

## 5. POTENTIAL FOR IITJMAN EXPOSURE

### 5.1 OVERVIEW

1,2-Dichloropropane is a man-made chemical whose presence in the environment results from anthropogenic activity. Emission sources of 1,2-dichloropropane include process and fugitive emissions from its production and use as a chemical intermediate and industrial solvent, and evaporation from wastewater streams. Many of the major uses of 1,2-dichloropropane, other than as a chemical intermediate and industrial solvent, have been eliminated or curtailed. Most importantly, all uses with significant consumer and general population exposure may have been eliminated in the U.S. 1,2-Dichloropropane is no longer used as a soil fumigant in the United States, a use that has been responsible for polluting groundwater supplies in some agricultural areas. Its major producer, Dow Chemical Company, has recommended that it no longer be used in paint stripping formulations, varnish, and furniture finish removers, uses with potential for widespread consumer and occupational exposure. Dow Chemical Company asserts that occupational exposure is minimal since all their processes involving the production, conversion, or disposal of 1,2-dichloropropane are in closed systems. Additionally, vent gas from their production process is destroyed by thermal oxidation. There is evidence that there were substantial releases of 1,2-dichloropropane into wastewater by industries that use 1,2-dichloropropane as a solvent. An example of such industries are those that use 1,2-dichloropropane in the manufacture of ion exchange resins.

The major releases of 1,2-dichloropropane will be to the atmosphere and to soil. However, when 1,2-dichloropropane is spilled on soil, landfilled, or applied to soil, as it formerly had been, as a fumigant, it will partially volatilize, and the remainder will leach into the subsurface soil and groundwater. In one experiment in which soil was treated with 1,2-dichloropropane, immediately covered with 12 cm of untreated soil and stored outdoors in open jars protected from rain, 99% of the chemical was lost within 10 days. With the elimination of 1,2-dichloropropane's use in agriculture, its potential for polluting groundwater has been substantially reduced. In groundwater, where volatilization is unlikely, the principal reactions will be hydrolysis and anaerobic biotransformation. Hydrolysis is estimated to be very slow (half-life 25-200 weeks) and the potential for anaerobic biotransformation has not been evaluated. Therefore groundwater supplies that are contaminated with 1,2-dichloropropane may remain so for a long and indeterminate period of time.

The dominant removal process of 1,2-dichloropropane in the atmosphere is expected to be reaction with photochemically-generated hydroxyl radicals (half-life >23 days). Washout in precipitation should also occur; although most 1,2-dichloropropane removed by this mechanism is likely to reenter the atmosphere by volatilization. Since degradation in the atmosphere is slow, considerable dispersion of 1,2-dichloropropane from source areas can occur before it degrades or is removed in washout. Besides dispersal, importation

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of 1,2-dichloropropane may also occur from other countries where it may be more widely used. Volatilization will be the primary fate process in surface water (half-life 5.8 hr in a model river). In soil, 1,2-dichloropropane is expected to volatilize rapidly from the soil surface and to leach into the ground, where the potential for groundwater contamination exists.

The general population may be exposed to low levels of 1,2-dichloropropane through inhalation of contaminated ambient air, consumption of contaminated drinking water, or dermal contact. With the elimination of its use as a soil fumigant and curtailment of its use in paint strippers, varnishes, and furniture finish removers, exposure of the general population to 1,2-dichloropropane by inhalation or dermal contact should be much lower than it once was. Any groundwater supplies that are already contaminated, may remain so for a long time. A 1981-1983 National Occupational Exposure Survey (NOES) by NIOSH estimated that 2119 non-agricultural workers, including 949 females, were potentially exposed to 1,2-dichloropropane in the United States. The number of exposed workers should be much lower now because of the chemical's diminished use. Occupational exposure is primarily by inhalation and dermal contact,

