Drinking Water Standards Summary
Appendix B

Oregon Drinking Water News

PIPELINE

Department of Human Services, Drinking Water Program

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OREGON DRINKING WATER QUALITY STANDARDS

Fall 2006

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Oregon Drinking Water Quality Standards

Fall 2006

This summary provides a broad overview of current and future drinking water quality standards that public water systems in Oregon must meet through 2020. It is organized in two major sections — Section I: Current standards, and Section II: Future standards. The summary of current standards is for reference only, and is not a substitute for the actual statutes and regulations that govern public water supply in Oregon. Future standards described here are still under development at the national level, and are subject to change.

Types of drinking water contaminants

The sources of drinking water, both tap water and bottled water, include surface water (rivers, lakes, ponds, reservoirs), and ground water (wells and springs). As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and in some cases natural radioactive materials, and can pick up substances from the presence of animals or from human activities.

Drinking water contaminants are any substances present in drinking water that could adversely affect human health if present in high enough concentrations. All drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily mean that the water presents a health risk.

There are now drinking water quality standards for 91 different contaminants established by the U.S. Environmental Protection Agency. They can be grouped into the following general categories:

- **Seven microbial contaminants** — such as viruses, bacteria and parasites which can come from sewage treatment plants, septic systems, agricultural and livestock operations and wildlife. Includes turbidity.
- **Seven disinfectants and disinfection byproducts** — chemical disinfectants used in water treatment to kill harmful microbes, and the chemical byproducts formed from the reaction of disinfection treatment chemicals with natural substances in the water.
- **Sixteen inorganic chemicals** — such as salts or metals, which can be naturally-occurring or can result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming. Includes lead and copper leached into the water from household plumbing and fixtures.
- **Fifty-six organic chemicals** — pesticides and herbicides, which may come from a variety of sources, such as agriculture, urban storm water runoff and residential uses. Also includes synthetic and volatile chemicals, which are used in industrial processes and petroleum production and can come from gas stations, urban storm water runoff and septic systems.
- **Five radiologic contaminants** — Naturally occurring or resulting from oil and gas production or mining operations.

Every drinking water supply is vulnerable to microbial or chemical contaminants of one type or another from a variety of sources. Disease-causing microorganisms from human or animal feces (bacteria, viruses, parasites) can be present in surface water or from ground water. Microorganisms can also enter the water system through pipe breaks or cross connections. Organic chemicals (industrial solvents, pesticides) are mainly man-made and can enter drinking water supplies from chemical production, storage, use or disposal in the water source area. Inorganic chemicals can be introduced by human activities (nitrate from fertilizer) but more often result from natural occurrence in rocks, soils, and mineral deposits (radon, arsenic). Drinking water treatment, essential to remove microbes and chemicals, can also add or form contaminants in drinking water, such as disinfectant chemicals themselves, byproducts of disinfectants reacting with other substances in the water, and treatment chemicals used in filtering water. Finally, water storage tanks, pipes and household plumbing that are in direct contact with water can contribute contaminants from either the material used in the tanks and pipes or from internal coatings used to protect the materials from contact with the water.

Drinking water standards and health protection

To protect health, national regulations set by the US Environmental Protection Agency (USEPA) under the Safe Drinking Water Act limit the amounts of certain contaminants in tap water provided by public water systems. Other regulations set by the federal Food and Drug Administration establish limits for contaminants in bottled water that must provide the same level of protection of public health.

In order to be regulated under the federal Safe Drinking Water Act, a drinking water contaminant must meet certain criteria. The contaminant must be one that:

- Has an adverse effect on the health of persons,
- Is known or likely to occur in public drinking water systems at frequency and at a level of health concern, and
- Where regulation provides a meaningful opportunity for health risk reduction.

Drinking water standards take several forms:

- **Maximum Contaminant Level Goal (MCLG)** — The level of a contaminant in drinking water below which there is no known or expected risk to health, allowing for a margin of safety. All regulated contaminants must have a MCLG, although the MCLG is not enforceable.
- **Maximum Contaminant Level** (MCL) — The highest level of a contaminant allowed in drinking water, set as close to the MCLG as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable. Most MCLs are expressed in concentration units called "milligrams per liter" (mg/L), which for drinking water is the same as parts per million (ppm). MCLs can be expressed in a variety of other measurement units.
- **Treatment Technique (TT)** — A required treatment process intended to reduce the level of a contaminant in drinking water. For any contaminant that cannot be effectively measured or detected in drinking water, the standard may be a treatment technique requirement instead of an MCL. This means that all

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Drinking water standards and health protection — continued

water systems at risk of the contaminant must provide continuous water treatment to remove the contaminant at all times. Performance Standards (PS) are used to determine whether or not a water system is meeting a specific treatment technique requirement. Performance Standards are measurements of water quality parameters related to specific treatment processes, such as turbidity, disinfectant residual, pH or alkalinity.

- **Action Level (AL)** — The concentration of a contaminant, which when exceeded, triggers treatment or other requirements that a water supplier must follow.
- **Maximum Residual Disinfectant Level (MRDL)** — The maximum allowable level of a specific disinfectant treatment chemical.

Public water suppliers and bottled water producers must sample for contaminants routinely to ensure that standards are met, and report the results of that sampling to the regulatory agency. Sampling frequencies for public water systems vary by the type of drinking water contaminant. Contaminants that are associated with immediate health impacts, like bacteria and nitrates, must be sampled as often as every month, quarter or year. Contaminants that are associated with health effects that could develop from very long-term exposures, like arsenic, are sampled less frequently, such as once every year to every three years or more.

Some people may be more vulnerable to drinking water contaminants than the general population. Immune-compromised persons, such as persons with cancer and undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from microbial infections. These people should seek advice from their health care provider. USEPA and the federal Centers for Disease Prevention and Control (CDC) developed guidelines on appropriate measures to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants. These are available from the USEPA at *http://www.epa.gov/safewater/crypto.html.*

Public Drinking Water Regulatory Program

The first national public drinking water standards were called the National Interim Primary Drinking Water Regulations (NIPDWR). The US Environmental Protection Agency (USEPA) adopted these on December 24, 1975, under the 1974 Safe Drinking Water Act. By 1986, drinking water quality standards were in place for 23 different contaminants. The 1986 Safe Drinking Water Act mandated USEPA to set standards for 83 contaminants within three years, and 25 more contaminants every three years thereafter. The 1996 Safe Drinking Water Act significantly redirected this standard-setting schedule to focus on the highest remaining risks to health.

In Oregon, public drinking water systems are subject to the Oregon Drinking Water Quality Act (ORS 448 - Water Systems). The primary purpose of the 1981 Oregon Act is to "assure all Oregonians safe drinking water." According to the Oregon Act, safe drinking water means water that is "sufficiently free from biological, chemical, radiological or physical impurities such that individuals will not be exposed to disease or harmful physiological effects." Under the Oregon Act, the Department of Human Services (DHS) has broad authority to set water quality standards necessary to protect public health through insuring safe drinking water within a public water system. To accomplish this, DHS is directed under the Act to require regular water sampling by water suppliers. These samples must be analyzed in laboratories approved by the department, and the water supplier must report the results of those laboratory tests to DHS. The department must investigate water systems that fail to submit samples, or whose sample results indicate levels of contaminants that are above maximum allowable levels. Water suppliers who fail to sample the water or report the results, or whose water contains contaminants in excess of allowable levels must take corrective action and notify water users.

Since 1986, DHS has exercised primary responsibility for administering the federal Safe Drinking Water Act in Oregon, an arrangement called *primacy*. The department adopts and enforces standards that are no less stringent than the federal standards, and in return, the USEPA gives the department the regulatory responsibility for public drinking water systems and partial financial support for the Oregon program operation.

In practice, the Oregon drinking water standards match the national standards established under the Safe Drinking Water Act by the USEPA. This is because setting maximum levels for drinking water contaminants to protect human health involves considerable development of health effects information and other scientific research that is best carried out at the national level. The Department of Human Services concentrates its efforts on implementing the national standards at Oregon public water systems.

Oregon public water systems

Today, there are 2,699 public water systems in Oregon subject to regulation under the federal Safe Drinking Water Act. They serve 25 or more people at least 60 days per year. Of these, 882 are community water systems, which means the systems serve at least 15 connections used by year-round residents. These systems perform the most frequent water sampling for the greatest number of contaminants, because the people served have the most ongoing exposure to the drinking water. Community water systems in Oregon serve a total of more than three million people and range in size from 15-home subdivisions and mobile home parks up to and including the City of Portland. Nontransient noncommunity water systems serve nonresidential populations consisting of the same people every day, such as a school or workplace with its own independent water supply system. There are 346 of these in Oregon. Transient noncommunity water systems serve transient populations. Examples are campgrounds, parks or restaurants with their own independent water supply systems, and there are 1,471 of these in Oregon. There are many small water systems in Oregon. About 86 percent of the public water systems in Oregon serve 500 or fewer people each.

