Drinking Water Quality

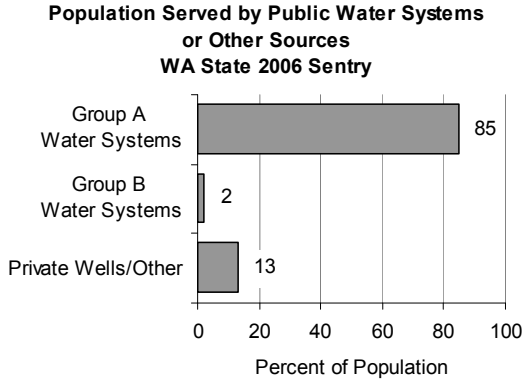
Definition: There are many ways to measure drinking water quality. To determine microbiological water quality, water systems test for "indicator organisms," which are bacteria that signal the presence of human or animal wastes. The risk to the public is measured by the proportion of public water systems that have not fully completed all water quality tests for microorganisms and nitrate and the proportion of water systems that do not meet these standards. Protective efforts are measured by the percentage of water systems that have certified operators and the number of water system facility inspections (sanitary surveys) per year.

Summary

In 2006, about 87% of the population received tap water from a state-regulated public water supply. Of the people served by Group A community water systems, 91% received drinking water that met all health-based water quality standards (see Technical Notes for definition of Group A). The most common drinking water contaminants are microorganisms, nitrate, and arsenic. Water quality monitoring has improved over the past five years. In 2006, 92% of the Group A water systems completed required annual testing for nitrate, and 96% completed required testing for microbial contamination.

Introduction

Microorganisms and chemical compounds in the environment can contaminate drinking water supplies. The most common contaminants are nitrate and microorganisms such as bacteria, viruses, and protozoa.[1] These contaminants can cause serious illness, and in some circumstances, death. Infants, children, the elderly, and immune-compromised people are particularly susceptible to serious health effects from contaminants in drinking water.



About 5.5 million Washington residents (85% of the state population) get water from 4,180 Group A water systems, according to state water system data (Sentry). Group A water systems also provide drinking water for schools, restaurants, motels, hospitals, offices, and other public places. Almost 110,000 people (2% of Washington's population) get their water from 13,000 Group B systems. (See Technical Notes for definitions.)

State and federal laws require public water systems to test drinking water for more than 200 contaminants. These laws set limits, known as maximum contaminant levels (MCLs), on the levels of contaminants allowed in drinking water. Some smaller water systems and systems that are unlikely to become contaminated do not have to test for all regulated contaminants.

About 725,000 Washington residents (11%) get water from individual private wells, according to data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS) survey. Counties regulate private wells. Most counties require well testing only during construction. They test primarily for microorganisms, nitrate, and in some cases, arsenic. Only 80% of private well owners have ever had their well water tested, and only half had their wells tested within the past three years. Of the owners who had their wells tested, 7% reported results of contaminated well water.

Description of Potential Indicators

The indicators used to measure the risk of consuming contaminated drinking water focus on the level of contaminants in drinking water supplied by public water systems. There are no comprehensive data covering private wells.

Hazard indicators are the concentrations of individual contaminants in drinking water and the number of times these concentrations exceed public health water quality standards. Microorganisms (bacteria, viruses, and protozoa) and nitrate are the

most commonly detected hazard indicators. In addition, elevated levels of arsenic have been found in some locations in the state.

Exposure indicators are tests that measure the level of contaminants in a person. These tests are rare. Exposure can be estimated by combining water quality information with information about the source (i.e., tap water or bottled water) and the amount of water ingested per day. While water quality data are available for people served by public water supplies, individual water consumption information is not routinely collected. The proportion of the population served by water supplies that meet water quality standards is an indicator of population exposure levels.

Protective indicators measure the effectiveness of the steps we take to ensure water is safe to drink. For example, we train water system operators and conduct inspections (sanitary surveys) of water system facilities. Some protective indicators are results of water quality testing, the proportion of public water systems that conduct all required tests for nitrate and microorganisms, the percentage of water systems with certified operators, and the proportion with a current sanitary survey.

