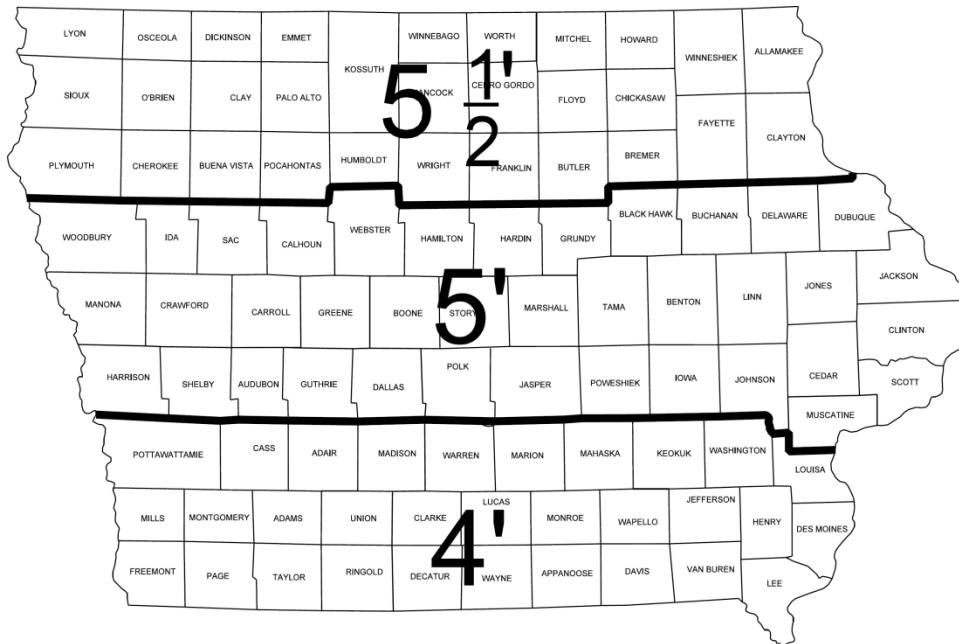
B. Water mains

1. Water main pipe will typically be either polyvinyl chloride (PVC) pipe or ductile iron pipe (DIP); and meet AWWA Standards. For larger mains (24 inch and greater), prestressed concrete cylinder pipe meeting AWWA Standards can be used.

Where distribution systems and service connections are installed in areas of groundwater contaminated by volatile organic compounds, pipe and joint materials (non-PVC pipe) that do not allow permeation of the volatile organic compounds should be used.

2. Water mains should be extended to the plat or property boundaries, to the next street, or as directed by the Jurisdiction.
3. New main installation should be located in the parking area (between the curb and the property line) of the right-of-way and minimum of 4 feet behind the curb. Where possible, water mains should be located along the south and east sides of the street.
4. Dead-ends should be minimized by looping mains whenever possible. Dead-ends should terminate with an approved flushing device (blowoff, hydrant, flushing hydrant). They may terminate with an approved fire hydrant when adequate pressure is available at required flows. For maintenance considerations and when adequate fire flows are not available, flushing hydrants may be allowed by the Jurisdiction with the hydrant outlet sized and arranged to prevent the attachment of fire hoses. Unless required by a Jurisdiction, permanent inline shut-off valves should not be placed at the end of dead-end mains.
5. Water mains and extensions should be designed with a minimum cover as indicated on Figure 1, unless more or less cover has been approved by the Jurisdictional Engineer. Greater depths of cover, surface loading conditions, or unusual trench conditions may require a stronger class of pipe according to the AWWA standard regarding the type of pipe being installed. Where a dip must be placed in a main in order to pass under another utility, the length of the deeper main should be kept to a minimum, and bends should be considered to affect the desired offset.

Figure 1: Minimum depth of cover for water main installation



C. Blowoffs

A blowoff or approved flushing device should be required on all dead-end mains where a hydrant is not installed. The minimum riser assembly size should be no less than 2 diameter sizes smaller than the diameter of the water main. When the water main is extended, the blowoff should be removed. A new valve should be placed between the existing and extended main.

