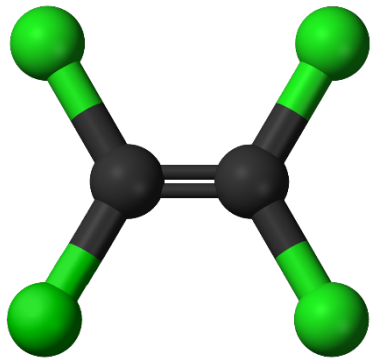
Groundwater Fact Sheet
Tetrachloroethylene (PCE)



Constituent of Concern
Tetrachloroethylene (PCE)

Synonym
1,1,2,2-Tetrachloroethene, Perchloroethylene, Carbon Dichloride, Perc, Perchlor, Ankilostin, Antisal 1

Chemical Formula
C_2Cl_4 or $Cl_2C{=}CCl_2$

CAS Number
127-18-4

Storet Number
34475

Summary
Tetrachloroethylene (PCE) is a regulated contaminant with an established Maximum Contaminant Level (MCL) for drinking water at 5 micrograms per liter (µg/L). PCE is a nonflammable colorless liquid with a sharp sweet odor that is denser than water (dense non-aqueous phase liquid, DNAPL). It is a volatile and persistent manmade chemical that is not easily degraded or absorbed by soil particles.

PCE is most used for dry cleaning and textile processing, as a chemical intermediate, and for vapor degreasing in metal-cleaning operations. Scientific evidence shows PCE may cause cancer from prolonged exposure even at levels below the MCL. Reductive dechlorination processes in groundwater can degrade PCE to trichloroethylene (TCE) and eventually to vinyl chloride (VC), which are considered human carcinogens.

Based on State Water Resources Control Board (SWRCB) data from 2007 to 2017, 173 active and standby public water wells (of 8,994 sampled, 622 detections) had at least one detection of PCE above the MCL (5 µg/L). Most detections occurred in Los Angeles (128 wells), San Bernardino (9 wells), and Tulare (5 wells) counties.

REGULATORY WATER QUALITY LEVELS[1]

TETRACHLOROETHYLENE (PCE)

Type	Agency	Concentration
Federal MCL	EPA[2]	5 µg/L
State MCL	SWRCB[3]	5 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB[3]	0.5 µg/L
Public Health Goal (PHG)	OEHHA[4]	0.06 µg/L

[1]These levels are generally related 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]SWRCB - State Water Resources Control Board.
[4]OEHHA – Office of Environmental Health Hazard Assessment

Revised October 2017

PCE DETECTIONS IN PUBLIC WATER WELL SOURCES[5]	
Number of active and standby public water wells with PCE concentrations > 5 µg/L [6]	173 of 8,994 wells tested with 622 detections
Top 3 counties with PCE detection in public wells above the MCL	Los Angeles (128), San Bernardino (9) and Tulare (5)

[5]Based on 2007-2017 public standby and active well (groundwater sources) data collected by the SWRCB.
[6]Water from public active and standby public groundwater sources is typically treated to prevent exposure to chemical concentrations above MCLs. Data from private domestic wells and wells with less than 15 service connections are not available.

ANALYTICAL INFORMATION			
Approved EPA methods	502.2	524.2	551.1
Detection Limit (µg/L)	0.04	0.05	0.002
Known Limitations to Analytical Methods	Sample must be cooled to 4 °C upon collection, analyzed within 14 days and free of air bubbles.		
Public Drinking Water Testing Requirements	Groundwater sources must be initially monitored for PCE during four consecutive quarterly sampling events. If PCE is not detected the groundwater system must take annual samples for a minimum of three consecutive years. The groundwater system may then reduce monitoring to one sample per compliance period. If granted a waiver for VOC monitoring, a system using groundwater shall collect a minimum of one sample every six years. If PCE is detected in groundwater, the site will have to be monitored for vinyl chloride during each compliance period.		

PCE Occurrence

Anthropogenic Sources

PCE is a contaminant which presence in the environment is associated with dry cleaning industries, textile operations, and metal degreasing activities. It was also widely used in the production of CFC-113 (Freon-113) and other fluorocarbons. PCE is also used in rubber coatings, solvent soaps, printing inks, adhesives and glues, sealants, polishes, lubricants, and pesticides.

Natural Sources

PCE is a manufactured chemical that does not occur naturally in the environment.

