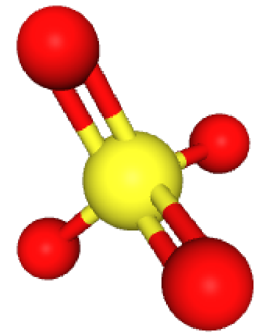
Groundwater Fact Sheet
Hexavalent Chromium (Cr6)



Constituent of Concern
Hexavalent Chromium

Synonym
Chromium VI, Chromium Six, Chrome 6+, Cr^{6}

Chemical Formula
Cr^{6+}

CAS Number
18540-29-9

Storet Number
01032

Summary
Chromium is an odorless and tasteless metallic element, found naturally in the environment. The most common valence states in the environment are trivalent chromium (Cr^{3}), an essential element in humans, and hexavalent chromium (Cr^{6}), a human carcinogen which can also be produced by industrial processes. These states can convert into one another under different oxidation and pH conditions.

On October 1, 2024, The State Water Board established a Maximum Contaminant Level (MCL) of 10 micrograms per liter (10 µg/L) for hexavalent chromium (Cr^{6}), which was used to display its occurrence. Based on State Water Board data from 2015 to 2025, 693 public water wells (of 8,776 wells sampled, 5,526 detections) had at least one concentration of Cr^{6+} above the MCL. The most detections were reported in Los Angeles (724), San Bernardino (675), and Fresno (453) counties.

REGULATORY WATER QUALITY LEVELS HEXAVALENT CHROMIUM (Cr^{6})		
Type	**Agency**	**Concentration**
Federal Maximum Contaminant Level (MCL)	US EPA[1]	Not established
State Maximum Contaminant Level (MCL)	SWRCB[2]	10 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB[2]	1 µg/L
Public Health Goal (PHG)	OEHHA[3]	0.02 µg/L
Health Based Screening Level (HBSL)	USGS[4]	20 µg/L
Cancer Potency Factor as a drinking water level	Cal/EPA[5]	0.07 µg/L

[1] US EPA – United States Environmental Protection Agency
[2]SWRCB - State Water Resources Control Board.
[3]OEHHA – Office of Environmental Health Hazard Assessment
[4] USGS – United State Geological Survey
[5] Cal/EPA – California Environmental Protection Agency

HEXAVALENT CHROMIUM DETECTIONS IN PUBLIC WATER WELL SOURCES[6]	
Number of public water wells with Cr^6 concentrations above 10 µg/L [7]	693 of 8,776 wells tested with 5,526 detections
Top 3 counties with Cr^6 detection in public wells above the MCL	Los Angeles (83), Riverside (83), Yolo (69)

[6] Based on 2015-2025 public standby and active well (groundwater sources) data collected by the SWRCB.
[7] Data from private domestic wells and wells with less than 15 service connections are not available.

ANALYTICAL INFORMATION		
Approved US EPA methods	218.7	218.6
Detection Limit (µg/L)	0.01	0.3
Notes	Ion chromatography with post-column derivatization and UV-visible spectroscopic detection (SWRCB approved for drinking water)	Ion chromatography (SWRCB approved for drinking water)
Known Limitations to Analytical Methods	Water sample pH must be adjusted to 9.0-9.5, stored at 4° C and analyzed within 24 hours.	
Public Drinking Water Testing Requirements	In January 2001, Cr^6 was identified as an unregulated chemical requiring monitoring. As a result, public water systems began to test for Cr^6 in their drinking water supplies to the DLR of 1µg/L. In 2014, MCL for Cr^6 was established at 10 µg/L. On August 1, 2017, the MCL was repealed, and was re-established at 10 µg/L on October 1, 2024.	

Hexavalent Chromium Occurrence

Anthropogenic Sources

Chromium is a metallic chemical that originates as a contaminant in the environment from the discharges of dye and paint pigments, wood preservatives, chrome-plating liquid wastes, and leaching from hazardous waste sites. The greatest use of chromium is in metal alloys such as stainless steel, protective coatings on metal, magnetic tapes, pigments for paints, cement, paper, rubber, composition floor covering, etc. The two largest sources of chromium emission in the atmosphere are from the chemical manufacturing and combustion of natural gas, oil and coal.

Natural Sources

Chromium is a metal found in natural deposits of ores containing other elements, mostly as chrome-iron ores. It is also widely present in soil and plants. Under most conditions, natural chromium in the environment occurs as Cr^3. Under oxidizing conditions, alkaline pH range, presence of MnO_2, and minerals containing chromium, part of it may occur as hexavalent chromium dissolved in groundwater. Recent sampling of drinking water sources throughout California suggests that hexavalent chromium may occur naturally in groundwater at many locations. Naturally occurring hexavalent chromium may be associated with serpentinite-containing rock or chromium containing geologic formations.

