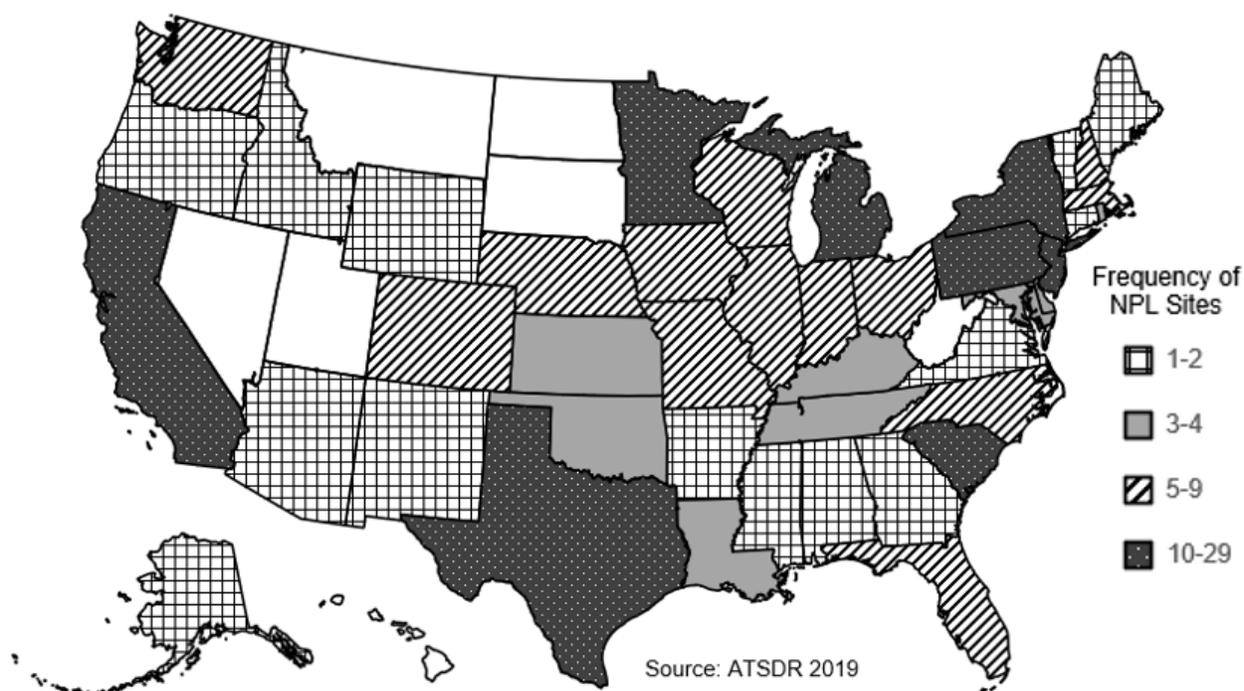


CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

1,1,2-Trichloroethane has been identified in at least 263 of the 1,867 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2019). However, the number of sites in which 1,1,2-trichloroethane has been evaluated is not known. The number of sites in each state is shown in Figure 5-1. Of these sites, 262 are located within the United States and 1 is located in the Virgin Islands (not shown).

Figure 5-1. Number of NPL Sites with 1,1,2-Trichloroethane Contamination



- The general population may be exposed to low levels of 1,1,2-trichloroethane through inhalation of contaminated air and ingestion of contaminated well water (exposure via drinking water is uncommon based on monitoring data for groundwater supplies).
- People who live or work near industries that produce or use 1,1,2-trichloroethane could most likely be exposed from contaminated air (from emissions and volatilization from waste water).
- 1,1,2-Trichloroethane does not absorb appreciably to suspended solids, sediment, or soil.
- 1,1,2-Trichloroethane undergoes anaerobic biodegradation in groundwater and sediment and volatilization in surface water. 1,1,2-Trichloroethane in the air is oxidized by hydroxyl radicals.

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1,1,2-Trichloroethane is predominantly a man-made chemical whose presence in the environment results from anthropogenic activity. This chemical has also been identified as an intermediate in the biodegradation of 1,1,2,2-tetrachloroethane, another man-made chemical. It is made commercially by the chlorination of ethylene with chlorine or by the oxychlorination of ethylene with HCl and oxygen. It is primarily used as a captive intermediate in the manufacture of 1,1-dichloroethene (vinylidene chloride), but may also be used as a solvent, especially in chlorinated rubber manufacture. In December 2019, 1,1,2-trichloroethane was designated as a high priority substance for risk evaluation following the process as required by section 6(b) of the Toxic Substances Control Act (TSCA) (EPA 2020a). In the future, EPA intends to evaluate the manufacture, importation, processing, and distribution, as well as commercial and consumer uses, along with disposal of 1,1,2-trichloroethane in a broader risk evaluation.

If 1,1,2-trichloroethane is released into soil, it is expected to partially leach into the subsurface and groundwater (because it has a low soil adsorption coefficient), and to partially volatilize. In groundwater, it will be subject to anaerobic biodegradation; however, no information concerning reaction rates is available. Biodegradation is expected to occur in sediment and landfills when anaerobic conditions are present. The mechanism for biodegradation is reductive dehalogenation, which leads to the formation of vinyl chloride, a human carcinogen (USDHHS 1985). From the limited data available, biodegradation under aerobic conditions, such as exists in surface soil, will be very slow, at best. In surface water, volatilization is the primary fate process (half-life 4.5 hours in a model river). Adsorption to sediment, bioconcentration in aquatic organisms, aerobic biodegradation, and hydrolysis are thought to be negligible by comparison. In the atmosphere, the dominant removal process is expected to be oxidation by photochemically-generated hydroxyl radicals, which proceeds by H-atom abstraction (estimated half-life 49 days). The radical so produced subsequently reacts with atmospheric oxygen and other atmospheric gases (methane, carbon monoxide, and others). Removal from the atmosphere is also thought to occur from washout by precipitation; however, most of the 1,1,2-trichloroethane removed by this process is expected to reenter the atmosphere by volatilization. Because oxidation in the atmosphere is slow, considerable dispersion of 1,1,2-trichloroethane from source areas would be expected to occur. Thus, it is conceivable that 1,1,2-trichloroethane could be transported from other countries where it may be more widely used.

