DRAFT
GROUNDWATER INFORMATION SHEET

Trichloroethylene (TCE)

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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	Trichloroethylene (TCE)
Aliases	Ethylene trichloride, Acetylene trichloride, Triclene, Trichloroethene, 1,1,2-Trichloroethylene
Chemical Formula	C_2HCl_3
Cas No.	79-01-6
Storet No.	39180
Summary	The California Department of Health Services (DHS) regulates TCE as a drinking water contaminant. The current State Maximum Contaminant Level (MCL) for TCE, set by DHS, is 5 μg/L. Common anthropogenic sources of TCE include discharges related to solvent operations and metal degreasing processes. TCE is present in groundwater in dissolved form and as a free product that sinks below the water table a dense non-aqueous phase liquid (DNAPL). Based on DHS data through 2000, 262 of approximately 16,000 public drinking water wells (active and standby status) have had concentrations of TCE ≥ 5 μg/L, with most detections occurring in Los Angeles, San Bernardino and Riverside Counties.

REGULATORY AND WATER QUALITY LEVELS[1]		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	5 µg/L
State MCL	DHS	5 µg/L
Detection Limit for Purposes of Reporting (DLR)	DHS	0.5µg/L
Others: Public Health Goal (PHG) Preliminary Remediation Goal (PRG) – tap water	 OEHHA US EPA, Region 9	 0.8 µg/L 1.6 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 (Marshack, 2000).

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[2]	
Detection Type	**Number of Groundwater Sources**
Number of active and standby public drinking water wells[3] with TCE concentration ≥ 5 µg/L.	262 of approximately 16,000.
Top 3 counties having public drinking water wells[3] with PCE concentration ≥ 5 µg/L.	Los Angeles, San Bernardino, Riverside

[2]Based on DHS data collected from 1984-2000 (Geotracker). See Figures 1 and 2.
[3]In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to water exceeding MCLs. Individual wells and wells for small water systems not regulated by DHS are not included in these figures.

ANALYTICAL INFORMATION		
Method	**Detection Limit**	**Note**
EPA Method 524.2 (GC/MS)	0.19 µg/L (quantitation limit 0.25 µg/L)	DHS approved for public drinking water systems
EPA Method 502.2	0.01 µg/L (quantitation limit 0.5 µg/L)	DHS approved for public drinking water systems
EPA Method 8260B (GC/MS)	0.02 to 0.19 µg/L (quantitation limit 0.5µg/L)	
Known Limitations to Analytical Methods	Sample must be cooled to 4° C upon collection and analyzed within 14 days. Sample must be free of air bubbles.	

Public Drinking Water Testing Requirements	TCE has been regulated in public water systems by DHS since 1989. Between 1993 and 1995, DHS required water suppliers to collect water samples every 3 months for one year and analyze them for TCE in excess of 0.5 μg/L. If TCE was present at this level, the water system had to continue monitoring for TCE until remediation steps were complete or DHS had determined that TCE concentrations would remain reliably and consistently below the MCL. If TCE levels were found to be consistently above the MCL, the water system was required to take steps to reduce the amount of TCE.

TCE OCCURRENCE	
Anthropogenic Sources	TCE is primarily used as a solvent to remove grease from metal parts, particularly in the automotive industry and metal machining industry. As a general solvent or as a component of solvent blends, TCE is used with adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. It can be found in many household products, including paint removers, adhesives, spot removers, and rug-cleaning fluids. It is also used in various chemical manufacturing processes.. Historically, TCE was also used in foods, beverages (decaffeination of coffee), pet foods, medicine, pharmaceuticals and cosmetics.
Natural Sources	TCE is a manufactured chemical that does not occur naturally in the environment.
History of Occurrence	TCE has been in use for more than fifty years. The largest sources of TCE in groundwater are releases from chemical waste sites, improper disposal practices, and leaking storage tanks and pipelines. In 1993, 30,128,003 pounds of TCE were released (U.S.EPA Toxic Release Inventory Program). Of those releases, 14,488,988 pounds were fugitive or non-point air emissions; 15,625,125 pounds were stack or point air emissions; 5,218 pounds were surface water discharges; 460 pounds were released by underground injection; and 8,212 pounds were released to land. According to US EPA between 1987 and 1993, 100,293 pounds of TCE were released to water and 191,088 pounds were released to land. TCE at concentrations above the MCL (5 μg/L) was found in groundwater from more than 200 public drinking water wells in California, most of them in southern California. Most of the California sites with TCE groundwater plumes listed in the NPL (National Priority List of contaminated sites in the USEPA Superfund program) occur in the San Gabriel Valley,

