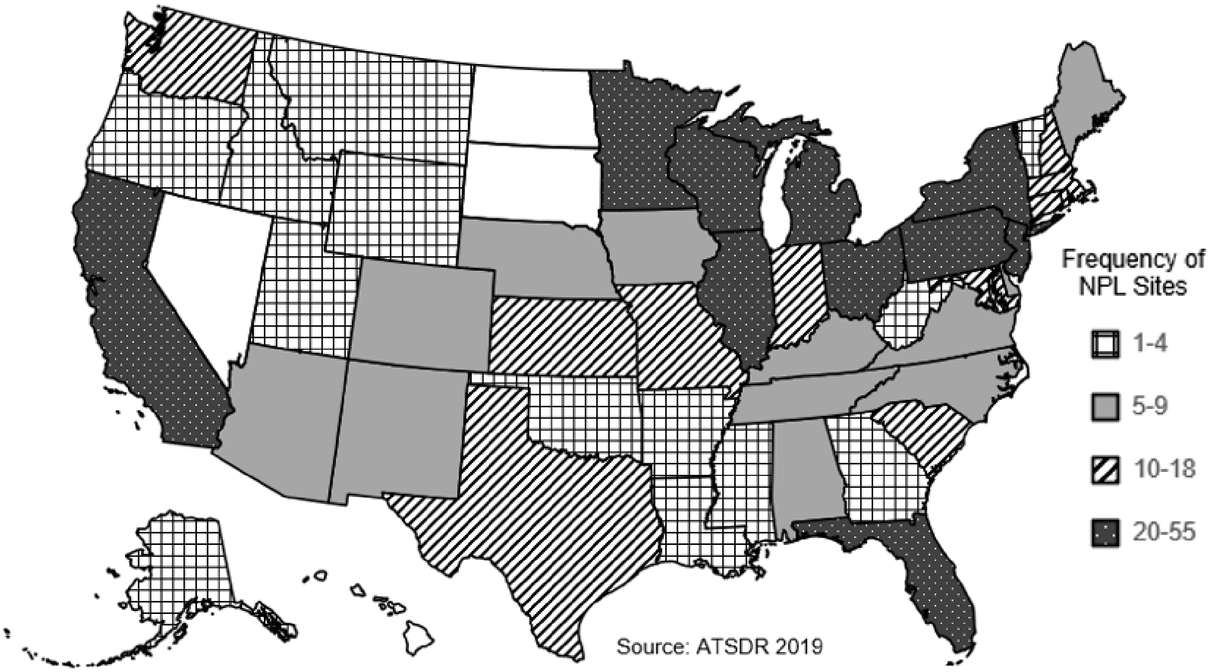
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

1,1-Dichloroethene has been identified in at least 610 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-dichloroethene has been evaluated is not known. The number of sites in each state is shown in Figure 5-1. Of these sites, 608 are located within the United States, and 2 are located in Puerto Rico (not shown).

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



Source: ATSDR 2019

- The potential for human exposure to 1,1-dichloroethene is greatest for individuals at its point of production, formulation, or transport. Occupational exposure to 1,1-dichloroethene may occur by inhalation and dermal contact. Workers involved in cleaning up hazardous waste or spill sites that contain 1,1-dichloroethene may potentially be exposed to this chemical.

- The general population may be exposed to 1,1-dichloroethene by inhalation of ambient air and ingestion of drinking water contaminated with this chemical. Those who live near hazardous waste sites contaminated with 1,1-dichloroethene, especially those who receive their drinking water from underground sources, may potentially be exposed to 1,1-dichloroethene, the levels of which will vary by location. Quantitative data that address levels of human exposure to 1,1-dichloroethene are limited.

- 1,1-Dichloroethene has been detected in air, surface water, groundwater, and soil, with the frequency of detection and the concentrations greatest near source areas (e.g., industrial areas, landfills, hazardous wastes sites).