Oregon public water systems get their water either from wells or springs (called ground water) or from rivers, lakes, or streams (called surface water). Of the 2,699 public water systems in Oregon, 2,388 get their water exclusively from ground water; 311 water systems get their water in whole or in part from surface water supplies. Generally

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Oregon public water systems —continued

speaking, surface water requires much more treatment and processing to ensure safety for drinking than does ground water.

An additional 921 very small systems, serving 10–24 people each, are subject only to the Oregon Act, serving a total of about 16,000 people. Based on Oregon's estimated 2004 population of 3.6 million people, as many as 600,000 Oregonians get their drinking water from individual home wells, which are not subject to either state or federal public drinking water standards.

For more information

Visit the Oregon Drinking Water Web page for drinking water information and publications *(http://www.oregon.gov/dhs/ph/dwp)*. Use the "Data Online" feature to look at past and current water sample test results and regulatory compliance status information for any Oregon public water system. You can use "links" at this site to access many other sources of drinking water information.

County health department staffs in most counties conduct local drinking water programs under contract with DHS. They are responsible for community water systems serving 3,300 people or fewer that use ground water sources, and all nontransient noncommunity and transient noncommunity systems. Questions about these systems may be directed to the respective county health department.

Department of Human Services staff are responsible for all community water systems serving more than 3,300 people and all community systems that use surface water sources. In counties without drinking water programs, department staff is responsible for all public water systems. Department staff assist county drinking water programs as needed. The department's Drinking Water Program can be reached in Portland at 971-673-0405.

Compliance with drinking water standards is summarized for each calendar year on a statewide basis in the Oregon Annual Compliance Report, which is prepared in June and posted on the drinking water Web page. Each community water system must distribute to users an annual Consumer Confidence Report, detailing the levels of contaminants detected in the water system and their significance, listing any violations of standards or sampling requirements that occurred, and providing information on the water sources used by the community.

I. Current standards

There are now USEPA-established drinking water quality standards for 91 contaminants, including seven microbials and turbidity, seven disinfection byproducts and residuals, 16 inorganics (including lead and copper), 56 organics, and five radiologic contaminants. These standards either have established MCLs or treatment techniques, and are summarized in this section.

Microbial contaminants — General

All source water from lakes, rivers, reservoirs and some source water from ground water aquifers need to be disinfected to inactivate or kill microbes that cause disease, called pathogens. Microbial pathogens include a few types of bacteria, viruses, protozoa and other organisms. Some pathogens are found in water as a result of fecal matter from:

- Wildlife
- Domestic animals
- Human waste from sewage discharges or septic/drainfield systems

These waterborne pathogens can cause acute gastrointestinal illness in people; symptoms are nausea, diarrhea, cramps and sometimes headaches *(see Table 1, page 17)*. They may pose a special health risk to infants, young children and people with severely compromised immune systems.

To protect drinking water from these pathogens, water suppliers often add a disinfectant to drinking water, such as chlorine. However, disinfection practices can be problematic because:

- Certain microbial pathogens, such as *Cryptosporidium*, are highly resistant to traditional disinfection practice.
- Naturally occurring materials in water form byproducts, such as haloacetic acids and trihalomethanes, which may pose health risks.

A major challenge for water suppliers is to balance the risks from microbial pathogens and disinfection byproducts. It is important to provide protection from microbial pathogens while simultaneously minimizing health risks to the population from disinfection byproducts.

Microbial contaminants — Coliform bacteria

Purpose and benefits. Reduce the risk of waterborne illness from disease-causing organisms, called pathogens, associated with human or animal wastes. Improve public health protection by reducing fecal pathogens to minimal levels through control of total coliform bacteria, including fecal coliforms and *E. coli.*

Coliforms are bacteria that are naturally present in the environment and in feces. Their presence in drinking water is used as an indicator that other organisms that are potentially harmful may be present. Routine samples collected by Oregon public water suppliers are analyzed for total coliform bacteria. Samples that show the presence of total coliforms are further examined for fecal coliforms or *E. coli*, which are more specific indicators of fecal contamination.

Health effects. Coliform bacteria normally do not cause illness through drinking water. The presence of total coliforms indicates potential problems with water system operations or maintenance that require

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attention and correction by the water supplier. Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes, and urgent action is required to protect health including advising water users to boil drinking water or use alternate supplies. Other viruses, bacteria and parasites in these wastes can cause short-term health effects, including nausea, cramps, diarrhea and associated headaches *(see Table 1, page 17)*. They may pose a special health risk for infants, young children and people with severely compromised immune systems.

Application. All public water systems must regularly test for coliform bacteria from locations in the distribution system, identified in a coliform sampling plan.

Monitoring. All community systems, and noncommunity systems using surface water sources or serving more than 1,000 people, must sample monthly:

Population	Number of monthly samples
up to 1,000	1
1,001-2,500	2
2,501-3,300	3
3,301-4,100	4
4,101-4,900	5
>4,900	See rules

All other systems must test for coliform bacteria once per quarter.

Water treatment/control measures. Use of disinfection processes for source waters, such as chlorination, ozonation and ultraviolet light. Other control measures include maintaining a disinfectant residual in the distribution system, protecting the source water area, proper well construction, maintaining distribution system pressure, and control or elimination of cross connections within the distribution system.

Compliance. Compliance is based on the presence or absence of total coliforms in any calendar month (or quarter). Sample results are reported as "coliform-absent" or "coliform-present." If any sample is coliform-present, a set of at least three repeat samples must be collected within 24 hours. Small water systems that collect one routine sample per month or quarter must collect a fourth repeat sample. Repeat sampling continues until the maximum contaminant level is exceeded or a set of repeat samples with coliform-absent results is obtained. Small systems (fewer than 40 samples/ month) are allowed no more than one coliform-present sample per month, including any repeat sample results. Larger systems (40 or more samples/month) are allowed no more than five percent coliform-present samples in any month, including any repeat sample results. Confirmed presence of fecal coliform or *E. coli* presents an acute health risk and requires immediate notification of the public to take protective actions such as boiling or using bottled water.

Rule history.

Federal rule - 12/24/75 (National Interim Primary Drinking Water Regulation)

Oregon rule - 9/24/82

Federal rule - 6/29/89 (Total Coliform Rule)

Oregon rule - 1/1/91

Microbial contaminants — Surface water treatment

Purpose and benefits. The Surface Water Treatment, Interim Enhanced Surface Water Treatment, Long-Term 1 Enhanced Surface Water Treatment and Filter Backwash Recycling rules increase protection against gastrointestinal illness from *Cryptosporidium*, *Giardia*, and other disease-producing (pathogenic) organisms by improving filtration and disinfection treatment in water systems that use surface water supplies. The rules reduce likelihood of illness from *Cryptosporidium* by an estimated 122,000 to 504,000 cases per year nationally. They also reduce likelihood of community waterborne disease outbreaks from *Cryptosporidium* and *Giardia*, and prevent significant increases in microbial risk that might otherwise occur when water suppliers act to limit the levels of disinfection byproducts (described below). The Long-Term 2 Enhanced Surface Water Treatment rule provides additional protection for filtered water systems with high levels of *Cryptosporidium* in their surface water sources, and for all unfiltered water systems using surface water sources.

Health effects. Pathogenic organisms in drinking water can cause acute gastrointestinal disease in humans *(see Table 1, page 17)*. These organisms include bacteria, viruses and parasites that can cause symptoms such as nausea, cramps, diarrhea and associated headaches.

Application. All public water systems using surface water sources. Also all public water systems using ground water sources determined by the department to be under the "direct influence of surface water," as indicated by:

- Significant similarities in water characteristics such as turbidity, temperature, conductivity or pH between the ground water source and nearby surface water, and if so,
- A significant occurrence of insects or other macroorganisms, algae, organic debris or large pathogens like *Giardia* and *Cryptosporidium*, as indicated by microscopic particulate analysis.

Water treatment/control measures. Alternatives:

- Filtration plus disinfection treatment meeting performance standards, or
- Disinfection treatment to control *Cryptosporidium* plus meeting filtration exception criteria for unfiltered systems, or
- Disinfection plus "natural filtration" plus wellhead/source water protection for ground water sources under the direct influence of surface water.

All water systems using surface water sources must provide a total level of treatment to remove/inactivate 99.9 percent (3-log) of *Giardia lamblia*, and to remove/ inactivate 99.99 prcent (4-log) of viruses. All water systems must meet specified CxT [concentration x time] requirements for disinfection, and meet required removal/ inactivation levels. Filtered water systems must physically remove 99 percent (2-log) of *Cryptosporidium*, and those systems with source water *Cryptosporidium* levels exceeding specified limits must install and operate additional treatment processes.