	San Fernando Valley and Santa Clara Valley. However, TCE is found in groundwater in many other locations within the state.
Contaminant Transport Characteristics	Mobility of TCE in soil and groundwater is described as moderate, with solubility in water of 1,100 mg/L at 20°C, and organic carbon partition coefficient (K_{OC}) of 152 (Fetter 1988). Because its density is heavier than water, free phase TCE will sink to the bottom of the aquifer in the dense non-aqueous phase liquid (DNAPL) form. TCE can destroy the structure of clayey minerals, making them more permeable to dissolved contaminants. TCE is not readily degraded in most groundwaters. Its half-life, based upon biodegradation in aerobic conditions, is between 0.5 to 1 year. Under anaerobic conditions, the half-life is from 3 months to 4.5 years (Howard et.al 1991). However, at most contaminated sites, TCE may last much longer than would be expected based on those half-life estimations. Dissolved TCE in groundwater may naturally degrade under anaerobic conditions. However, the daughter products are dichloroethylene (DCE) and vinyl chloride. Those products are toxic and often more difficult to degrade than TCE, and require different (oxidizing) conditions to be naturally attenuated.

REMEDIATION & TREATMENT TECHNOLOGIES	
Groundwater Remediation	TCE may be removed from groundwater using a traditional pump and treat system. Pumped water is treated above ground by air-stripping and activated carbon filtration. Increasingly, permeable reactive barriers, filled with zero-valent iron granules and/or organic matter are used to remediate and contain TCE plumes in-situ. Innovative methods, such as oxidation using potassium permanganate, thermal remediation using electrodes, steam or enhanced biodegradation are currently being tested.
Drinking Water and Wastewater Treatment	Drinking water may be treated using various in-line processes. Traditionally, air stripping and activated carbon filters are used to remove TCE and other volatile organic carbons (VOCs) from water. Ultra-violet radiation with the addition of hydrogen peroxide is also used for low-flow systems. Wastewater treatment plants use chemical oxidizers (such as potassium permanganate) and biodegradation processes to remove VOCs from water. However, under certain conditions, biological treatment may convert TCE to vinyl chloride (also a carcinogen).

HEALTH EFFECT INFORMATION

Acute overexposure to TCE vapor can cause central nervous system effects (e.g., light-headedness, drowsiness, and headache), which may lead to unconsciousness or prove fatal in extreme circumstances. In addition, TCE may irritate the respiratory tract at high vapor concentrations. Repeated or prolonged contact with the chemical in liquid form can cause irritation of the skin and eyes.

Chronic (repeated) exposure, in excess of recommended occupational limits, has been associated with damage to the liver, kidneys, and nervous system. TCE is known to the State of California to cause cancer, for purposes of the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65') and was added to the list of carcinogens in 1988. US EPA classifies TCE as a probable human carcinogen. The California PHG for TCE is calculated to represent a negligible risk of contracting cancer from the use of water containing TCE in the household environment over a lifetime.

KEY REFERENCES

1. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. Public Health Goal for Trichloroethylene In Drinking Water. February 1999 http://www.oehha.ca.gov/water/phg/pdf/tce_f.pdf

2. California Environmental Protection Agency. Regional Water Quality Control Board, Central Valley Region. August 2000. *A Compilation of Water Quality Goals*. Prepared by Jon B. Marshack. http://www.swrcb.ca.gov/rwqcb5/available_documents/wq_goals/wq_goals.pdf

3. Fetter, C. W., Applied Hydrogeology. 1988. Merrill Publishing Company.

4. Howard, H. Philip, et al., Environmental Degradation Rates. 1991. Lewis Publisher.

5. National Safety Council. Chemical Backgrounders. *Trichloroethylene.* http://www.nsc.org/ehc/ew/chems/trichlor.htm (Sept. 2002)

6. U S Environmental Protection Agency. Field Applications of In-Situ Remediation Technologies: Permeable Reactive Barriers. April 1999. EPA 542-R-99-002.

