Size Determination

A. General

Domestic usage requirements for a service area can be determined either from past records or from general usage information shown in Table 4B-1.01. This data should then be adjusted for commercial, industrial, and projected growth factors to ensure the system's design capacity should meet future demand.

A factor in sizing main facilities is the need for fire protection. Fire flow requirements are set by the Insurance Services Office (ISO). This group determines the minimum flow the system must be able to maintain for a specified period of time in order to achieve a certain fire protection rating. Fire insurance rates are then based, in part, on this classification.

B. Network Analysis

Pipe carrying capacity depends on pipe size, pressure, flow velocity, and head loss resulting from friction. Friction factors include roughness of pipe, flow velocity, and pipe diameter. The required pipe size can be calculated when the other requirements and characteristics are known.

When the distribution system or system expansion is extensive, it may be necessary to analyze the system and balance the flow among all areas in relation to demand. This analysis requires a plot of pressures and flows at points throughout the system.

C. Velocity Requirements

Velocity of flow is also a factor in determining the capacity of pipes and, therefore, the required pipe size. Velocities should normally be 5 fps or less, due to high friction losses that occur at greater velocities. This may be difficult to obtain under normal operating conditions, and velocities can significantly exceed this guideline under fire-flow conditions.

D. Minimum Criteria

1. **Minimum Design Period Requirements:** Water mains should have a minimum size based on a hydraulic analysis utilizing 20 year design for a specified water demand. Consideration should be given to projected land uses and demand based on full development of the service area. The specified water demand depends on the area to be serviced and the type of water main (feeder, arterial, or distribution).

2. **Minimum Size Requirements:**

   a. **Water Service Stub:** The water service stub must meet the Jurisdiction's standards and provide adequate design flows.

   b. **Distribution Mains:** All water mains should be sized large enough to provide existing and future residential, commercial, and industrial water demands and fire protection flows to the area to be served. The minimum water main size is 8 inches in diameter, unless otherwise approved by the Jurisdictional Engineer. The Jurisdiction reserves the right to increase the size of the mains to meet future water demands.

   c. **Arterial or Feeder Mains:** Arterial or feeder mains, typically 12 inches and larger, should conform to an existing grid pattern or as directed by the Jurisdiction to meet long range plans of the Jurisdiction.

3. **Pressure Requirements:** The recommended minimum operating pressure of the distribution system should be no less than 35 psi. The residual pressure required under fire flow conditions should not drop below 20 psi at any hydrant or any point in the system. When operating pressure exceeds 100 psi, individual or system pressure reducing devices may be required.

E. Flow Considerations

1. **Design Flows:** The water main system must be able to meet the following flow requirements:

   a. Peak day demands plus fire flow demands.

   b. Instantaneous peak demands for water mains from source, treatment, and/or storage facilities.

2. **Peak Day Demands:**

   a. **General:** The peak day demand is the average rate of consumption on the maximum day. The maximum day is the 24 hour period during which the highest consumption total is recorded in the latest 3 year period. High consumption that will not occur again due to changes in the system, or that was caused by unusual operations, should not be considered.

   When no actual figure for maximum daily consumption is available, it should be estimated on the basis of consumption in other cities of similar character. Such estimates should be at least 2.0 times greater than the average daily water demand for cities having more than 500 people and 2.5 times greater than the average daily water demand for cities having 500 people or less.

   b. **Average Day Demand (minimum):**

   Area x Area Density x Rate = Average Daily Demand **Equation 4B-1.01**

   Number of Units x Unit Density x Rate = Average Daily Demand **Equation 4B-1.02**

Table 4B-1.01: Density

Land Use	Area Density	Unit Density	Rate
Low Density (Single Family) Residential	10 people/AC	3.0 people/unit	100 gpcd
Medium Density (Multi-Family) Residential	15 people/AC	3.0 people/unit 6.0 people/duplex	100 gpcd
High Density (Multi-Family) Residential	30 people/AC	2.5 people/unit	100 gpcd
Office and Institutional	Special Design Density[1]		
Commercial	Special Design Density[1]		
Industrial	Special Design Density[1]		

[1] Special design densities should be subject to approval by the Jurisdictional Engineer based on methodology provided by the Project Engineer.

Note: If the Project Engineer uses values different than the above table, approval by the Jurisdictional Engineer and Iowa DNR is required.

3. **Instantaneous Peak Demands:** Where existing data is not available to accurately predict the instantaneous peak demand for the design year, the following criteria may be used as a minimum for estimating the instantaneous peak demand:

   a. 220 people or less = Average day demand (gpm) x 9.0.

   b. More than 220 people = Average day demand (gpm) x $7/P^{0.167}$
   P = design year population in thousands.

   If major water users exist in the system, the peak may be greater than those listed above.

4. **Fire Flows:** The following general information is taken from the *Fire Suppression Rating Schedule* (Edition 05-2008) of the Insurance Services Office (ISO). The latest ISO requirements must be checked to verify fire flow criteria. Insurance requirements for fire protection may vary with each Jurisdiction and must be confirmed by the Project Engineer.

   a. For one- and two- family dwellings not exceeding two stories in height, the following needed fire flows should be used.

Distance Between Buildings	Needed Fire Flow
Over 100’	500 gpm
31’ to 100’	750 gpm
11’ to 30’	1,000 gpm
10’ or less	1,500 gpm

   For wood shingle roof coverings on the building or on exposed buildings add 500 gpm to the needed fire flows.

   b. Multi-family, commercial, and industrial areas are considered high risk areas. The fire flows available in these areas require special consideration. The distribution and arterial mains in the high risk areas are to accommodate required fire flows in those areas.