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Filtered water systems must meet specified performance standards for combined filter effluent turbidity levels, and water systems using conventional and direct filtration must also record individual filter effluent turbidity and take action if specified action levels are exceeded. Filtered water systems that recycle spent filter backwash water or other waste flows must return those flows through all treatment processes in the filtration plant. Unfiltered water systems must include *Cryptosporidium* control in their watershed control programs; must install and operate ozone, ultraviolet light, or chlorine dioxide disinfection to inactivate *Cryptosporidium*; and meet specific criteria to remain unfiltered.

Compliance — Disinfection. Disinfection performance standards for all water systems:

- Continuous recording of disinfectant residual at the entry point to the distribution system (small systems can substitute one to four grab samples per day).
- Daily calculation of CxT (disinfectant concentration x time) at highest flow.
- Provide adequate CxT to meet needed removal/inactivation levels.
- Maintain a continuous minimum 0.2 mg/L disinfectant residual at entry point to the distribution system.
- Maintain a minimum detectable disinfectant residual in 95 percent of distribution system samples (collected at coliform bacteria monitoring points).

Disinfection profiling and benchmarking:

- All systems must sample for total trihalomethane (TTHM) and haloacetic acid (HAA5). Large systems sample quarterly, smaller systems sample during the month of warmest water temperature and at maximum residency time in the distribution system.
- If TTHM $\geq$ 0.064 mg/L, or HAA5 $\geq$ 0.048 mg/L as an annual average (large water systems) or during the month of warmest water temperature and at maximum residency time in the distribution system (small water systems), develop disinfection profile reflecting daily (large systems) or weekly (small systems) inactivation rates for *Giardia* for at least one year.
- Using the profile, calculate a disinfection benchmark (lowest monthly average inactivation) and consult with the department before making significant changes to the disinfection process.

Compliance — Filtered water systems. Performance standards for combined filter effluent for systems using conventional or direct filtration treatment:

- Turbidity measurements of filtered water at least every four hours by grab sampling or continuous monitoring.
- Ninety-five percent of turbidity readings in any month less than or equal to 0.3 ntu.
- All turbidity readings less than or equal to 1 ntu.

Filtration treatment performance standards for combined filter effluent for systems using slow sand, diatomaceous earth filtration and alternative filtration (membrane filtration and cartridge filtration):

- One turbidity measurement per day.
- 95 percent of turbidity readings in any month less than or equal to 1 ntu.
- All turbidity readings less than or equal to 5 ntu.

Individual filter effluent requirements for systems using conventional or direct filtration treatment:

- Continuous turbidity monitoring of individual filters, recorded every 15 minutes.
- Specific follow up actions required if any individual filter has:
  - Turbidity > 1.0 ntu in two consecutive measurements 15 min. apart, or
  - Turbidity > 1.0 ntu in two consecutive measurements 15 min. apart in the same filter for three months in a row, or
  - Turbidity >2.0 ntu in two consecutive measurements 15 min. apart in the same filter for two months in a row, or
  - For water systems with 10,000 or more people only: turbidity > 0.5 ntu in two consecutive measurements 15 min. apart after four hours of operation following backwash.
  - Specific follow-up actions include additional reporting, filter self-assessment, and/or comprehensive performance evaluations.

Requirements for recycle notification to state by water systems with conventional or direct filtration and that recycle spent filter backwash, thickener supernatant or liquids from dewatering process:

- Plant schematic showing origin of recycle flows, how recycle flows are conveyed, and return location of recycle flows.
- Typical recycle flows (gpm), highest observed plant flow experienced in the previous year (gpm), and design flow of the treatment plant (gpm).
- State-approved plant operating capacity (if applicable).

Additional control of *Cryptosporidium* for filtered systems:

- Source water monitoring:
  - Large water systems serving 10,000 or more people: 24 months of *Cryptosporidium* monitoring.
  - Water systems serving fewer than 10,000 people: 12 months of *E. coli* monitoring, 12-24 months of *Cryptosporidium* monitoring if *E. coli* trigger level exceeded.
- Installation of additional treatment:
  - Filtered systems: must provide additional treatment selected from microbial toolbox list if average source water *Cryptosporidium* concentrations exceed specified levels.
- Uncovered finished treated water storage reservoirs:
  - Cover, or
  - Treat storage discharge to inactivate viruses, *Giardia* and *Cryptosporidium*.
- Before making changes in disinfection practice:
  - Create disinfection profile for *Giardia*/*Cryptosporidium*, and
  - Calculate disinfection benchmark, and
  - Consult with DHS.

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Compliance — Unfiltered water systems. Criteria for surface water systems to remain unfiltered:

- Source water quality criteria:
  - Coliform bacteria:
    - Less than or equal to 100 total coliform bacteria per 100 ml in 90 percent of samples collected for a running six month period, or
    - Less than or equal to 20 fecal coliform bacteria per 100 ml in 90 percent of samples collected for a running six month period.
  - Turbidity:
    - Continuous monitoring, or test every four hours.
    - No exceedence of 5 ntu.
    - Collect source water coliform sample on any day where turbidity exceeds 1 ntu.
- Site-specific criteria:
  - Adequate disinfection:
    - 99.9 percent (3-log) *Giardia* inactivation.
    - 99.99 percent (4-log) enteric virus inactivation.
    - Continuous recording of disinfectant residual at distribution system entry point.
    - Reliable backup equipment.
    - Maintain distribution residuals throughout system.
  - Control over the watershed area, and a formal Watershed Control Program addressing control of *Cryptosporidium*.
  - Annual sanitary survey showing no source water quality, disinfection treatment, or watershed control deficiencies.
  - On-going compliance with total coliform and disinfection byproducts standards.
  - No history of waterborne disease outbreaks.

Additional control of *Cryptosporidium* for unfiltered systems:

- Source water monitoring:
  - Large water systems serving 10,000 or more people: 24 months of *Cryptosporidium* monitoring.
  - Water systems serving fewer than 10,000 people: 12 months of *E. coli* monitoring, 12-24 months of *Cryptosporidium* monitoring if *E. coli* trigger level exceeded.
- Installation of additional treatment:
  - Unfiltered systems: must provide additional treatment for *Cryptosporidium* using ozone, ultraviolet light, or chlorine dioxide.
- Uncovered finished treated water storage reservoirs:
  - Cover, or
  - Treat storage discharge to inactivate viruses, *Giardia* and *Cryptosporidium*.
- Before making changes in disinfection practice:
  - Create disinfection profile for *Giardia*/*Cryptosporidium*, and
  - Calculate disinfection benchmark, and
  - Consult with DHS.

Compliance — Sanitary survey inspections. Rule requires regular sanitary survey inspections by state/county staff of all public water systems using surface water sources or ground water under the direct influence of surface water. The inspections must evaluate critical components of each water system to identify any significant deficiencies that cause or have potential to cause the introduction of contamination into the drinking water. Inspections must cover water source; treatment; distribution; finished water storage; pumps, pump facilities and controls; monitoring, reporting and data verification; system management and operation; and operator certification. Community water systems must be inspected every three years; those that have outstanding performance can be reduced to five-year frequency. All noncommunity water systems must be inspected every five years. Water suppliers with deficiencies must respond in writing within 45 days to the state/county with a plan for correcting the deficiencies.

Compliance dates.

2/99 - Construction of uncovered finished water reservoirs prohibited at water systems serving 10,000 or more people.

3/01 - Large systems complete disinfection profile, if applicable.

1/02 - Large systems start individual filter monitoring and meet combined filter effluent turbidity performance standards.

1/02 - State/counties begin first round of sanitary survey inspections.

3/02 - Construction of uncovered finished water reservoirs prohibited at water systems serving fewer than 10,000 people.

7/03 - Systems serving 500-9,999 persons report TTHM/HAA5 monitoring data and start disinfection profiling if applicable.

12/03 - Systems that recycle waste flows within the treatment plant provide notice to the state.

1/04 - Systems serving fewer than 500 persons report TTHM/HAA5 monitoring data and start disinfection profiling if applicable.

6/04 - Systems serving 500-9,999 persons complete disinfection profile.

6/04 - Systems that recycle waste flows complete collection of technical data on recycling practices and treatment, retain information on-site for state review.

6/04 - Systems that recycle waste flows comply with filter backwash recycling requirements.

12/04 - Systems serving fewer than 500 persons complete disinfection profile.

12/04 - State/counties complete first round of sanitary survey inspections for community water systems.

1/05 - Systems serving fewer than 10,000 people start individual filter monitoring and meet combined filter effluent turbidity performance standards.

