

GROUNDWATER INFORMATION SHEET

Mercury

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information, compiled by the staff of the Groundwater Ambient Monitoring and Assessment (GAMA) Program, is pulled from a variety of sources and relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	Mercury (Inorganic)
Synonyms	Quicksilver, Liquid Silver, and Hydrargyrum
Chemical Formula:	Hg
CAS No.	7439-97-6
Storet No.	71900
Summary	Inorganic mercury exists as a native metal or bound to other elements in minerals. Health effects related to drinking water with elevated concentrations of inorganic mercury may lead to kidney damage. The United States Environmental Protection Agency (US EPA) and the California Department of Public Health (CDPH) regulate mercury levels in drinking water. The current State and Federal Maximum Contaminant Level (MCL) for inorganic mercury is 2 micrograms per liter (µg/L). Common sources of mercury include discharges from metal processing, incineration of coal, medical and other waste, and mining of gold and mercury ores. Based on CDPH data through 2008, 70 public groundwater sources (including both active and standby sources) have had concentrations of mercury above the MCL. Mercury levels above the MCL in public groundwater sources were primarily found in Los Angeles, Sacramento, Riverside, and Kern counties.

FORMS OF MERCURY

Mercury is found naturally in rock deposits as a native element, and bound to other elements in minerals. Mercury in these forms is referred to as “inorganic mercury.” Under certain conditions, inorganic mercury may combine with one carbon and three hydrogen atoms (CH₃), which is referred to as a methyl group. Mercury that has combined with at least one such methyl group is referred to as both “methyl mercury” and/or as “organic mercury.”

The Federal and State MCL for mercury of 2 µg/L (or 2 parts per billion, or ppb) refers to inorganic mercury. Methyl mercury can be more toxic than inorganic mercury. However, there is no Federal or State MCL for methyl mercury. The California Toxics Rule (CTR), which regulates discharges to surface waters, has established human health criteria for mercury that includes both organic and inorganic forms of mercury. Due to the toxicity of organic (methyl) mercury, and its tendency to accumulate more quickly in fish and other animals, the CTR mercury Human Health criteria for consumption of water and organisms is lower than the established MCL for inorganic mercury.

This fact sheet’s primary focus is on the inorganic form of mercury, for which Federal and State drinking water standards are available.

REGULATORY AND WATER QUALITY LEVELS MERCURY¹

Type	Agency	Concentration
Federal MCL ²	US EPA	2 µg/L
State MCL	CDPH	2 µg/L
Detection Limit for Purposes of Reporting (DLR)	CDPH	1 µg/L
Public Health Goal (PHG)	OEEHA	1.2 µg/L
Others: California Toxic Rule Criteria Human Health Criteria for Consumption of Water and Organisms (total mercury, including organic forms)	US EPA	0.050 µg/L

¹These levels generally relate to drinking water. Other water quality levels may exist. For further information, see *Water Quality Goals* (Marshack, 2008).

²Maximum Contaminant Level

SUMMARY OF DETECTIONS IN PUBLIC GROUNDWATER SOURCES ³	
Detection Type	Number of Sources
Number of active and standby public groundwater sources ⁴ with concentrations greater than the 2 µg/L	70
Top 3 Counties with detections ≥ 2 µg/L	Sacramento, Los Angeles, Kern

³Based on January 2009 CDPH drinking water source data. (GeoTracker)

⁴In general, drinking water from active and standby sources is treated or blended so consumers are not exposed to the water exceeding MCLs. Private domestic wells and groundwater sources for small water systems are not regulated by CDPH and are not included in these figures.

ANALYTICAL INFORMATION	
Analytical Test Method	US EPA methods: 200.7 (ICP/AES), 200.8 (ICP/MS), 1631 (Cold Vapor Atomic Absorption)
Detection Limit	Most methods can attain a detection limit of 0.2 µg/L. EPA Method 1631 is able to achieve lower detection limits (0.002 µg/L) – however, most drinking water samples do not require such low analytical resolution.
Known Limitations to Analytical Methods	Proper sample handling is required for samples tested by EPA Method 1631, where even minor contamination may greatly affect the results.
Public Drinking Water Testing Requirements	Mercury is a regulated chemical for drinking water sources, with monitoring and compliance requirements (Title 22, Section 64431, et seq.).

