Emerging Contaminant – 1,2,3-Trichloropropane (TCP)

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FACT SHEET

At a Glance

- Colorless to straw-colored liquid.
- Not found in nature – completely man-made.
- Exposure from industrial settings or hazardous waste sites.
- Not likely to sorb to soil and has low solubility in water. In the pure form, likely to exist as a dense nonaqueous phase liquid (DNAPL).
- Federal maximum contaminant level (MCL) not established.
- EPA Region 9 identifies preliminary remediation goals (PRGs) for various matrices and has established a notification level (NL) for drinking water.
- Numerous methods are available for TCP detection.
- Remediation technologies available to treat TCP contamination in ground water and soil include granular activated carbon (GAC) and soil vapor extraction (SVE), among others.

Introduction

An "emerging contaminant" is a chemical or material that is characterized by a perceived, potential or real threat to human health or the environment or lack of published health standards. A contaminant may also be "emerging" because of the discovery of a new source or a new pathway to humans, or a new detection method or treatment technology (DoD 2007).

This fact sheet, developed by the U.S. Environmental Protection Agency (EPA) Federal Facilities Restoration and Reuse Office (FFRRO), provides a brief summary for 1,2,3-trichloropropane (TCP), including physical and chemical properties; environmental and health impacts; existing federal and state guidelines; detection and treatment methods; and additional sources of information.

TCP is an emerging contaminant that is of interest to the government, private sector, and other parties. It is recognized by the State of California to cause cancer and is a known toxin. This fact sheet is intended for use by site managers and other field personnel in addressing TCP contamination at a cleanup site or in a drinking water supply.

What is 1,2,3-TCP?

- Synonyms include allyl trichloride, glycerol trichlorohydrin, and trichlorohydrin (Barbalace 2007).
- TCP is exclusively a man-made chemical (Dombeck and Borg 2005; TOSC 2007).
- TCP has been used as an industrial solvent, as a cleaning and degreasing agent, and in the production of pesticides (NTP 2005; TOSC 2007).
- TCP is currently used as a chemical intermediate in the creation of other chemicals, including polysulfone liquid polymers and dichloropropene, and in the synthesis of hexafluoropropylene. In addition, it is used as a crosslinking agent in the creation of polysulfides (NTP 2005).
- TCP is a chlorinated hydrocarbon (Stepek 2003).

Exhibit 1: Physical and Chemical Properties of 1,2,3-TCP
(NTP 2005; ATSDR 1992; Dombeck and Borg 2005; WHO 2003; OSHA 2007)

Property	Value
CAS Number	96-18-4
Physical Description (at room temperature)	Colorless to straw-colored liquid
Molecular weight (g/mol)	147.43
Water solubility (mg/L)	1,750 (slightly soluble)
Boiling point (^{o}C)	156.8
Vapor pressure at 25^{o}C (mm Hg)	3.1
Specific gravity	1.39
Octanol-water partition coefficient (log K_{ow})	1.98 to 2.27 (temperature dependent)
Soil organic carbon-water partition coefficient (log K_{oc})	1.70 to 1.99 (temperature dependent)
Henry's law constant (atm m^3/mol)	4.087×10^{-4}

Notes: g/mol – gram per mole; mg/L – milligrams per liter; ^{o}C – degrees Celsius; mm Hg – millimeters of mercury.

What are the environmental impacts of 1,2,3-TCP?

- TCP is not likely to sorb to soil based on its low soil organic carbon-water partition coefficient; therefore, is likely to leach from soil into ground water (TOSC 2007).
- TCP will sink to the bottom of a ground water aquifer because it has a density greater than water (TOSC 2007). Therefore, in pure form, TCP is likely to exist as DNAPL (Stepek 2003).
- TCP is typically found at industrial or hazardous waste sites.
- TCP evaporates from surface soil and water (ATSDR 1995).
- When in the atmosphere, TCP is subject to photodegradation, with a half-life of 15 days (ATSDR 1995).
- Because of its low bioconcentration factor (BCF ~ 9.2), TCP is unlikely to become concentrated in plants, fish, or other seafood (ATSDR 1992, 1995).

What are the health effects of 1,2,3-TCP?

- Exposure occurs through vapor inhalation, dermal exposure, or ingestion (NTP 2005).
- Exposure is most likely to occur near hazardous waste sites where TCP was improperly stored or disposed, or at locations that manufacture the chemical (ATSDR 1992, 1995).
- TCP is recognized by the State of California as a human carcinogen (State of California 2007).
- Animal studies have shown that long-term TCP exposure may cause kidney failure, reduced body weight, and increased incidences of tumors within numerous organs (Stepek 2003; NTP 2005; ATSDR 1992).
- Short-term exposure through inhalation of 100 parts per million (ppm) can cause eye and throat irritation (ATSDR 1995) and can affect concentration and muscle coordination (Stepek 2003).

Are there any existing federal and state guidelines and health standards for 1,2,3-TCP?

- The California Department of Health Services (DHS) has established a NL of 0.005 parts per billion (ppb) for drinking water based on a 10^{-6} cancer risk (DHS 2006).
- No federal or state MCLs have been set for TCP.