### 5.2 RELEASES TO THE ENVIRONMENT

#### 5.2.1 Air

The total estimated annual environmental release of 1,2-dichloropropane from production and industrial use, primarily in the manufacture of perchloroethylene, was 1,146,000 lbs (EPA 1986c). This figure represents releases regulated by the Toxic Substances Control Act (TSCA), and therefore excludes pesticidal uses of 1,2-dichloropropane. Of these releases, 772,000 lbs were to air, 198,000 lbs to water, and 176,000 lbs to land disposal sites. They include releases from process emissions to the air, secondary air emissions resulting from volatilization during wastewater treatment (aeration), releases to water in wastewater effluent, emissions to air from incomplete incineration, and land disposal of solid waste residues. The inclusion of fugitive emissions would increase the total. Recently it has been shown that a variety of chlorinated organic compounds are formed during combustion of hydrocarbons when chlorine is present; two isomers of dichloropropane were among the more than 100 chemicals formed during the combustion of propane in the presence of HCl under oxygen deficient conditions (Eklund et al. 1987). These conditions may occur in municipal incinerators and, therefore, 1,2-dichloropropane may be released from incinerators. A correlation of data from the EPA Air Toxics Emission Inventory with industrial source categories (SIC codes), shows volatile emissions of 1,2-dichloropropane from electronic components, photographic equipment and supplies, and apartment building operators (SIC Codes 3679, 3861, 6513). (EPA 1987a).

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### 5.2.2 Water

The total estimated annual environmental release of 1,2-dichloropropane in wastewater from production and industrial use was 198,000 lbs (EPA 1986c). Table 5-1 shows the types of industries that discharged 1,2-dichloropropane, their frequency of release, and concentrations in wastewater. These data come from a comprehensive wastewater survey conducted by EPA's Effluent Guidelines Division. Over 4000 samples of wastewater from a broad range of industrial facilities and publicly-owned treatment works were analyzed in this survey. Between 1980 and 1988, 708 samples of wastewater in EPA's STORET database were analyzed for 1,2-dichloropropane (STORET 1988). Ten percent of the samples were 10 parts per billion (ppb) or higher with a maximum level of 910 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.

1,2-Dichloropropane was found at concentrations of 5.6, 22, 60, 310 ppb in four outfalls from the Dow Chemical of Canada plant into the St. Clair River for a net loading of 11.8 kg/day (King and Sherbin 1986). This survey was performed as a result of puddles of chlorinated hydrocarbons discovered on the bottom of the St. Clair River. These chemicals are thought to be products or byproducts of chlorinated hydrocarbon 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. The concentration of 1,2-dichloropropane before and after treatment was 320 and 510 ppb. However, the carbon filter was reportedly spent at the time of the survey.

Rohm and Haas in Philadelphia, PA, a manufacturer of ion exchange resins, discharged weekly average amounts of 1,2-dichloropropane of 60-2250 lbs/day into the Northeast Philadelphia Treatment Plant during August and September of 1981 (Hinnegan 1981). The daily amount of 1,2-dichloropropane discharged on five days in 1979 ranged from 37.2 to 5100 lbs (Weston 1980). The report covering the discharges in 1979 stated that on 4 days Rohm and Haas contributed all of the 1,2-dichloropropane influent going into Philadelphia's Northeast Water Pollution Control Plant (NEWPCP). On one day, 35% came from elsewhere. At times, all of the 1,2-dichloropropane was removed in the treatment plant. Tidal excursions of the NEWPCP effluents affects the intake of the Baxter Drinking Water Plant, located 2 miles upstream on the Delaware River. EPA's Philadelphia Geographic Area Pollutant Survey found that average 1,2-dichloropropane concentration in the intake water during 1982-1983 was 1.6 ppb, indicating that 1,2-dichloropropane was being discharged from the wastewater treatment plant into the Delaware River (EPA 1986~). If the typical daily discharge from the Rohm and Haas plant was 500 lbs, then the annual discharge would have been 182,000 lbs, a figure approaching the estimated 198,000 lbs of 1,2-dichloropropane discharged into waterways for all production and industrial use. It is not clear for what year the estimated environmental release

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TABLE 5-1. Sources of of 1,2-Dichloropropane Effluents<sup>a</sup>

Industry	Frequency	Concentration (ppb)		
		Maximum	Medium	Low
Paint and ink	3	3457.22	38.9176	29.30
Organics and plastics	2	15.93	38.92	6.25
Inorganic chemicals	14	54.30	3.31	0.74
Textile mills	2 <sup>b</sup>	40.43	38.76	37.09
Plastics and synthetics	1	5.60	5.60	5.60
Rubber processing	1	0.82	0.82	0.82
Auto and other laundries	1	66.92	66.92	66.92
Pesticides manufacture	1	0.90	0.90	0.90
Photographic industries	3	121.79	36.34	3.59
Organic chemicals	16	1411.98	23.67	1.23
Publicly owned treatment works	4	52.22	24.86	1.94
Industry unknown	4	60.03	27.07	22.44

<sup>a</sup>Source: Shackelford et al. 1983.

