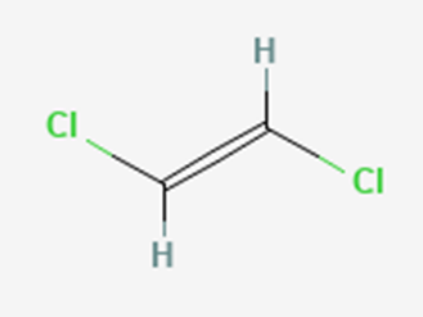
Updated EHS Summary of Trans 1,2-dichloroethylene for the MA TURA Science Advisory Board Meeting – October 7, 2024

CAS #: 156-60-5  	**NAME: Trans 1,2-dichloroethylene** **Synonyms:** Trans DCE, trans-1,2-DCE, trans dichloroethylene **Molecular Weight**: 96.94 g/mol **Molecular Formula:** $C_2H_2Cl_2$ **Trans DCE is one of two geometric isomers of 1,2 Dichloroethene; each having distinct properties.** **Trans DCE is a byproduct of vinyl chloride, trichloroethylene, and tetrachloroethylene**
PHYSICAL CHARACTERISTICS	
Primary Use	Solvent in degreasing and metal cleaning applications TransDCE is more widely used in industry than either cisDCE or the commercial mixture (EPA 2020; Gosselin et al. 1984; ATSDR, 2023) 1,2-Dichloroethylene is included on the TRI chemical list as a mixture of its cis- and trans geometric isomers (CASRN 540-59-0). For reporting year 2017, seventeen facilities filed a TRI report for 1,2-dichloroethylene, and the release quantities they reported total 8,728 pounds (EPA, 2019).
Physical state, odor at room temperature & pressure	Colorless liquid
Melting point; Boiling point	MP: -49.8°C BP: 48.7°C
Solubility	5,300 mg/L at 25°C
SAFETY/PHYSICAL HAZARDS	
Vapor Pressure	331 mm Hg at 25°C
Flammability	Highly flammable
Flashpoint	2°C
Flammability Rating	3 – ability to ignite under almost all ambient temperature conditions
Explosivity (UEL, LEL, shock sensitive)	9.7 - 12.8% in air
HEALTH HAZARDS	
Chronic or Sub-chronic Toxicity	
Carcinogenicity	TransDCE is not listed by the HHS NTP in the 15th Report on Carcinogens. EPA has not classified the carcinogenicity of TransDCE due to inadequate information (EPA, 2010). IARC has not evaluated the carcinogenicity of TransDCE (IARC, 2022).

Neurotoxicity	Two single-dose oral studies observed neurotoxic effects in rats. "(Hayes, 1987) observed clinical signs of neurotoxicity, including central nervous system depression, ataxia, and depressed respiration, at all doses (doses not reported), with dose-dependent severity. (Barnes, 1985) observed decreased activity, ataxia, and suppressed or total lack of righting reflex in rats following doses of 1,600– 3,500 mg/kg."
Developmental/Reproductive Toxicity	A gestational exposure study in rats observed increased resorptions following inhalation exposure to 6,000 ppm trans-1,2-dichloroethene and decreased fetal weight in females at 12,000 ppm (Hurtt et al. 1993). One epidemiological study of pregnant women who were exposed to contaminated drinking water at Camp Lejeune, North Carolina examined effects of in utero and possible early life exposure to transDCE and did not find correlations between exposure and oral cleft lips or neural tube defects (Ruckart, 2013).
Genotoxicity/Mutagenicity	ATSDR's review of transDCE concluded that it did not produce genotoxic effects when tested in vivo or in vitro (See Tables 2-6 and 2-7 in ATSDR Tox Profile for summary of testing results). NTP (2002) studies determined that "neither cis-, trans-, nor cis,trans-1,2-dichloroethylene was mutagenic in S. typhimurium strain TA97 (cis isomer only), TA98, TA100, TA1535, or TA1537, with or without S9 metabolic activation enzymes."
Hematological	A few studies in laboratory animals showed that some hematological parameters may be affected by exposure to transDCE (NTP 2002). Effects were either very small or not clinically consistent (e.g., decreased hematocrit without decreased erythrocyte count) (ATSDR, 2023).
Immunotoxicity	ATSDR noted "the most sensitive effect of intermediate-duration oral exposure is the immune system (decreased humoral immunity). Immunological effects of trans 1,2-dichloroethene are a presumed health effect for humans based on limited evidence in mice. Decreased humoral immunity, but not cellular immunity, was observed following intermediate-duration oral exposure. No changes in immune function were observed in animal studies following acute-duration oral exposure." The Shopp et al. (1985) study was chosen as the principal study in EPA 2010 Toxicological Review of transDCE. "Shopp et al. (1985) reported a statistically significant dose-related suppression of sRBC-specific AFCs in the spleen in male mice exposed to trans-1,2-DCE in drinking water