7. US Environmental Protection Agency. Ground Water Currents No. 40. July 2000. EPA 542-N-01-006.

8. US Environmental Protection Agency. Office of Water. *Technical Fact Sheet:*

Trichloroethylene. http://www.epa.gov/ODWDW/dwh/t-voc/tetrachl.html (Sept. 2002)

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

FOR MORE INFORMATION, CONTACT:
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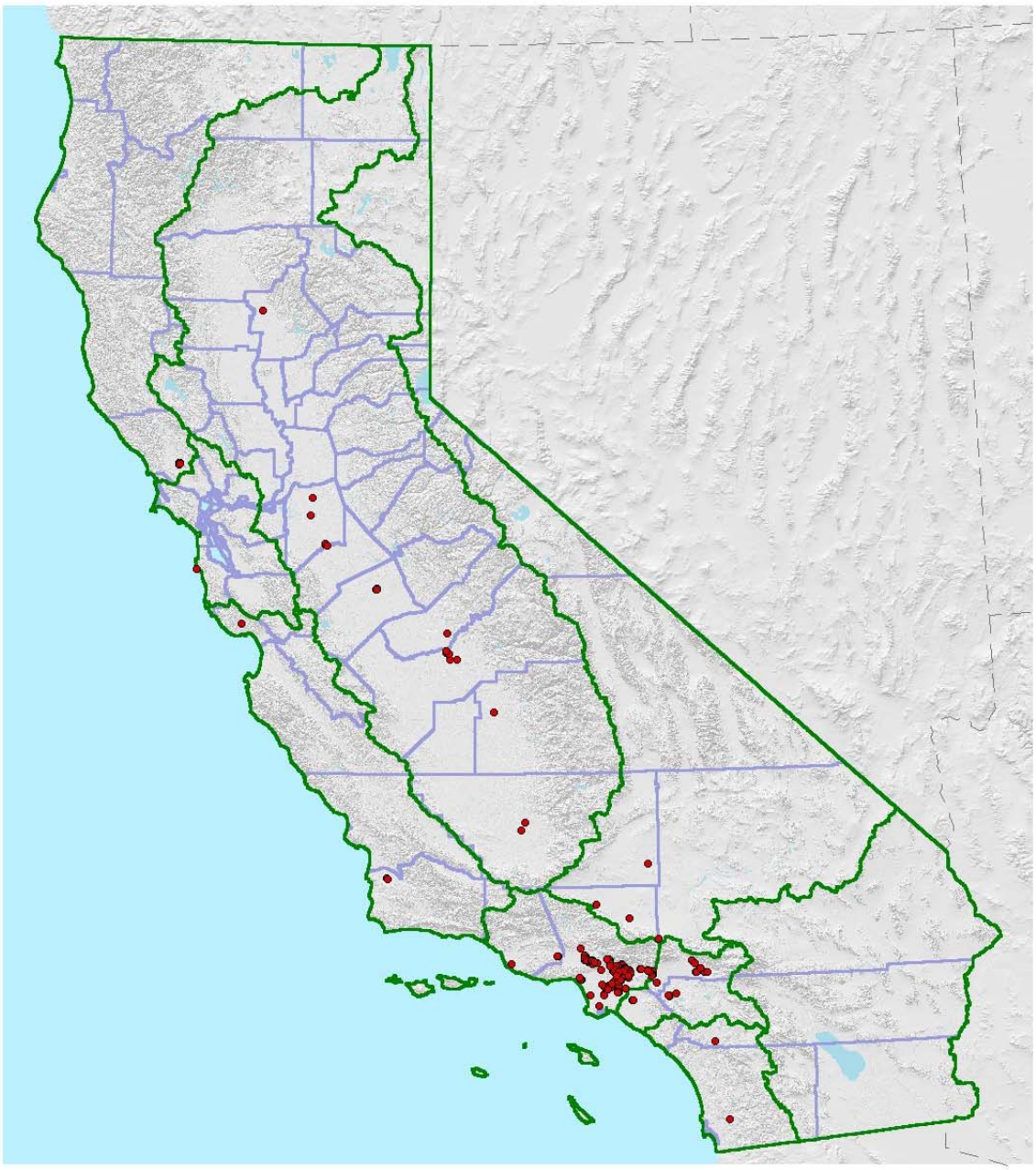
Groundwater Information Sheet: TCE
Figure 1



Active and Standby DHS Wells (262 Total) with at Least One Detection of TCE >= 5 PPB MCL

