

5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

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. Production and use information are proprietary, however effluent monitoring data indicate that high levels (>100 ppb) of discharge are associated with laundries, and the organic chemicals and mechanical products industries (Table 5-1). The maximum levels in these waste-waters were 109-250 ppb. Gaseous releases include vent gas and fugitive emissions from the production and use of 1,1,2-trichloroethane as well as volatilization from wastewater and municipal treatment plants. Releases to soil are expected to involve the landfilling of sludge and process residues. Thus far, 1,1,2-trichloroethane has been found at 45 of 1177 hazardous waste sites on the National Priorities List (NPL) in the United States (VIEW Database 1989). Based on the release pattern of other chlorinated ethanes and ethenes, it is expected that the release pattern for 1,1,2-trichloroethane is 70-90% to air, 10-30% to land, and a few percent to water. No use with significant consumer, and general population exposures has been identified.

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 hr 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 species. 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

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TABLE 5-1. Sources of 1,1,2-Trichloroethane Effluents^a

Industry	Frequency	Concentration (ppb)		
		Maximum	Medium	Low
Timber products	1	18.46	18.46	18.46
Organics and plastics	1	7.12	7.12	7.12
Inorganic chemicals	2	6.00	4.00	2.01
Plastics and synthetics	2	31.85	3.65	0.26
Auto and other laundries	1	108.99	108.99	108.99
Organic chemicals	1	203.77	203.77	203.77
Mechanical products	4	249.52	45.74	1.33
Transportation equipment	3	75.33	66.34	24.53
Synfuels	1	2.43	2.43	2.43
Publicly owned treatment works	4	15.22	1.20	0.42

^aDischarges to water

Source: Shackelford et al. 1983

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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 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 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 (Page 1981; Greenberg et al. 1982). 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, estimates that 1,036 employees are potentially exposed to 1,1,2-trichloroethane in the United States. Occupational exposure will be primarily via inhalation.

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

1,1,2-Trichloroethane is emitted in vent gas when produced by the oxychlorination of ethylene dichloride (Liepins et al. 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 wastewater 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

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equipment and supplies (SIC Codes 2821, 2869, 2911, 3293, 3471, 3645, 3662, 3679, 3714, 3811, 3861) (EPA 1987a).

1,1,2-Trichloroethane was found at hazardous waste sites that are included in the National Priorities List (NPL). 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.

5.2.2 Water

Wastewater 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 (Liepins et al. 1977). Information on industries that discharge 1,1,2-trichloroethane, the frequency of discharge, and concentration levels can best be obtained from the results of a comprehensive wastewater survey conducted by the Effluent Guidelines Division of the EPA shown in Table 5-1. Over 4000 samples of wastewater from a broad range of industrial facilities and publicly-owned treatment works were analyzed in this survey. While the percentage of industries in a particular category containing 1,1,2-trichloroethane or the volume of wastewater generated by them was not indicated, the data suggest that significant amounts of 1,1,2-trichloroethane are released into waterways nationwide (see Table 5-1). Between 1980 and 1988, 707 samples of wastewater in EPA's STORET database were analyzed for 1,1,2-trichloroethane (STORET 1988). Ten percent of the samples contained 10 parts per billion (ppb) or higher concentrations of 1,1,2-trichloroethane and the maximum level obtained was 360 ppb. Unfortunately, the detection limit is apparently recorded when no chemical is detected, so it is impossible to say whether the 90 percentile figure represents positive samples or merely higher detection limits. 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 2100 ppb, respectively (EPA 1982c).

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 (King and Sherbin 1986; Kaiser and Comba 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.

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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 at the time of the survey.

1,1,2-Trichloroethane was detected in two samples at 2-3 ppb from Eugene, OR in the National Urban Runoff Program, in which 86 samples of runoff from 19 cities throughout the U.S. 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 was found in the available literature.

5.2.3 Soil

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, 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.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

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 m/set with a wind of 3 m/set is estimated to be 4.5 hr, 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 wastewater 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 5 pilot scale treatment plants, 98 - >99% of 1,1,2-trichloroethane was removed by this process (EPA 1981). 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).

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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 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).

The bioconcentration factors 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.

5.3.2 Transformation and Degradation

5.3.2.1 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-set which would give rise to a half-life of 49 days, assuming an average hydroxyl radical concentration of 5×10^5 radicals/cc (Jeong et al. 1984).

5.3.2.2 Water

1,1,2-Trichloroethane undergoes both a pH-independent and a base-catalyzed hydrolysis at environmental pH's. 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} l/mol-set at 25°C and is dominant above pH 5.4; the neutral rate is only 9×10^{-8} sec⁻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 11-12°C (Jensen and Rosenberg 1975).