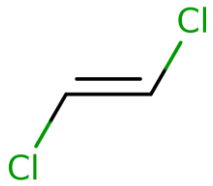
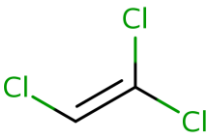
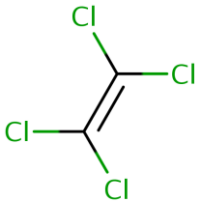
	for 90 days. The authors of this study reported marked suppression in humoral immune status in male mice as indicated by the significantly decreased number of AFCs. As described in more detail in Section 4.6.1.2, EPA concluded that the 26% suppression in the number of sRBC-specific AFCs per 106 spleen cells of male mice in Shopp et al. (1985) is a biologically significant measure indicating suppressed antibody response associated with oral exposure to trans-1,2-DCE." (EPA, 2010) "Kelly (1998) was an adequately designed subchronic study that evaluated a number of endpoints following exposure to three concentrations of trans-1,2-DCE. This study was chosen as the principal study and the corresponding benchmark concentration lower confidence limit 1 standard deviation (BMCL1SD) human equivalent concentration (HEC) of 109 mg/m3 for decreased lymphocyte counts in male rats was identified as the most sensitive point of departure (POD) for deriving screening-level p-RfC values. The observed leukopenia in rats (decreased white blood cell [WBC] and lymphocyte counts) was determined to be treatment related and suggests potential effects on the immune system." (EPA, 2020) Munson (1982) assessed the immunotoxicity of trans 1,2 dichloroethylene by measuring the number of IgM antibody forming cells (AFC) to small red blood cells (sRBC), and on the AFC/spleen basis TransDCE showed a statistically significant trend toward producing immunosuppression.
Liver	In a case-control study of the general population (e.g., non-occupational), the risk of gallstone disease was positively associated with trans-1,2-dichloroethene levels in adipose tissue (Ji et al. 2016). NTP studies concluded limited evidence for effects on the liver, mainly due to observed increases in liver weight.
Skin, Eye and Respiratory Effects	
*Irritant – **S**kin, **E**ye, or **R**espiratory*	ATSDR concluded the most sensitive effect of acute-duration inhalation exposure is contact irritation of the eye (lacrimation). Exposure can cause skin and ocular irritation.
Metabolites	TransDCE has been shown to be a more potent inhibitor of CYP than cisDCE and is more slowly metabolized than cisDCE (ATSDR, 2023).
Environmental and Human Health Exposure and Risk Values	
RfC/RfD	US EPA calculated a chronic oral RfD of 0.02 mg/kg day, derived from a BMDL1SD of 65 mg/kg-day based on adverse effects on the immune system found in the Shopp et al. (1985) study and applying an

	uncertainty factor of 3,000 (10 for intraspecies variability, 10 for interspecies extrapolation, 10 for extrapolation from a subchronic exposure and 3 for database deficiencies) Information was considered insufficient to determine a RfC for trans DCE. (EPA, 2010).
ATSDR-MRL	"A provisional acute-duration inhalation MRL of 3 ppm was derived for trans1,2-dichloroethene based on lacrimation in pregnant rats exposed to trans-1,2-dichloroethene on GDs 7– 16. The MRL is based on a BMCL10 of 256.47 ppm (unadjusted for exposure duration because exposure was concentration dependent) and a total uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability)." (ATSDR, 2023)
Health Based Exposure Limits	
NIOSH-REL/IDLH/Ceiling Limits	NIOSH REL – 200 ppm NIOSH IDLH – 1,000 ppm
OSHA-PEL	200 ppm
ACGIH TLV-TWA	200 ppm
Biomonitoring Action Limits	California lists transDCE as a designated priority chemical for biomonitoring (CAL EPA, 2019).
Drinking Water Standards	TransDCE is subject to National Primary Drinking Water Regulations (NPDWR) under the SDWA with a MCLG of 100 ppb and an enforceable MCL of 100 ppb (Section 1412). TransDCE is designated as a toxic pollutant under Section 307(a)(1) of the CWA and as such is subject to effluent limitations. Under CWA Section 304, transDCE is included in the list of total toxic organics (TTO) (40 CFR 413.02(i)).
Other	Listed as a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Releases of more than 1,000 pounds within a 24-hour period must be reported. Release in wastewater is regulated under the Clean Water Act by the National Pollutant Discharge Elimination System (NPDES) (ATSDR, 2023).
ENVIRONMENTAL & ECO-SYSTEM HAZARDS	
PBT	In the US, transDCE has been detected in industrial wastewater, surface water, groundwater, and drinking-water supplies. It was detected in 16 of 466 randomly selected and 38 of 479 purposely selected drinking-water supplies taken from groundwater at levels of up to 2 and 120 µg/litre, respectively (WHO, 2003).
Bioaccumulation	Low bioaccumulation potential based on bioconcentration factor and bioaccumulation factor estimates of 11 and 13, respectively, and its measured log KOW of 2.09 (EPA, 2019).
BAF	13 (estimated) (EPA, 2019)