The general population may be exposed to low levels of 1,1,2-trichloroethane through inhalation of contaminated ambient air. Limited environmental monitoring data suggest that roughly one-quarter to one-half of the urban population may be so exposed. Where 1,1,2-trichloroethane is found, levels appear to be about 10–50 ppt. Results from a nationwide monitoring study of groundwater supplies show that

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exposure to 1,1,2-trichloroethane from contaminated drinking water appears to be uncommon (Westrick et al. 1984). However, in a New Jersey survey, 6.7% of the wells contained detectable levels of 1,1,2-trichloroethane; the most polluted wells being associated with urban land use (Greenberg et al. 1982; Page 1981). It is difficult to assess occupational exposure because data on current production and use are unavailable. A National Occupational Exposure Survey (NOES) by the National Institute of Occupational Safety and Health (NIOSH) through May 1988 estimated that 1,036 employees were potentially exposed to 1,1,2-trichloroethane in the United States. Occupational exposure will be primarily via inhalation.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

The Chemical Data Reporter indicated that there were four U.S.-based companies that either manufactured or imported 1,1,2-trichloroethane to the United States in 2015 (CDR 2016). Based on the 2016 Chemical Data Reporting (CDR) period, 1,1,2-trichloroethane total production volume from the four reporting facilities in 2015 was between 100 million and 250 million pounds (EPA 2020b). Most companies reported the production or import volume as confidential business information (CBI); however, in 2010, two corporations (i.e., Shin Etsu and Georgia Gulf Corporation) reported production volumes of 2,960,761 and 3,148,388 pounds, respectively.

1,1,2-Trichloroethane is produced from ethylene. In one method of preparation, ethylene is chlorinated to give 1,2-dichloroethane, which is then reacted with chlorine to give 1,1,2-trichloroethane (Archer 1979). A second method is via the oxychlorination of ethylene with hydrogen chloride and oxygen at 280–370°C in the presence of a catalyst (Archer 1979). 1,2-Dichloroethane and higher chlorinated ethanes are also formed in this process. 1,1,2-Trichloroethane is also produced as a coproduct in the thermal chlorination of 1,1-dichloroethane to produce 1,1,1-trichloroethane, especially when the reaction is carried out in the liquid phase (Archer 1979).

1,1,2-Trichloroethane is sometimes present as an impurity in commercial samples of 1,1,1-trichloroethane and trichloroethylene (Henschler et al. 1980; Tsuruta et al. 1983). 1,1,2-Trichloroethane has been shown to be formed during the anaerobic biodegradation of 1,1,2,2-tetrachloroethane; anaerobic conditions may occur in groundwater or in landfills (Bouwer and McCarty 1983; Hallen et al. 1986).

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Table 5-1 summarizes information on U.S. companies that manufactured or used 1,1,2-trichloroethane in 2016 (TRI18 2020).

Table 5-1. Facilities that Produce, Process, or Use 1,1,2-Trichloroethane

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AR	2	100	999,999	12
IL	1	1,000	9,999	12
KS	1	10,000	99,999	1, 5
KY	1	1,000,000	9,999,999	1, 3, 6
LA	9	1,000	9,999,999	1, 3, 5, 6, 12, 13
MN	1	1,000	9,999	11, 12
OH	2	1,000	99,999	12
OR	1	10,000	99,999	12
SC	1	100	999	12
TX	8	10,000	9,999,999	1, 3, 4, 5, 6, 12, 13, 14

^aPost office state abbreviations used.

^bAmounts on site reported by facilities in each state.

^cActivities/Uses:

- | | | |
|----------------------|-----------------------------|--------------------------|
| 1. Produce | 6. Reactant | 11. Manufacture Aid |
| 2. Import | 7. Formulation Component | 12. Ancillary |
| 3. Used Processing | 8. Article Component | 13. Manufacture Impurity |
| 4. Sale/Distribution | 9. Repackaging | 14. Process Impurity |
| 5. Byproduct | 10. Chemical Processing Aid | |

Source: TRI18 2020 (Data are from 2018)

5.2.2 Import/Export

Limited data pertaining to the import/export of 1,1,2-trichloroethane were located in the available literature. EPA employed the database Datamyne, which is a commercially available trade database that covers the import-export data and global commerce of more than 50 countries across five continents. In 2015, one shipment of liquid 1,1,2-trichloroethane to New York was identified; however, the shipper, consignee, and volume were not available (EPA 2020c).

5.2.3 Use

The principal use of 1,1,2-trichloroethane is as a chemical intermediate in the production of 1,1-dichloroethene (Archer 1979). There is no information available on the uses of the 'low millions of

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pounds' that were said to have been sold to other industries by Dow Chemical. Some 1,1,2-trichloroethane was sold for use in consumer products (Thomas et al. 1982). There was no indication in the literature as to what these products were. Moolenaar and Olson (1989), in a written communication as spokesmen for the Dow Chemical Company, a major producer of 1,1,2-trichloroethane, however, stated that they are not aware of any consumer uses and that the Dow Chemical Company screens potential customers to determine how they intend to use it.

5.2.4 Disposal

1,1,2-Trichloroethane is included on the list of hazardous wastes pursuant to the Resource Conservation Recovery Act (RCRA) (EPA 2020a). It is typically disposed of by incineration or landfill disposal, although it has been reported to also be recycled (EPA 2020c). 1,1,2-Trichloroethane that may be present in commercial and consumer products may be disposed of in Municipal Solid Waste (MSW) landfills. Releases to ambient air from municipal and industrial hazardous waste incineration or energy recovery units that result in the formation of byproducts from combustion of 1,1,2-trichloroethane wastes may be subject to regulations, as would 1,1,2-trichloroethane burned for energy recovery (EPA 2020a).