6/06 - Compliance date for systems that recycle waste flows, but need capital improvements to meet the rule.

7/06-7/08 - Systems submit source water monitoring schedule to EPA.

10/06-10/08 - Systems begin source water monitoring.

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Microbial contaminants — Surface water treatment — continued

12/06-12/08 - Systems begin reporting source water results or past "grandfathered" data to EPA.

12/06 - State/counties complete first round of sanitary survey inspections for noncommunity water systems.

4/08 - Systems identify and report any uncovered finished water storage facilities.

9/08-3/12 - Systems complete source water *Cryptosporidium* monitoring.

3/09-9/12 - Filtered systems report "bin classification" for additional treatment based on source monitoring.

3/09-9/12 - Unfiltered systems report source water monitoring results.

4/09 - All uncovered finished water storage reservoirs covered, or discharge treated.

3/12-9/14 - Systems install and operate additional treatment as per bin classification.

1/15-1/19 - Systems submit plan for second round source water monitoring.

4/15-4/19 - Systems begin second round source water monitoring.

Cost. Total US cost estimated to be $352.3M/yr.

Rule history.

Federal rule - 12/24/75 (turbidity)

Oregon rule - 9/24/82 (turbidity)

Federal rule - 6/29/89 (Surface Water Treatment Rule - SWTR)

Oregon rule - 1/1/91 (SWTR)

Federal rule - 12/16/98 (Interim Enhanced Surface Water Treatment Rule- IESWTR)

Federal rule - 4/14/00, 6/13/00 (revisions)

Oregon rule - 7/15/00 (IESWTR)

Federal rule - 1/16/01, 2/12/01 (revisions)

Federal rule - 6/8/01 (Filter Backwash Recycling Rule-FBRR)

Oregon rule - 10/31/01 (revisions)

Federal rule - 1/14/02 (Long Term 1 Enhanced Surface Water Treatment Rule-LT1ESWTR)

Oregon rule - 12/02 (FBRR)

Oregon rule - 12/03 (LT1ESWTR)

Federal rule - 1/5/06 (Long Term 2 Enhanced Surface Water Treatment Rule-LT2ESWTR)

Oregon rule - Due by 1/5/10 (LT2ESWTR)

Microbial contaminants — Ground water

Purpose and benefits. Provide additional protection for ground water sources of drinking water from disease-causing viruses and bacteria such as *E. coli.* EPA estimates the rule will prevent 42,000 cases of acute viral waterborne illness per year.

Health effects. Ingestion of these pathogens can cause acute gastroenteritis, or in rare cases serious illnesses such as meningitis, hepatitis, or myocarditis *(see Table 1, page 17)*. Health implications in sensitive populations can be severe and may cause death.

Application. All public water systems that serve ground water, and all systems that mix ground and surface water if the ground water is added directly to the distribution system without treatment.

Monitoring. Triggered source water monitoring:

- Required for any system that lacks treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and experiences a positive routine total coliform sample from the distribution system.
- If a customer water supplier experiences a positive routine distribution total coliform sample, the water supplier must notify the wholesale water supplier who must then a collect source water sample.
- Water supplier must collect a source water sample, from a point prior to any treatment, within 24 hours for fecal indicator analysis (*E. coli*, enterococci, or coliphage). If source water sample is positive, then water supplier must collect five repeat samples over next 24 hours unless immediate corrective action is required by the state.
- If fecal indicator is confirmed, water supplier must implement one of corrective action options, and notify the public.

Optional assessment source water monitoring:

- State can require source water monitoring at any time for any system that lacks treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and is judged to be at risk from:
  - High population density combined with on-site wastewater disposal,
  - Aquifers with restricted geographical extent,
  - Sensitive aquifers,
  - Shallow, unconfined aquifers,
  - Aquifers with thin or absent soil cover, or
  - Wells previously identified as fecally contaminated.

Compliance — Sanitary survey inspections. Rule requires regular sanitary survey inspections of critical components of each water system by state/county staff to identify any significant deficiencies that cause or have potential to cause the introduction of contamination into the drinking water. Inspections must cover water source; treatment; distribution; finished water storage; pumps, pump facilities, and controls; monitoring, reporting, and data verification; system management and operation; and operator certification. Community water systems must be inspected every three years;

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Microbial contaminants — Ground water — continued

those with 99 percent (4-log) treatment for viruses or that have outstanding performance can be reduced to five-year frequency. All noncommunity water systems must be inspected every five years. Water suppliers with identified deficiencies must consult with state/county within 30 days, and within 120 days complete correction or be in compliance with a state-approved corrective action plan and schedule.

Corrective action measures. When a water system has either significant deficiencies or fecal indicator positive source water, the water supplier must:

- Correct identified deficiencies, or
- Provide alternate source of water, or
- Eliminate the source of contamination, or
- Provide treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and report treatment performance data (disinfectant residuals and contact time).

Compliance dates.

1/8/07 - Federal rule effective.

10/11/09 - State/county begins sanitary survey inspections to identify significant deficiencies in public water systems.

12/01/09 - Water systems comply with federal rule. Triggered monitoring and correction of significant deficiencies begins. Water systems with treatment must monitor and report disinfectant residuals and contact time.

12/31/12 - State/county completes first round of sanitary survey inspections and significant deficiency identification for community water systems.

12/31/14 - State/county completes first round of sanitary survey inspections and significant deficiency identification for nontransient noncommunity and transient noncommunity water systems.

Cost. $62M per year nationally.

Rule history.

Proposed federal rule - 5/10/00

Final federal rule - 10/11/06

Oregon rule - due 10/11/10

Table 1 — Microbial contaminents

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Giardia lamblia	TT[1]	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human and animal fecal wastes
Cryptosporidium	TT	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human and animal fecal wastes
Legionella	TT	Legionnaires disease, a type of pneumonia	Found naturally in water, multiplies in water heating systems
Heterotrophic plate count (HPC)	TT	HPC has no health effects. It is an analytical method used to measure the variety of bacteria that are common in water. The lower the concentration of HPC, the better maintained the water system is	HPC measures a range of bacteria that are naturally present in the environment
Turbidity	TT, PS[2]	Measure of cloudiness of water. It is used to indicate water quality and filtration effectiveness. Higher turbidity levels are often associated with higher levels of disease-causing organisms	Soil runoff
Viruses (enteric)	TT	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human fecal wastes

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Table 1 — Microbial contaminents — continued

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Total coliforms	Five percent positive[3]	Not a health threat in itself; used to indicate whether other potentially harmful bacteria are present	Bacteria naturally present in the environment, human and animal fecal wastes
Fecal coliforms	Confirmed presence	Presence indicates that the water may be contaminated with human or animal fecal wastes and could cause gastrointestinal illness	Human and animal fecal wastes, some natural environmental sources
E. coli	Confirmed presence	Presence indicates that the water may be contaminated with human or animal fecal wastes and could cause gastrointestinal illness	Human and animal fecal wastes

[1] Treatment Technique, such as filtration plus disinfection of surface water, or equivalent

[2] Performance Standard, see text

[3] No more than one positive routine sample per month (or quarter) for systems collecting fewer than 40 samples/month

Disinfectants and disinfection byproducts

Purpose and benefits. Protect public health by limiting the exposure of people to chemical disinfectant residuals and chemical byproducts of disinfection treatment (DBPs) that result from disinfection treatment practices. The Stage 1 rule controls average DBP levels across distribution systems, and the subsequent Stage 2 rule controls the occurrence of peak DBP levels within distribution systems. As many as 140 million people in the U.S. will receive increased protection from DBPs. Benefits also include a 24 percent reduction in trihalomethane levels across the U.S., and reduction in exposure to bromate and chlorite.

Disinfection treatment chemicals used to kill microorganisms in drinking water can react with naturally occurring organic and inorganic matter in source water, called DBP precursors, to form disinfection byproducts. The challenge is to apply levels of disinfection treatment needed to kill disease-causing microorganisms while limiting the levels of disinfection byproducts produced. The primary disinfection byproducts of concern in Oregon are the trihalomethanes (TTHM) and the haloacetic acids (HAA5).

Health effects. Some disinfection byproducts have been shown to cause cancer and reproductive effects in lab animals and suggested bladder cancer and reproductive effects in humans *(see Table 2, page 22).*

Application. All community and nontransient noncommunity water systems that apply a disinfectant to the drinking water for primary or residual water treatment, or distribute water that has been disinfected. In addition, transient noncommunity systems that use chlorine dioxide are also affected.

Monitoring (Stage 1 rule). Disinfection byproducts (DBPs) must be monitored throughout the distribution system at frequencies daily, monthly, quarterly or annually, depending on the population served, type of water source, and the specific disinfectant applied, and in accordance with an approved monitoring plan. Disinfectant residuals must be monitored at the same locations and frequency as coliform bacteria.

