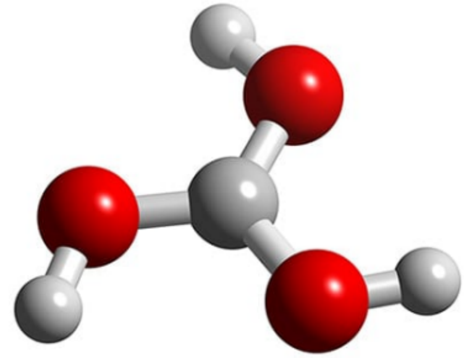
Groundwater Fact Sheet
Boron (B)



Constituent of Concern
Boron

Synonym
Boracium (obsolete)

Chemical Formula
B

CAS Number
7440-42-8

Storet Number
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). Boron does not exist as a pure element but is combined with oxygen as borate minerals and various boron compounds such as boric acid, borax, and boron oxide. Elemental boron is an insoluble, non-metallic trace element and a structural component of plant cell walls. The most prevalent sources of boron in drinking water are derived from the leaching of rocks and soils, wastewater, and fertilizers/pesticides. Boron compounds are also among the most widely used whitening and cleaning agents and are naturally present in many foods and available as a dietary supplement.

Based on State Water Resources Control Board (SWRCB)F data from 2007 to 2017, 175 active and standby public wells (of 3,282 wells sampled, 1,835 detections) had at least one detection above the CA-NL. Most boron detections above the NL occurred in Yolo (23), San Joaquin (20), and Contra Costa (20) counties.

REGULATORY WATER QUALITY LEVELS[1] Boron (B)		
Type	**Agency**	**Concentration**
Federal	EPA[2]	NA[5]
Health Advisory for non-cancer health effect	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

[1]These levels generally relate to drinking water, other water quality levels may exist. For further information, see *A Compilation of Water Quality Goals*, 17th Edition (SWRCB, 2016).
[2]EPA – United States Environmental Protection Agency
[3]Notification levels are non-regulatory health-based advisory levels established by SWRCB for chemicals for which maximum contaminant levels (MCL) have not been established.
[4]SWRCB- State Water Resources Control Board Division.
[5]EPA did not establish a drinking water standard for Boron.

BORON DETECTIONS IN PUBLIC WATER WELL SOURCES[6]	
Number of active and standby public water wells with boron concentrations > 1000 µg/L[7]	175 of 3,282 wells tested with 1,835 detections.
Top 3 counties with boron detection in public wells above the State Notification Level	Yolo (23), San Joaquin (20), and Contra Costa (20)

[6]Based on 2007-2017 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 EPA methods	200.7
Detection Limit (µg/L)	3
Notes	SWRCB approved for drinking water. Determination of metals and trace elements in water and wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES).
Known Limitations to Analytical Methods	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

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 (B_2O_3). 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. 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.

Natural Sources

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. 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.

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.

Remediation and 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 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 Resources

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. GAMA GIS online tools. http://www.waterboards.ca.gov/water_issues/programs/gama/geotracker_gama.shtml
3. California State Water Resources Control Board, *A Compilation of Water Quality Goals*, 17th Edition, (SWRCB, 2016). 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

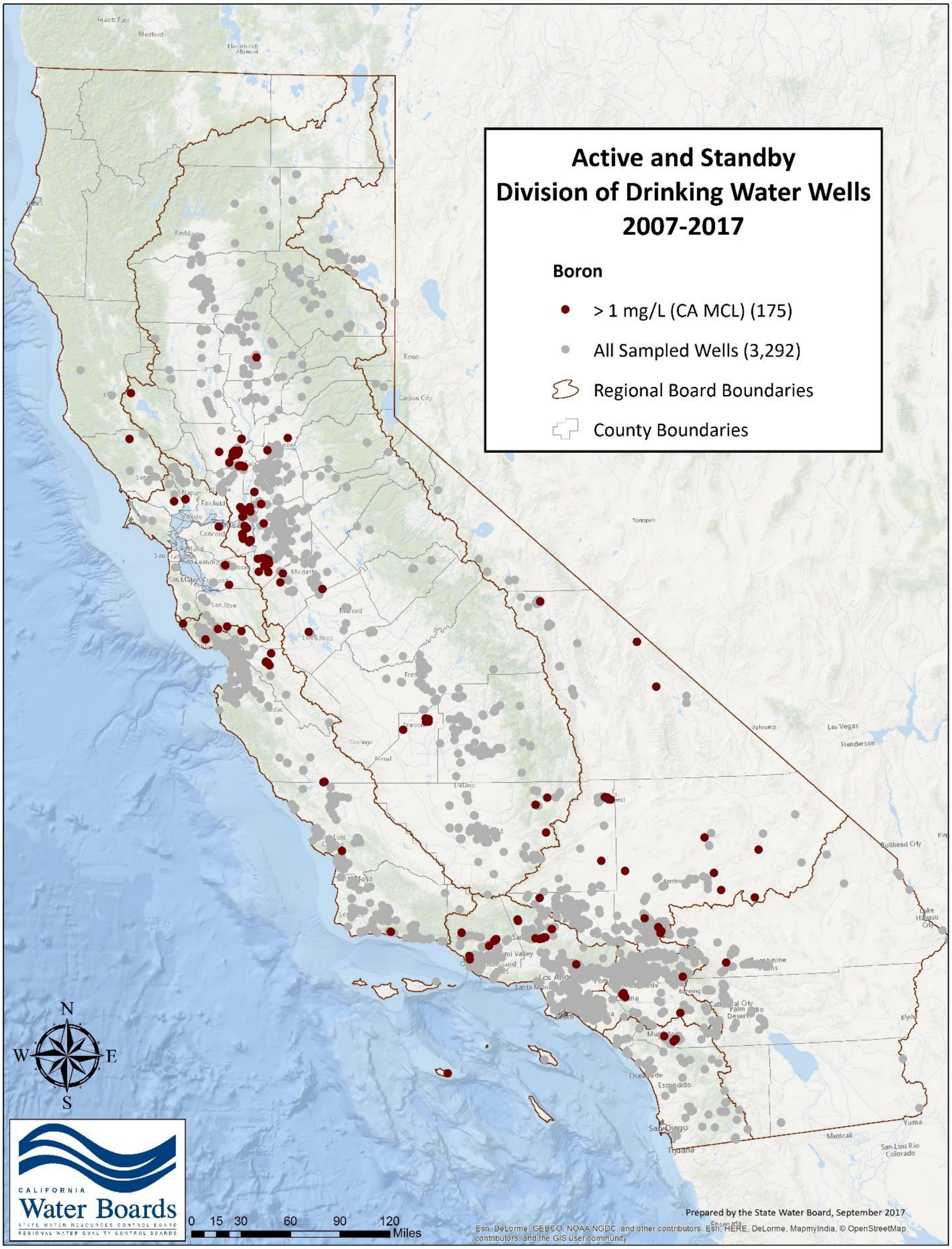


Figure 1 Active and standby public drinking water wells that had at least one detection of boron above the CA-NL, 2007-2017, 175 wells. (*Source: Public supply well data in* <u>*GAMA GIS*</u>).