5.3 RELEASES TO THE ENVIRONMENT

EPA's National Emission Inventory (NEI) database contains information regarding sources that emit criteria air pollutants (CAPs) and their precursors, and hazardous air pollutants (HAPs) for the 50 United States, Washington DC, Puerto Rico, and the U.S. Virgin Islands (EPA 2014). Emissions are estimated from multiple sources, including state and local environmental agencies; the TRI database; computer models for on- and off-road emissions; and databases related to EPA's Maximum Achievable Control Technology (MACT) programs to reduce emissions of HAPs. 1,1,2-Trichloroethane emissions estimated from the 2014 inventory are summarized in Table 5-2.

Table 5-2. Estimated Emissions of 1,1,2-Trichloroethane

Emission sector	Pounds of 1,1,2-trichloroethane emitted
Bulk gasoline terminals	0.67
Fuel combustion; commercial/institutional; biomass	0
Fuel combustion; commercial/institutional; natural gas	114.5111
Fuel combustion; commercial/institutional; oil	0.005269
Fuel combustion; commercial/institutional; other	17.83245
Fuel combustion; electric generation - coal	593.52

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Table 5-2. Estimated Emissions of 1,1,2-Trichloroethane

Emission sector	Pounds of 1,1,2-trichloroethane emitted
Fuel combustion; electric generation - natural gas	28.48634
Fuel combustion; electric generation - oil	0.031461
Fuel combustion; electric generation - other	56.16732
Fuel combustion; industrial boilers, ICEs; biomass	2,290.041
Fuel combustion; industrial boilers, ICEs; coal	71.78031
Fuel combustion; industrial boilers, ICEs; natural gas	7,339.985
Fuel combustion; industrial boilers, ICEs; oil	3.866473
Fuel combustion; industrial boilers, ICEs; other	323.3723
Gas stations	4.21
Industrial processes; cement manufacturing	71.0915
Industrial processes; chemical manufacturing	11,864.05
Industrial processes; ferrous metals	3.87
Industrial processes; NEC	3,257.925
Industrial processes; non-ferrous metals	3
Industrial processes; oil and gas production	14,394.57
Industrial processes; petroleum refineries	2.731003
Industrial processes; pulp and paper	35,917.96
Industrial processes; storage and transfer	1,027.064
Solvent; degreasing	0.28013
Solvent; industrial surface coating and solvent use	134.82
Waste disposal	3,896.248

ICE = internal combustion engine; NEC = not elsewhere classified

Source: EPA 2014

The Toxics Release Inventory (TRI) data should be used with caution because only certain types of facilities are required to report (EPA 2005). This is not an exhaustive list. Manufacturing and processing facilities are required to report information to the TRI only if they employ ≥ 10 full-time employees; if their facility is included in Standard Industrial Classification (SIC) Codes 10 (except 1011, 1081, and 1094), 12 (except 1241), 20–39, 4911 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4931 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4939 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4953 (limited to facilities regulated under RCRA Subtitle C, 42 U.S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited to facilities primarily engaged in solvents recovery services on a contract or fee basis); and if their facility produces, imports, or processes

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≥25,000 pounds of any TRI chemical or otherwise uses >10,000 pounds of a TRI chemical in a calendar year (EPA 2005).

5.3.1 Air

Estimated releases of 46,291 pounds (~20.99 metric tons) of 1,1,2-trichloroethane to the atmosphere from 27 domestic manufacturing and processing facilities in 2018, accounted for about 71% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). These releases are summarized in Table 5-3.

Table 5-3. Releases to the Environment from Facilities that Produce, Process, or Use 1,1,2-Trichloroethane^a

State ^c	RF ^d	Reported amounts released in pounds per year ^b							Total release		
		Air ^e	Water ^f	UI ^g	Land ^h	Other ⁱ	On-site ^j	Off-site ^k	On- and off-site		
		AR	2	2	0	0	0	0	2	0	2
IL	1	1	0	0	5	0	1	5	6		
KS	1	0	0	94	0	0	94	0	94		
KY	1	2,143	35	0	0	0	2,178	0	2,178		
LA	9	19,489	6	0	38	0	19,494	38	19,532		
MN	1	21,283	0	0	0	0	21,283	0	21,283		
OH	2	3	0	0	0	502	3	502	505		
OR	1	0	0	0	18,396	0	18,396	0	18,396		
SC	1	1	0	2	0	0	1	2	3		
TX	8	3,370	0	0	0	0	3,370	0	3,370		
Total	27	46,291	41	96	18,439	502	64,822	547	65,369		

^aThe TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.

^bData in TRI are maximum amounts released by each facility.

^cPost office state abbreviations are used.

^dNumber of reporting facilities.

^eThe sum of fugitive and point source releases are included in releases to air by a given facility.

^fSurface water discharges, wastewater treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).

^gClass I wells, Class II-V wells, and underground injection.

^hResource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.

ⁱStorage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown

^jThe sum of all releases of the chemical to air, land, water, and underground injection wells.

^kTotal amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI18 2020 (Data are from 2018)

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1,1,2-Trichloroethane is emitted in vent gas when produced by the oxychlorination of ethylene dichloride (EPA 1977). Environmental releases of 1,1,2-trichloroethane from 1,1-dichloroethene manufacture are small; an EPA study found no 1,1,2-trichloroethane in process vent gas (Thomas et al. 1982). 1,1,2-Trichloroethane is formed in small quantities and may be released in vent gas or fugitive emissions during the production of other chlorinated hydrocarbons, for example, 1,2-dichloroethane and 1,1,1-trichloroethane (Thomas et al. 1982). Fugitive emission from its use as a solvent and volatilization from waste water constitute the major environmental release of 1,1,2-trichloroethane. An estimate of the total release of 1,1,2-trichloroethane was made for 1979 by comparing ambient levels of 1,1,1-trichloroethane and 1,1,2-trichloroethane in urban air and releases of 1,1,1-trichloroethane (Thomas et al. 1982). The annual amount of 1,1,2-trichloroethane released annually was calculated to be 10,000–20,000 million tons.