Source: 1984 - 2000 DHS Data (Map Revised 10/02/02)
Prepared by: B. Wyckoff

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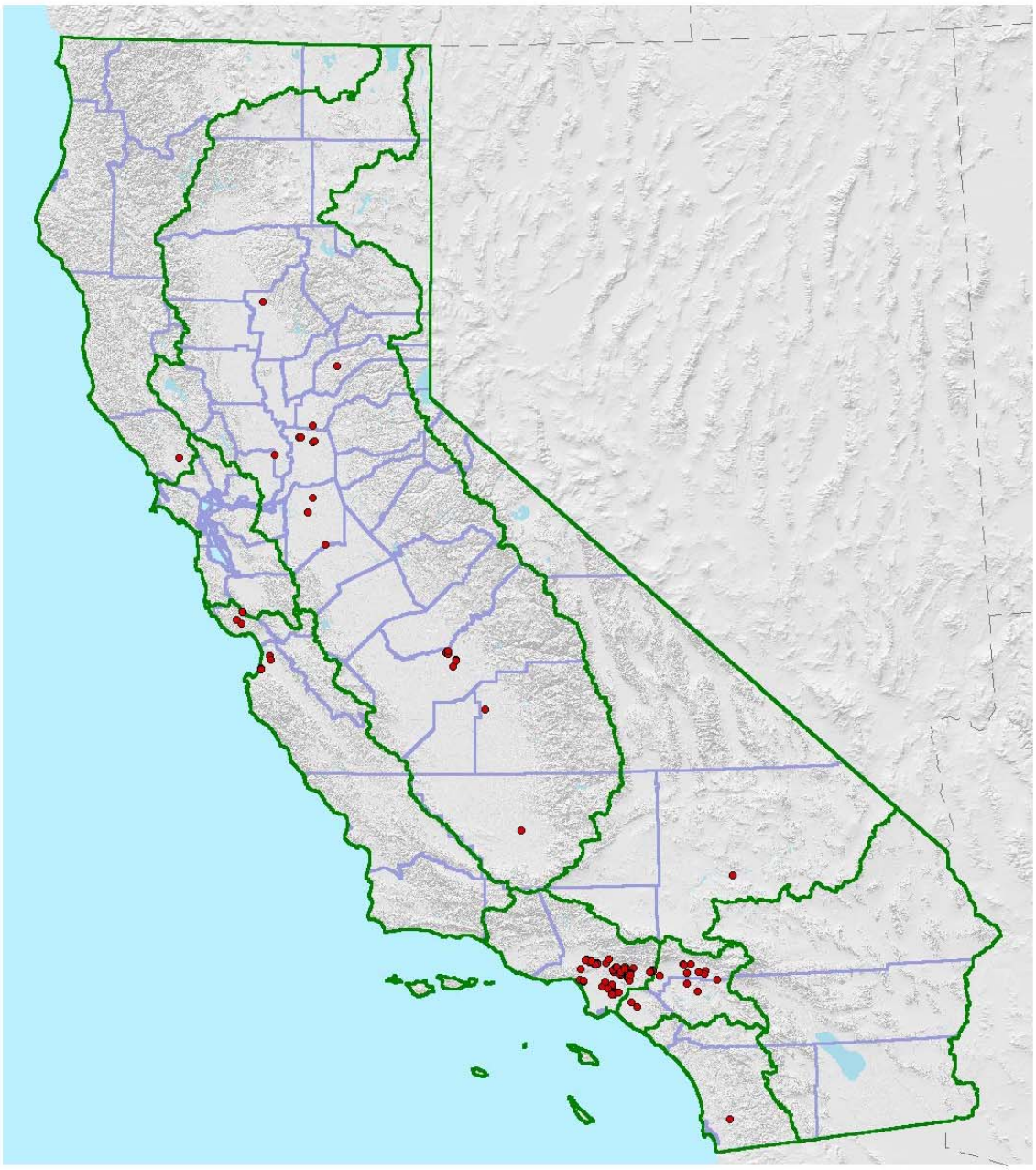
Groundwater Information Sheet: TCE
Figure 2



Abandoned, Destroyed, and Inactive DHS Wells (139 Total)
with at Least One Detection of TCE >= 5 PPB MCL

Source: 1984 - 2000 DHS Data (Map Revised 10/02/02)
Prepared by: B. Wyckoff

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