History of Occurrence

PCE has been used as a metal degreaser by military services and industry since the 1940s. Later, PCE was also used in dry cleaning processes. Due to poor handling and disposal practices, solvents such as PCE and trichloroethylene (TCE) entered the environment through evaporation, leaks, and improper disposal. U.S. EPA has found tetrachloroethylene in at least 945 of the 1,699 current or

former National Priority List (NPL) sites. In California, numerous solvent plumes have originated from dry cleaning facilities in the Central Valley, Southern California, and San Francisco Bay Area.

Contaminant Transport Characteristics

Mobility of PCE is described as moderate to high with an average solubility in groundwater of 150 mg/L (at 20 deg. C), soil sorption coefficient of 2.4 (log K_{oc}), and octanol/water partition coefficient of 2.5 (log K_{ow}). PCE is a dense non-aqueous phase liquid (DNAPL). A DNAPL is denser than and immiscible in water. In the presence of water, it will form a separate phase. The half-life degradation rate in groundwater is estimated to be between 1 to 2 years, based on aqueous aerobic biodegradation (Howard et al 1991) but may be considerably longer under certain conditions.

Remediation and Treatment Technologies

Groundwater remediation

Treatment of groundwater containing PCE includes traditional pump-and-treat technology (using air stripping or activated carbon filtration), in situ chemical oxidation with peroxide or ozone, de-chlorination by Hydrogen-Releasing Compound (HRC) and emerging biodegradation techniques. An important part of PCE remediation is source removal. This is accomplished often by integrating various methods of DNAPL mobilization using co-solvents, surfactants or thermal treatment and subsequent source removal - either by pump and treat or air sparging and soil vapor extraction. The bacteria strain (*Dehalococcoides ethenogenes* strain 195) preferentially uses PCE as a source of energy. Slow natural biodegradation of PCE may occur under anaerobic conditions when microorganisms are acclimated. However, the biodegradation process degrades PCE to TCE and eventually to VC, which are also considered human carcinogens.

Drinking Water and Wastewater Treatment

Drinking water can be treated by various in-line processes. Traditionally, air stripping and activated carbon filters are used to remove PCE and other volatile organic carbons (VOCs) from water. Ultra-violet radiation is also used for low-flow systems. Wastewater treatment plants use chemical oxidation and are increasingly using biodegradation processes to remove VOCs from water.

Health Effect Information

Acute

At levels above 100-200 mg/L in air, PCE may cause eye irritation and light-headedness; above 400 mg/L, eye and nasal irritation, lack of coordination within 2 hours; 600 mg/L, dizziness within 10 minutes; 1,500 mg/L, extreme irritation to eyes and respiratory tract, dizziness within 2 minutes, unconsciousness within 30 minutes.

Chronic

Long-term exposures in drinking water above the MCL (5 µg/L) can cause adverse effects to the liver, kidneys, and central nervous system. Prolonged dermal exposure can cause irritation, dryness, and dermatitis.

Carcinogen

Scientific evidence shows PCE may cause cancer from prolonged exposure even at levels below the MCL. The EPA classifies PCE as a probable human carcinogen. The calculated PHG of 0.06 µg/L represents a negligible risk of contracting cancer from drinking water containing PCE in a household environment over a lifetime.

Key Resources

1. Agency for Toxic Substances and Diseases Registry, Public Health Statement, Tetrachloroethylene, October 2014. https://www.atsdr.cdc.gov/ToxProfiles/tp18-c1-b.pdf
2. California State Water Resources Control Board. GAMA GIS online tools. https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/
3. Howard, H. Philip, et.al, Environmental Degradation Rates.1991. Lewis Publisher.
4. ITRC. DNAPL Source Reduction: Facing the Challenge, April 2002. http://www.itrcweb.org/Guidance/GetDocument?documentID=19
5. Montgomery, John H. Groundwater Chemicals, Desk Reference, 3rd Edition, 2000.
6. National Environmental Methods Index (NEMI), Tetrachloroethylene. https://www.nemi.gov/methods/keyword/?keyword_search_field=tetrachloroethylene
7. Office of Environmental Health Hazard Assessment. Public Health Goal for Tetrachloroethylene in Drinking Water. August 2001. http://oehha.ca.gov/media/downloads/water/chemicals/phg/pceaug2001.pdf
8. Safety Data Sheet, Perchloroethylene, All Grades, 2015. http://www.ppe.com/msds/MRS-3.PDF
9. State Water Resources Control Board, *A Compilation of Water Quality Goals*. 17th Edition. 2016. http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf
10. U.S. Environmental Protection Agency, Technology Innovation Office, Contaminated Site Clean-Up Information. http://www.clu-in.org/contaminantfocus/default.focus/sec/Dense_Nonaqueous_Phase_Liquids_(DNAPLs)/cat/Overview/
11. Yinjie J. Tang, Shan Yi, Wei-Qin Zhuang, Stephen H. Zinder, Jay D. Keasling, and Lisa Alvarez-Cohen, Investigation of Carbon Metabolism in "Dehalococcoides ethenogenes" Strain 195 by Use of Isotopomer and Transcriptomic Analyses. http://jb.asm.org/content/191/16/5224.full

