

WHAT CONSTITUTES “SAFE” DRINKING WATER?

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The fundamental purpose of a public water system is to deliver water to its customers in acceptable quantities (volume and pressure) and quality and at a reasonable price. This implies two primary tasks. The first addresses the fact that physically a water system operates within a supply and demand framework. Water is essentially an incompressible fluid and because the demand can vary on an instantaneous basis, a modern water system must include a means of supplying, storing and pressuring the water to meet the range of demand reasonably anticipated. The second task recognizes that unless the quality of the water delivered is acceptable, the water cannot be used without incurring some level of harm or damage. Of course, the question then becomes – what constitutes an acceptable quality level?

Historical Context

The design and operational standards of public water supplies has evolved dramatically over the past 100 years. Shortly after the turn of the century, Congress authorized the United States Public Health Service (USPHS) to develop regulations to minimize the spread of communicable diseases through public water supplies. First, a means to distinguish safe water from unsafe water had to be developed. The relationship between acute waterborne disease and microbial activity had been recognized and, thus, attention was focused on improving the ability to reliably test for safe levels of pathogens. The initial standards focused on using coliform bacteria as the surrogate parameter to test for microbial contamination. Interestingly, almost 100 years from the time the test was proposed and implemented, the coliform test remains the primary routine method for evaluating water safety from a biological perspective.

Concurrently water treatment methods were being examined which would deliver water of acceptable quality. It was observed that a reduction in turbidity through simple filtration provided significant beneficial effects especially for those systems that depended on surface waters for their basic supply. Studies examining methods for disinfecting water showed the efficacy of chlorine in reducing microbial levels. With the development of a means to safely apply chlorine at the water plant, engineers began to include chlorine as a disinfectant in water supplies beginning in 1908 (AWWA 1990). With the establishment of these two processes, a remarkable reduction in various waterborne diseases was noted. Although other improvements in sanitation and medical treatment also contributed to this reduction, a significant portion of the seventy-five (75) percent decline in the crude death rate for infectious disease from 1900 to 1940 can be attributed to these changes in water treatment (Armstrong et al. 1999). This is demonstrated graphically in Figure 1.

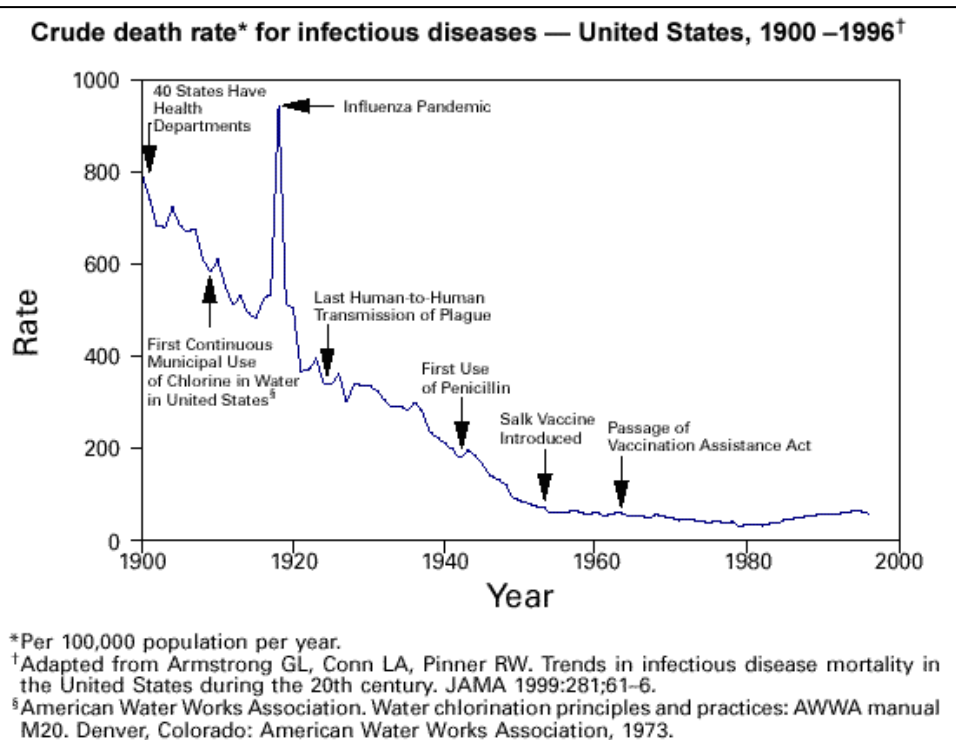


Figure 1

In the period between 1860 and 1960, the number of centralized municipal water systems had grown from 400 to 19,000 (AWWA 1990). Once the basic parameters of treatment were established, this rapid development of public supplies devoted much of its attention to the efficient and reliable delivery of water to its users. Advances in treatment process design, laboratory analyses, construction methods and materials, as well as use of information technologies for modeling and control of system components have allowed greater sophistication and efficiency in the development of water systems in this country.