- The primary sources of 1,1-dichloroethene in the environment are related to its synthesis, fabrication, and transport, and the manufacture of its polymer products. Smaller amounts of 1,1-dichloroethene may be released to surface water and soil primarily due to waste disposals. Most 1,1-dichloroethene in the environment evaporates quickly and enters the air. 1,1-Dichloroethene can enter soil, water, and air in large amounts during an accidental spill. It can also enter the environment as a degradation product of other chemicals in the environment.

- In the air, 1,1-dichloroethene undergoes rapid degradation with photochemically-produced hydroxyl radicals. 1,1-Dichloroethene has calculated atmospheric half-lives of 2–3 days. 1,1-Dichloroethene breaks down very slowly in water and the majority of this chemical will evaporate into air. 1,1-Dichloroethene is not readily transferred to fish or birds, and only very small amounts enter the food chain. In soil, 1,1-dichloroethene either evaporates to the air or percolates down through soil with rainwater and enters groundwater. Small living organisms in soil and groundwater may transform it into other less harmful substances, although this is a slow process.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

1,1-Dichloroethene is an anthropogenic compound and does not occur naturally, although it is found in landfills as the result of the breakdown of polyvinylidene chloride products and as a degradation product of other chemicals in the environment (EPA 1985; Zhang et al. 2006). 1,1-Dichloroethene is produced commercially by the dehydrochlorination of 1,1,2-trichloroethane with excess lime or caustic or by thermal decomposition of 1,1,1-trichloroethane (O’Neil et al. 2013; WHO 2003). 1,1-Dichloroethene can readily polymerize at room temperature following addition of peroxides and polymerizes after the addition of initiators via ionic or free radial reactions (Grayson 1985; Larranaga et al. 2016). Commercial products usually contain small portions of an inhibitor to prevent its polymerization reaction. Several inhibitors have been invented for this purpose; for example, p-hydroxyanisole (CAS Registry Number: 150-76-5; synonym: MEHQ), which can be added (typically at 200 ppm) and removed by distillation or washing (Grayson 1985; O’Neil et al. 2013). Typically, a commercial-grade product contains 99.8% 1,1-dichloroethene (EPA 1985).

1,1-Dichloroethene is manufactured in chemical plants located in Texas and Louisiana. Two producers listed in the United States are Dow Chemical and Pittsburgh Paint and Glass (PPG) Industries (SRI 2011). In 1978, plant capacity at PPG Industries was estimated at 78 million pounds/year (EPA 1985).

Production capacity in 1985 was reported as 178 million pounds/year (EPA 1985). This decreased from 1977, when production capacity was estimated at 270 million pounds (EPA 1977b). Up-to-date data for the United States can be found using the Chemical Data Reporting (CDR) website, which reports information on the production and use of chemicals manufactured, imported, and exported. The CDR (EPA 2020) lists two domestic manufacturers of 1,1-dichloroethene for 2016, Owensboro Specialty Polymers Inc. in Owensboro, Kentucky, using 1,1-dichloroethene as a reactant in the manufacture of adhesives and sealant chemicals, production volume of 9,088,728 pounds; and Olin Corporation's plant in Freeport, Texas, using 1,1-dichloroethene as a reactant in the manufacture of plastic material and resins, production volume withheld. The CDR lists two companies for 2012: The Dow Chemical Company's site in Freeport, Texas (manufacturing information is listed as confidential business information [CBI]) and Shin Etsu's Shintech Plaquemine Plant in Plaquemine, Louisiana, with a total production volume of approximately 108,000 pounds in 2011 and 63,000 pounds in 2010 (EPA 2014a). National aggregate production volumes since 2011 have been withheld.

According to the Toxics Release Inventory (TRI), 22 facilities manufactured or processed 1,1-dichloroethene in 2015 (TRI18 2020). These data are listed in Table 5-1. The TRI data should be used with caution because only certain types of facilities are required to report. This is not an exhaustive list.