A correlation of data from the EPA Air Toxics Emission Inventory with industrial source categories (SIC codes) shows that volatile emissions of 1,1,2-trichloroethane are associated with plastic materials and resins, industrial organic chemicals, petroleum refining, gaskets-packing and sealing devices, plating and polishing, residential lighting fixtures, radio and TV communication equipment, electronic components, motor vehicles parts and accessories, engineering and scientific instruments, photographic equipment, and supplies (SIC Codes 2821, 2869, 2911, 3293, 3471, 3645, 3662, 3679, 3714, 3811, 3861) (EPA 1987).

Volatile organic compound (VOC) emissions are observed at solid waste landfills (these emissions are 2.6 times greater in a wet climate than a dry one [Vogt et al. 1987]). Therefore, low levels of 1,1,2-trichloroethane may be expected in landfill gases from NPL sites.

5.3.2 Water

Estimated releases of 41 pounds (~0.02 metric tons) of 1,1,2-trichloroethane to surface water from 27 domestic manufacturing and processing facilities in 2018, accounted for about 0.06% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). These releases are summarized in Table 5-3.

Waste water streams from the production of 1,1,2-trichloroethane by liquid-phase chlorination of ethylene dichloride and the oxychlorination of ethylene dichloride with HCl contain 1,1,2-trichloroethane (EPA 1977). Between 1980 and 1988, 707 samples of waste water in EPA's STORET database were analyzed for 1,1,2-trichloroethane (STORET 1988). Ten percent of the samples contained ≥ 10 ppb concentrations of 1,1,2-trichloroethane and the maximum level obtained was 360 ppb. Unfortunately, the detection limit

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is apparently recorded when no chemical is detected, so it is impossible to say whether the 90 percentile figure represents the sample above or below the limit of detection. EPA investigated priority pollutants in 40 geographically distributed publicly-owned treatment works (POTWs) representing a variety of municipal treatment technologies, size ranges, and industrial flow conditions. In this study, 1,1,2-trichloroethane was detected in 7% of influent samples, 3% of effluent samples, and 4% of raw sludge samples at maximum concentrations of 135, 6, and 2,100 ppb, respectively (EPA 1982a).

1,1,2-Trichloroethane was found at concentrations of 2.1, 26, and 180 ppb in three outfalls from the Dow Chemical of Canada plant into the St. Clair River for a net loading of 3.5 kg/day (King and Sherbin 1986). Puddles containing chlorinated hydrocarbons had been discovered on the bottom of the St. Clair River, which received these effluents (Kaiser and Comba 1986; King and Sherbin 1986). These chemicals are thought to be products or byproducts of chlorinated hydrocarbons manufactured at this site. Waste from this operation is now being incinerated but was historically landfilled. Landfill leachate from the landfill is treated with carbon and then discharged into a ditch leading to the St. Clair River. The concentration of 1,1,2-trichloroethane before and after treatment was 1,300 and 1,800 ppb. However, the carbon filter was reportedly spent (owing to saturation of the carbon) at the time of the survey.

1,1,2-Trichloroethane was detected in two samples at 2–3 ppb from Eugene, Oregon in the National Urban Runoff Program, in which 86 samples of runoff from 19 cities throughout the United States were analyzed (Cole et al. 1984). Runoff water from NPL hazardous waste sites containing 1,1,2-trichloroethane might be contaminated with this pollutant. No monitoring studies of runoff water from wastes sites were found in the available literature.

5.3.3 Soil

Estimated releases of 18,439 pounds (~8.36 metric tons) of 1,1,2-trichloroethane to soil from 27 domestic manufacturing and processing facilities in 2018, accounted for about 28.21% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). An additional 96 pounds (~0.04 metric tons), accounted for about 0.15% of the total environmental emissions, were released via underground injection (TRI18 2020). These releases are summarized in Table 5-3.

No information on the release of 1,1,2-trichloroethane to soil was found in the available literature. It is anticipated that process residues and sludge containing this chemical may be landfilled (Jackson et al. 1984). In an experiment designed to simulate the anaerobic conditions for biodegradation in landfills,

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1,1,2-trichloroethane was found to be a biodegradation product of 1,1,2,2-tetrachloroethane (Hallen et al. 1986). Therefore 1,1,2-trichloroethane may be produced in landfills or other anaerobic environments (e.g., groundwater) that have been contaminated with 1,1,2,2-tetrachloroethane.

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

Air. In the atmosphere, the dominant removal process is expected to be oxidation by photochemically-generated hydroxyl radicals, which proceeds by H-atom abstraction. Breakdown in both the air is slow. In the air, half the 1,1,2-trichloroethane is expected to breakdown in 49 days and therefore, it is likely to spread far from where it is released before breaking down.

Water. Based on a measured Henry's Law constant of 9.1×10^{-4} atm/m³-mol (Ashworth et al. 1988), the volatilization half-life of 1,1,2-trichloroethane in a model river 1 m deep flowing 1 meter/second with a wind of 3 meters/second is estimated to be 4.5 hours, with resistance in the liquid phase primarily controlling volatilization (Thomas 1982). The half-life in a lake or pond would be much longer. The half-life of 1,1,2-trichloroethane in the lower Rhine river was 1.9 days (Zoeteman et al. 1980). This determination was based on monitoring data and river flow data. This half-life was ascribed to volatilization. In waste water treatment plants that receive refractory volatile compounds such as 1,1,2-trichloroethane from industrial discharges or other sources, stripping will be an important mechanism for transferring the chemical from the water into the air. In stripping, as opposed to ordinary volatilization, the liquid and gas phases are dispersed with the result that the interfacial surface area is much greater and liquid/gas mass transfer greatly enhanced. In five pilot scale treatment plants, 98–>99% of 1,1,2-trichloroethane was removed by this process (EPA 1981).