TTHM/HAA5 monitoring for surface water systems and systems under the direct influence of surface water:

- Water systems serving 10,000 or more people — four samples/plant/quarter.
- Water systems serving 500-9,999 people — one sample/plant/quarter.
- Water systems serving fewer than 500 people — one sample/plant/year (warmest month).

TTHM/HAA5 monitoring for ground water systems that disinfect:

- Water systems serving 10,000 or more people — one sample/plant/quarter.
- Water systems serving fewer than 10,000 people — one sample/plant/year (warmest month).

Systems using surface water sources and conventional filtration treatment must monitor source water for total organic carbon (TOC) and alkalinity monthly and practice enhanced coagulation to remove TOC if

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Disinfectants and disinfection byproducts — continued

it exceeds 2.0 mg/L as a running annual average. TOC is an indicator of the levels of DBP precursor compounds in the source water.

Monitoring (Stage 2 rule). Water systems must monitor for DBPs at specific locations identified by an Initial Distribution System Evaluation and monitor quarterly or annually at those locations. Water systems that purchase all their water must monitor disinfectant residual levels.

Water treatment/control measures. Optimize treatment processes to reduce disinfectant residuals. DBPs can be reduced by moving the point of chlorine application from prior to filtration to after filtration, where many of the natural organic compounds in the water have been reduced, and by enhanced coagulation treatment to remove total organic carbon prior to disinfection. Alternative disinfectants such as ozone, or using chlorine combined with ammonia (chloramines), can reduce DBP levels. Management of distribution system and storage operation to reduce water age can reduce peak DPB levels.

Compliance (Stage 1 rule). Compliance is determined based on meeting maximum contaminant levels (MCLs) for disinfection byproducts and maximum levels for disinfectant residual (MRDLs) over a running annual average of all sample results at all sample locations, computed quarterly. See Table 2, page 22, for MCLs. Maximum Residual Disinfectant Levels (MRDLs) are:

- Chloramines (total chlorine residual) - 4.0 mg/L (as Cl_2).
- Chlorine (free chlorine residual) - 4.0 mg/L (as Cl_2).
- Chlorine dioxide - 0.8 mg/L (as ClO_2).

Compliance (Stage 2 rule). Compliance is determined based on meeting maximum contaminant levels (MCLs) for disinfection byproducts over a locational running annual average of the sample results, computed for each sampling location.

Compliance dates.

1/02 - Surface water systems and ground water systems under the direct influence of surface water serving 10,000 or more people must comply with DBP Stage 1 requirements.

1/04 - Surface water systems and ground water systems under the direct influence of surface water serving fewer than 10,000 people, and all ground water systems must comply with DBP Stage 1 requirements.

1/06 - Small systems submit data to EPA for waiver from Initial Distribution System Evaluation (IDSE) monitoring.

10/06-4/08 - Systems without a waiver submit to EPA a Standard Monitoring Plan (SM), System Specific Study (SSS), or 40/30 certification.

10/07-9/09 - Systems begin Stage 2 monitoring.

9/08-4/09 - Systems complete Stage 2 monitoring.

1/09-3/10 - Systems submit IDSE monitoring report.

4/09-7/10 - Customer water systems begin monitoring for disinfectant residuals.

4/12-10/13 - Systems complete monitoring plan, and comply with DBP Stage 2 monitoring requirements.

1/13-7/14 - Systems comply with Stage 2 MCLs.

Cost. Total cost U.S. is estimated at $684M/yr. Benefits difficult to quantify due to uncertainties in health data, but are believed to exceed costs.

Rule history.

Federal rule - 11/29/79 (Total Trihalomethanes (TTHM), 0.10 mg/L, for water systems serving more than 10,000 people)

Oregon rule - 9/24/82 (TTHM)

Federal rule - 12/16/98 (Stage 1 Disinfectants/Disinfection Byproducts Rule - D/DBP)

Federal rule - 4/14/00, 5/30/00, 6/13/00 (revisions)

Oregon rule - 7/15/00 (Stage 1 D/DBP)

Federal rule - 1/16/01, 2/12/01 (revisions)

Oregon rule - 10/31/01 (revisions)

Federal rule - 1/4/06 (Stage 2 Disinfectants/Disinfection Byproducts Rule - D/DBP)

Oregon rule - Due 1/4/10 (Stage 2 D/DBP)

Lead and copper

Purpose and benefits. Protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. Lead and copper enter drinking water mainly from corrosion of plumbing materials containing lead and copper.

Although lead and copper are naturally present in geologic deposits, they are rarely present in Oregon at significant levels in surface water or ground water sources. They are present in drinking water primarily from corrosion of plumbing and plumbing fixtures in homes and buildings. Lead comes from lead solder and brass fixtures, and copper comes from copper tubing and brass fixtures.

Health effects. Exposure to lead can cause damage to brain, red blood cells and kidneys, especially for young children and pregnant women. Infants and young children are typically more vulnerable to lead in drinking water than the general population. Infants and children who drink water containing lead in excess of the action level could experience delays in their physical or mental development. Children could show deficits in attention span and learning abilities. Adults who drink water with lead in excess of the action level over many years could develop kidney problems or high blood pressure. EPA considers lead a probable human carcinogen. Exposure to copper can cause stomach and intestinal distress, liver or kidney damage, and complications from Wilson's disease in genetically predisposed people.

Application. All community and nontransient noncommunity systems.

Continued on page 22

Table 2. Disinfectants and disinfection byproducts

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection
Chloramines	4.0 (MRDL)	Eye/nose irritation, stomach discomfort, anemia	Water additive to control microbes
Chlorine as Cl_2	4.0 (MRDL)	Eye/nose irritation, stomach discomfort, anemia	Water additive to control microbes
Chlorine Dioxide (as ClO_2)	4.0 (MRDL)	Anemia, infants/young children-nervous system effects	Water additive to control microbes
Chlorite	1.0	Anemia, infants and young children: nervous system effects	By-product of drinking water disinfection
Haloacetic acids (HAA5)[1]	0.060	Increased risk of cancer	By-product of drinking water disinfection
Total Trihalomethanes (TTHMs)[2]	0.080	Liver, kidney, central nervous system effects, increased risk of cancer	By-product of drinking water disinfection

[1] Sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids

[2] Sum of the concentrations of chloroform, bromoform, dibromochloromethane and bromodichloromethane

Monitoring. Samples from community systems are collected from homes with lead-soldered plumbing built prior to the 1985 prohibition of lead solder in Oregon. One-liter samples of standing water (first draw after six hours of non-use) are collected at homes identified in the water system sampling plan. Nontransient noncommunity systems sample at high-risk locations as identified in their sampling plan. The number of samples required for initial and subsequent monitoring is summarized in the next column.

Water system population	Initial sampling sites	Reduced sampling sites
>100,000	100	50
10,001 – 100,000	60	30
3,301 – 10,000	40	20
501 – 3,300	20	10
101 – 500	10	5
<101	5	5

Two rounds of initial sampling for lead and copper are required, collected at six-month intervals. Subsequent annual sampling from the reduced number of sites is required after demonstration that lead and copper action levels are met. After three rounds of annual sampling, samples are required every three years.

Water treatment/control measures. Water systems that cannot meet the Action Levels must either install corrosion control treatment or develop alternate sources of water. Water treatment alternatives include adding chemicals to adjust pH, alkalinity or both (such as soda ash, caustic soda) or adding passivating agents (such as orthophosphates or ortho/polyphosphate blends). Water systems practicing corrosion control treatment must also monitor for water quality parameters (such as pH, temperature, alkalinity) at customer taps in the distribution system and at the entry points to the distribution system at prescribed frequencies, and comply with optimal levels for these parameters as specified by the department. If lead action levels are not met even after treatment installation and optimization, then continuing public education efforts are required.

It is possible that lead levels in a particular home may be higher than at other homes in the community as a result of the materials used in that home's plumbing. People who are concerned about elevated lead levels can arrange to test their water and if the results are high, can flush taps until the water temperature becomes colder before using tap water, especially after periods of extended non-use.

Compliance. In each sampling round, 90 percent of samples from homes must have lead levels less than or equal to the Action Level of 0.015 mg/L, and copper levels less than or equal to the Action Level of 1.3 mg/L. Water systems with lead above the Action Level must conduct periodic public education, and either install corrosion control treatment, change water sources or replace plumbing.

Rule history.