OCCURRENCE	
Natural Sources	<p>Mercury is naturally present in geologic deposits, soil, water, air, plants, and animals. Elemental mercury can readily volatilize and enter the atmosphere, where it can combine with other materials and settle. Natural sources of mercury include volcanoes, geologic deposits of mercury, volatilization from the ocean, and some geothermal springs. Approximately half of all mercury released to the environment is natural in origin.</p>
Anthropogenic Sources	<p>Globally, approximately 5,000 tons of mercury are released to the environment per year due to anthropogenic activities (see Ref. 14). The United States contributes approximately 3 percent of the world's total mercury emissions, with coal combustion responsible for about one-third of the total US contribution (approximately 48 tons per year). Production of electrical products such as dry-cell batteries, fluorescent light bulbs, thermostats, and other control equipment account for the remaining industrial contribution of mercury to the environment. Improper handling or disposal of these items may result in the release of mercury to the environment. In the past, mercury was used in fungicides and wood preservatives. Trace amounts of mercury may still be found in some wood preservatives and paints. Other sources include smelters and catalyst manufacture. In the United States the amount of mercury released to the environment from industrial sources has been rapidly declining, and is now less than half the amount released during the 1950s.</p> <p>Other anthropogenic sources of mercury to the environment include wastes and byproducts from dentistry and from historic mining. Dental fillings (amalgam) consisting of approximately 50% mercury are widely used throughout the United States. An estimated 35 tons per year of mercury are released to the environment through use of amalgam fillings. In California, historic mercury mining in the Coast Ranges and mercury used for gold ore recovery in the Sierra Nevada are also a continuing source of mercury.</p>
History of Occurrence	<p>Approximately 90% of all mercury used in the United States between 1846 and 1890 (about 115,000 tons) was mined from the California Coast Ranges. Over 11,000 tons of mercury were used in Sierra Nevada gold mines – because mercury combines with small gold flakes, mercury used in sluices allowed greater gold recovery. Approximately 39,000 tons of mercury were released to the environment from mines in the Coast Ranges. Approximately 6,500 tons of mercury entered the environment as the result of mining activity in the Sierra Nevada (see reference 7). Mercury from historical mining continues to enter the environment through stream runoff.</p>

Transport Characteristics	<p>Mercury naturally volatilizes from soil and surface waters and enters the atmosphere. Ambient air concentrations of mercury have been reported to average between 10 to 20 nanograms per cubic meter (ng/m³). Mercury from the atmosphere is the dominant source to most of the land surface. Most atmospherically deposited mercury will re-volatilize or adsorb to organic material in the soil. As a result, only a very small amount of mercury is transported to groundwater. Mercury can also occur naturally in groundwater, usually at low concentrations. In some cases, elevated mercury in groundwater may result from releases from past mining and chemical spills, or from improper disposal of materials that contain mercury. Groundwater generally contains less than 2 µg/L of mercury, although areas near historic mining districts or where certain geologic conditions are prevalent may have locally higher concentrations.</p> <p>Freshwater without known sources of mercury contamination generally contains less than 5 ng/L of total mercury in aerobic surface waters. However, surface water contamination is significantly more extensive than groundwater contamination. Inorganic mercury may be converted to methyl mercury, which is soluble, mobile, and quickly enters the aquatic food chain. Methyl mercury accumulates in biological tissue more quickly than inorganic mercury. Concentrations in carnivorous fish tissue at the top of the food chain (“top trophic”) may have methyl mercury concentrations from 10,000 to 100,000 times greater than that of the surrounding water. <i>Bioaccumulation</i> occurs in organisms when the rate of intake exceeds the rate at which the contaminant is removed from the organism; the bioaccumulation rate of methyl mercury exceeds inorganic mercury. As a result, most of the mercury found in top trophic fish tissue is in the form of methyl mercury. Since methyl mercury is not typically found in groundwater, CDPH does not typically require sampling except in rare instances.</p>
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REMEDATION & TREATMENT TECHNOLOGIES

The main types of treatment processes accepted by the EPA for mercury in water are:

- Precipitation — coagulation/filtration (C/F)
- Lime softening (LS)
- Adsorption processes — Granular Activated Carbon (GAC);
- Membrane filtration — reverse osmosis (RO),

In-situ methods include chemical precipitation (immobilization) and impermeable barriers.

HEALTH EFFECT INFORMATION

According to EPA 1996 IRIS database information, mercury is not classifiable as human carcinogen. There is inadequate evidence in humans for the carcinogenicity of mercury and mercury compounds.

The kidney appears to be the critical organ of toxicity for the ingestion of mercuric salts. Acute renal failure has been observed in a number of case studies of mercuric chloride ingestion. The other major target organ for metallic and organic mercury is the nervous system. A range of neurological changes are produced by inhalation or ingestion of both high and low levels of food, fish and marine mammals contaminated with methyl mercury.

KEY REFERENCES

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FOR MORE INFORMATION, CONTACT: Erik Ekdahl, Ph.D., SWRCB (916) 341-5480.