

GROUNDWATER INFORMATION SHEET

Boron (B)

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The information, provided herein relates to wells (groundwater sources) used for public drinking water, not water served at the tap.

GENERAL INFORMATION	
Constituent of Concern	Boron
Aliases	None
Chemical Formula	B
CAS No.	7440-42-8
Storet No.	01020 (dissolved); 01022 (total)
Summary	Boron is an unregulated chemical without an established Maximum Contaminant Level (MCL). The California State Notification Level (CA-NL) is 1,000 micrograms per liter (µg/L). The most prevalent sources of boron in drinking water are from the leaching of rocks and soils, wastewater, and fertilizers/pesticides. Public well data from 2006 to May 2016, indicates there are approximately 171 active and standby public wells (of 12,158 wells sampled) with at least one detection above the CA-NL. Most detections occurred in three counties; Yolo (25), San Joaquin (21), and Contra Costa (18).

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REGULATORY AND WATER QUALITY LEVELS¹		
Type	Agency	Concentration
Federal	US EPA ²	NA ⁵
Health Advisory for non-cancer health effect	US EPA ²	5,000 µg/L
State Notification Level (NL) ³	SWRCB ⁴	1,000 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB ⁴	100 µg/L

¹These levels generally relate to drinking water, other water quality levels may exist. For further information, see *A Compilation of Water Quality Goals*, 17th Edition (Marshack, 2016).

² US EPA – United States Environmental Protection Agency

³ Notification levels are non-regulatory health-based advisory levels established by CDPH for chemicals for which maximum contaminant levels have not been established.

⁴SWRCB- The California Department of Public Health Drinking (CDPH) Water Program was transferred to the State Water Resources Control Board Division of Drinking Water in 2014.

⁵US EPA did not establish a drinking water standard for boron.

SUMMARY OF DETECTIONS IN PUBLIC WATER WELLS⁶	
Detection Type	Number of Groundwater Sources
Number of active and standby public wells that have had boron concentrations > 1,000 µg/L. ⁷	171 of 12,158 wells sampled
Top 3 counties with active and standby public wells that have had boron concentrations >1,000 µg/L.	Yolo (25), San Joaquin (21), and Contra Costa (18)

⁶Based on 2006-2016 public well (groundwater sources) data collected by the State Water Resources Control Board.

⁷Water from active and standby wells is typically treated to prevent exposure to concentrations above the MCL. Data from private domestic wells and wells with less than 15 service connections are not available.

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ANALYTICAL INFORMATION		
Method	Detection Limit (Quantitation Limit)	Note
EPA 200.7	3 µg/L	Approved by the SWRCB for public drinking water systems.
Analytical Notes	Boron samples can be contaminated by borosilicate (pyrex) glass. Only plastic or polytetrafluoroethylene (PTFE) materials should be used when collecting, storing, or handling water samples for boron analysis.	
Public Drinking Water Testing Requirements	Public water systems are required to test for boron on a schedule established by the SWRCB. When boron is detected at levels greater than the CA-NL, the utility or responsible agency must report that detection to relevant public agencies.	

BORON OCCURRENCE	
Anthropogenic Sources	<p>According to the U.S. Geological Survey, the United States is the world's leading manufacturer of refined boron compounds. In 2010, mining operations in Trona and Boron, California produced refined boron compounds containing approximately 600,000 metric tons of boric oxide (B₂O₃).</p> <p>The use of boron in some cleaning agents is beginning to decrease due to environmental concerns. However, boron compounds are among the most widely used whitening agents today. Borate compounds are used in the manufacturing of many different commercial products including: insulation and textile-grade fiberglass, borosilicate glass, fire retardants, enamels, ceramic glazes, laundry bleach, agricultural fertilizers, and herbicides.</p> <p>Major anthropogenic sources of boron to groundwater include: industrial wastewater discharges, municipal wastewater discharges, and agricultural activities. Boron is also released to the atmosphere via industrial air emissions.</p>
Natural Sources	<p>Boron is a naturally occurring element found in rocks, soil, and water. Boron does not exist as a pure element. Boron has a high affinity for forming very stable bonds with electronegative atoms (atoms that donate electrons), and as a result often exists in compounds bound to oxygen atoms. Boron containing minerals are common in nature as sodium and calcium borates, borosilicate minerals, and boric acid. Examples of natural borate minerals include borax, borax pentahydrate, ulexite, and inyoite. Boron concentrations in groundwater are derived from leaching of rocks and soils that contain borate and borosilicate minerals.</p> <p>Boron is found in seawater and can be found in evaporite deposits and other sedimentary rocks. Boron deposits are found in the desert areas of California. The world's largest boron mine, and California's largest open-pit mine, is located near the town of Boron, California.</p>