Federal rule - 12/24/75 (Lead MCL, 0.05 mg/L)

Oregon rule - 9/24/82

Oregon rule - 7/1/85 (Lead solder ban)

Federal rule - 6/7/91 (Lead and Copper Rule)

Oregon rule - 12/7/92

Federal rule - 7/15/91, 6/29/92, 6/30/94 (technical corrections)

Federal rule - 1/12/00 (minor revisions)

Oregon rule - 10/31/01 (technical corrections, revisions)

Federal rule - 7/18/06 (proposed minor revisions to enhance implementation and public education)

Federal rule – Fall 2007 (projected final rule)

Oregon rule – 2009-2011 (projected)

Inorganic contaminants

Purpose. Control levels of metals and minerals in drinking water, both naturally-occurring and resulting from agricultural or industrial use. Inorganic contaminants most often come from the source of water supply, but can also enter water from contact with materials used for pipes and storage tanks. A new and more stringent drinking water standard was recently established for arsenic *(see Table 3, page 25).*

Health effects. For most inorganic contaminants, health concerns are related to long-term or even lifetime exposures *(see Table 3, page 25)*. Arsenic is a naturally-occurring mineral known to cause cancer in humans at high concentrations over years of exposure. Nitrate and nitrite, however, can seriously affect infants in short-term exposures by interfering with the transfer of oxygen from the lungs to the bloodstream. Infants younger than age six months who drink water containing nitrate or nitrite in excess of the MCLs could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Application. All public water systems. The exceptions are the arsenic, fluoride and asbestos maximum contaminant levels which apply only to community and nontransient noncommunity systems.

Monitoring.

Nitrate — Community and nontransient noncommunity systems must sample quarterly for surface water sources (reduction to annual available), and annually for ground water sources. All noncommunity and state-regulated water systems must sample annually.

Asbestos — Community and nontransient noncommunity systems with asbestos-cement water pipes or with water sources in geologic asbestos deposit areas must sample every nine years.

Arsenic — Community and nontransient noncommunity systems begin monitoring and comply with the new standard by January 23, 2006. Water systems with surface water sources must sample annually, and systems with ground water sources must sample every three years.

All other inorganics — Community and nontransient noncommunity systems must sample surface water sources annually and ground water sources every three years. Waivers are available based on monitoring record showing three sampling rounds below MCLs. All noncommunity and state-regulated water systems must sample once for inorganics, including arsenic.

Water treatment/control measures. A variety of water treatment processes are available for reducing levels of specific inorganic contaminants in drinking water, including ion exchange and reverse osmosis.

Compliance. Applicable water systems must meet the established maximum contaminant levels *(see Table 3, page 25).* Nitrate compliance is based on a single sample result, and averaged with a resample result taken within 24 hours if the level in the original sample is above the MCL. Water systems that exceed an MCL in any sample for an inorganic contaminant other than nitrate must monitor quarterly and meet the MCL as a running annual average. Systems that cannot meet one or more MCLs must either install water treatment systems or develop alternate sources of water.

Compliance dates for arsenic:

1/06 - 0.010 mg/L MCL becomes effective, water systems begin monitoring.

12/06 - Surface water systems complete initial monitoring.

12/07 - Ground water systems complete initial monitoring.

Cost — Arsenic. EPA estimates the cost of meeting the new arsenic standard is $165M per year in the U.S. A drinking water research organization estimates the U.S. cost at $605M per year. Benefits include avoiding 16 to 26 non-fatal bladder and lung cancer cases per year in the U.S., avoiding 21 to 30 fatal bladder and lung cancer cases per year, and reducing non-cancer diseases.

Rule history.

Federal rule - 12/24/75 (inorganic chemicals)

Oregon rule - 9/24/82 (inorganic chemicals)

Federal rule - 4/2/86 (fluoride)

Oregon rule - 11/13/89 (fluoride)

Federal rule - 7/1/91 (Phase II)

Federal rule - 6/29/92, 7/1/94 (corrections to Phase II)

Federal rule - 7/19/92 (Phase V)

Federal rule - 7/1/94 (corrections to Phase V)

Oregon rule - 6/9/92 (Phase II), and 1/14/94 (Phase V)

Federal rule - 1/22/01 (arsenic)

Oregon rule – 10/21/04 (arsenic)

Table 3. Inorganic contaminants

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Antimony	0.006	Blood cholesterol increases, blood sugar decreases	Discharge from petroleum refineries, fire retardants, ceramics, electronics, solder
Arsenic	0.010	Skin damage, circulatory system effects, increased cancer risk	Erosion of natural deposits of volcanic rocks, runoff from orchards, runoff from glass and electronics production wastes

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Table 3. Inorganic contaminants — continued

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Asbestos	Seven million fibers per liter (>10 um fiber size)	Increased risk of developing benign intestinal polyps	Erosion of natural geologic deposits, decay of asbestos-cement water pipes
Barium	2	Increase in blood pressure	Discharge of drilling wastes, discharge from metal refineries, erosion of natural deposits
Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories, discharge from electrical, aerospace, and defense industries
Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes, erosion of natural deposits, discharge from metal refineries, runoff from waste batteries and paints
Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills, erosion of natural deposits
Cyanide	0.2	Thyroid, nervous system damage	Discharge from steel/metal factories, discharge from plastic and fertilizer factories
Fluoride	4[1]	Bone disease, mottled teeth	Erosion of natural deposits, discharge from fertilizer and aluminum industries, drinking water additive promoting strong teeth
Mercury (total inorganic)	0.002	Kidney damage	Erosion of natural deposits, discharges from refineries and factories, runoff from landfills, runoff from cropland

Continued on next page

Table 3. Inorganic contaminants — continued

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Nitrate (as N)	10	Infants younger than age six months could become seriously ill and if untreated may die. Symptoms include shortness of breath and "blue baby" syndrome	Runoff from fertilizer use, leaching from septic tank/drain fields, erosion of natural deposits
Nitrite	1	Infants younger than age six months could become seriously ill and if untreated may die. Symptoms include shortness of breath and "blue baby" syndrome	Runoff from fertilizer use, leaching from septic tank/drain fields, erosion of natural deposits (rapidly converted to nitrate)
Selenium	0.05	Hair and nail loss, numbness in fingers and toes, circulatory problems	Discharge from petroleum and metal refineries, erosion of natural deposits, discharge from mines
Thallium	0.002	Hair loss, blood changes, and kidney, liver, intestinal effects	Leaching from ore processing sites, discharge from electronics, drugs and glass factories

[1]Note: a secondary standard for fluoride is set at 2.0 mg/L to control tooth discoloration
[2]Oregon regulatory standard only, federal standard withdrawn 2/23/95

Organic chemicals

Purpose. Reduce exposure of people to organic contaminants in drinking water *(see Table 4, page 28)*. Organic contaminants are most often associated with industrial or agricultural activities that affect sources of drinking water supply. Major types of organic contaminants are Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs). These include industrial and commercial solvents and chemicals, and pesticides used in agriculture and landscaping. Organic contaminants can also enter drinking water from materials in contact with the water such as pipes, valves and paints and coatings used inside water storage tanks.

Health effects. For organic contaminants, health concerns are related to long-term or even lifetime exposures to low levels of contaminant *(see Table 4, page 28)*.

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Organic chemicals — continued

Application. Community and nontransient noncommunity water systems.

Monitoring. At least one test for each contaminant from each water source is required during every three-year compliance period. Public water systems serving more than 3,300 people must test twice during each three-year compliance period for SOCs. Public water systems using surface water sources must test for VOCs annually. Quarterly follow up testing is required for any contaminants that are detected above specified levels. The exceptions are dioxin and acrylamide/epichlorohydrin. Only those systems determined by DHS to be at risk of contamination must monitor for dioxin. Water systems using polymers containing acrylamide or epichlorohydrin in their water treatment processes must keep their dosages below specified levels.

Water treatment. A variety of water treatment processes are available for reducing levels of specific organic contaminants in drinking water, including activated carbon and aeration.

Compliance. Water systems must meet the established maximum contaminant levels (Table 4, page 28) as a running annual average. Systems that can not meet one or more MCLs must either install or modify water treatment systems or develop alternate sources of water.

Rule history.