Sediment and Soil. In view of its moderately high vapor pressure and low adsorptivity to soil, 1,1,2-trichloroethane is expected to volatilize rapidly from soil surfaces. In one experiment in which 1,1,2-trichloroethane was applied to a column of sandy soil with a very low organic carbon content, volatilization and leaching were equally important transport processes (Thomas et al. 1982).

The adsorption based on organic carbon, K_{oc} , of 1,1,2-trichloroethane on a sandy forest soil (low organic carbon content and cation exchange capacity, CEC), an agricultural soil, and a forest soil (pH lower than the agricultural soil) was 60.0, 63.7, and 108, respectively (Seip et al. 1986). In soil column experiments with these soils, the 1,1,2-trichloroethane moved through the sandy forest soil almost at the same rate as

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water, whereas the retardation was progressively greater in the agricultural soil and greatest in forest soil; the respective retention coefficients (velocity of water through the soil divided by the velocity of pollutant through the soil) being 1.53, 4.52, and 8.11 (Seip et al. 1986). Therefore 1,1,2-trichloroethane would not adsorb appreciably to soil, sediment, and suspended solids in the water column and would be expected to readily leach into the subsurface soil and groundwater. A second investigator obtained a K_{oc} of about 70 and a retardation factor of <1.5 using a sandy soil of lower organic carbon content than that used in the first study (Wilson et al. 1981).

Other Media. The bioconcentration factors (BCFs) for 1,1,2-trichloroethane reported in the literature are <10 (Kawasaki 1980) and 17 (Isnard and Lambert 1988). Therefore, it would not be expected to bioconcentrate in fish to any great extent.

5.4.2 Transformation and Degradation

Air. In the atmosphere, 1,1,2-trichloroethane will be degraded by reaction with photochemically-produced hydroxyl radicals. The reaction proceeds by H-atom abstraction to yield water and the corresponding $C_2H_2Cl_3$ radical. The rate of this reaction is 3.28×10^{-13} cc/molecules-second, which would give rise to a half-life of 49 days, assuming an average hydroxyl radical concentration of 5×10 radicals/cc (Jeong et al. 1984).

Water. 1,1,2-Trichloroethane undergoes both a pH-independent and a base-catalyzed hydrolysis at environmental pH. The neutral hydrolysis process is a substitution reaction leading to the formation of an alcohol, while the base-catalyzed reaction is an elimination reaction giving rise to 1,1-dichloroethene and HCl (Mabey et al. 1983; Vogel et al. 1987). In the case of 1,1,2-trichloroethane, the base-catalyzed rate is 5.9×10^{-3} /mol-second at 25°C and is dominant above pH 5.4; the neutral rate is only 9×10^{-8} seconds⁻¹ at 80°C (Mabey et al. 1983). The half-life would be 37 years at pH 7 and 135 days at pH 9. This is consistent with observations that no significant decrease in concentration occurs in 8 days in sterilized water (Jensen and Rosenberg 1975). No significant degradation was obtained in seawater (pH 7.4–7.7) in 14 days at a temperature of $11\text{--}12^\circ\text{C}$ (Jensen and Rosenberg 1975).

1,1,2-Trichloroethane showed no biodegradation in both a 24-day modified shake flask test and a river die-away test (Mudder and Musterman 1982). In two other biodegradation screening tests, one investigator reported no degradation and the other slow degradation after a long acclimation period

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(Kawasaki 1980; Tabak et al. 1981). However, the unknown extent to which volatilization contributed to losses in the second study makes the results suspect.

Under anaerobic conditions, 1,1,2-trichloroethane is reported to undergo dehalogenation. In order to establish whether this is a biologically mediated reaction and not simply an abiotic reaction catalyzed by free iron or iron porphyrin at low redox potential, Dow Chemical conducted 28-day studies in sterile solutions (Klecka and Gonsior 1983). They found that ppm concentrations of 1,1,2-trichloroethane did not undergo nonenzymatic dehalogenation in a sterile, anaerobic solution at pH 7 or when a sulfide redox buffer or hematin was added (Klecka and Gonsior 1983).

Sediment and Soil. The only study located regarding the degradation of 1,1,2-trichloroethane in soil involved subsurface samples taken from the margin of a floodplain near Lula, Oklahoma (Wilson et al. 1983). These samples were obtained both above the water table of a shallow aquifer and in the unconsolidated material in the saturated zone. A portion of the soil was sterilized and slurries were made and test chemical added. Manipulations made with samples from the saturated zone were carried out under nitrogen. After 16 weeks of incubation, no degradation of 1,1,2-trichloroethane was observed in the samples from above or below the water table. These results are in conflict with other studies (Wilson et al. 1983). It has been suggested that the time frame for the experiment may have been insufficient for resident microorganisms to have become acclimated to the chemical (Newsom 1985).

In an attempt to simulate the anaerobic conditions for biodegradation in landfills, experiments were performed under anoxic conditions using inocula from anaerobic digester units of waste water treatment facilities that were not acclimated to industrial solvents. After 1 week of incubation with 10 µg/L of 1,1,2-trichloroethane, 0.44 µg/g of vinyl chloride was formed, the highest level observed from any of the chlorinated ethanes or ethenes studied (Hallen et al. 1986). In further experiments when the concentration of inoculum was increased, 4.3 and 5.8 µg/g of vinyl chloride was formed after 1 and 2 weeks, respectively. The degradation reactions observed not only include reductive dehalogenation but the transformation of chlorinated ethanes into ethenes. It is interesting to note that autoclaved controls for a 1,1,2-trichloroethane anaerobic biodegradation experiment yielded 1,1-dichloroethene (Molton et al. 1987). The formation of 1,1-dichloroethene indicates that the conversion of 1,1,2-trichloroethane is nonbiological.