<sup>b</sup>Incorrectly listed as 1 in reference; data are consistent with a frequency of 2.

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figure applies and whether the releases into water include industrial discharges that may undergo treatment before being discharged into a waterway or only that which is discharged into a waterway. As of January, 1989, Rohm and Haas has discontinued use of 1,2-dichloropropane in the manufacture of ion exchange resins (Rohm and Haas 1989). There are three other manufacturers of ion exchange resins in the U.S. with potentially similar release patterns (HSDB 1988). 1,2-Dichloropropane was only detected in one sample at 3 ppb from Eugene, OR in the National Urban Runoff Program which analyzed runoff in 86 samples from 19 cities throughout the U.S. (Cole et al. 1984).

### 5.2.3 Soil

The total estimated annual environmental release of 1,2-dichloropropane by industry into land disposal sites was 176,000 lbs (EPA 1986c). This is not the recommended method of disposal and this figure may have been much higher in the past.

In the past, the major source of release of 1,2-dichloropropane into soil was from its use as a soil fumigant for nematodes. For this purpose, the fumigant was injected into the root zone, after which the soil was compacted to enhance retention of the vapor. However, 1,2-dichloropropane is no longer permitted to be used in the U.S. for agricultural purposes because this use pollutes groundwater.

Production of 1,2-dichloropropane for use as a solvent in consumer products such as paint strippers, varnishes, and furniture finish removers, from which inadvertent releases to soil (i.e. spills) would be expected, has been discontinued. In addition to spills, chemicals can be released into soil from leaking storage tanks. A case of groundwater contamination by 1,2-dichloropropane resulting from a leaking underground storage tank at a paint factory has been documented in the literature (Botta et al. 1984).

Releases into the subsoil and groundwater can also result from the landfilling of process residues. Four out of 11 samples of landfill leachate in Minnesota and Wisconsin contained 2.0-81 ppb 1,2-dichloropropane (Sabel and Clark 1984).

## 5.3 ENVIRONMENTAL FATE

### 5.3.1 Transport and Partitioning

The relatively high water solubility of 1,2-dichloropropane suggests that washout by rain should be an important process for removing the chemical from the atmosphere. The dominant removal process for 1,2-dichloropropane from surface waters is expected to be volatilization. Based on the measured relative mass transfer coefficient of 1,2-dichloropropane between water and air of 0.57 (Cadena et al. 1984) and the range of reaeration coefficients typical of relatively rapid and shallow streams

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found in the western U.S., 0.14 to 1.96 hr<sup>-1</sup> (Cadena et al. 1984), the half-life of 1,2-dichloropropane in these streams will range from 0.62 to 8.68 hr. The residence time in a lake or pond would be much longer. Based on measured Henry's Law Constant at 24°C of  $1.67 \times 10^{-3}$  atm-m<sup>3</sup>/mol (Chiou et al. 1980) and  $2.07 \times 10^{-3}$  atm-m<sup>3</sup>/mol (Mackay and Yeun 1983), the volatilization half-life of 1,2-dichloropropane in a model river 1 m deep flowing 1 m/sec with a wind speed of 3 m/sec is estimated to be 3.7-4.6 hr, with resistance in the liquid phase controlling volatilization (Lyman et al. 1982). In such cases, the current will have a much greater effect on volatilization than the wind speed. In wastewater treatment plants that receive volatile compounds such as 1,2-dichloropropane 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 is greatly enhanced. More than 99% removal of 1,2-dichloropropane from wastewater plants has been attributed to this process (Kincannon et al. 1983).