D. Valves

1. As a minimum, valves should be located at intersections, such that only one unvalved pipe exists at the intersection. Valves should be equally spaced, if possible, with spacing no more than 800 feet in residential areas and no more than 400 feet in high density areas. (See Figures 2-4 for valve location at intersections).
2. Valves should not be located in the sidewalk line or in driveways.
3. All valves should be installed with valve boxes.
4. No valves (except blowoff valves) should be placed at the end of a dead-end main unless required by a Jurisdiction. A valve should be installed between the existing main and new main when the main is extended. Intermediate valve locations between the end of a dead-end main and last valved street intersection may be required by the Jurisdiction to provide required valve spacings.
5. A tapping sleeve and valve should be used when making a perpendicular connection to an existing main.

E. Hydrants

1. Hydrants should comply with AWWA C502. The connecting pipe between the supply main and the hydrants should be a minimum of 6 inches in diameter and be independently valved. Fire hydrants should not be installed on water mains that do not provide a minimum pressure.
2. Hydrant drains should not be connected to or located within 10 feet of sanitary sewers.
3. Locations of fire hydrants are governed by the rules and regulations of the IDNR and the local Jurisdiction and by the following principles. Satisfy each principle in the order they are listed. See Figures 1-3 for typical hydrant locations.

- a. Locate fire hydrants within 25 feet of each street intersection, measured from an end of a street paving return.

Locate fire hydrants outside street paving returns. Avoid conflicts with storm sewers, intakes, and sidewalks. Whenever possible, locate fire hydrants at the high point of the intersection.

- b. Locate fire hydrants between street intersections to provide spacings of no more than 450 feet in single family residential districts and no more than 300 feet in all other districts.

Vary spacings slightly to place fire hydrants on extensions of property lines. When hydrants are required between intersections, they should be located at the high point of the main for air release or at a significant low point for flushing on the downhill side of an in-line valve.

When street curvature or grid patterns places a proposed protected structure at an unusual distance from the fire hydrant, the coverage radius should not exceed 300 feet in single family residential districts and 150 feet in all other districts. The Jurisdiction's fire marshall may have additional private fire protection requirements.

- c. On cul-de-sac streets, hydrants should be located at the intersection of the cul-de-sac street and cross-street and the end of the cul-de-sac.
 - 1) For cul-de-sacs between 300 feet and 500 feet in length, an additional hydrant should be located at the mid block.
 - 2) For cul-de-sacs greater than 500 feet in length, hydrants should be placed at near equal spacings, but not exceeding the spacings described above.
- d. Hydrants must be located to provide the required fire flows. ISO evaluates fire hydrant locations within 1000 feet of the test location, measured along the streets as fire hose can be laid, to evaluate the availability of water for fire protection. Hydrant capacity is credited as shown in the following table:

Hydrant Location	Credited Capacity
Within 300' of location	1000 gpm
Within 301' to 600' of location	670 gpm
Within 601' to 1000' of location	250 gpm

F. Water service stubs

Water service stub for each building or platted lot should be provided, including corporation stop, service line, and curb stop (shut-off) with box. The service stub from the water main to the shut-off will normally be 6 feet from the property line or 1 foot from the street side of the sidewalk. In no case should the shut-off be in the sidewalk. Avoid locations where driveway approaches are likely to be constructed in the future.

G. Separation of water mains from sewer mains

The following requirements are from Iowa DNR's *Iowa Wastewater Facilities Design Standards*, Chapter 12, Section 12.5.8, "Protection of Water Supplies."

1. **"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:
 - a. the top of a sewer main is at least 18 inches below the bottom of the water main, and
 - b. 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.

2. **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:
 - a. 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
 - b. the sewer force main is laid at least four linear feet from the water main.
3. **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.

Where the sewer crosses over or 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."

H. Water crossings (Great Lakes-Upper Mississippi River Board)

Surface water crossings, whether over or under water, present special problems. The reviewing authority should be consulted before final plans are prepared.