Federal rule - 12/24/75 (National Interim Primary Drinking Water Regulation)

Oregon rule - 9/2/82

Federal rule - 7/8/87 (Phase I Volatile Organic Chemicals)

Oregon rule - 11/13/89 (Phase I)

Federal rule - 1/30/91 and 7/1/91(Phase II Synthetic Organic Chemicals)

Federal rule - 6/29/92, 7/1/94 (corrections to Phase II)

Federal rule - 7/19/92 (Phase V Synthetic Organic Chemicals)

Federal rule - 7/1/94 (corrections to Phase V)

Oregon rule - 6/9/92 (Phase II); and 1/14/94 (Phase V)

Table 4. Organic contaminants

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Acrylamide	TT[1]	Central nervous system and blood effects, increased risk of cancer	Added to water during water and sewage treatment
Alachlor	0.002	Eye, liver, kidney, spleen effects, anemia, increased risk of cancer	Runoff from herbicides used on row crops
Aldicarb Aldicarb sulfone Aldicarb sulfoxide	(MCLs stayed by EPA)	Gastrointestinal and neurological effects	Runoff from insecticide used on ornamental plants and crops

Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Atrazine	0.003	Cardiovascular and reproductive effects	Runoff from herbicides used on row crops
Benzene	0.005	Decreased blood platelets, anemia, increased risk of cancer	Discharge from factories, leaching from landfills and gas storage tanks
Benzo(a)pyrene (Polyaromatic hydrocarbons)	0.0002	Reproductive difficulties and increased risk of cancer	Leaching from linings of water storage tanks and water pipes
Carbofuran	0.04	Blood, nervous system, and reproductive system effects	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	0.005	Liver effects and increased risk of cancer	Discharge from chemical plants and other industrial activities
Chlordane	0.002	Liver and nervous system effects, increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	Kidney and liver effects	Discharge from chemical and agricultural chemical factories
2,4-D	0.07	Liver, adrenal gland, and kidney damage	Runoff from herbicides used on row crops
Dalapon	0.2	Minor kidney effects	Runoff from herbicides used on rights of way
1,2-dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties and increased risk of cancer	Runoff from soil fumigant used on soybeans, cotton, pineapples, orchards
o-Dichlorobenzene	0.6	Liver, kidney, circulatory system damage	Discharge from industrial chemical factories
p-Dichlorobenzene	0.075	Liver, kidney, spleen damage, anemia, blood effects	Discharge from industrial chemical factories

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Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
1,2-Dichloro-ethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories
1,1-Dichloro-ethylene	0.007	Liver damage	Discharge from industrial chemical factories
cis 1,2-Dichloro-ethylene	0.07	Liver damage	Discharge from industrial chemical factories
trans 1,2-Dichloroethylene	0.1	Liver damage	Discharge from industrial chemical factories
Dichloromethane (methylene chloride)	0.005	Liver damage and increased risk of cancer	Discharge from drug and chemical factories
1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories
Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, and reproductive effects	Discharge from chemical factories
Di(2-ethylhexyl) phathalate	0.006	Liver effects, reproductive difficulties, increased risk of cancer	Discharge from chemical and rubber factories
Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	3×10^{-8}	Reproductive difficulties and increased risk of cancer	Emissions from waste incineration and other combustion, discharge from chemical factories
Diquat	0.02	Cataracts	Runoff from herbicide use
Endothall	0.1	Stomach, intestine effects	Runoff from herbicide use
Endrin	0.002	Liver damage	Residue of banned insecticide

Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Epichlorohydrin	TT[1]	Stomach effects and increased risk of cancer	Discharge from industrial chemical factories, impurity in some water treatment chemicals
Ethylbenzene	0.7	Liver, kidney damage	Discharge from petroleum refineries
Ethylene dibromide	0.00005	Liver, stomach, kidney, reproductive system effects, and increased risk of cancer	Discharge from petroleum refineries, soil fumigant
Glyphosate	0.7	Kidney, reproductive system effects	Runoff from herbicide use
Heptachlor	0.0004	Liver damage, increased risk of cancer	Residue of banned termiticide
Heptachlor epoxide	0.0002	Liver damage, increased risk of cancer	Breakdown of heptachlor
Hexachlorobenzene	0.001	Liver, kidney, reproductive system effects, and increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
Hexachloro-cyclopentadiene	0.05	Kidney, stomach damage	Discharge from chemical factories
Lindane	0.0002	Liver, kidney effects	Runoff/leaching from insecticide used on lumber, gardens, cattle
Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetable, alfalfa, livestock
Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, tomatoes
Pentachlorophenol	0.001	Liver and kidney effects, increased risk of cancer	Discharge from wood preserving operations

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Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Picloram	0.5	Liver damage	Herbicide runoff
Polychlorinated biphenyls (PCBs)	0.0005	Skin, thymus gland, reproductive system, and nervous system effects, immune deficiencies, increased risk of cancer	Runoff from landfills, discharge of waste chemicals
Simazene	0.004	Blood effects.	Herbicide runoff
Styrene	0.1	Liver, kidney, circulatory system damage	Discharge from rubber and plastic factories, leaching from landfills
Tetrachloro-ethylene	0.005	Liver damage and increased risk of cancer	Discharge from factories and dry cleaning
Toluene	1	Liver, kidney, nervous system effects	Discharge from petroleum refineries
Toxaphene	0.003	Kidney, liver, thyroid effects, increased risk of cancer	Runoff/leaching from insecticide used on cattle, cotton
2,4,5-TP (Silvex)	0.05	Liver damage	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	Adrenal gland changes	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.2	Liver, nervous system, circulatory system effects	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.005	Kidney, liver, immune system damage	Discharge from industrial chemical factories
Trichloroethylene	0.005	Liver damage and increased risk of cancer	Discharge from metal degreasing sites and other factories
Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipe, discharge from plastics factories

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Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories, discharge from chemical factories
[1]Treatment technique requirement (limit dosage of polymer treatment chemicals)			

Radiologic contaminants

Purpose and benefits. Reduce exposure of people to radioactive contaminants in drinking water (see Table 5, page 34). These contaminants originate from both natural and man-made sources. Reduced uranium exposure for 620,000 persons in the US and protection from toxic kidney effects of uranium.

Health effects. Primarily increased cancer risk from long-term exposure. *(see Table 5, page 34).*

Application. All community water systems.

Monitoring. Initial tests, quarterly for one year at the entry point from each source, must be completed prior to December 31, 2007 for gross alpha, radium-226, radium-228 and uranium. A single analysis for all four contaminants collected between June 2000 and December 2003 will substitute for the four initial samples. Gross alpha may substitute for radium 226 monitoring if the gross alpha result does not exceed 5 pCi/L. Gross alpha may substitute for uranium monitoring if the gross alpha result does not exceed 15 pCi/L. Subsequent monitoring every three, six or nine years depending on initial results, with a return to quarterly monitoring if the MCL is exceeded. Only those communities with water supplies potentially impacted by man-made radiation sources, as designated by the department, must sample for beta/photon radiation, iodine-131, strontium-90 or tritium.

Water treatment. Variety of treatment processes will reduce radiologic contaminants, including ion exchange and reverse osmosis.

Compliance. Compliance with MCLs is based on the average of the four initial monitoring results, or subsequent quarterly tests. Community water systems that can not meet MCLs must install treatment or develop alternate water sources.

Compliance dates.

6/00-12/03 - Monitoring data collected is eligible for use as initial data

12/03 - Systems begin initial monitoring

12/07 - All systems complete initial monitoring

Cost. $81M per year in the US. About 800 public water systems in the US will have to install treatment.

Rule history.

Federal rule - 7/9/76

Oregon rule - 9/24/82

Federal rule -12/7/00 (uranium, Ra 226&228)

Oregon rule - 10/02 *Continued on page 34*

Radiologic contaminants — continued

Table 5. Radiologic contaminants

Contaminant	MCL, pCi/L (picocuries per liter), unless otherwise noted	Potential health effects	Sources of drinking water contamination
Gross alpha	15	Increased risk of cancer	Erosion of natural deposits
Beta and photon emitters[1]	4 mrem/yr	Increased risk of cancer	Decay of natural and man-made deposits
Combined Radium 226 & 228 (combined)[3]	5	Increased risk of cancer	Erosion of natural deposits
Uranium	30 ug/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits
Iodine-131[2]	3	Increased risk of cancer	Power production
Strontium 90[2]	8	Increased risk of cancer	Power and weapons production
Tritium[2]	20,000	Increased risk of cancer	Power and weapons production

[1]Sampling required only if designated by the department - Gross beta + photon emitters not to exceed 4 millirems per year (mrem/yr)

[2]State standards only, sampling required only if designated by the department. (Based on 4 mrem/yr dose)

[3]Measured separately.

Review and update of current standards

The 1996 Safe Drinking Water Act requires EPA to review and revise as appropriate each current standard at least every six years. On July 18, 2003, EPA determined that 68 current chemical regulations remain appropriate, and that the Coliform Rule should be revised. The second regulatory review decisions are to be finalized in 2009, and include arsenic, fluoride and radionuclides.

II. Future standards

New and revised drinking water quality standards are mandated under the 1996 federal Safe Drinking Water Act. This Section is intended to preview these standards, currently under development by USEPA and not yet final. This Section concludes with an overview of the process EPA uses to consider drinking water contaminants for future regulation.

The future standards (and their likely EPA promulgation date) include:

Radon rule — 2009

Distribution rule, including revised coliform bacteria requirements — 2010

These are described generally below. Additional details will be found in the final EPA rules once they are promulgated. Water suppliers should be aware of and familiar with these mandates and deadlines, and plan strategically to meet them. The Department of Human Services, under the *primacy* Agreement with USEPA, has up to two years to adopt each federal rule after it is finalized, with a possible extension of two additional years. Water suppliers generally have at least three years to comply with each federal rule after it is finalized.