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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 (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).

5.3.2.3 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 wastewater 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.

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5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

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 parts per trillion (ppt) of 1,1,2-trichloroethane, 95% of 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 U.S. the 25th, 50th, 75th percentile and maximum concentration of 1,1,2-trichloroethane was 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 6-41 ppt (Singh et al. 1981; Singh et al. 1982; Harkov et al. 1983; Liroy et al. 1983). In the study by Harkov et al., (1983) air concentrations in Camden, Elizabeth, and Newark, NJ 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 20-50 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 U.S. was 45 ppt. Of these samples, 25% exceeded 210 ppt and a maximum concentration was 2,300 ppt was measured in Dominguez, CA (Brodzinsky and Singh 1982). The data compiled by Brodzinsky and Singh (1982) has 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 (Shah and Heyerdahl 1988). 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 10-50 ppt.

The only data on levels of 1,1,2-trichloroethane measured in indoor air were contained in a study of eight homes in Knoxville, TN obtained during the winter (Gupta et al. 1984). Eleven of sixteen samples contained 1,1,2-trichloroethane with a mean [SD] 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).

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1,1,2-Trichloroethane was not detected in composite samples of the water supplies of Philadelphia, PA and Huntington, WV, both of which are derived from surface sources (Dreisch et al. 1980). The levels in finished water from a New Orleans, LA water supply ranged from 0.1 to 8.5 ppb (EPA 1980). In a 10-city EPA survey conducted in 1975, 1,1,2-trichloroethane was only detected in the water supply of Miami, FL, 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, NY, was 13 ppb (Zaki et al. 1986). 1,1,2-Trichloroethane has been found in 10 private wells in Rhode Island, at a concentration range of 1.0 to 14.0 ppb (RIDH 1989). A survey of Denver, CO, drinking water conducted in late 1985 to early 1986, found no 1,1,2-trichloroethane in the samples tested (Rogers et al. 1987). 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). 1,1,2-Trichloroethane was found in 6 of the 1174 community wells and 19 of the 617 private wells in a Wisconsin survey conducted in the early 1980s (Krill and Sonzogni 1986). All wells contained less than the recommended health advisory level of 6.1 ppb. Representative samples of ground and surface water were analyzed from the state of New Jersey during 1977-1979 (Page 1981). These samples were collected from every county, from urban, suburban, and rural areas, and from areas of every land use common in the state. Seventy-two of the 1069 groundwater samples (6.7%) and 53 of the 603 surface water samples (8.7%) contained detectable levels of 1,1,2-trichloroethane with concentrations as high as 31.1 and 18.7 ppb being found for ground and surface water, respectively. Some of the most polluted wells were under urban land use areas (Page 1981, Greenberg et al. 1982). Ground water near landfill sites in Minnesota and Wisconsin contained up to 31 ppb of 1,1,2-trichloroethane (Sabel and Clark 1984).

Of 7 samples from two Ohio River tributaries, 3 were positive for 1,1,2-trichloroethane (0.6 ppb maximum). However, only 4% of the samples from the Ohio mainstream were positive and the compound was not found in 88 additional stations (Ohio River Valley Sanitation Commission 1980). One measurement of 1,1,2-trichloroethane in marine water was found, 153 ppt off the shore at Point Reyes, CA (Singh et al. 1977).

Between 1980 and 1988, 3255 samples of surface water in EPA's STORET database were analyzed for 1,1,2-trichloroethane (STORET 1988). Ten percent of the samples contained the chemical at 10 parts per billion (ppb) or higher. A maximum level of 18,000 ppb was reported in 1982. The maximum concentration of 1,1,2-trichloroethane reported for subsequent years ranged from 10 to 125 ppb. Of the 22,615 samples of groundwater in the database, 10% were above 3 ppb. The maximum concentration of 1,1,2-trichloroethane in a groundwater was 350,000 ppb, reported in 1985. For the other years, the

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maximum concentration reported ranged from 18 to 1800 ppb. Unfortunately, the detection limit is apparently recorded in STORET when no chemical is detected, so it is impossible to say whether the 90 percentile figure represents positive samples or merely higher detection limits.

5.4.3 Soil

1,1,2-Trichloroethane was found in 25 of the 418 hazardous waste sites listed on the National Priorities List of highest priority sites for possible remedial action (Mitre 1987). Additionally, it was found in 3 sites in the Contract Laboratory Statistical Database at mean concentrations ranging from 12 to 636 ppb (Viar and Company 1987).

5.4.4 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).