History of Occurrence

Hexavalent chromium has been detected in groundwater at several industrial sites where wood treatment or metal plating solutions were used. Between 1952 and 1966, Pacific Gas & Electric (PG&E) used hexavalent chromium to reduce corrosion in its natural gas compressor plant in Hinkley, near Barstow. Hexavalent chromium contaminated groundwater was suspected of causing cancer and tumors in residents beginning in the mid 1980's. Since then, elevated levels of hexavalent chromium have been detected in groundwater at several other locations including Glendale, Topock, and Kettleman City. Hexavalent chromium also occurs naturally in groundwater at the Presidio of San Francisco and Lawrence Livermore National Laboratory.

Contaminant Transport Characteristics

Hexavalent chromium is readily soluble in water. Under high Eh (oxidizing) and alkaline (pH above 7) conditions, hexavalent chromium can be predominant in groundwater. However, in the presence of organic matter, ferrous iron (Fe II) and sulfide, hexavalent chromium can be readily reduced to Cr^3 and immobilized. Adsorption of hexavalent chromium by clayey soil and natural aquifer materials is low to moderate under near-neutral pH ranges commonly encountered in groundwater.

Remediation and Treatment Technologies

In-situ Treatment

In several laboratory and field pilot tests, and full-scale remediation systems, hexavalent chromium has been removed using a permeable reactive barrier filled with zero-valent iron granules or surfactant-modified zeolite. Engineered chemical reduction technologies involve the addition or in-situ injection of an electron donor such as hydrogen sulfite, sodium dithionite, sodium metabisulfite, calcium metabisulfite calcium polysulfide or tin(II) chloride. Other methods include geochemical fixation, soil flushing and extraction, bioremediation and electrokinetic.

Above-Ground Treatment

Drinking water can be treated by different Pump and Treat remediation systems. Cr^3 and Cr^6 can be removed by reverse osmosis or ion exchange resin. The ion exchange method should be used with caution, as presence of other metals may interact with the process and decrease system effectiveness. Removal of Cr^6 by seaweed biosorbent and bacteria (Bacillus sp.) within packed bed reactors has also been used.

Natural Attenuation

Natural attenuation of hexavalent chromium may occur in the subsurface environment through reduction by organic matter, iron hydroxides or sulfides. Prior to selection of natural attenuation as an option for remediation, the following conditions need to be demonstrated: 1) there are natural reducers present within the aquifer, 2) the amount of hexavalent chromium and other reactive constituents do not exceed the capacity of the aquifer to reduce them, 3) the rate of hexavalent chromium reduction is greater than the rate of transport of the aqueous hexavalent chromium off the impacted site, 4) the hexavalent chromium remains immobile, and 5) there is no net oxidation of Cr^3 to Cr^6.

Health Effect Information

Hexavalent chromium is known to cause cancer in humans when inhaled. It can also damage the lining of the nose and throat and irritate the lungs. Several scientific studies have found elevated rates of lung cancer in workers with occupational exposure to hexavalent chromium by inhalation.

A few studies of workers exposed to Cr^6 inhalation have shown an increase in cancers of the gastrointestinal tract. When swallowed, hexavalent chromium can upset the gastrointestinal tract and damage the liver and kidneys. In recent scientific studies of laboratory animals, hexavalent chromium has been linked to cancer when ingested, although it is rapidly converted to Cr^3 after entering the stomach and coming into contact with organic matter.

Current Groundwater Quality Results

A map visualizing public water supply wells that have had at least one detection of Cr^6 above the MCL between 2015 – 2025 is included with this fact sheet (Figure 1). For up-to-date groundwater quality results for Cr^6 occurrence in California, please visit the link below:

https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/?well_cat=Municipal&dset=&chem=CR6&mytype=&mytime=10YR&lat=38.380195196071185&lng=-119.72184232222706&zoom=6&mapType=terrain

