WATER DISTRIBUTION

A community develops a water distribution works to supply sufficient quantities of potable water at adequate pressure to utility customers. The components of distribution vary between villages, but the basic operation and elements of the works are common to nearly all systems. Potable water is pumped from a treatment plant through a network of interconnected mains to the users. The precise manner and routes by which water is conveyed to the user depend on the hydraulic configuration of the distribution network. System hydraulics is an aspect of engineering design influenced by the high service pumps; the elevated storage tanks; the valving, size, and condition of the waterlines; and the specific water demand within the system.

The ensuing section provides an overview of distribution works and a discussion of the techniques used in distribution analysis. This material is intended to provide background information helpful to both layman and practitioner in understanding the analysis and recommendation section of this report.

Distribution Overview

A water distribution system must meet the industrial and residential needs of a community every day while maintaining sufficient reserve capacity for filling tanks and fighting fires. If water demand were constant, meeting system requirements would be fairly simple; however, demand varies with the time of day, week, and year. For example, maximum daily demands are commonly 1.5 and 2.5 times the average daily use. Maximum hourly demands are often 6 to 10 times the average daily rates. Fire or special events also increase demand.

Variations of water use complicate system hydraulics and necessitate careful selection of distribution methods and components to meet overall system requirements. The selection of distribution methods is also influenced by local conditions, such as topography; status of the existing network; location of pumping facilities with respect to major users; size, development, and area of the community; and utility operating policy.

Waterlines are generally laid parallel to the surface of the ground, at a depth of not less than 4 feet and sometimes up to 5 feet to prevent freezing, and are, therefore, less subject to control by topography and subsurface conditions than sewerage systems. Where bedrock lies close to the surface, construction becomes more difficult and costly which presents an economic issue. The major factor to be considered in the expansion of a water supply system is the capacity of the system to serve the expanded area. This includes both the capacity of the distribution system, including storage and booster pumping, and the capacity of the treatment plant including raw water sources.

The pump-storage method used in this geographic area utilizes a combination of pumps and elevated storage to meet the consumption and fire requirements of the system. During periods of low consumption, water is pumped into the elevated storage tanks. During periods high consumption, the stored water is used to augment the water being pumped to users.

Equipping a water distribution system with elevated storage increases capital expenses and may be physically difficult or aesthetically displeasing. Nevertheless, pump-storage offers better pressure control, lower energy consumption, smaller equipment capacities and improved fire-fighting capacity.

If the overflow elevations of the storage facilities are properly chosen, the storage will float on the distribution system. Storage units that float on a system, fill and empty by gravity in response to higher or lower system pressures. Having part of the water fed by gravity into the distribution system reduces fluctuations in pressure and minimizes the impact of short-term power outages.

Many communities use elevated storage in areas of high consumption and low pressure to increase local pressures without adding mains or changing pumps. The storage water is used during the day and replaced at night when water use and energy costs are lower and line pressure is higher. The pump-storage method can also save money for a community because the system uses less expensive, more efficient constant speed pumps rather than variable speed pumps.

<u>Distribution Analysis</u>

An engineering analysis of a water distribution works assesses the capacity of the system under existing and future conditions. The evaluation normally leads to recommendations designed to correct existing deficiencies and prepare the system for anticipated demands. The analysis can be diverted into two broad analytic categories: community requirements and local conditions and system hydraulic capacities and sizings.

Community requirements and local conditions are assessed to quantify future water demand and define other factors affecting water distribution. Projecting water demand accurately is difficult, but in practical terms, it requires estimating future domestic and industrial needs and adding fire protection requirements. Domestic water use projections are a function of population and per capita use. Industrial water use projections are based on anticipated by the Insurance Services Office based on the size and density of the community and the values and locations of residences, businesses, and industries.

Each community has particular characteristics that affect water distribution including physical or political limits to growth and community expectations and attitudes. Topography and water availability also influence the make-up of the distribution system and the growth of the community.

The hydraulic analysis of a distribution works determines whether the system can convey a quantity of water with sufficient pressures to particular locations. Network hydraulic analysis is quite complex as flow velocities and pressures must be determined for every main in the system. This requires assessing the distribution network's flow characteristics and headloss. Capacities, sizings, and locations of pumps, storage facilities and mains are evaluated on the basis of the hydraulic analysis and water use.

In addition to the peak daily and/or hourly demands, water systems must also be designed to meet the requirements for fire protection at any time of day or night, regardless of the normal usage at that particular time. A maximum fire demand occurring during a period of peak hourly demand would be the most severe condition to be met. However, the probability of both peak requirements coinciding is slight, and the maximum coincidental demand is usually taken as the maximum daily rate plus the maximum fire demand.

It is also recommended that fire flow requirements be capable of being concentrated in one location in flows ranging from 750 gpm to 3,500 gpm. Required fire flows are determined by the type of building construction and total floor area in square feet. The following table lists the amount of water required to be available for fire fighting purposes for two and three hour durations with domestic consumption at the 24 hour maximum rate.

TABLE 20 ISO FULL CREDIT REQUIRED FIRE FLOWS		
Classification	Needed Fire Flow	Duration (hours)
One- and Two-Family Dwellings	750 - 1,000 gpm	2
Small Commercial	1,500 - 2,000 gpm	2
Medium Commercial and Industrial	2,000 - 3,000 gpm	3
Large Commercial and Industrial	3,500 gpm	3
Note: The above-listed fire flows are dependent on type of building construction material, total floor area of structure, and distances between structures.		

The maximum water demand to be placed on any water system is based upon either the maximum hourly demand or the maximum daily demand plus the demand for fire protection, whichever is greater.

The projected usage is a very speculative quantity. Water usage could experience significant increases due to industrial growth, commercial and residential development, or due to normal fluctuations in usage caused by new appliances, seasonal or climatic conditions, etc. We would expect none of these factors to cause a significant increase in usage long term. Some short-term peaks due to extended drought or heat waves could be experienced, but these are unpredictable and of a relatively short duration which could be typically handled through limited conservation or extended operation.

Fire Flow Tests

Fire flow tests are assessments of the amount of water available for fighting fires. The test procedure consists of discharging water through a particular hydrant at a measured rate of flow and observing the corresponding pressure drops in nearby mains. From the data collected, the flow at any residual pressure can be computed. Twenty (20) pounds per square inch (psi) residual line pressure is the minimum pressure maintained while providing the specific rate of flow for fighting fires.

A fire flow test is conducted by selecting a group of test hydrants in an area and designating one as the residual hydrant. The normal pressure at this hydrant is first observed with all other hydrants closed. The pressure is again observed while all other hydrants are simultaneously discharging a measured flow. The total flow rate is determined by summing the individual hydrant flow rates.

Regional Water System

Regional water supplies are becoming more prevalent with the proliferation of environmental regulations and the added responsibilities in which they create. In recent years, increased levels of contaminants have affected both ground and surface water supply available in Sandusky County. Moreover, the regulations and costs of adequately treating water has affected many municipal and private water supplies. In the future, these costs and the level of treatment required could increase the desire to regionalize water systems or to look for alternative sources of raw water. Regulations for monitoring volatile organic chemicals, herbicides, pesticides, synthetic organic compounds and heavy metals are but a few of the additional reporting requirements before us.

Cost of compliance with EPA regulations has risen sharply and can be expected to continue to rise as the national concern for health and the environment matures.