1. **Above-water crossings.** The pipe should be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.
2. **Underwater crossings.** A minimum cover of 2 feet should be provided over the pipe. When crossing water courses greater than 15 feet in width, the following should be provided:
 - a. The pipe should be of special construction, having flexible, restrained, or welded watertight joints.
 - b. Valves should be provided at both ends of the water crossings so the section can be isolated for testing or repair; the valves should be easily accessible and not subject to flooding.
 - c. Permanent taps or other provisions to allow insertion of a small meter to determine leakage and obtain water samples should be made on each side of the valve closest to the supply source.

I. Air relief facilities (Great Lakes-Upper Mississippi River Board)

1. **Air relief valves.** At high points in water mains where air can accumulate, provisions should be made to remove the air by means of air relief valves. Automatic air relief valves should not be used in situations where flooding of the manhole or chamber may occur.
2. **Air relief valve piping:**
 - a. Use of manual air relief valves is recommended wherever possible.
 - b. The open end of an air relief pipe from a manually operated valve should be extended to the top of the pit and provided with a screened, downward-facing elbow if drainage is provided for the manhole.
 - c. The open end of an air relief pipe from automatic valves should be extended to at least 1 foot above grade and provided with a screened, downward-facing elbow.
 - d. Discharge piping from air relief valves should not connect directly to any storm drain, storm sewer, or sanitary sewer.

J. Valve, meter, and blowoff chambers (Great Lakes-Upper Mississippi River Board)

Wherever possible, chambers, pits, or manholes containing valves, blowoffs, meters, or other such appurtenances to a distribution system should not be located in areas subject to flooding or in areas of high groundwater. Such chambers or pits should drain to the ground surface or to absorption pits underground. The chambers, pits, and manholes should not connect directly to any storm drain or sanitary sewer. Blowoffs should not connect directly to any storm drain or sanitary sewer.

K. Thrust blocks and restrained joints

Concrete thrust blocks and restrained joints are used to counteract joint movement at points where piping changes directions or at dead-ends.

1. **Thrust blocks.** Concrete thrust blocks are typically used on pipes 16 inches in diameter or smaller. Thrust blocks may be used on other pipes independently or in combination with restrained joints. Table 1 assumes a bearing area of thrust blocks based on 1000 psf soil pressure and 150 psi water pressure. Where water pressures are higher and/or soil conditions are poor, the designer should design the correct block size using the equation below Table 1. No bolts should come into contact with the concrete thrust blocks. If necessary, polyethylene wrap should be wrapped around the pipe, including the bolt circle, before the concrete is placed. Concrete should have a minimum compressive strength of 4000 psi at 28 days.

Table 1: Thrust block minimum bearing surface (SF)

Pipe Size (in)	Bends				Tee or Dead-end
	11.25°	22.5°	45°	90°	
4	1.0	1.0	2.0	4.0	3.0
6	1.0	2.0	4.0	8.0	6.0
8	2.0	4.0	7.0	14.0	10.0
10	3.0	6.0	11.0	21.0	15.0
12	4.0	8.0	16.0	29.0	21.0
14	5.0	11.0	21.0	39.0	28.0
16	7.0	14.0	27.0	50.0	36.0
18	9.0	17.0	34.0	63.0	45.0
20	11.0	21.0	42.0	78.0	55.0
24	15.0	31.0	60.0	111.0	78.0
30	24.0	47.0	92.0	171.0	121.0
36	34.0	67.0	132.0	244.0	173.0

Note: Areas based upon water pressure of 150 psi and allowable soil pressure of 1000 psf.

Required Area, $\text{ft}^2 = (2) (\text{water pressure, psi})(\text{cross sectional area of pipe, in}^2) / (\sin(\text{angle of bend} / 2)) / (\text{allowable soil pressure, psf})$

2. Restrained joints

- a. **For pipe diameters 8 inch through 12 inch.** Provide a minimum of 40 feet of restrained pipe in all directions along the pipe from the fitting for pipe diameters 8 inch through 12 inch, depths of bury of at least 5 feet, and a maximum test pressure of 150 psi.
- b. **For pipe diameters greater than 14 inch.** Restrained joints are typically used on pipes larger than 14 inches in diameter. They may be used on other pipe sizes independently or in combination with concrete thrust blocks. See pipe manufacturer's recommendations for determining restrained lengths of pipe required.