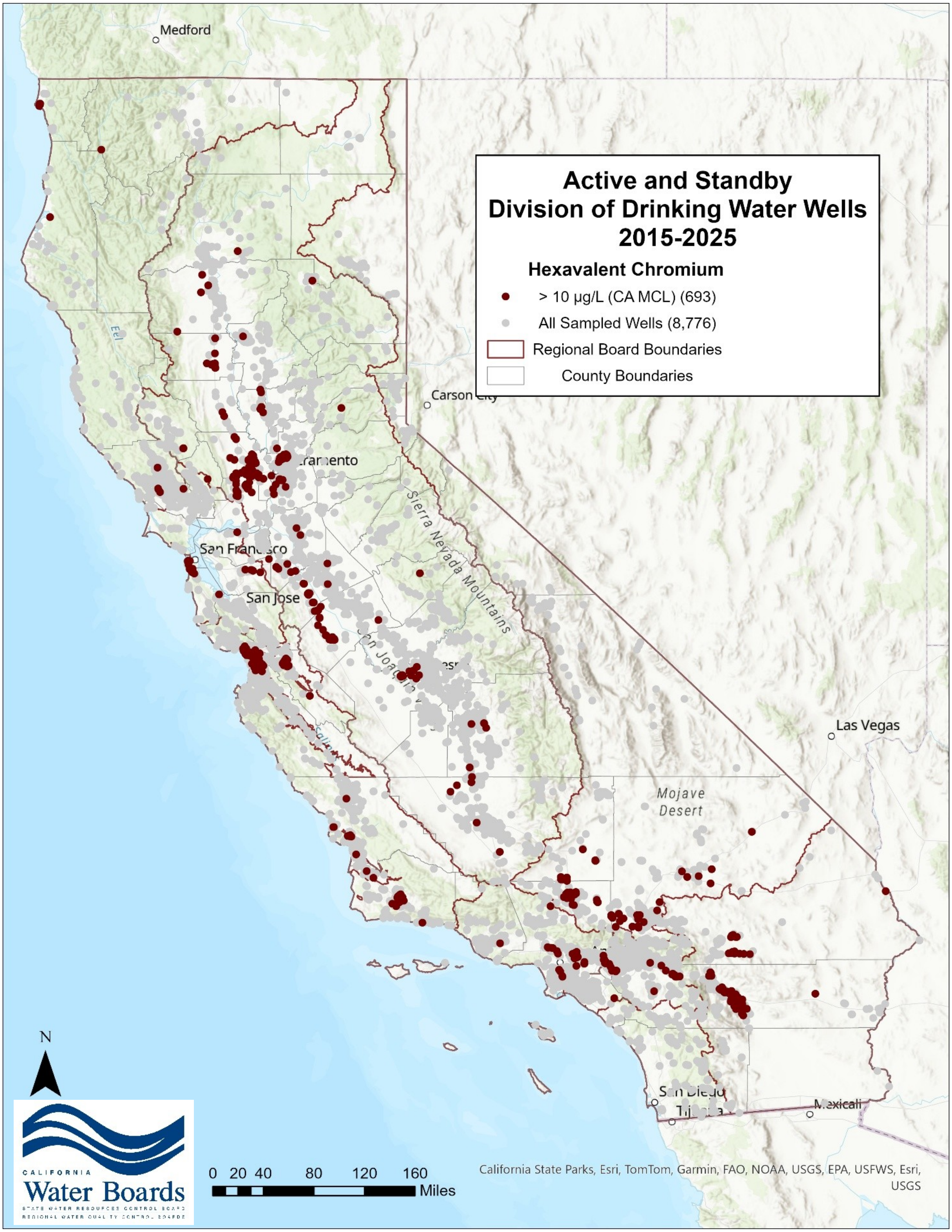


Figure 1: Public drinking water wells that had at least one detection of Cr6 above the MCL, 2015-2025, 693 wells. (*Source: Public supply well data in GAMA GIS*).

Key References

1. Kratochvil D., Pimentel, P., Volesky B. Removal of Trivalent and Hexavalent Chromium by Seaweed Biosorbent, Environmental Science & Technology; 1998; 32(18); 2693-2698. https://doi.org/10.1021/es971073u
2. Haman D.Z., Bottcher D.B. Home Water Quality and Safety, University of Florida, Cooperative Extension Service, Institute of Food and Agricultural Science. http://www.pinecrest-fl.gov/Modules/ShowDocument.aspx?documentid=2809
3. OEHHA, Public Health Goal for Hexavalent Chromium, July 2011. https://oehha.ca.gov/media/downloads/water/chemicals/phg/cr6phg072911.pdf
4. US Environmental Protection Agency. An In-Situ Permeable Reactive Barrier for the Treatment of Hexavalent Chromium and Trichloroethylene in Ground Water, EPA 600-R-99-095b, September 1999. http://www.clu-in.org/download/techfocus/prb/In-situ-prb-vol-2-600r99095b.pdf
5. US Environmental Protection Agency; Groundwater Issue; Natural attenuation of Hexavalent Chromium in Groundwater & Soils; by Robert Puls, 1994, EPA/540/S-94/505. https://www.epa.gov/sites/default/files/2015-06/documents/natatt_hexavalent_chromium.pdf
6. McLean, J. E. AND B. E. Bledsoe. Behavior of metals in soils (EPA/540/S-92/018). U.S. Environmental Protection Agency, Washington, D.C., 1992. https://www.epa.gov/sites/default/files/2015-06/documents/issue_behavior_metals_soil.pdf
7. US EPA -Technology Innovation Program-Contaminant Focus-Chromium VI (Aug 15, 2007). http://www.clu-in.org/contaminantfocus/default.focus/sec/chromium_VI/cat/Overview/
8. Yi-Tin Wang; Hexavalent Chromium Reduction by Bacillus sp. in a Packed-Bed Bioreactor, Environmental Science & Technology; 31(5); 1446-1451. (Article) https://doi.org/10.1021/es9606900
9. USGS - Health-Based Screening Levels for Evaluating Water-Quality Data. https://water.usgs.gov/water-resources/hbsl/
10. USGS; John A. Izbicki, James W. Ball, Thomas D. Bullen, Stephen J. Sutley, Chromium, chromium isotopes and selected trace elements, western Mojave Desert, USA, 2008. https://pubs.er.usgs.gov/publication/70033341