Health outcome indicators measure the number and intensity of waterborne disease outbreaks each year (an outbreak is two or more related waterborne diseases). Typically there are no reported waterborne disease outbreaks in Washington. The number of individual waterborne illnesses that occur each year is unknown and difficult to estimate because many do not make people sick enough to seek medical care. Even when people do go to a doctor with symptoms of waterborne disease, it usually is not possible to tell if the illness is due to contaminated water because the same pathogens that cause most waterborne illnesses are in contaminated food or transmitted by poor hygienic practices. It is even more difficult to determine the number of other illnesses, such as cancer, that might be associated with chemical contaminants in drinking water because these diseases have multiple causes and modes of exposure.

Microorganisms

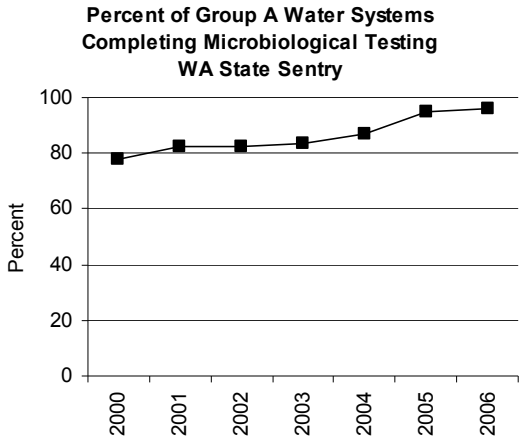
Bacteria, viruses, and protozoa (such as *Giardia lamblia* and *Cryptosporidium*) are drinking water contaminants that can rapidly cause widespread and serious illness. These microbes primarily come from human or animal wastes that wash into lakes and rivers or that rain or irrigation water carry into shallow groundwater aquifers. An aquifer is an underwater storage area of rock, sand, or gravel.

Water systems treat water from reservoirs or rivers before distributing it as drinking water, so microbiological contamination is rare. Water systems that use groundwater from shallow aquifers, which may be susceptible to contamination, are required to chlorinate (disinfect) the water. Water from systems supplied by deep, protected wells is less likely to be contaminated.

Water systems test for the presence of total coliform and *E. coli*, two kinds of bacteria that signal the presence of human or animal wastes. When these bacteria are found in a water sample, the water supplier must immediately conduct further testing, look for the source of contamination, and in some cases, increase water treatment. If the problem appears serious, the water supplier must inform all customers about the problem and instruct them to use bottled water or boil their tap water before they drink it.

Time Trends

Group A water systems are required to test for microorganisms at least once a month. The proportion of Group A systems that completed required microbiological water testing increased from 78% in 2000 to 96% in 2006. This measure was not tracked before 2000. Smaller Group B systems test yearly, but the data are not compiled statewide.



In 2006, 38 water systems (less than 1%) had serious violations of the microbiological water quality standards (i.e., presence of bacteria that indicated a risk of waterborne disease). In these cases, residents were advised to boil their tap water or drink bottled water.

There is no comprehensive database on the quality of private well water. If a private well is found to be contaminated, the owner is advised to disinfect the well, remove nearby sources of human or animal waste, and correct any problems with the wellhead that might allow contamination to enter the well directly.

Geographic Variation

Group B public water systems and private wells are usually in rural areas. Group B systems are less likely to complete all required water quality testing and tend to have less extensive water treatment. Most private well water is not treated. As a result, these systems can have more bacteriological water quality problems than large public water supplies.

Nitrate

Nitrate is a chemical found in most fertilizers, manure, and liquid waste discharged from septic tanks. Natural bacteria in soil can convert nitrogen into nitrate. Rain or irrigation water can carry nitrate through the soil into groundwater. Nitrate most often affects water from shallow, poorly constructed, or improperly located wells.