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Contaminant Transport Characteristics	While elemental boron is insoluble in water, borate minerals including borax, borax pentahydrate, and anhydrous borax are extremely soluble. Once boron compounds dissolve, they generally act as a salt (dissolved ion) and are difficult to remove from water. Borates and boric acids are adsorbed to soils rich in aluminum and iron oxides with maximum adsorption occurring in the pH range of 7.5 to 9.0.
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REMEDATION & TREATMENT TECHNOLOGIES

Distillation and ion exchange units are effective boron treatment methods. Distillation involves producing, collecting, and condensing steam. Boron and other impurities do not travel with the steam and are left out of the condensate. Ion exchange involves the selective removal of charged inorganic species from water using an ion-specific resin.

Reverse osmosis places water under pressure and forces the water through a fine membrane that keeps boron and other minerals out. Both distillation and reverse osmosis are costly, require significant time and energy to operate efficiently, and require approximately three times the amount of water usage. Both methods are low-yield systems and storage space is needed for the treated water. Blow-down or reject water must be safely disposed of, as well. Reverse osmosis is ineffective when boron concentrations are low (around 100 µg/L). Ion exchange with a boron-specific exchange resin has been proven to be the most cost effective and efficient treatment method.

Boiling, over-the-counter water filters (pitcher filters or faucet-attachment filters), and water softeners are not effective at removing boron from water.

HEALTH EFFECT INFORMATION

Most human exposure to boron comes from either boric acid or borax. Boric acid is the form of boron most likely to be encountered in drinking water, and can be lethal at high concentrations (200 to 300 mg/kg). Other symptoms of boric acid ingestion at level of 20-25 mg/kg include gastrointestinal tract distress, vomiting, abdominal pain, diarrhea, and nausea. Animal studies have observed reproductive and developmental effects when boron was ingested at high levels.

