Water Age: Background Information on Distribution System Areas of Concern

Findings from White Paper

Water age, the time from when the water is treated to when it reaches the customer, impacts the quality of water reaching the customer. Many finished water quality problems result from interactions between water within the pipe and the pipe wall, and within the bulk water. Increasing water age increases the reaction time, allowing for additional formation of contaminants that can lead to adverse health effects.

What are the water quality problems that pose a risk to public health?

Disinfection byproduct (DBP) formation (organic): DBPs are formed by reactions of disinfectants with organic matter. Reaction time is a key variable in DBP production. Potential health effects include cancer and problems with the liver, kidneys, and central nervous system.

Nitrification: Bacteria oxidize nitrogen compounds (primarily ammonia from the source water or from the chloramination disinfection process) and form nitrite and nitrate. Nitrifying bacteria have slow growth rates, thus these problems usually occur only in large reservoirs or low-flow sections of the distribution system. Nitrate and nitrite cause illness in infants, and if untreated can cause death. Blue baby syndrome is commonly associated with nitrite or nitrate poisoning.

Microbial survival and growth: Areas of low or stagnant flow provide more favorable conditions for microorganism accumulation or growth compared to well-circulated areas. Microorganisms can attach or integrate into existing biofilm or sediment and thus be shielded from residual disinfectants. Some microorganisms found in the distribution system and their related health effects include the following: bacteria (M. avium complex–associated with chronic diarrhea, lung disease); protozoa (Acanthamoeba–associated with corneal inflammation); algae (blue-green algae–produce neurotoxins); and fungi (Cryptococcus neoformans–associated with meningitis, lung infections).

Corrosion: Increased residence time can allow for increased corrosion. Corrosion control methods involve phosphate inhibitors and pH management that can be adversely affected as residence time increases in poorly buffered waters. Corrosion of unlined cast iron can decrease chlorine residual levels.

What contributes to increased water age?

When designing expansions or upgrades to distribution system infrastructure, water systems should consider fire flow and future growth needs. Fire flow needs not only increase storage requirements but also pipe size (particularly in residential areas), compared to those needed solely for the provision of drinking water. As a result, flow through the pipes is slower and the turnover rate of stored water is often less. Designing and building according to future demands can also have similar effects.

What indicates increased water age?

The following water quality problems are indications of increased water age: discoloration; water temperature changes (stagnant water will approach ambient temperature); reduced disinfectant levels; elevated DBPs, bacteria, taste and odors, and nitrite/nitrate levels.

What prevention and mitigation methods are available?

Design standards: Ten State Standards, AWWARF, and AWWA provide guidelines for hydraulic considerations in the planning and design of distribution system piping networks.
Operational techniques: Areas with high residence times can be identified using hydraulic modeling and tracer studies. Adjusting valves and modifying pressure zone boundaries or pressure set points at pumping stations, optimizing tank mixing, and increasing storage turnover rates can all reduce residence time.

Maintenance techniques: Cleaning or replacing deteriorated pipelines that are contributing to bulk water quality decay and conducting routine flushing to remove sediment and stagnant water can mitigate the effects associated with water age.

Optimize source water treatment: Reducing the biodegradable and assimilable organic carbon in the finished water can reduce the chemical reactions that occur, regardless of water age. Removal of iron and manganese from the water can reduce sediment load in pipelines and storage facilities.

Corrosion Control: The impacts associated with corrosion can be controlled by pH and the addition of inhibitors.