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
GA	1	100,000	999,999	6
KY	3	100	999,999	1, 3, 6
LA	6	100	99,999	1, 4, 5, 13, 14
MI	2	100,000	9,999,999	1, 5, 6, 12
NC	1	100,000	999,999	6
NY	1	0	99	12
OH	2	1,000	99,999	12

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
TX	5	100	9,999,999	1, 4, 5, 6, 12, 13, 14
WI	1	Not reported	Not reported	Not reported

[a]Post office state abbreviations used.
[b]Amounts on site reported by facilities in each state.
[c]Activities/Uses:

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

Source: TRI18 2020 (Data are from 2018)

5.2.2 Import/Export

No data are available on the import activities for 1,1-dichloroethene. The CDR reported export data for Shin Etsu’s Shintech Plaquemine Plant in Plaquemine, Louisiana as slightly over 8,000 pounds for 2011.

5.2.3 Use

1,1-Dichloroethene is used as a reactant for organic chemical synthesis, in the production of polyvinylidene chloride copolymers, and sparingly as a chlorinated solvent (CDR 2018; Larranaga et al. 2016; O’Neil et al. 2013). Because of the instability of the polymer, 1,1-dichloroethene is usually used as a copolymer with acrylonitrile, vinyl chloride, methacrylonitrile, and methacrylate (Grayson 1985; Rossberg et al. 1986). 1,1-Dichloroethene can be copolymerized with vinyl chloride or acrylonitrile to produce flexible films for food packaging, the major applications of polyvinylidene chloride copolymers (EPA 1977b; Larranaga et al. 2016). These polymers, which have been commercially important since their introduction in the early 1940s, are used extensively in many types of flexible packing materials (including barrier, multilayer, and monolayer), as flame retardant coatings for fiber and carpet backing, and in piping, coating for steel pipes, and adhesive applications (EPA 1977b). 1,1-Dichloroethene is found in many food and other packaging materials. Plastic packaging films can contain no more than 10 ppm 1,1-dichloroethene (FDA 1988). If 1,1-dichloroethene is employed as an unavoidable solvent in the production of pharmaceuticals, the U.S. Food and Drug Administration (FDA) has set a concentration limit of 8 ppm in the final product (FDA 2020a).

5.2.4 Disposal

1,1-Dichloroethene is classified as an extremely flammable and toxic liquid (EPA 2009a; WHO 2018; Weiss 1986). The EPA (1987) requires compliance with the regulations of the Resource Conservation and Recovery Act (RCRA) when producing, treating, transporting, storing, or disposing of this substance. RCRA Hazardous Waste Code for 1,1-dichloroethene is U078; its maximum concentration in solid hazardous waste is 0.7 mg/L, above which the solid waste is considered toxic waste and should be disposed of according to the appropriate regulations (EPA 2009a; 2017a). Disposal regulations of 1,1-dichloroethene require dissolving it in combustible solvents and scatter spraying the solvent into a furnace with an afterburner and alkaline scrubber. The waste mother liquor likely contains higher concentrations (>200 ppm) of the inhibitor, MEHQ. Disposal of accidental spills should be according to local regulations; collect leaking and spilled liquid in sealable containers and absorb remaining liquid in sand or an inert absorbent (WHO 2018).

5.3 RELEASES TO THE ENVIRONMENT

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 ≥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 22,653 pounds (~10.28 metric tons) of 1,1-dichloroethene to the atmosphere from 22 domestic manufacturing and processing facilities in 2018, accounted for 99.9% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). These releases are summarized in Table 5-2.