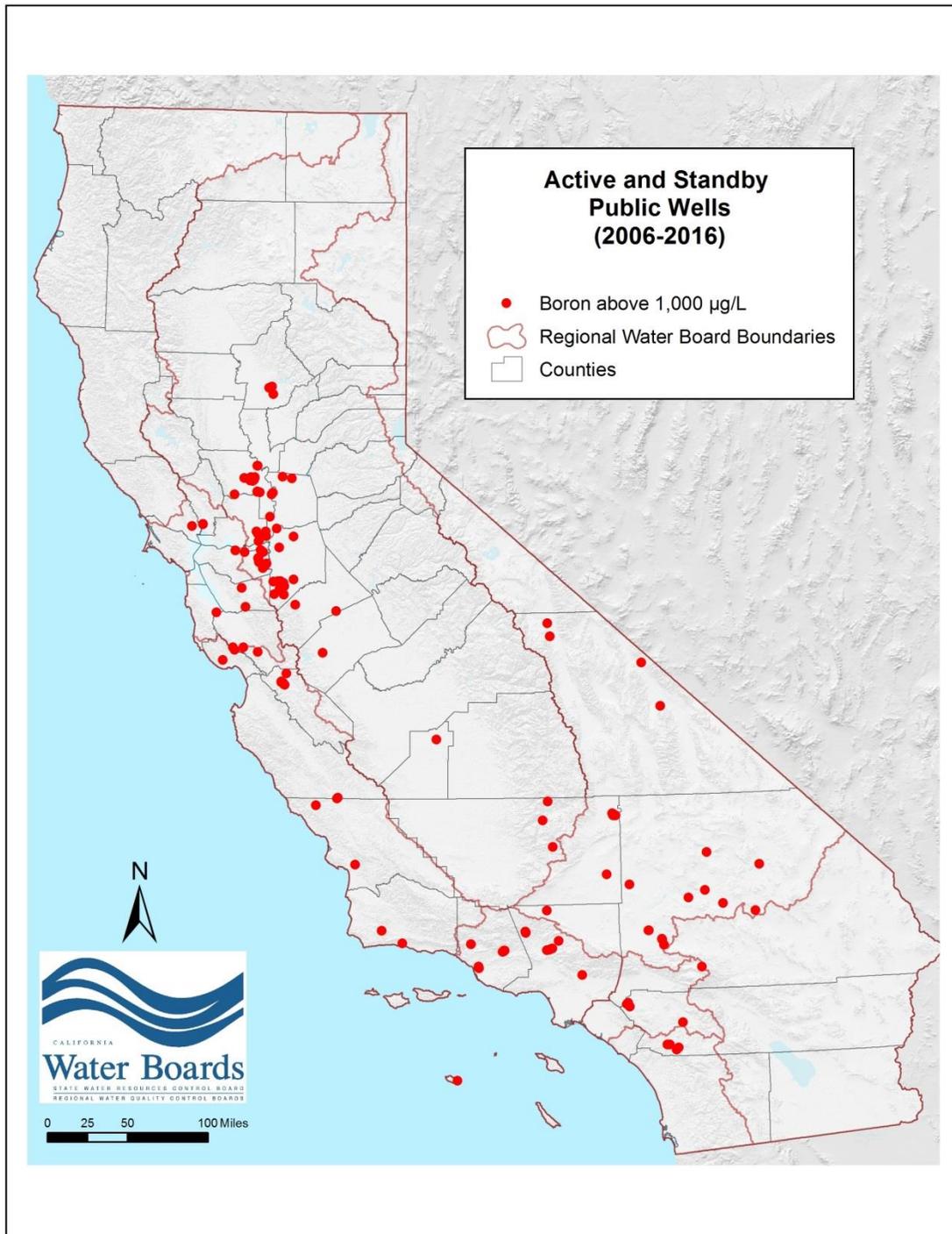
Boron is essential for plant growth and may also be a trace micronutrient. Deficiency studies in animals and humans indicate that low intake of boron affects cellular functions and the activity of other nutrients such as utilization and metabolism of other important substances including calcium, copper, magnesium, nitrogen, glucose, triglycerides, reactive oxygen, and estrogen.

The EPA reference dose (RfD) for boron is 0.2 mg/kg/day. Based on RfD, EPA calculated the health reference level (HRL) of 1.4 mg/L. EPA also has established the Lifetime Health Advisory Level for children at 2.0 mg/L and for adults at 5.0 mg/L.

KEY REFERENCES

1. Agency for Toxic Substances and Disease Registry. 2010. Toxicological Profile for Boron, <http://www.atsdr.cdc.gov/ToxProfiles/tp26.pdf>
2. California State Water Resources Control Board. GeoTracker GAMA (Groundwater Ambient Monitoring and Assessment) Database, http://www.waterboards.ca.gov/water_issues/programs/gama/geotracker_gama.shtml
3. California State Water Resources Control Board, January 2016. *A Compilation of Water Quality Goals*, 17th Edition, Prepared by Jon B. Marshack, http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf
4. United States Environmental Protection Agency. 2008. Drinking Water Health Advisory for Boron, <http://nepis.epa.gov/Exe/ZyPDF.cgi/P1000ZWU.PDF?Dockey=P1000ZWU.PDF>
5. United States Environmental Protection Agency. 2008. Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2), http://www.epa.gov/sites/production/files/2014-09/documents/report_ccl2-reg2_supportdocument_full.pdf
6. United States Environmental Protection Agency. 2008. Summary Document from the Health Advisory for Boron and Compounds, http://www.epa.gov/sites/production/files/2014-09/documents/summary_document_from_the_ha_for_boron.pdf
7. United States Geological Survey, 2011. 2010 Minerals Yearbook – Boron, <http://minerals.usgs.gov/minerals/pubs/commodity/boron/myb1-2010-boron.pdf>

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Active and Standby Public Wells with at least one detection of boron above the CA-NL of 1,000 µg/L, 171 wells. (Source: *Public Well Data using Geotracker-GAMA*)