Degradation products (i.e., chloroethane, 1,2-dichloroethane, and vinyl chloride) were detected in 1,1,2-trichloroethane-amended microcosms constructed from anaerobic wetland sediments from the

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Aberdeen Proving Ground, Maryland, but no chlorinated daughter products were found in abiotic (killed) 1,1,2-trichloroethane-amended microcosms (Lorah and Voytek 2004).

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to 1,1,2-trichloroethane depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens.

Concentrations of 1,1,2-trichloroethane in unpolluted atmospheres and in pristine surface waters are often so low as to be near the limits of current analytical methods. In reviewing data on 1,1,2-trichloroethane levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable.

Table 5-4 shows the lowest limit of detections that are achieved by analytical analysis in environmental media. An overview summary of the range of concentrations detected in environmental media is presented in Table 5-5.

Table 5-4. Lowest Limit of Detection Based on Standards^a

Media	Detection limit	Reference
Air	<5 ppt	Grimsrud and Rasmussen 1975
Drinking water	0.2 µg/L	Comba and Kaiser 1983
Surface water and groundwater	0.2 µg/L	Comba and Kaiser 1983
Soil	0.2 µg/kg	EPA 1982b, 1986a
Sediment	5 µg/L	EPA 1987
Whole blood	No data	Cramer et al. 1988

^aDetection limits based on using appropriate preparation and analytics. These limits may not be possible in all situations.

Table 5-5. Summary of Environmental Levels of 1,1,2-Trichloroethane

Media	Low	High	For more information
Outdoor air (ppbv)	<LOD	0.011	Section 5.5.1
Indoor air (ppbv)	<LOD	2.5	Section 5.5.1
Surface water (ppm)	10	18	Section 5.5.2
Ground water (ppm)	1	350	Section 5.5.2

LOD = limit of detection

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Detections of 1,1,2-trichloroethane in air, water, and soil at NPL sites are summarized in Table 5-6.

Table 5-6. 1,1,2-Trichloroethane Levels in Water, Soil, and Air of National Priorities List (NPL) Sites

Medium	Median ^a	Geometric mean ^a	Geometric standard deviation ^a	Number of quantitative measurements	NPL sites
Water (ppb)	39	77.2	51.9	83	55
Soil (ppb)	1,400	2,140	124	39	27
Air (ppbv)	3.3	15	228	15	11

^aConcentrations found in ATSDR site documents from 1981 to 2019 for 1,867 NPL sites (ATSDR 2019). Maximum concentrations were abstracted for types of environmental media for which exposure is likely. Pathways do not necessarily involve exposure or levels of concern.

5.5.1 Air

1,1,2-Trichloroethane is a pollutant monitored for in the national Air Quality System (AQS) database, which contains ambient air pollution data collected by EPA, state, local, and tribal air pollution control agencies from monitors throughout the country. Table 5-7 shows the yearly mean 24-hour percentile distributions of 1,1,2-trichloroethane at monitoring stations across the United States.

Table 5-7. Summary of Annual Concentration of 1,1,2-Trichloroethane (ppbv) Measured in Ambient Air at Locations Across the United States^a

Year	Number of samples	Average of the arithmetic mean at all locations	Maximum concentration
2016	8,809	0.00247	0.06
2017	9,158	0.001241	0.03125
2018	8,641	0.004965	0.49661
2019	5,923	0.002081	0.119492
2020 ^b	161	No detections	No detections

^aValues were originally reported in parts per billion carbon (ppbC) and converted to ppbv; 24-hour sampling period.

^bAs of May 15, 2020.

Source: EPA 2020d

Two air samples from rural Oklahoma and air samples from rural areas of the Pacific Northwest did not contain 1,1,2-trichloroethane (Brodzinsky and Singh 1982; Grimsrud and Rasmussen 1975). While both inland and nearshore rural sites near San Francisco averaged 14 ppt of 1,1,2-trichloroethane, 95% of

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inland sites and 46% of nearshore sites contained levels above the 6 ppt detection limit (Singh et al. 1977). In 930 urban/suburban sites in the United States, the 25th, 50th, 75th percentile and maximum concentrations of 1,1,2-trichloroethane were 0, 9.1, 22, and 11,000 ppt, respectively (Brodzinsky and Singh 1982). Other studies that include 13 major U.S. cities report average air concentrations of 1,1,2-trichloroethane ranging from 6 to 41 ppt (Harkov et al. 1983; Lioy et al. 1983; Singh et al. 1981, 1982). In the study by Harkov et al. (1983) air concentrations in Camden, Elizabeth, and Newark, New Jersey were monitored during the summer of 1981. Of the 111 samples measured, 27% contained a detectable quantity of the pollutant, with a detection limit of 5 ppt. The following winter, 41% of the samples from these cities contained 1,1,2-trichloroethane. The geometric mean concentrations ranged from 20 to 50 ppt for the winter measurements. This was significantly higher than the 10 ppt value obtained the previous summer (Harkov et al. 1987). The median concentration of 1,1,2-trichloroethane in 97 samples obtained from source-related areas throughout the United States was 45 ppt. Of these samples, 25% exceeded 210 ppt and a maximum concentration was 2,300 ppt was measured in Dominguez, California (Brodzinsky and Singh 1982). The data compiled by Brodzinsky and Singh (1982) have been reviewed and most of it is of good quality. More data have now been added to this National Ambient Volatile Organic Compounds Database bringing the number of monitoring data points to 886 (EPA 1988b). According to this database, the median concentration of 1,1,2-trichloroethane in rural, suburban, and urban areas was 0 ppt; at source-dominated sites, the median 1,1,2-trichloroethane concentration was 2 ppt. The limited monitoring data suggest that roughly one-quarter to one-half of the urban population may be exposed to the compound in air. Where 1,1,2-trichloroethane is found, most levels range from 10 to 50 ppt.