Are there any existing federal and state guidelines and health standards for 1,2,3-TCP? (continued)

- The Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) of 50 ppm (OSHA 2007).
- The National Institute of Occupational Safety and Health (NIOSH) has set a recommended exposure limit (REL) of 10 ppm (60 milligrams per cubic meter [mg/m^3]) and an immediately dangerous to life and health (IDLH) level of 100 ppm (NTP 2005).
- The EPA Integrated Risk Information System (IRIS) lists a no observed adverse effect limit (NOAEL) of 5.71 mg/kg/day, a lowest observed adverse effect limit (LOAEL) of 11.4 mg/kg/day, and an oral reference dose (RfD) of 0.006 mg/kg/day (EPA 2007).
- The American Conference of Industrial Hygienists (ACGIH) has set a threshold limit value – time-weighted average limit (TLV-TWA) of 10 ppm (NTP 2005).
- The Health Effects Assessment Summary Tables (HEAST) identifies an oral cancer slope factor of 7.0 per mg/kg-day (EPA 1997).

What detection and site characterization methods are available for 1,2,3-TCP?

- EPA Method 8260B (based on gas chromatography [GC]/mass spectrometry [MS]) for solid matrices (Stepek 2003).
- EPA Method 504.1 (based on microextraction and GC) for ground water and drinking water (Stepek 2003; EPA 1995a).
- EPA Method 551.1 (based on liquid-liquid extraction and GC with electron-capture detection) for drinking water, water being treated, and raw source water (Stepek 2003; EPA 1990).
- EPA Method 524.2 for surface water, ground water, and drinking water in any stage of water treatment (Stepek 2003; EPA 1995b).
- California DHS has developed a method based on liquid-liquid extraction and GC and purge and trap GC for trace-level detection of TCP in drinking water (DHS 2002a, 2002b).

What technologies are being used to treat 1,2,3-TCP?

- Treatment technologies for ground water that are available for remediation of chlorinated hydrocarbons include pump and treat, permeable reactive barriers, in situ oxidation, biodegradation, and dechlorination by hydrogen release compound (Stepek 2003).
- TCP in water can be removed using GAC (Molnaa 2003; Dombeck and Borg 2005).
- TCP in soil may be removed by SVE (TOSC 2007).
- Treatment for TCP in ground water has been successful using ultraviolet (UV) radiation and chemical oxidation with potassium permanganate (Dombeck and Borg 2005; Stepek 2003).
- Laboratory-scale use of an oxidation process (HiPOx) using ozone and hydrogen peroxide for removal of TCP from ground water has been successful (Dombeck and Borg 2005).

Where can I find more information about 1,2,3-TCP?

- Agency for Toxic Substances and Disease Registry (ATSDR). 1992. "Toxicological Profile for 1,2,3-Trichloropropane." Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service.
- ATSDR. 1995. ToxFAQs - "1,2,3-Trichloropropane."
- Barbalace, Kenneth. 2007. Chemical Database — 1,2,3-Trichloropropane. http://EnvironmentalChemistry.com/yogi/chemicals/cn/1,2,3-Trichloropropane.html.

Where can I find more information about 1,2,3-TCP? (continued)

- California Department of Heath Services (DHS). 2002a. Determination of 1,2,3-Trichloropropane in Drinking Water by Continuous Liquid-Liquid Extraction and Gas Chromatography/Mass Spectrometry.
- DHS. 2002b. Determination of 1,2,3-Trichloropropane in Drinking Water by Purge and Trap Gas Chromatography/Mass Spectrometry.
- DHS. 2006. Drinking Water Notification Levels and Response Levels: An Overview.
- Department of Defense (DoD). 2007. Emerging Contaminants. www.denix.osd.mil/denix/Public/Library/MERIT/merit.html.
- Dombeck, Glenn, and Charles Borg. 2005. "Multi-contaminant Treatment for 1,2,3 Trichloropropane Destruction Using the HiPOx Reactor." Reprinted from the Proceedings of the 2005 NGWA Conference on MTBE and Perchlorate: Assessment, Remediation, and Public Policy with permission of the National Ground Water Association Press. Copyright 2005. ISBN #1-56034-120-3.
- Molnaa, Barry. 2003. "1,2,3-TCP California's Newest Emerging Contaminant" PowerPoint Presentation, ENTECH 2003.
- Occupational Safety and Health Administration (OSHA). 2007. "OSHA/EPA Occupational Chemical Database." . www.osha.gov/web/dep/chemicaldata/CHEMICALRESULT.asp?RecNo=163.
- State of California. 2007. "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity." www.oehha.ca.gov/prop65/prop65_list/files/060107LST.pdf.
- Stepek, Jan. 2003. "Ground Water Information Sheet 1,2,3-Trichloropropane (TCP)." SWRCB – Division of Clean Water Programs, Ground Water Special Studies Unit.
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- U.S. Department of Health and Human Services. 2005. "Substance Profiles Report on Carcinogens, Eleventh Edition." Public Health Service, National Toxicology Program (NTP).
- U.S. Environmental Protection Agency (EPA). 1990. Method 551.1, Determination of Chlorination Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides/Herbicides in Drinking Water by Liquid-Liquid Extraction and Gas Chromatography with Electron-Capture Detection.
- EPA. 1995a. Method 504.1, 1,2-Dibromoethane (EDB), 1,2-Dibromo-3-chloropropane (DBCP), and 1,2,3-Trichloropropane (123TCP) in Water by Microextraction and Gas Chromatography. National Exposure Research Laboratory, Office of Research and Development.
- EPA. 1995b. Method 524.2, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry. National Exposure Research Laboratory, Office of Research and Development.
- EPA. 1997. "Health Effects Assessment Summary Tables (HEAST) FY 1997 Update". EPA 540/R-97-036-PB97-921199. Office of Solid Waste and Emergency Response.
- EPA. 2007. Integrated Risk Information System (IRIS). 1,2,3-Trichloropropane. www.epa.gov/iris/subst/0200.htm.
- World Health Organization (WHO). 2003. "Concise International Chemical Assessment Document 56, 1,2,3-Trichloropropane."

Contact Information

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