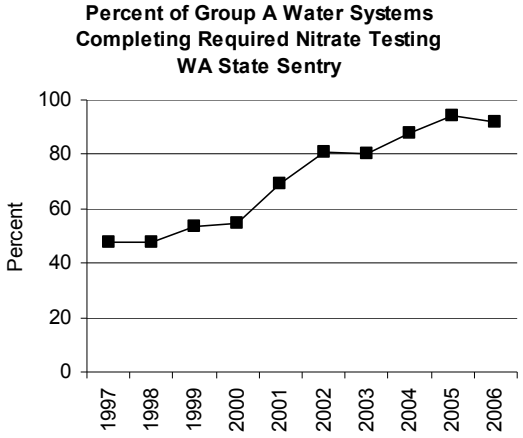
Nitrate contamination is particularly hazardous for infants and pregnant women.[2] Nitrate impairs the ability of red blood cells to carry oxygen. In most exposed adults and children, red blood cells rapidly return to normal. But infants can experience a serious health condition called methemoglobinemia or “blue-baby syndrome.” There is limited information on the number of cases that occur in Washington because it is not a “notifiable condition.” (Washington State requires health care providers to report suspected or confirmed cases of selected diseases or conditions to public health authorities.) There is mixed evidence as to whether nitrate exposure is linked to cancer and spontaneous abortions.[3, 4]

The maximum contaminant level for nitrate is 10 milligrams per liter. Group A water suppliers are required to test for nitrate annually. Group B systems test at least once every three years, but these data are not compiled statewide. When the nitrate level is above five milligrams per liter, the water supplier must test more frequently. If the nitrate level is above the MCL, the water supplier must notify consumers and take steps to reduce the level of nitrate through treatment or using other water sources.

Most counties require nitrate tests for private wells only when they are constructed. Some counties also require testing when the property is sold. If a private well has high nitrate levels, the owner should use bottled water for food and drink for infants or pregnant women.

Time Trends

The proportion of Group A water systems that completed testing for nitrate increased from less than 50% in 1997 to 92% in 2006 due to increased compliance and enforcement by the state Department of Health. This information was not compiled prior to 1997. Since 2002, fewer than 2% of the Group A water systems that tested for nitrate had levels greater than the MCL.



Geographic Variation

Nitrate contamination occurs primarily in rural agricultural areas. Portions of Adams, Benton, Clark, Franklin, Grant, Walla Walla, and Whatcom counties have nitrate concentrations in groundwater above the MCL of 10 milligrams per liter. The Department of Health is concerned about people who use private wells that are not tested regularly because they may not know if their water is high in nitrates.

Arsenic

Most arsenic in drinking water comes from rock formations that contain arsenic. Groundwater that flows through these rock formations can dissolve the arsenic and carry it into underground aquifers, streams, or rivers. High levels usually occur only in groundwater. The level of arsenic in groundwater varies widely. High concentrations are found in many localized areas across the state including the western foothills of the Cascade Mountains and the lowlands and islands of Puget Sound.

Long-term exposure to arsenic in drinking water has been linked to several types of cancer (bladder, lung, skin, kidney, nasal passages, liver, and prostrate) and is known to have adverse effects on the cardiovascular, pulmonary, immunological, neurological, and endocrine systems.[3,,5]

For many years, the public health standard for arsenic was an MCL of 50 parts per billion. To reduce the public's risk of health problems from arsenic in drinking water, the state adopted the recent U.S. Environmental Protection Agency's standard of 10 parts per billion in January 2006. Only Group A public water systems must meet the new standard. Based on historical sampling records, as many as 210 of Washington's Group A water systems may be required under the new standard to reduce the level of arsenic in the water they provide their customers.

Water System Inspections and Operator Training

While water quality monitoring provides the assurance that drinking water meets public health standards, well-designed and maintained water systems and certified public water works operators are critical factors in providing high quality drinking water. Prior to 2001, only the 780 Group A community systems that served more than 250 people were required to have a certified operator. Since then, the Department of Health extended the certification requirement to 1,900 more Group A water systems. Today, 98% are in compliance with this requirement.

Sanitary surveys are inspections of water system facilities, operations, and records designed to identify conditions that may present a public health risk. The Department of Health requires all Group A water systems to have a sanitary survey every three to five years. The number of sanitary survey inspections per year increased from 385 in 2000 to 832 in 2006. This has contributed to the increase in water quality monitoring compliance.