The only data on levels of 1,1,2-trichloroethane measured indoors were contained in a study of eight homes in Knoxville, Tennessee obtained during the winter (Gupta et al. 1984). Eleven of 16 samples contained 1,1,2-trichloroethane with a mean (standard deviation) concentration of 14.1 (7.8) $\mu\text{g}/\text{m}^3$ (2.5 [1.4] ppb); however, samples taken outside the homes did not contain detectable levels of the chemical. Sources of the 1,1,2-trichloroethane inside the homes may be building materials or solvent-containing products.

Traces to 0.32 ppb of 1,1,2-trichloroethane in air samples were found in Iberville Parish, Louisiana, where many organic chemical and producer, user, and storage facilities are located along the Mississippi River (Pellizarri 1982). 1,1,2-Trichloroethane was not detected in ambient air samples collected from superfund sites of Ogden Railyard in June of 2000 and Intermountain Waste Oil Refinery from May to July 2004 (WQP 2020).

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5.5.2 Water

1,1,2-Trichloroethane was monitored as part of the Unregulated Contaminant Monitoring Rule (UCMR Round 1 monitoring data). This program collects data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the Safe Drinking Water Act (SDWA). 1,1,2-Trichloroethane was monitored for in 19,964 public water systems (PWS) in 24 states and was detected above its reporting level (5 ppb) in 0.04% of the PWS (EPA 2001). The maximum observed level was reported as 46 ppb obtained from a PWS in Florida and the median value of all detects was 0.99 ppb. As part of the EPA's Office of Ground Water and Drinking Water assessment of contaminants in public drinking water, 1,1,2-trichloroethane was monitored during the second Six-Year Review of National Primary Drinking Water Regulations (EPA 2010). 1,1,2-Trichloroethane was detected in 0.179% of samples obtained from PWS at concentrations ranging from 0.15 to 40 ppb (EPA 2010). It was reported that 13 PWS (0.026% of the total sampled) had levels of 1,1,2-trichloroethane that exceeded the threshold of interest (5 ppb).

1,1,2-Trichloroethane was not detected in composite samples of the water supplies of Philadelphia, Pennsylvania and Huntington, West Virginia, both of which are derived from surface sources (EPA 1980a). The levels in finished water from a New Orleans, Louisiana water supply ranged from 0.1 to 8.5 ppb (EPA 1980b). In a 10-city EPA survey conducted in 1975, 1,1,2-trichloroethane was only detected in the water supply of Miami, Florida, which obtains its water from a groundwater source (EPA 1975). The level of contamination was not determined. The maximum concentration of 1,1,2-trichloroethane detected in a survey of community and noncommunity water supplies from groundwater sources and private wells in Suffolk County, New York, was 13 ppb (Zaki 1986). 1,1,2-Trichloroethane has been found in 10 private wells in Rhode Island, at a concentration range of 1.0–14.0 ppb (RIDH 1989). A survey of Denver, Colorado, drinking water conducted in late 1985 to early 1986, found no 1,1,2-trichloroethane in the samples tested (Rogers et al. 1987). More recent data on 1,1,2-trichloroethane concentrations in drinking water or drinking water supplies were not available.

In a U.S. Groundwater Supply survey, none of the 945 groundwater supply sources tested contained 1,1,2-trichloroethane at a quantitation limit of 0.5 ppb (Westrick et al. 1984). Water quality data compiled from the Retrieval (STORET) Data Warehouse and the U.S. Geological Survey (USGS) National Water Information System (NWIS) indicated that 1,1,2-trichloroethane has been analyzed in over 6,000 groundwater samples across the United States in the last 5 years; it has been detected in

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approximately 27% of samples, but not above the lower reporting limit of 4.0 ppb (WQP 2020). Similarly, water quality data compiled from STORET and NWIS indicated that 1,1,2-trichloroethane was not detected at or above detection limits of 0.20–5.0 µg/L in surface water samples collected from 2016 to 2020 throughout the United States (WQP 2020). 1,1,2-Trichloroethane was not detected above the lower reporting limit of 0.40–0.60 ppb in storm water samples collected 2016 from the New Mexico Environmental Department or storm water samples collected in 2015 from the State of Oregon Department of Environmental Quality (WQP 2020). 1,1,2-Trichloroethane was not found above the minimum reporting level of 0.60–30.0 ppb in leachate samples collected by the State of Oregon Department of Environmental Quality from 2015 to 2020 (WQP 2020).

5.5.3 Sediment and Soil

1,1,2-Trichloroethane was not found in 128 sediment samples collected from 2010 to 2019 from various locations across the United States (WQP 2020). Data from the EPA Great Lakes National Program indicated 1,1,2-trichloroethane was detected in 85% of 244 sediment samples collected from 2011 to 2015 at levels less than the detection limit of 3.1–7,300 ppb (WQP 2020). 1,1,2-Trichloroethane was found in 25 of the 418 hazardous waste sites listed on the NPL of highest priority sites for possible remedial action (Mitre 1987). Additionally, it was found in three sites in the Contract Laboratory Statistical Database at mean concentrations ranging from 12 to 636 ppb (Viar and Company 1987). Soil samples from Idaho and Alaska did not contain 1,1,2-trichloroethane, but it was detected in samples from the Salt Chuck Mine superfund site at 3.5–14 ppb, which was less than the reporting limit (WQP 2020).

5.5.4 Other Media

1,1,2-Trichloroethane was detected in 9 of 22 commercial batches of technical-grade 1,1,1-trichloroethane supplied by eight different European manufacturers and dealers (Henschler et al. 1980). The concentration in these samples ranged from 300 to 3,015 ppm and the detection limit was 0.5 ppm. It was also found in some commercially available trichloroethylene in Japan (Tsuruta et al. 1983).

In a U.S. Food and Drug Administration (FDA) Total Diet Study conducted in the 1990s (specific date not reported) of 234 table-ready food items, 1,1,2-trichloroethane was detected in sandwich cookies at a concentration of 3.78 ppb (Heikes et al. 1995). More current data for the presence of 1,1,2-trichloroethane in food were not located.