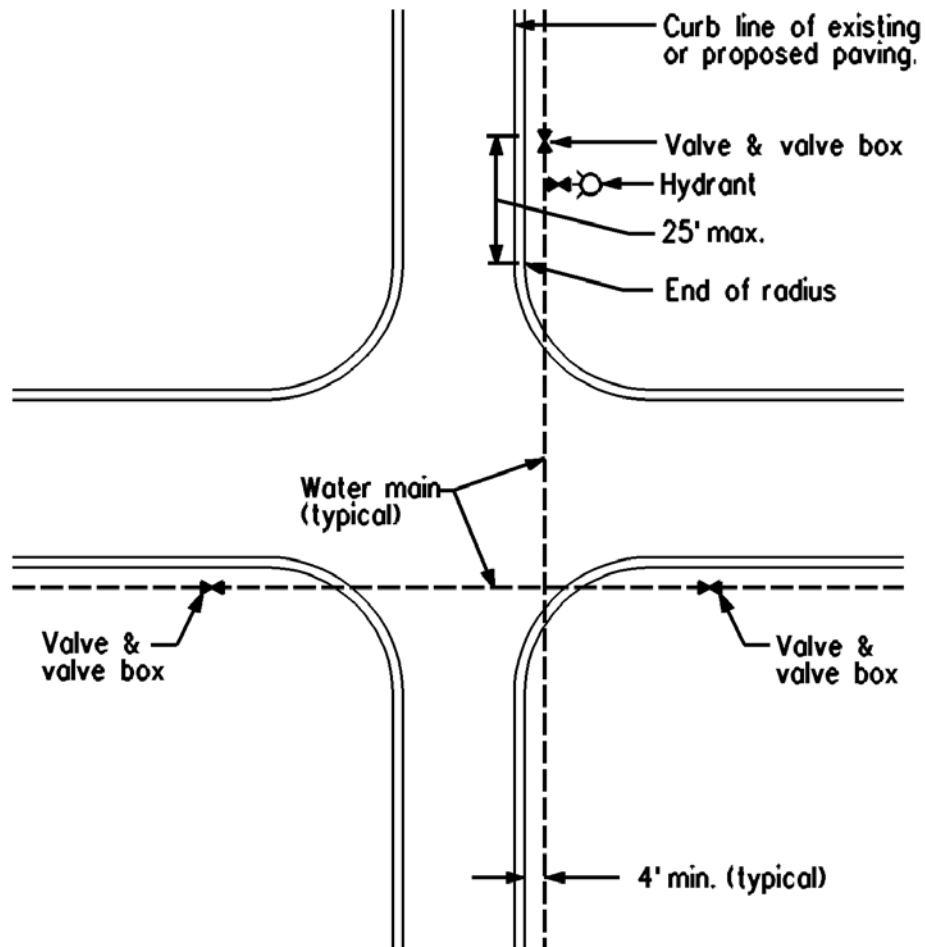
L. Crossings

1. **Railroad crossings.** The regulations of the railroad company involved will govern when a water main is installed under or over any railroad tracks.
2. **Roadway crossings.** The jurisdiction responsible for the roadway should have regulations for crossing a roadway. For Primary and Interstate Highways, the Iowa DOT is the responsible jurisdiction. For non-primary, federal-aid roadways use the most recent version of the “Policy for Accommodating Utilities on the County and City Non-Primary Federal-Aid System”. For all other roadways, contact the responsible jurisdiction.