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 (Stanley 1986). The composite specimens represented the nine U.S. census divisions stratified by three age groups (0-14, 15-44, 45 plus). 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 to 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.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

A National Occupational Exposure Survey (NOES) conducted by NIOSH from 1981 to 1983 estimates that 1036 workers, including 15 women, are potentially exposed to 1,1,2-trichloroethane in the United States (NIOSH 1988). The estimate is provisional, as all of the data for trade name products which may contain 1,1,2-trichloroethane have not been analyzed. The NOES survey 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

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NIOSH National Occupational Hazard Survey, the highest exposures occurred around blast furnaces, in steel rolling mills and in factories manufacturing technical instruments (Konietzko 1984).

Consistent with its tendency to partition into air, most exposures to 1,1,2-trichloroethane are from air. Limited 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.

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURE

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, LA, 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 to 820 $\mu\text{g}/\text{g}$, compared with a median intake of 2.6 $\mu\text{g}/\text{g}$ for all the urban/suburban areas of the United States that were monitored. Other cities where air concentrations greater than 0.1 ppb were sometimes observed were Elizabeth, NJ, Deer Park, TX, Freeport, TX, Geismar, LA, Edison, NJ, and Domingues, CA (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, NY, New Jersey, and near landfills in Minnesota and Wisconsin contain 1,1,2-trichloroethane concentrations as high as 13 to 31 ppb, corresponding to an average daily intake of 26 to 62 $\mu\text{g}/\text{g}$ 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.

5.7 ADEQUACY OF THE DATABASE

5.7.1 Data Needs

Physical and Chemical Properties. The physical and chemical properties of 1,1,2-trichloroethane have been adequately characterized (see Table 3.2).

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Environmental Fate. Further investigation would resolve the discrepancies in the data for anaerobic degradation of 1,1,2-trichloroethane. Additional studies are needed to characterize the nature of the transformation and to clarify whether biotic, abiotic, or catalyzed abiotic reactions are involved. Will these reactions generally occur under environmental conditions? A determination of the half-life in representative groundwater and sediment-water systems would be useful. From the available evidence, biodegradation in aerobic systems appears unlikely, although additional studies, particularly in soil, are desirable and would clarify this point.

Exposure Levels in Environmental Media. The best estimates of exposure are based on monitoring data and these data add credence to emission and exposure estimates based on production and use. In the case of 1,1,2-trichloroethane, monitoring data are fragmentary and not very recent; most of the data are from the early 1980s or earlier. Information on production and use, particularly that with the largest probability for exposure, is not available. While 1,1,2-trichloroethane may be contained in some consumer products, the Dow Chemical Company is not aware of any consumer uses (Moolenaar and Olson 1989).

Exposure Levels in Humans. Estimates of general population and occupational exposure require current monitoring data or current data on production and use. This information is not available. The use pattern of 1,1,2-trichloroethane may have changed since the NOES. If this is the case, the results of the NOES could be reanalyzed in order to reflect current occupational exposures.

Exposure Registries. Other than the NIOSH survey, no exposure registries for 1,1,2-trichloroethane were located. The development of a registry of exposed persons would provide a useful reference tool in assessing exposure levels and frequency. In addition, a registry would allow an assessment of the variations in exposure concentrations by, for example, geography, season, regulatory actions, presence of hazardous waste landfills, or manufacturing or use facility. These assessments, in turn, would provide a better understanding of the needs for some types of research or data acquisition based on the current exposure concentrations. Additionally, such a database of exposures would be useful for linking exposure to 1,1,2-trichloroethane with specific toxic effects or diseases.

5.7.2 On-going Studies

No information was found which would indicate that there are studies in progress that relate to the environmental fate of 1,1,2-trichloroethane. As part of the Third National Health and Nutrition Evaluation Survey (NHANES III), the Environmental Health Laboratory Sciences Division of the Center for Environmental Health and Injury Control, Centers for Disease Control, will be analyzing human blood samples for 1,1,2-trichloroethane and other

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volatile organic compounds. These data will give an indication of the frequency of occurrence and background levels of these compounds in the general population. NIOSH is continuing to revise its estimates of occupational exposures in its National Occupational Exposure Survey (NOES) through the inclusion of trade name compounds. No other on-going studies regarding general or occupational exposure to 1,1,2-trichloroethane were located. According to the Emergency Planning and Community Right to Know Act of 1986 (EPCRTKA), (§313), (Pub. L. 99-499, Title III, §313), industries are required to submit release information to the EPA. The Toxic Release Inventory (TRI), which contains release information for 1987, became available in May of 1989. This database will be updated yearly and should provide a more reliable estimate of industrial production and emission, which will be useful for determining potential human exposure.