

Technical Factsheet on: CADMIUM

[List of Contaminants](#)

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:
National Primary Drinking Water Regulations

Drinking Water Standards

MCLG: 0.005 mg/l

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HAL(child): 1- to 10-day: 0.04 mg/L; Longer-term: 0.005 mg/L

Health Effects Summary

Acute: EPA has found cadmium to potentially cause a variety of effects from acute exposures, including: nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure.

Drinking water levels which are considered "safe" for short-term exposures: For a 10-kg (22 lb.) child consuming 1 liter of water per day, a one- to ten-day exposure to 0.04 mg/L; a longer-term (up to 7 years) exposure to 0.005 mg/L.

Chronic: Cadmium has the potential to cause kidney, liver, bone and blood damage from long- term exposure at levels above the MCL.

Cancer: There is inadequate evidence to state whether or not cadmium has the potential to cause cancer from lifetime exposures in drinking water.

Usage Patterns

2.9 million lbs of cadmium were produced in the US in 1986, and nearly twice that amount was imported in the same year.

According to 1986 estimates, cadmium is used primarily for metal plating and coating operations (35%), including transportation equipment, machinery and baking enamels, photography, television phosphors. It is also used in nickel-cadmium and solar batteries (25%), in pigments (20%), as a stabilizer in plastics and synthetic products (15%), alloys and other uses (5%). Cadmium salts have had a very limited use as fungicide for golf courses and home lawns.

Release Patterns

Cadmium occurs naturally in zinc, lead and copper ores, in coal and other fossil fuels, shales and is released during volcanic action. These deposits can serve as sources to ground and surface waters, especially when in contact with soft, acidic waters.

Major industrial releases of cadmium are due to wastestreams and leaching of landfills, and from a variety of operations that involve cadmium or zinc. These may include: during the smelting and refining of zinc, lead and copper bearing ores; during recovery of metal by processing scrap; during melting and pouring of cadmium metal; during casting of various cadmium alloy products used for coating telephone cables, trolley wires, welding, electrodes, automatic sprinkling systems, steam boilers, fire alarms, high pressure/temperature bearings, starting switches, aircraft relays, light duty circuit breakers, low

temperature solder, and jewelry; during fabrication of metal, alloys, or plated steel; during casting and use of solders; during melting of cadmium ingots for paint and pigment manufacture used for coloring of plastics and ceramic glazes, electroplating, and in chemical synthesis; during coating of metals by hot dipping or spraying; during manufacture of nickel-cadmium batteries for use in radio portable telephones, convenience appliances, and vented cells used in airplanes, helicopters, and stand-by power and lighting. The remaining cadmium emissions are from fossil fuel combustion, fertilizer application, and sewage sludge disposal.

Cadmium also occurs as a by-product of corrosion of some galvanized plumbing and distribution system materials.

From 1987 to 1993, according to EPA's Toxic Chemical Release Inventory, cadmium releases were primarily from zinc, lead and copper smelting and refining industries, with the largest releases occurring in Arizona and Utah.

Environmental Fate

The oxide and sulfide are relatively insoluble while the chloride and sulfate salts are soluble. The adsorption of cadmium onto soils and silicon or aluminum oxides is strongly pH-dependent, increasing as conditions become more alkaline. When the pH is below 6-7, cadmium is desorbed from these materials. Cadmium has considerably less affinity for the adsorbents tested than do copper, zinc, and lead and might be expected to be more mobile in the environment than these materials.

Studies have indicated that cadmium concentrations in bed sediments are generally at least an order of magnitude higher than in overlying water. A study of Ottawa River sediments found that sediment composed mainly of well sorted sand may be an efficient sink for heavy metals if there is a significant amount of organic material added to the sediments by the commercial activities such as logging. Both sorption and desorption were controlled by the nature of total heavy metal loading, the sediment type, and the surface water characteristics.

Addition of anions, such as humate, tartrate, to dissolved cadmium caused an increase in adsorption. The mode by which cadmium is sorbed to the sediments is important in determining its disposition toward remobilization.

Cadmium found in association with carbonate minerals, precipitated as stable solid compounds, or co-precipitated with hydrous iron oxides would be less likely to be mobilized by resuspension of sediments or biological activity. Cadmium adsorbed to mineral surfaces (eg clay) or organic materials would be more easily bioaccumulated or released in the dissolved state when sediments are disturbed, such as during flooding.

Cadmium is not known to form volatile compounds in the aquatic environment.

Bioconcentration of cadmium sulfate, nitrate and chloride has been studied in a wide variety of aquatic organisms, and can be quite high in some species, low in others. For example, rainbow trout have a BCF of 33 while a BCF of 2213 was measured in the mosquito fish. Similarly, different species of clams have BCFs ranging from 160 to 3770.

Chemical/Physical Properties

CAS Number: 7440-43-9 (metal)

Color/ Form/Odor: Cadmium is a lustrous silvery metallic element found only in combined forms in nature.

Soil sorption coefficient: Koc = N/A; mobility higher than other metals

Bioconcentration Factor: Fish: 33 to 2213; Shell fish: 5 to 2500; Other invertebrates: 164 to 4190; Plants: 603 to 960.

Common Ores: sulfide- greenockite; carbonate- octavite; others: hawleyite. Also found in zinc, copper, lead ores.

Solubilities (water):

acetate- very soluble
bromide- 570 g/L at 10 deg C
carbonate- insoluble
chloride- 1400 g/L at 20 deg C
fluoroborate- very soluble
mercury sulfide- N/A
nitrate- 1090 g/L at 0 deg C
oxide- insoluble
sulfate- 755 g/L at 0 deg C
sulfide- insoluble
stearate- N/A

Other Regulatory Information

Monitoring:

-- For Ground Water Sources:

Initial Frequency-1 sample once every 3 years

Repeat Frequency-If no detections for 3 rounds, once every 9 years

-- For Surface Water Sources:

Initial Frequency-1 sample annually

Repeat Frequency-If no detections for 3 rounds, once every 9 years

-- Triggers - If detect at > 0.005 mg/L, sample quarterly.

Analysis

<u>Reference Source</u>	<u>Method Number</u>
EPA 600/4-79-020	213.2
NTIS PB 91-231498	200.7
Standard Methods	3113B

Treatment/Best Available Technologies: Coagulation/Filtration, Ion Exchange, Lime Softening, Reverse Osmosis

Toxic Release Inventory - Releases to Water and Land, 1987 to 1993 (in pounds):

Water

Land

TOTALS	31,487		2,059,574
Top Seven States *			
AZ	503	433,035	
UT	1,750	372,010	
MT	0	315,965	
TN	2,700	288,781	
ID	250	225,761	
MO	2,361	189,914	
WI	0	106,000	
Major Industries*			
Zinc, lead smelting		5,061	831,948
Copper smelting, refining		2,253	805,045
Indust. inorganic chems		250	225,761
Electroplating, anodizing		0	106,000
Steelworks, blast furnaces		5	13,000
Inorganic pigments		5,140	7,000

* State/Industry totals only include facilities with releases greater than a certain amount - usually 1000 to 10,000 lbs.

For Additional Information:

EPA can provide further regulatory and other general information:
EPA Safe Drinking Water Hotline - 800/426-4791

Other sources of toxicological and environmental fate data include:
Toxic Substance Control Act Information Line - 202/554-1404
Toxics Release Inventory, National Library of Medicine - 301/496-6531
Agency for Toxic Substances and Disease Registry - 404/639-6000