Regulatory Framework

The design and operation of potable water systems in the United States is heavily regulated. In fact the regulatory structure defines to a great extent what constitutes “safe” or acceptable water quality, at least from a human consumption standpoint. These regulations codify much of the professional practice which over the years has created a network of water supplies that are unparalleled in history for their safety and reliability. Although taken for granted by most Americans, it is truly remarkable that one can travel from coast to coast drinking water from public supplies all along the way and not give any thought to the potential of contracting waterborne disease.

Public water supplies are primarily governed by the Safe Drinking Water Act (SDWA) of 1974 and its amendments along with the Lead Contamination Control Act (LCCA) of 1988. At this point, there have been five (5) major amendments to the SDWA which were promulgated in 1977, 1979, 1980, 1986, and 1996. The Environmental Protection Agency (EPA) has federal responsibility for implementing the law, although the operational management and enforcement for the most part has been delegated to the states through the primacy process. In order to achieve primacy, states must stipulate and demonstrate capacity to enforce the federal requirements as outlined in the law and the subsequent EPA regulations. Any state unwilling or unable to meet these requirements does not receive primacy and, in that case, the EPA assumes responsibility for regulation and enforcement in that state. Florida has been granted primacy and enforces drinking water laws primarily through the Florida Department of Environmental Protection (FDEP). The FDEP also by interdepartmental agreement delegated certain responsibilities to the Department of Health.

Consequently, every aspect of a water utility is governed by the overarching requirements of the SDWA as implemented through state law and regulations. These regulations relate to water quality standards, testing methodologies, critical design criteria, source water protection, enforcement authority and consumer notification/awareness of violations.

Public Water Systems are generally classified as Community Water Systems (CWSs) and Noncommunity Water Systems (NCWSs). 40 CFR 141.2 defines a *Community Water System* as a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. NCWSs are systems smaller than this.

Water quality standards are among the most important sections of the regulations. They stipulate the chemical and biological concentrations and characteristics that constitute “safe” or potable water. There are a series of criteria that set to guide the design and operation of water systems. The most common standards are set forth in the National Primary Drinking Water Regulations (NPDWR) and the National Secondary Drinking Water Regulations (NSDWR).

The NPDWR, which currently consists of 87 chemical, microbiological and physical parameters, forms the basis of the regulatory examination of a water system’s performance. These parameters are assigned enforceable criteria levels called Maximum Contaminant Levels (MCLs) that define an acceptable potable water. Facilities which exceed established MCLs are deemed in violation of their permit to operate and are subject to enforcement action if not acceptably remedied. There are a few parameters in the NPDWR that have not been assigned an MCL because they cannot be feasibly measured or the testing is prohibitively expensive. In those cases, a Treatment Technique is assigned. Thus, in systems where a particular parameter has been demonstrated to exist or is likely to exist, the water utility must implement the treatment technique associated with that parameter in order to be deemed in compliance with the regulations. In other words, this is a presumptive criterion as explicit monitoring is not performed. In summary, MCLs are health based criteria, they are enforceable and they are developed with consideration to the cost-benefit associated with them.

NSDWRs differ from NPDWR in that they are non-enforceable guidelines that address contaminants that may have adverse cosmetic or aesthetic effects in drinking water. In other words, these parameters may affect the palatability or cosmetic/staining characteristics of the water, but have no meaningful impact on its safety. While not enforceable under federal law, it is noted however that a state may elect to make a secondary parameter enforceable.

In addition, the SDWA requires that every contaminant with an MCL have an associated Maximum Contaminant Level Goal (MCLG) which is a non-enforceable health based criteria. These are based upon the National Research Council (NRC) risk assessment process and are formulated to be set at a level at which there are no known adverse effects and with an adequate safety factor. The MCLGs are set without regard to cost to achieve the stipulated concentration. Historically, MCLGs for carcinogens have always been set at zero following theoretical and practical limits to determine the existence of a threshold of action. More recently the EPA uses a “weight of evidence” process which assigns a contaminant to one of three categories based on the knowledge base and potency of the carcinogen to determine whether a non-zero value for the MCLG may be assigned. While not enforceable, the MCLGs provide valuable information as to treatment targets to be achieved and potential regulatory direction in future years.

Of course, non-carcinogens also have MCLGs and are established based on using No Observable Adverse Effect Levels (NOAEL) or Lowest Observable Adverse Effect Levels (LOAEL) to determine a Reference Dose (RfD). This is then related to a Drinking Water Effect Level (DWEL) which is used to compute the MCLG.

The list of regulated contaminants continues to grow as the SDWA requires the EPA to review and add other chemicals or microbials to the NPDWR. These are first assigned a proposed MCLG and then they proceed through the public notification and comment period before a final decision is made on their regulatory status.

From this brief sketch, it may be observed that Congress has established a broad and continually evolving framework to govern the design and operation of public water systems. Water quality relative to human consumption is paramount in the legislative and regulatory history. This responsibility is transferred to the design and operating professionals to actually develop systems that will comply with these high standards.

References:

Armstrong, G. L., Conn, L. A., and Pinner, R. W. (1999). “Trends in Infectious Disease Mortality in the United States During the 20th Century.” *Journal of the American Medical Association*, 281(1), 6166.

AWWA. (1990). *Water Quality and Treatment: A Handbook for Community Water Supplies*, McGraw-Hill, Inc., New York, N.Y.

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