The  $K_{oc}$  of 1,2-dichloropropane is 47 in a silt loam soil (Chiou et al. 1979). This value is low, suggesting that 1,2-dichloropropane will not adsorb appreciably to soil, sediment, and suspended solids in water. 1,2-Dichloropropane sorbs to clay minerals in dry soil but desorbs when the soil is moist (Cohen et al 1984). Where 1,2-dichloropropane has been used as a soil fumigant for nematodes in California and the coastal areas of Georgia, South Carolina, North Carolina, and Virginia, the soils are sandy and have a low organic carbon content (Cohen et al. 1984). Adsorption to these soils will be lower than to soils with a higher organic content and should not reduce the mobility of 1,2-dichloropropane significantly. The leaching potential of 1,2-dichloropropane is illustrated by a case study in California in which a soil core was taken from an agricultural field where a fumigant containing the chemical had recently been used. Residues of 1,2-dichloropropane up to 12.2 ppb were detected throughout much of the 24-foot core profile and two adjacent drinking water wells contained concentrations of 1,2-dichloropropane in excess of 10 ppb (Ali et al. 1986). As much as 300 ppt of 1,2-dichloropropane have been detected in bank-filtered Rhine River water indicating that all of the chemical was not being retained by the soil (Piet and Morra 1979). The finding that highly mobile and biologically-resistant residues of the fumigant pesticide 1,2-dibromoethane persisted in topsoil for years after application, despite its mobility and volatility, spurred a study of this phenomenon in other halogenated hydrocarbons (Sawhney et al. 1988). Sandy loam soils treated with 10,000 ppm of 1,2-dichloropropane for 1 day were extracted 16 times with water. The apparent soil water partition coefficient, initially 0.56 ( $K_{oc}$  22), rose to 72 ( $K_{oc}$  2800); the final concentration of 1,2-dichloropropane in the soil was 1.4 ppm. After a 57-day period, the apparent partition coefficient was >250 ( $K_{oc}$  >9700). Some of the 1,2-dichloropropane molecules were adsorbed more strongly than others and these molecules became even more strongly adsorbed in time. The fact that pulverization of the soil released a portion of the

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chemical, suggests that the strongly adsorbed 1,2-dichloropropane eventually became occluded in the soil structure. Additionally, these observations suggest that the rate at which the chemical becomes occluded, or the adsorption coefficient increases, is diffusion-controlled.

The dissipation of 1,2-dichloropropane was determined in two clay and two sandy soils in closed systems following application at normal field rates (Van Dijk 1980). The mean dissipation rate was  $0.013 \text{ day}^{-1}$  (half-life 52 days), with the rate roughly twice as high in the sandy soil as in the clay soil. Additionally, the rate of volatilization increased by a factor of two for a  $10^\circ\text{C}$  increase in temperature. In another experiment in which 1,2-dichloropropane was mixed with 3 cm of soil in an open container, covered with 12 cm of soil and left outdoors, <1% of the chemical remained after 10 days (Roberts and Stoydin 1976). This loss was attributed to volatilization.

A bioconcentration factor (BCF) of 19 in fish has been estimated for 1,2-dichloropropane using linear regression equations with an estimated log Kow of 1.99 (EPA 1988b; Lyman et al. 1982). An experimental value for the bioconcentration factor of <10 has also been reported (Kawasaki 1980). Only for those chemical with BCF values greater than 500-1000 is bioconcentration considered to be important. Therefore, 1,2-dichloropropane would not be expected to bioconcentrate significantly in fish. When potatoes were grown in sandy loam soil that had been treated with a mixture of  $^{14}\text{C}$ -labeled 1,2-dichloropropane and 1,3-dichloropropene 5 months before sowing, only 7 ppb of the radioactivity was found in the mature potatoes indicating minimal uptake of either of these chemicals (Roberts and Stoydin 1976).

### 5.3.2 Transformation and Degradation

#### 5.3.2.1 Air

The primary mode of degradation in air is through reaction with photochemically-produced hydroxyl radicals by H-atom abstraction (Singh et al. 1982). Experimental determinations of the reaction rate yield a half-life of >23 days (Atkinson 1985), whereas theoretical estimates result in a half-life of 16 days (Atkinson 1985). Lacking a chromophore that absorbs radiation >290 nm, direct vapor phase photolysis would not be expected. Accordingly, no photolysis occurred when 1,2-dichloropropane was exposed to simulated sunlight for prolonged periods of time (Cohen et al. 1984).