M. Flushing, disinfection, and pressure tests

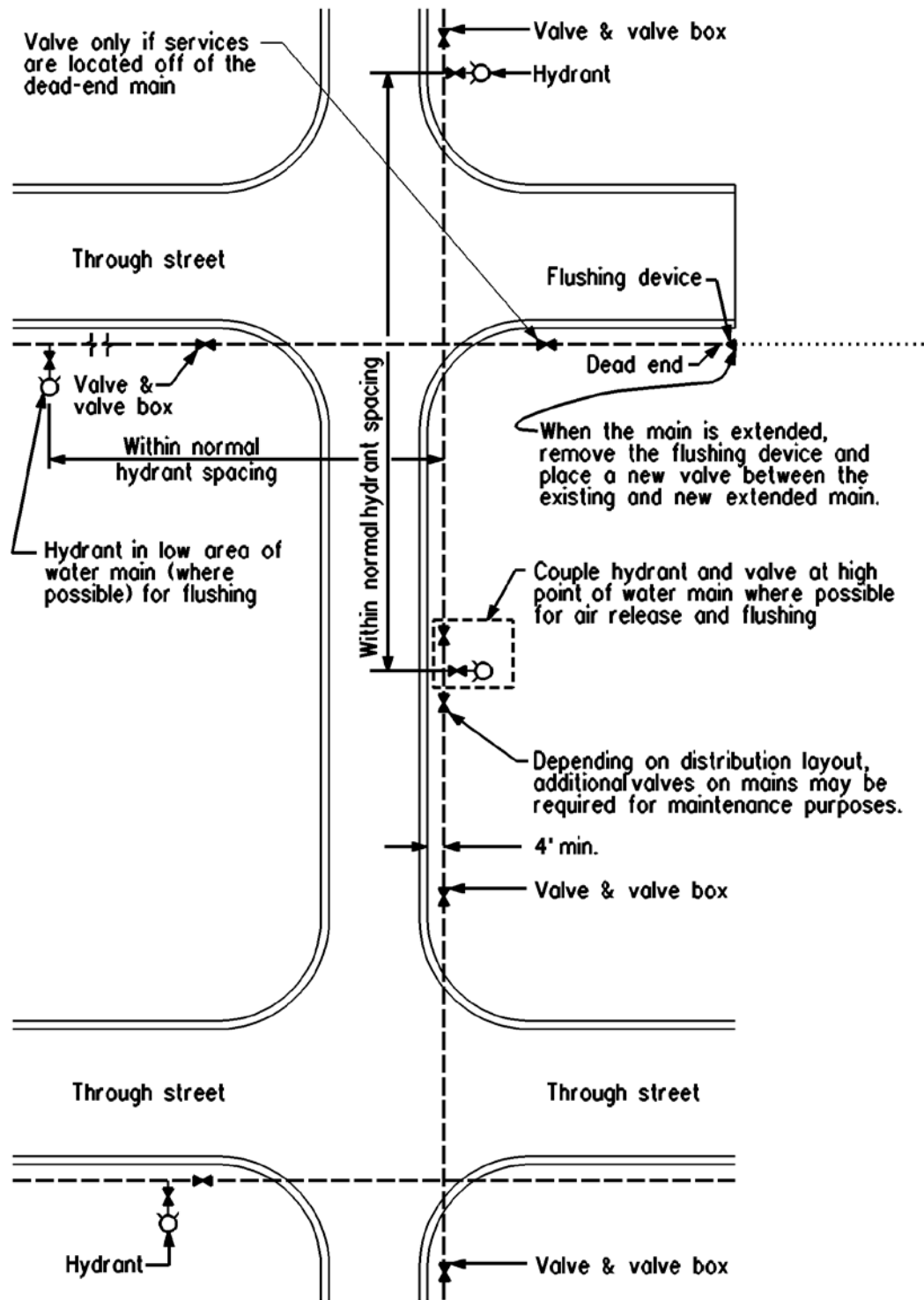
Before going into service, all new mains shall be adequately flushed, pressure tested, and disinfected according to the rules and regulations of the local Jurisdiction and the IDNR. The procedures, once approved by the Jurisdiction, should be conducted under the supervision of the Jurisdiction or designated representative.

Figure 3: Standard water main location

**Notes:**

1. Install three valves and one fire hydrant at each intersection except T-intersections, which will have two valves.
2. When possible, locate fire hydrant near high point.
3. Locate fire hydrants within 25 feet of intersection return radius, but outside of radius to avoid conflicts with storm sewers and intakes.

Figure 4: Standard water main location



Where possible, locate hydrants on the downhill side of an on-line valve for air release and flushing purposes.