BCF	11 (estimated) (EPA, 2019)
BMF	In fish, BCFs ranging between 5 and 23 have been estimated for the isomers using linear regression equations based on log Kow, and water solubility data (Bysshe 1982; Horvath 1982; Lyman 1982). These estimates suggest that they do not bioconcentrate significantly in aquatic organisms. Based on this information, there is minimal potential for biomagnification within aquatic food chains (ATSDR, 2023).
Ecological Toxicity	During prioritization EPA identified environmental hazard effects for aquatic and terrestrial organisms.
Breakdown/degradation /combustion products	Vinyl chloride is a known degradation product
Anaerobic degradation	"1,2-Dichloroethene is an anaerobic degradation product of other chlorinated solvents such as trichloroethylene (TCE) and tetrachloroethylene (PCE) and can be unintentionally released in environments that are contaminated with these substances. This may occur in contaminated subsurface soils and groundwater, which may lead to vapor intrusion of 1,2-dichloroethene into buildings or dwellings around the contaminated sites. (ATSDR, 2023)" 18%/40 weeks (serum bottle) vinyl chloride was the primary degradation product (HSDB, 2018; citing Wilson (1986). (EPA, 2019) 73%/6 months (microcosoms with uncontaminated organic sediment from the Everglades); vinyl chloride was the degradation product. (HSDB 2018); citing Barrio-Lage (1986) (EPA, 2019)
Aerobic degradation	Not readily biodegradable in aerobic aquatic environments. It had a 0% BOD over a 28 day incubation period using a sewage sludge inoculum and the MITI test method. TransDCE may persist in subsurface environments, groundwater, or enclosed pipes when volitization is not an option (EPA, 2019).
Other observable ecological effects (e.g. BOD)	"In muck and sediment microcosms, tetrachloroethylene is converted to 1,2-dichloroethene with a preponderance of cis-1,2-dichloroethene (Parsons et al. 1984). cis-1,2-Dichloroethene apparently is the more common isomer found, although it may be mistakenly reported as trans-1,2-dichloroethene. Because it is a priority pollutant, trans-1,2-dichloroethene is more commonly analyzed for, and the analytical procedures used generally do not distinguish between isomers (Cline and Viste 1985)." (ATSDR, 2023) Stable; transDCE is not expected to undergo hydrolysis based on its chemical structure, which lacks functional groups known to undergo hydrolysis under environmental conditions (EPA, 2019).

Transport Issues	High mobility is expected in soil based on a measured Koc of 59 (EPA, 2020).

CompTox Data

Property	Trans DCE	TCE	Perc
			
CAS #	156-60-5	79-01-6	127-18-4
Soil adsorption coeff (Koc) L/kg	54.6	100	251
Water Solubility, mol/L	4.84e-2	1.00e-2	1.78e-3
Octanol water coefficient, LogKow	1.86	2.51	3.4
Biodeg. Half-life, days	8.71	6.17	20.9
BCF, L/kg	10.4	17	134

References:

1. American Conference of Industrial Hygienists (ACGIH) Substance Information Page Accessed July 26, 2024 from: https://www.acgih.org/12-dichloroethylene/
2. Agency for Toxics Substances and Disease Registry (ATSDR) 2023 Toxicological Profile for 1,2-Dichloroethene. Accessed August 2, 2024 from: https://www.atsdr.cdc.gov/ToxProfiles/tp87.pdf
3. Barnes DW, Sanders VM, White KL, et al. 1985. Toxicology of trans-1,2-dichloroethylene in the mouse. Drug Chem Toxicol 8(5):373-392. http://doi.org/10.3109/01480548509041065.
4. Environmental Protection Agency (EPA) September 2010 Toxicological Review of cis-1,2-dichloroethylene and trans-1,2-dichloroethylene. In Support of Summary Information on the Ingegrated Risk Information System (IRIS)
5. Environmental Protection Agency (EPA) 2019 Proposed Designation of trans-1,2-Dichloroethylene (CASRN 156-60-5) as a High-Priority Substance for Risk Evaluation. Accessed August 2, 2024 from:

https://www.epa.gov/sites/default/files/2019-08/documents/trans-12-dichloroethylene_156-60-5_high-priority_proposeddesignation_082319.pdf

6. Environmental Protection Agency (EPA) Final Scope of Risk Evaluation for trans-1,2-dichloroethylene. EPA Document # EPA-740-R-20-007 August 2020. Accessed August 2, 2024 from: https://www.epa.gov/sites/default/files/2020-09/documents/casrn_156-60-5_trans-12-dichloroethylene_final_scope.pdf
7. Environmental Protection Agency (EPA) September 2020. Provisional Peer-Reviewed Toxicity Values for trans-1,2-Dichloroethylene (CASRN 156-60-5) [Noncancer Inhalation Values] EPA/690/R-20/006F. Accessed August 2, 2024 from: https://hhpprtv.ornl.gov/issue_papers/Dichloroethylenetrans12.pdf
8. Freundt KJ, Liebaldt GP, Lieberwirth E. Toxicity studies on trans-1,2-dichloroethylene. Toxicology. 1977 Apr;7(2):141-53. doi: 10.1016/0300-483x(77)90059-2. PMID: 854930.
9. Hayes JR, Condie LW, Egle JL, et al. 1987. The acute and subchronic toxicity in rats of trans-1,2- dichloroethylene in drinking water. J Am Coll Toxicol 6(4):471-478. http://doi.org/10.3109/10915818709075692.
10. Hurtt ME, Valentine R, Alvarez L. Developmental toxicity of inhaled trans-1,2-dichloroethylene in the rat. Fundam Appl Toxicol. 1993 Feb;20(2):225-30. doi: 10.1006/faat.1993.1030. PMID: 8449394.
11. Ji G, Xu C, Sun H, Liu Q, Hu H, Gu A, Jiang ZY. Organochloride pesticides induced hepatic ABCG5/G8 expression and lipogenesis in Chinese patients with gallstone disease. Oncotarget. 2016 Jun 7;7(23):33689-702. doi: 10.18632/oncotarget.9399. PMID: 27203212; PMCID: PMC5085112.
12. Munson, A. E., Sanders, V. M., Douglas, K. A., Sain, L. E., Kauffmann, B. M., & White, , Kimber L. (1982). In vivo Assessment of Immunotoxicity. Environmental Health Perspectives, 43, 41–52. https://doi-org.umasslowell.idm.oclc.org/10.2307/3429167
13. National Toxicology Program (NTP) Technical Report on the toxicity studies of trans-1,2-dichloroethylene (CAS no. 156-60-5) administered in microcapsules in feed to F344/N rats and B6C3F(1) mice. Toxic Rep Ser. 2002 Apr;(55):1-F12. PMID: 12118262.
14. Ruckart PZ, Bove FJ, Maslia M. Evaluation of exposure to contaminated drinking water and specific birth defects and childhood cancers at Marine Corps Base Camp Lejeune, North Carolina: a case-control study. Environ Health. 2013 Dec 4;12:104. doi: 10.1186/1476-069X-12-104. PMID: 24304547; PMCID: PMC3880212.

15. Shopp, G. M., Sanders, V. M., White, K. L., & Munson, A. E. (1985). Humoral and Cell-Mediated Immune Status of Mice Exposed to Trans-1,2-Dichloroethylene. Drug and Chemical Toxicology, 8(5), 393–407. https://doi.org/10.3109/01480548509041066
16. World Health Organization (2003) 1,20Dichloroethene in Drinking-water. *Background document for development of WHO Guidlines for Drinking-water Quality* WHO/SDE/WSH/03.04/21 https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/1-2-dichloroethene-background.pdf?sfvrsn=d4718881_3