#### 5.3.2.2 Water

1,2-Dichloropropane is resistant to hydrolysis, with an estimated hydrolysis half-life of 25-200 wk (Cohen et al. 1984). Most studies indicated that 1,2-dichloropropane is also resistant to biotransformation. There was no degradation in a semicontinuous activated sludge process in ten weeks even when the retention time was as long as 25 hr (Shell 1984). There is also no degradation in standard 4-week tests that simulate

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biodegradability in environmental waters (Kawasaki 1980; Anonymous 1983). While >99% of 1,2-dichloropropane was lost in a wastewater treatment facility, the loss was attributed to stripping, rather than biodegradation (Kincannon et al. 1983).

### 5.3.2.3 Soil

Little or no degradation of 1,2-dichloropropane has been reported in soil. When 71 ppm of radiolabeled 1,2-dichloropropane was applied to a sandy loam and medium loam soil in closed glass containers and incubated for 20 weeks, <0.2% of the applied radioactivity was found in degradation products (Roberts and Stoydin 1976).

## 5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

### 5.4.1 Air

No levels of 1,2-dichloropropane in rural or remote areas of the U.S. have been reported in the literature. Samples collected in 397 urban/suburban areas of the country had a median concentration of 57 parts per trillion (ppt) and a range of 22 to 110 ppt (Brodzinsky and Singh 1982). Round-the-clock sampling for periods of 1-2 weeks in seven U.S. cities ranged from 21-78 ppt (Singh et al. 1982). Levels of some of the chemicals measured were highest at night or in the early morning, and lowest in the afternoon, although no mention of this fact was specifically directed to 1,2-dichloropropane. Only 2% of the 1,2-dichloropropane levels monitored at four sites by the California Air Monitoring Program were above the quantitation limit of 0.2 ppt, although one value recorded in Riverside was 1100 ppt (Shikiya et al. 1984). During rain events in Portland, Oregon, gas phase concentrations of 1,2-dichloropropane ranged from 4.4-8.4 ppt (Ligocki et al. 1985). Levels of 1,2-dichloropropane in industrial or source-related areas of the U.S. ranged (39 sites) from 0-130 ppt with 120 ppt median (Brodzinsky and Singh 1982). The average concentration during a 3-month survey of ten source-related sites in Philadelphia, PA, was 259 ppt (Sullivan et al. 1985). In EPA's Philadelphia Geographic Area Multimedia Pollutant Survey, average ambient 1,2-dichloropropane levels ranged from 40-740 ppt in various sections of the city and 7700-120,000 ppt downwind of the Northeast Water Pollution Control Plant (EPA 1986c). This plant had received discharges from the Rohm and Haas plant which produced ion exchange resins using 1,2-dichloropropane as a solvent. The data compiled by Brodzinsky and Singh (1982) has been reviewed and most of it is of good quality. More data has now been added to this National Ambient Volatile Organic Compounds Database bringing the number of monitoring data points to 714 (Shah and Heyerdahl 1988). With the addition of the new data, the overall median concentration of 1,2-dichloropropane is 22 ppt and the lower and upper quartile concentrations are 11 and 65 ppt. The median concentration of the suburban, urban, and source-dominated sites were 42 ppt, 11 ppt, and 1 ppt, respectively. The fact that the 1,2-dichloropropane concentrations are higher at the 'cleaner' sites may



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indicate that the degradation rate is lower at these sites rather than that there are more 1,2-dichloropropane emissions at these sites. The concentration of hydroxyl radicals that are responsible for the photooxidation of 1,2-dichloropropane are generally lower in cleaner atmospheres than dirty ones (Winer et al. 1984). The fact that the addition of more recent data to the National Ambient Volatile Organic Compounds Database has lowered the median 1,2-dichloropropane concentration from 57 ppt to 22 ppt (Brodzinsky and Singh 1982; Shah and Heyerdahl 1988) suggests that the reduction in 1,2-dichloropropane use has had an effect on ambient air concentrations.

Traces of 1,2-dichloropropane were detected outside 2 of 9 homes at the Old Love Canal in Niagara Falls, N.Y. (Barkley et al. 1980), while 0.29 ppb was found in the ambient air in a household basement (Pellizzarri 1982). The same authors did not find any 1,2-dichloropropane at the Kin-But waste disposal site near Edison, N.J. Traces to 0.46 ppb of 1,2-dichloropropane were found in Iberville Parish, LA, where many organic chemical and producer, user, and storage facilities are located along the Mississippi River (Pellizzarri 1982).