Radon

Purpose. Reduce exposure of people to both indoor air radon and radon in drinking water. Radon is a naturally occurring gas formed from the decay of uranium-238. Radon enters indoor air primarily from soil under homes. Tap water from ground water sources is a relatively small source of radon in air. Surface water supplies of drinking water are unlikely to contain radon.

Health effects. Inhalation of radon and its decay products causes lung cancer, with smokers at particular risk. EPA estimates that 15,000 to 22,000 deaths per year in the U.S. result from indoor air radon, primarily from soil gases. Radon in drinking water can contribute to indoor air radon levels from washing and showering. Ingestion of radon in drinking water presents a small risk of stomach cancer. One hundred sixty-eight deaths are likely due to radon in drinking water (149 from inhalation, 19 from ingestion).

Application. All community water systems using ground water sources.

Monitoring. Quarterly initial sampling at distribution system entry points for one year. Subsequent sampling is required once every three years. Oregon radon data from 65 deep community wells collected in 1981 showed 23 with radon greater than 300 pCi/L, and none greater than 4,000 pCi/L. Oregon geologic mapping and results of voluntary indoor air testing in homes suggest that a maximum of four percent of Oregon homes may exceed the EPA indoor air action level due to soil radon.

Water treatment. Aeration, granular activated carbon.

Compliance. Meet MCL of 300 pCi/L. An alternative MCL (AMCL) of 4,000 pCi/L is proposed, if the department develops and adopts an EPA-approved statewide Multi-Media Mitigation program (MMM). Elements of the MMM program include public participation in MMM development, quantitative goals for remediation of existing homes and radon-resistant new construction, strategies for achieving goals, and tracking

Continued on page 36

Radon — continued

and reporting of results. Finally, local communities have the option of developing an EPA approved local MMM program, in the absence of a statewide MMM program, and meeting the drinking water AMCL.

Cost. Estimated national annual costs of radon MCLs: 300 pCi/L, $408M/yr; 4,000 pCi/L, $43M/yr.

Regulation dates.

Proposed Radon Rule - 11/2/99

Final Radon Rule - 2009

Distribution rule, including revised coliform bacteria requirements

Purpose. Current requirements for coliform bacteria will be revised, emphasizing fecal coliforms and *E. coli,* and focusing on protection of water within the distribution system.

Health effects. Gastrointestinal illness. Actual numbers of illness cases are very difficult to quantify — typically, only large and sudden outbreaks are likely to be recognized. Smaller outbreaks and low levels of illness are unlikely to be recognized. Waterborne disease outbreak data from the federal Centers for Disease control suggest that a significant number of documented waterborne disease outbreaks were associated with distribution system failures and deficiencies.

Application. All public water systems.

Water treatment/control measures. Identify and correct sanitary defects and hazards in water systems and use best management practices to control coliform bacteria in distribution systems.

Compliance. Meet MCLs, correct sanitary defects, and use best management practices for distribution systems.

Costs. Significant costs to some water systems are expected, depending on the scope and content of the final rules. Some water systems will need to improve distribution system protection and practices.

Regulation dates.

Proposed coliform bacteria/distribution rule - 2008

Final coliform bacteria/distribution rule - 2010

Identifying drinking water contaminants for future regulation

The Safe Drinking Water Act directs EPA to identify and list unregulated drinking water contaminants suspected to be present in drinking water and that may require a national drinking water regulation in the future. EPA must periodically publish this list of contaminants, called the Contaminant Candidate List (CCL). EPA uses the CCL to prioritize research and data collection efforts to help determine if specific contaminants should be regulated. *See Table 6, page 38*, for the second Contaminant Candidate List. Water suppliers are called upon to participate and contribute to the data collection effort through the Unregulated Contaminant Monitoring Rules (UCMR). All water suppliers serving more than 10,000 people must conduct UCMR monitoring, use EPA-approved labs, and report results to EPA. Selected water suppliers serving 10,000 or fewer people are sampled at EPA expense. *See Table 7, page 39*, for the listing of contaminants included in the second unregulated contaminant monitoring proposed rule. All validated results are stored in and accessible through the National Contaminant Occurrence Database (NCOD). EPA must decide whether or not to regulate at least five or more contaminants on each CCL list, called Regulatory Determinations.

This process is designed to support development of future standards for those contaminants based on the following three criteria:

- The projected adverse health effects from the contaminant, and
- The extent of occurrence of the contaminant in drinking water, and
- Whether the regulation of the contaminant would present a "meaningful opportunity" for reducing risks to health.

EPA is currently working to develop a broader, more comprehensive approach for selecting contaminants for future CCLs, with the advice and assistance of the National Research Council and the National Drinking Water Advisory Committee.

History.

1988-97 - Unregulated contaminant monitoring requirements under drinking water rules for systems serving more than 500 people.

3/98 - Contaminant Candidate List 1 (60 contaminants).

9/99 - Unregulated Contaminant Monitoring Rule 1-UCMR1 (28 contaminants).

2001-05 - UCMR1 monitoring by water suppliers.

7/03 - Regulatory determination 1 (9 contaminants-do not regulate).

2/05 - Contaminant Candidate List 2 (51 remaining contaminants from CCL1).

8/05 - Proposed Unregulated Contaminant Monitoring Rule 2-UCMR2 (26 contaminants).

12/06 - Final UCMR2.

12/06 - Nominations due for contaminants for Contaminant Candidate List 3.

2007-10 - UCMR2 monitoring by water suppliers.

2007 - Draft Contaminant Candidate List 3.

2007 - Regulatory determination 2.

2009 - Final Contaminant Candidate List 3.

Continued on page 38

Identifying drinking water contaminants for future regulation — continued

Table 6. Contaminant Candidate List 2	
Microbial contaminants	**Chemical contaminants**
Adenoviruses	1,1,2,2-tetrachloroethane
Aeromonas hydrophilia	1,2,4-trimethylbenzene
Caliciviruses	1,1-dichloroethane
Coxsackieviruses	1,1-dichloropropene
Cyanobacteria, other freshwater algae, toxins	1,2-diphenylhydrazine
Echoviruses	1,3-dichloropropane
Helicobacter pylori	1,3-dichlororpropene
Microsporidia	2,4,6-trichlorophenol
Mycobacterium avium intracellulare (MAC)	2,2-dichloropropane
	2,4-dichlorophenol
	2,4-dinitrophenol
	2,4-dinitrotoluene
	2,6-dinitrotoluene
	2-methyl-Phenol (o-cresol)
	Acetochlor
	Alachlor ESA
	Aluminum
	Boron
	Bromobenzene
	DCPA mono-acid degradate
	DCPA di-acid degradate
	DDE
	Diazinon
	Disulfoton
	Diuron
	EPTC (s-ethyl-dipropylthiocarbamate)
	Fonofos
	p-Isopropyltoluene
	Linuron
	Methyl bromide
	Methyl-t-butyl ether (MTBE)
	Metolachlor
	Molinate

Continued on next page

Table 6. Contaminant Candidate List 2 — continued

	Nitrobenzene
	Organotins
	Perchlorate
	Prometon
	RDX
	Terbacil
	Terbufos
	Triazines and degradation products
	Vanadium

Table 7. Unregulated Contaminant Monitoring 2 (proposed rule)			
Assessment Monitoring List:		**Screening Survey List:**	
Contaminant	**Analytical Method**	**Contaminant**	**Analytical Method**
Dimethoate	EPA 527	Acetochlor ESA	EPA 535
Terbofos sulfone		Acetochlor OA	
2,2',4,4'-tetrabromodiphenyl ether		Alachlor ESA	
2,2',4,4',5-pentabromodiphenyl ether		Alachlor OA	
2,2',4,4',5,5'-hexabromobiphenyl		Metolachlor ESA	
2,2',4,4',5,5'-hexabromodiphenyl ether		Metolachlor OA	
2,2',4,4',6-pentabromodiphenyl ether		Acetochlor	EPA 525.2
1,3-dinitrobenzene	EPA 529	Alachlor	
2,4,6-trinitrotoluene (TNT)		Metolachlor	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)		N-nitroso-diethylamine (NDEA)	EPA 521
Perchlorate	EPA 314.0	N-ditroso-dimethylamine (NDMA)	
	EPA 314.1	N-nitroso-di-n-butylamine (NDBA)	
	EPA 330.0	N-nitroso-di-n-propylamine (NDPA)	
	EPA 332.0	N-nitroso-methylethyleamine (NMEA)	
		N-nitroso-pyrrolidine (NPYR)	

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