GROUNDWATER INFORMATION SHEET

Tetrachloroethylene (PCE)

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information is pulled from a variety of sources and data relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	Tetrachloroethylene (PCE)
Aliases	Tetrachloroethene, Perchloroethylene, Carbon Dichloride, Perchlor, Antisol, Ankilostin
Chemical Formula	C_2Cl_4
CAS No.	127-18-4
Storet No.	34475
Summary	The California Department of Public Health (CDPH) regulates PCE as a drinking water contaminant. The current State Maximum Contaminant Level (MCL) for PCE, set by the CDPH, is 5 micrograms per liter (µg/L). Common anthropogenic sources of PCE include discharges related to dry cleaning operations and metal degreasing processes. CDPH data show approximately 268 out of 8,534 active and standby public water wells have at least one reported concentration of PCE at or above the MCL (5 µg/L). Most detections occur in Los Angeles, San Bernardino and Kern Counties.

REGULATORY AND WATER QUALITY LEVELS[1]		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	5 µg/L
State MCL	CDPH	5 µg/L[2]
MCL Goal	US EPA	0 µg/L
Detection Limit for Purposes of Reporting (DLR)	CDPH	0.5µg/L[2]
Public Health Goal (PHG)	OEHHA	0.06 µg/L
Risk based SSL[3] protective of groundwater	US EPA, Region 9	5.2E-05 mg/kg
MCL based SSL protective of groundwater	US EPA, Region 9	2.4E-03 mg/kg

[1]These levels generally relate to drinking water, other water quality levels may exist. For further information, see Water Quality Goals at the Region 5 website, updated July 2008 (see references).
[2] CDPH considers revision of DLR and MCL if resources available.
[3]SSL - Soil Screening Level

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[4]	
Detection Type	**Number of Groundwater Sources**
Active, pending and standby public drinking water wells[5] with PCE concentrations ≥ 5 µg/L	Approximately 268 of 8,534
Abandoned, destroyed and inactive public wells with PCE concentrations ≥ 5 µg/L	Approximately 134 of 8,534
Top 3 counties having public drinking water wells with PCE concentrations ≥ 5 µg/L	Los Angeles, San Bernardino, Kern

[4]Based on CDPH data accessed in November 2008 (Geotracker). See Figures 1 and 2.
[5]In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to chemical concentrations exceeding MCLs. Individual wells and wells for small water systems are not regulated by the CDPH and are not included.

ANALYTICAL INFORMATION	
Analytical Test Methods	US EPA Methods 502.2, 524.2, 551.1, 8260B
Detection Limit	0.5 µg/L
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 each compliance period. The compliance period is established by the CDPH, and in the case of no detections, may be up to six years.

PCE OCCURRENCE	
Anthropogenic Sources	PCE is a contaminant in the environment associated with dry cleaning, 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 and 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. There are approximately more than 400,000 sites in the US where soil and ground water are contaminated by chlorinated solvents. 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 (Fetter 1988) with an average solubility in groundwater of 200 mg/L, and a soil-water partition coefficient (K_{oc}) of 152. 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 & 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, dechlorination by Hydrogen-Releasing Compound (HRC) and emerging biodegradation techniques. An important part of PCE DNAPL remediation is source removal. This is accomplished often by integrating various methods of DNAPL mobilization using cosolvents, surfactants or thermal treatment and subsequent source removal - either by pump and treat or air sparging and soil vapor extraction. The bacteria strain (Dehalococcoid 195, *Cornell University*) 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 vinyl chloride, 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 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; 1500 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 US 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 REFERENCES

1. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. Public Health Goal for Tetrachloroethylene in Drinking Water. August 2001 http://www.oehha.ca.gov/water/phg/pdf/tce_f.pdf

2. California State Water Resources Control Board. Geotracker-Groundwater Database http://geotrackerbeta.ecointeractive.com/gama/default.asp

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/Documents/DNAPLs-2.pdf

5. National Safety Council. Chemical Backgrounders. *Tetrachloroethylene.* (Oct. 23, 2002) http://www.nsc.org/ehc/chemical/Tetrachl.htm

6. Page, Douglas. *Perc-Eating Sewer Bacteria Could Cleanup Cleaners* (Oct. 23, 2002) www.hightechcareers.com/doc498a/perc498a.html

7. Regional Water Quality Control Board, Central Valley Region. July 2008. *A Compilation of Water Quality Goals*. Prepared by Jon B. Marshack. http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/wq_goals_2008.pdf

8. Siegrist, Robert L. In-Situ Chemical Oxidation for Remediation of Contaminated Soil and Ground Water, Ground Water Currents No. 37. September 2000. http://clu-in.com/Products/Newsltrs/GWC/gwc0900.htm

9. U.S. Environmental Protection Agency, Technology Innovation Office. Bioremediation of Chlorinated Solvent Contaminated Groundwater. August 1998. Prepared by Megan Grindstaff. http://207.86.51.66/products/intern/bioremed.htm

10. U.S. Environmental Protection Agency. Chemical Summary for Perchloroethylene. August 1994. EPA 749-F-94-020a. http://epa.gov/opptintr/chemfact/s_perchl.txt

11. U.S. Environmental Protection Agency. Office of Water. *Technical Fact Sheet: Tetrachloroethylene.* (Sept. 2002) http://www.epa.gov/ODWDW/dwh/t-voc/tetrachl.html

FOR MORE INFORMATION CONTACT: Jan Stepek (916) 341-5777

Groundwater Information Sheet: Tetrachloroethene (PCE)
Figure 1

Active and Standby CDPH Wells (268 Total) with at Least One Detection of PCE >= 5 ppb (MCL)

Source: 1984 – 2008 CDPH Data, Geotracker GAMA

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Figure 2

Abandoned, Destroyed and Inactive CDPH Wells (146 Total) with at Least One Detection of PCE >= 5 ppb (MCL)

Source: 1984-2008 CDPH Data, Geotracker GAMA