Year 2010 Goals

Healthy People 2010 includes three objectives directly related to drinking water quality. The first aims to increase the proportion of people served by public water suppliers whose drinking water meets all water quality regulations of the federal Safe Drinking Water Act to 95% (1995 baseline, 73%). In Washington in 2006, 91% of the people served by Group A community water systems received drinking water that met all the water quality standards. Although we are close to meeting this *Healthy People 2010* goal, it may be difficult to make the further improvement necessary to meet the goal because the population and requirements for water quality testing continue to increase.

The second objective is to reduce the number of waterborne outbreaks among people served by community water systems from six to two per year nationwide. Washington meets this goal with no reported outbreaks related to water served by community water systems during the past five years.

A third *Healthy People 2010* objective aims to increase or maintain the number of territories, tribes, and states that monitor diseases or conditions caused by exposure to environmental hazards, including methemoglobinemia. Currently nine states track this condition. The 2010 target is 10 states. Methemoglobinemia is not a notifiable condition in Washington State.

Intervention Strategies

The primary methods of ensuring safe drinking water quality are:

- Protecting water sources from contamination
- Testing water for contamination
- Treating water to remove or neutralize contamination
- Enforcing water quality and operating standards
- Inspecting water systems and reporting problems
- Requiring system operators to be trained and certified
- Securing drinking water infrastructure and ensuring systems have emergency plans
- Responding quickly to water quality problems during emergencies
- Helping systems obtain funds to develop, construct, operate, maintain and manage operations in full compliance with regulations
- Keeping consumers well-informed
- Setting standards for water system construction and expansion.

See Related Chapter: Other Issues in Environmental Health

Data Sources (For additional detail, see Appendix B.)

Washington water system data is on Sentry Internet at http://www.doh.wa.gov/ehp/dw/sentry.htm.

Behavioral Risk Factor Surveillance System (BRFSS), 1996–2006.

The Safe Drinking Water Act is on at the U.S. Environmental Protection Agency Web site at http://www.epa.gov/safewater/sdwa/index.html.

For More Information

Washington State Department of Health, Office of Drinking Water

Toll-free calls to (800) 521-0323

E-mail questions to dwinfo@doh.wa.gov.

Technical Notes

There are three types of Group A systems:

1. **Community systems** regularly serve 15 or more residential connections or 25 or more people, 60 or more days per year.
2. **Non-transient, non-community systems** primarily serve schools, businesses, and other establishments
3. **Transient non-community systems** primarily serve hotels, motels, and other places of accommodation.

The data in this report on microbiological and nitrate contamination apply to all three types of Group A systems.

Group B water systems usually serve two to 14 connections and fewer than 25 people, or more than 25 people but for fewer than 60 days per year.

Endnotes

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[1] Blackburn, B. G., Craun, G. F., Yoder, J. S., Hill, V., Calderon, R. L., Chen, N., et al. (2004). Surveillance for waterborne-disease outbreaks---United States, 2001-2002. In: CDC Surveillance Summaries, *Morbidity and Mortality Weekly Report, 53*(SS08), 23-45.

[2] http://www.cdc.gov/NCIDOD/dpd/healthywater/factsheets/nitrate.htm.

[3] Cantor, K. P., Ward, M. H., Moore, L. E., & Lubin, J. H. (2006). Water contaminants. In D. Schottenfeld, & J. F. Fraumeni (Eds.), *Cancer Epidemiology and Prevention* (3rd ed.). Oxford, UK: Oxford University Press.

[4] Manassaram, D. M., Backer, L. C., & Moll, D. M. (2006) A review of nitrates in drinking water: maternal exposure and adverse reproductive and developmental outcomes. *Environmental Health Perspectives, 114*, 320-327.

[5] Agency for Toxic Substances and Disease Registry. (2006). *Arsenic*. Retrieved February 4, 2008 from www.atsdr.cdc.gov/cabs/arsenic.