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1,1,2-Trichloroethane was not detected in any of the 46 composite samples of human adipose tissue collected during FY82 as part of the National Human Adipose Tissue Survey (EPA 1986b). The composite specimens represented the nine U.S. census divisions stratified by three age groups (0–14, 15–44, and ≥ 45 years). Between July and December 1980, air and breath from nine New Jersey subjects were monitored in a pilot study to measure personal exposure to volatile organic substances for EPA's Total Exposure Assessment Methodology (TEAM) Study (Wallace et al. 1984). The personal air concentrations of 1,1,2-trichloroethane were below the detection limit in 151 of 161 of the samples; 7 contained trace levels of the chemical and the others ranged from 0.14 to 34.70 $\mu\text{g}/\text{m}^3$ (0.025–6.25 ppb), with a median of 0.35 $\mu\text{g}/\text{m}^3$ (0.063 ppb) (Wallace et al. 1984). Breath samples were negative in 44 of 49 samples and the others ranged from trace to 5.13 $\mu\text{g}/\text{m}^3$ (0.92 ppb), with a median of 0.2 $\mu\text{g}/\text{m}^3$ (0.036 ppb). No 1,1,2-trichloroethane was found in the subjects' drinking water at home. 1,1,2-Trichloroethane was identified, not quantified, in samples of blood obtained in October 2001 from firefighters who responded to the collapse of the World Trade Center (Edelman et al. 2003).

5.6 GENERAL POPULATION EXPOSURE

Consistent with its tendency to partition into air, most exposures to 1,1,2-trichloroethane are from air. Limited environmental monitoring data suggest that one-quarter to one-half of the urban population may be exposed to the compound in air. Where 1,1,2-trichloroethane is found, levels appear to be about 10–50 ppt, for an average daily intake of 1.1–5.5 $\mu\text{g}/\text{day}$. It appears that the general population is rarely exposed to 1,1,2-trichloroethane in drinking water.

1,1,2-Trichloroethane in water is expected to volatilize; thus, there is potential for inhalation exposure during showering and bathing. ATSDR's three-compartment Shower and Household-Use Exposure (SHOWER) model predicts air concentrations in the shower stall, bathroom, and main house throughout the day by estimating the contribution from showering or bathing and the contribution from other water sources in the house, such as the dishwasher, clothes washer, and faucets. This information, along with human activity patterns, is used to calculate a daily time-weighted average exposure concentration via inhalation exposure and from dermal uptake from skin contact. ATSDR's SHOWER model is available by sending a request to showermodel@cdc.gov.

Vapor intrusion may also be a potential source of 1,1,2-trichloroethane exposure, as vapor intrusion has been observed for several volatile organic chemicals (VOCs) with similar properties. EPA's compilation

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of four studies of background indoor air concentrations found a 0% detection rate for 1,1,2-trichloroethane in 1,002 U.S. resident samples between 1990 and 2005 (EPA 2011). ATSDR extracted environmental data from 135 ATSDR reports evaluating the vapor intrusion pathway at 121 sites published between 1994 and 2009 (Burk and Zarus 2013); levels of 1,1,2-trichloroethane did not exceed ATSDR health risk comparison values.

1,1,2-Trichloroethane levels have been monitored in blood samples from the 2003–2004, 2005–2006, 2007–2008, 2009–2010, and 2011–2012 NHANES. Blood levels were below the detection limit of 0.01 ng/mL in all surveys using participants' whole blood sample (CDC 2017).

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

A NOES conducted by NIOSH from 1981 to 1983 estimates that 1,038 workers, including 16 women, were potentially exposed to 1,1,2-trichloroethane in the United States (NIOSH 1988). The NOES was based on field surveys of 4,490 facilities and was designed as a nationwide survey based on a statistical sample of virtually all workplace environments in the United States where eight or more persons are employed in all SIC codes except mining and agriculture. In the earlier NIOSH National Occupational Hazard Survey, the highest exposures occurred around blast furnaces, in steel rolling mills, and in factories manufacturing technical instruments (Konietzko 1984).

If people use products containing 1,1,2-trichloroethane as a solvent, they will be potentially exposed to high levels of this chemical. Moolenaar and Olson (1989), in a written communication as spokesmen for the Dow Chemical Company, however, stated that they are not aware of any consumer uses and that the Dow Chemical Company screens potential customers to determine how they intend to use the 1,1,2-trichloroethane they purchase. Therefore, the potential for exposure from use of consumer products is probably low.

While it appears that exposure to high levels of 1,1,2-trichloroethane is rare, there are a few data that indicate that a small number of people may be exposed to high levels of 1,1,2-trichloroethane from contaminated air or drinking water. In Lake Charles, Louisiana, the median and maximum air concentrations of 1,1,2-trichloroethane were 4.8 and 7.4 ppb (Brodzinsky and Singh 1982). This indicates that half of the population of this community have a daily intake of 530–820 $\mu\text{g/g}$, compared with a median intake of 2.6 $\mu\text{g/g}$ for all the urban/suburban areas of the United States that were monitored. Other cities where air concentrations >0.1 ppb were sometimes observed were Elizabeth,

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New Jersey; Deer Park, Texas; Freeport, Texas; Geismar, Louisiana; Edison, New Jersey, and Dominguez, California (Brodzinsky and Singh 1982). The data indicate that the air concentrations are variable, and only occasionally are high levels of 1,1,2-trichloroethane observed. From the available data, it is apparent that some wells in Suffolk County, New York, New Jersey, and near landfills in Minnesota and Wisconsin contain 1,1,2-trichloroethane concentrations as high as 13–31 ppb, corresponding to an average daily intake of 26–62 $\mu\text{g/g}$ per day. The available data are insufficient to estimate the number of people that may be exposed to high levels of 1,1,2-trichloroethane.