While one of 1,2-dichloropropane's major uses was once as a soil fumigant, no air monitoring data could be located in the available literature for agricultural areas in which it was used.

### 5.4.2 Water

1,2-Dichloropropane has been identified in 1.6% of samples from 11 water utilities along the Ohio River at a level of 0.1 ppb (Ohio River Valley Sanitation Commission 1979). In a U.S. Groundwater Supply survey in which 945 water supplies derived from groundwater sources were tested, 13 supplies were positive for 1,2-dichloropropane, with a median and maximum concentrations of 0.9 and 21 ppb, respectively (Westrick et al. 1984). In an ongoing study of 575 community water systems using groundwater sources and approximately 19,000 non-community and private wells in Suffolk County, NY, 0.9% of the community water systems and 5.5% of the other wells contained 1,2-dichloropropane making it the 5th most common contaminant found there (Suffolk County 1983b; Zaki 1986). In 1982 the California State Water Resources Control Board started investigating the presence of 1,2-dichloropropane in wells (Cohen et al. 1986; Ali et al. 1986) because of its high mobility in soil and possible carcinogenicity and mutagenicity. They found the chemical in 75 wells in nine counties ranging up to 1200 ppb; 12 wells exceeded the State's action level of 10 ppb (Ali et al. 1986). It is worth noting that 3 contaminated wells in residential and residential/commercial areas of Suffolk County, NY with 1,2-dichloropropane levels of 13-550 ppb were in areas where agricultural use was claimed not to be a source of contamination (Suffolk County 1983a). 1,2-Dichloropropane was found in at least 7 shallow wells in western Washington associated with soil injection in strawberry fields (Cohen et al. 1986). Nine out of 20 samples of groundwater underlying landfills in Minnesota contained 0.5-43

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ppb of 1,2-dichloropropane (Sabel and Clark 1984). In a separate Minnesota landfill study, 1.5-7.6 ppb of 1,2-dichloropropane was found in the groundwater underlying a landfill in a sand plain that was known to have received industrial waste, but was absent from the boring taken directly above the contaminated groundwater; while 1.1 ppb of 1,2-dichloropropane was found in the groundwater from a clay landfill in southwestern Minnesota (Sabel and Clark 1984).

1,2-Dichloropropane has been found in major rivers of the United States; up to 20% of the samples from monitoring studies contained from trace quantities to >10 ppb of the chemical (Kaiser et al. 1983; Ohio River Valley Water Sanitation Commission 1980; Ohio River Valley Water Sanitation Commission 1982). Of the 95 stations monitored in Lake Ontario, 4 had concentrations ranging from 210-440 ppt and 15 others had trace quantities, while in 16 stations in the Lower Niagara River, 4 stations had concentrations ranging from 7-55 ppt, while 5 other stations had trace quantities (Kaiser et al. 1983). Of the 4972 samples at 11 stations on the Ohio River monitored in 1980-81, 8.8% were positive, with 28 samples between 1-10 ppb and 1 sample contained >10 ppb (Ohio River Valley Water Sanitation Commission 1982). Between 1980 and 1988, 29,320 samples of surface water in EPA's STORET database were analyzed for 1,2-dichloropropane (STORET 1988). Ten percent of the samples were 0.40 parts per billion (ppb) or higher with a maximum level of 300 ppb. In addition, of the 859 sediment analyzed, 10% contained 1,2-dichloropropane above 44 ppb. Of the 22,457 samples of groundwater in the database, 10% were above 3 ppb and the maximum was 1500 ppb.

### 5.4.3 Soil

1,2-Dichloropropane was present in concentrations up to 12.2 ppb in soil cores underlying a recently fumigated field in California (Ali et al. 1986). In another California study, it was found at 0.2-2.2 ppb in soil cores up to 7 meters below the surface (Cohen et al. 1984). Some unspecified samples of soil, water, or sediment from the Love Canal contained unspecified amounts of 1,2-dichloropropane (Hauser and Bromberg 1982). 1,2-Dichloropropane was found at nine of the 951 hazardous waste sites listed on the National Priority List (NPL) of highest priority sites for possible remedial action (ATSDR 1988). Runoff and soil and groundwater contamination with 1,2-dichloropropane was reported at these sites. Additionally, it was found in 5 sites in the Contract Laboratory Statistical Database at median concentrations ranging from 6.5 to 23,000 ppb (Viar and Company 1987).