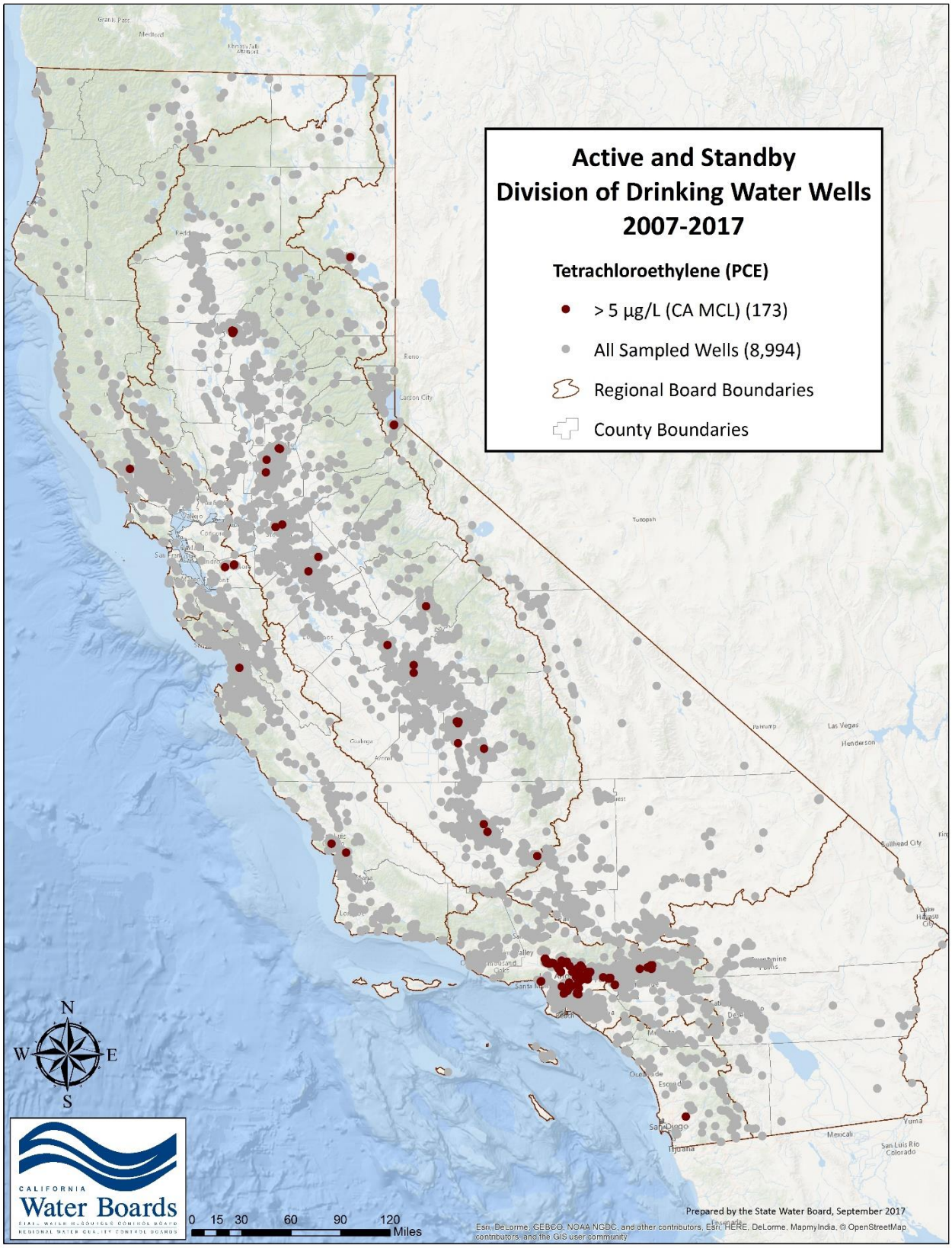


Figure 1. Active and standby public drinking water wells that had at least one detection of PCE above the MCL, 2007-2017, 173 wells. (*Source: Public supply well data in GAMA GIS*).