### 5.4.4 Other Media

No documentation of 1,2-dichloropropane in flora or fauna in the U.S. was located.

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### 5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

A National Occupational Exposure Survey (NOES) conducted by NIOSH from 1981 to 1983 estimated that 2119 workers including 949 women were potentially exposed to 1,2-dichloropropane in the United States (NIOSH 1988). The distribution of these estimated exposed workers by standard industrial category (SIC) was: 408 in business services, 831 in machinery, except electrical, 161 in fabricated metal products, 672 in the chemical and allied products, and 47 in textile mill products. The estimate was provisional as all of the data for trade name products which may contain 1,2-dichloropropane has not been analyzed. The NOES was based on field surveys of 4490 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 were employed in all SIC codes except mining and agriculture. The use pattern of 1,2-dichloropropane has changed radically since the survey was made, as it has been eliminated from agricultural fumigants, photographic film manufacture, and paint strippers. The results of the NOES, even though it excludes agricultural workers, are expected to be high. Another category of worker that may be exposed to 1,2-dichloropropane are workers at wastewater treatment facilities that handle effluent containing this chemical. Volatilization would be expected during treatment operations. According to Dow Chemical Company, the major manufacturer of 1,2-dichloropropane, all processes involving the production, conversion, and disposal of 1,2-dichloropropane are closed process (Dow Chem. Co. 1983). By their estimates, 45 and 123 workers are routinely and potentially exposed, respectively, to the chemical (Dow Chem. Co. 1983). The levels of exposure they report are <2 ppm for toluene diisocyanate (TDI) production, <1 ppm in ion exchange resin manufacture, and <25 ppm in paper coating (Dow Chem. Co. 1983).

According to drinking water surveys (Ali et al. 1986; Cohen et al. 1986; Ohio River Valley Sanitation Commission 1979; Westrick et al. 1984; Zaki 1986), a significant number of drinking water supplies contained 1,2-dichloropropane and people drinking this water would have been exposed to this chemical. In the most broadly-based groundwater survey, 1.4% of these supplies contained median water concentrations of 0.9 parts per billion (ppb) (Westrick et al. 1984). People drinking this water would ingest 1.8 c(g of 1,2-dichloropropane per day. While most of the drinking supplies tested for 1,2-dichloropropane were taken from groundwater sources, in cities such as Philadelphia, PA which obtains its water from a river that received sizeable amounts of 1,2-dichloropropane-containing effluent, the concentration of 1,2-dichloropropane in the drinking water from the Baxter Drinking Water Plant averaged 1.5 ppb (EPA 1986). People consuming this water would have ingested 3.0 µg of 1,2-dichloropropane daily.

The general population is exposed to 1,2-dichloropropane in ambient air, which contains median 1,2-dichloropropane levels of 22 ppt which translates into a daily intake of 2.1 µg. Residents of Philadelphia, according to EPA's Philadelphia Geographic Area Multimedia Pollutant Survey,

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would have been exposed to much higher inhalation doses, 98-660 µg/day because a large user of 1,2-dichloropropane was located there (EPA 1986c). People living in the vicinity of landfills containing 1,2-dichloropropane may be exposed to 1,2-dichloropropane present in landfill gases. Not enough information is available to estimate what the level of exposure from this source might be. Subsurface and surface emissions of volatile organic compounds (VOCs) have been found from RCRA Subtitle D disposal sites which reportedly received only non-hazardous waste. However, hazardous waste from small quantity generators or household hazardous waste may be disposed of at these landfills. For landfills that are similar in design and content, emissions are estimated to be a factor of 2.6 greater in a wet climate than in a dry one (Vogt et al. 1987)

### 5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURE

Those people consuming contaminated drinking water will have the greatest potential for exposure to significant levels of 1,2-dichloropropane. Since the odor threshold for 1,2-dichloropropane is 10 ppb (Amoore and Hautala 1983), people consuming water with this level of 1,2-dichloropropane may have a warning that their water is contaminated. In general, drinking water supplies that are most apt to be contaminated are those taken from groundwater sources. Contaminated drinking water wells are most likely to be found in agricultural areas with sandy soil where the chemical was used as a fumigant. However, there are special situations, such as in Philadelphia, where drinking water derived from surface water sources may be contaminated with 1,2-dichloropropane-containing effluent. In Philadelphia, 1,2-dichloropropane-containing effluent from an industrial plant was driven upstream to the influent of a drinking water plant by tidal action. This plant recently discontinued using 1,2-dichloropropane. People residing in the vicinity of industrial sources may be exposed to 1,2-dichloropropane in the ambient air, either from direct emissions or volatilization of the chemical from wastewater.

### 5.7 ADEQUACY OF THE DATABASE

Section 104 (i) (5) of CERCLA, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of 1,2-dichloropropane is available. Where adequate information is not available, ATSDR, in cooperation with the National Toxicology Program (NTP), is required to assure the initiation of a program of research designed to determine these health effects (and techniques for developing methods to determine such health effects). The following discussion highlights the availability, or absence, of exposure and toxicity information applicable to human health assessment. A statement of the relevance of identified data needs is also included. In a separate effort, ATSDR, in collaboration with NTP and EPA, will prioritize data needs across chemicals that have been profiled.

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### 5.7.1 Data Needs

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

**Environmental Fate.** Sufficient data exists to show that chemical hydrolysis and aerobic biodegradation of 1,2-dichloropropane are very slow and are not significant in determining the half-life in surface water or soil. No experimental studies of anaerobic biotransformation are available; these could be useful in estimating the half-life of 1,2-dichloropropane in soil and groundwater. Experimental hydrolysis data at pH 5-9 would be helpful for predicting the half-life of 1,2-dichloropropane in groundwater where volatilization is not significant.

**Exposure Levels in Environmental Media.** Since 1,2-dichloropropane was phased out as a fumigant and its use in solvents has declined, recent monitoring data are needed for air, groundwater, and surface water. This is particularly important with respect to groundwater, where it is especially long-lived and may be present in significant concentrations. Field monitoring studies of 1,2-dichloropropane would also be useful. This may be the only feasible way of determining the half-life of 1,2-dichloropropane in groundwater. Air monitoring and surface water studies would show the effects of changing 1,2-dichloropropane use patterns. While EPA's STORET database contains considerable water monitoring data, there are problems with the database that limit its usefulness. The detection limit is apparently recorded when no chemical is detected, so that it is impossible to say whether the 90 percentile figures for surface water and groundwater quoted in Section 5.4.2 represent positive determinations or merely detection limits. It would be helpful if this monitoring data would indicate whether 1,2-dichloropropane was actually detected in the samples.

**Exposure Levels in Humans.** The use pattern of 1,2-dichloropropane has changed radically since NIOSH's National Occupational Exposure Survey (NOES). Since the elimination of 1,2-dichloropropane from agricultural fumigants, photographic film manufacture, and paint strippers, fewer workers are exposed. While agricultural workers were not included in the survey, those engaged in the manufacture of agricultural chemicals were included. As a chemical in paint strippers, 1,2-dichloropropane would have a particularly high potential for exposing large numbers of people at high levels of exposure, since such applications are labor intensive and performed in the open. Therefore the results of the NOES will have to be reanalyzed in light of current use patterns in order to reflect current occupational exposures.

**Exposure Registries.** Other than the NIOSH survey, no exposure registries for 1,2-dichloropropane 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

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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 may be useful for linking exposure to 1,2-dichloropropane with specific toxic effects or diseases.

### 5.7.2 On-going Studies

No on-going monitoring studies or studies relating to the environmental fate of 1,2-dichloropropane were located in the available literature.

According to 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 can be updated yearly and should provide a more reliable estimate of industrial production and emissions, which will be useful for determining potential human exposure.

NIOSH is continuing to revise its estimates of occupational exposures in its National Occupational Exposure Survey (NOES) through the inclusion of trade name compounds. 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 1,2-dichloropropane and other volatile organic compounds. These data will give an indication of the frequency of occurrence and background levels of these compounds in the general population.