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use 1,1-Dichloroethene[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
GA	1	320	0	0	0	0	320	0	320
KY	3	6,111	0	0	0	1	6,111	1	6,112
LA	6	10,740	0	0	0	0	10,740	0	10,740
MI	2	970	25	0	1	0	995	1	996
NC	1	2	0	0	0	0	2	0	2
NY	1	0	0	0	0	0	0	0	0
OH	2	1	0	0	0	0	1	0	1
TX	5	4,510	0	0	0	0	4,510	0	4,510
WI	1	No data	No data	No data	No data	No data	No data	No data	No data
Total	22	22,653	25	0	1	1	22,679	2	22,681

[a] The 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.
[b] Data in TRI are maximum amounts released by each facility.
[c] Post office state abbreviations are used.
[d] Number of reporting facilities.
[e] The sum of fugitive and point source releases are included in releases to air by a given facility.
[f] Surface water discharges, waste water treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g] Class I wells, Class II-V wells, and underground injection.
[h] Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i] Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown.
[j] The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k] Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI18 2020 (Data are from 2018)

Air releases are the largest source of 1,1-dichloroethene releases to the environment, and emissions from polymer synthesis and fabrication industries contribute most to overall atmospheric loading. Singh et al. (1981) have estimated that air emissions of 1,1-dichloroethene from polymer synthesis in the United States range between 2 and 5% of the annual production. EPA (1985) estimated total annual air emissions of 1,1-dichloroethene of ≈650 tons/year, which was 0.8% of the production volume for that year. Over one-half of that total (355 tons) was from the polymer production/fabrication industries. The remaining emissions were from monomer synthesis (223 tons/year; 34%) and monomer storage, handling, and transportation (73 tons/year; 11%). Small amounts of 1,1-dichloroethene (not quantified) were estimated to be released during the incineration (disposal) of polymer products containing the 1,1-dichloroethene monomer, 1,1,1-trichloroethane, and other chlorinated solvents (Oki et al. 1990; Yasuhara and Morita 1988). Crume (1991) reported that 1,1-dichloroethene can be released to the atmosphere by air stripping contaminated groundwater. This process transfers groundwater contaminants into the gaseous phase and subsequently releases them into the atmosphere with no further treatment (the releases were not quantified). However, more recent data indicate that both the number of emission point sources and the total amount of 1,1-dichloroethene released to the atmosphere are much less than EPA’s earlier estimates. This decrease is the result of shifts away from the use of the compound by processors and improvements in control technology.

Hazardous waste sites and landfills where 1,1-dichloroethene have been improperly disposed of are additional potential sources of release of the chemical to the atmosphere because of volatilization (see Section 5.4.1).

5.3.2 Water

Estimated releases of 25 pounds (~0.01 metric tons) of 1,1-dichloroethene to surface water from 22 domestic manufacturing and processing facilities in 2018, accounted for 0.11% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). These releases are summarized in Table 5-2.

Industrial releases of 1,1-dichloroethene to surface water contribute to the overall environmental loading of the chemical, but to a much lesser extent than atmospheric emissions. Liquid effluents produced during polymerization operations were estimated to contribute ≈2 tons of waste 1,1-dichloroethene each year (EPA 1977b). Other potential industrial sources of waste 1,1-dichloroethene in surface water are metal finishing and nonferrous metals manufacturing industries, soap and detergent manufacturers, electric coil coating and battery manufacturers, coal mines, laundries, and industries involving paint and ink formulation. 1,1-Dichloroethene has been measured in raw wastewater from these industries at mean concentrations of 3–760 μg/L (EPA 1981).

Hazardous waste sites where 1,1-dichloroethene has been improperly disposed are additional potential sources of the chemical, although there are no quantitative data available to address how much 1,1-dichloroethene enters the environment from this source. In addition, surface water or groundwater contaminated with 1,1,1-trichloroethane, tetrachloroethylene, 1,1,2-trichloroethylene, and 1,2-dichloroethane can be an additional source of 1,1-dichloroethene through biotic or abiotic elimination or dehydrochlorination transformations (Baek et al. 1990; Cline and Viste 1985; Lesage et al. 1990). Hydrolysis of 1,1,1-trichloroethane in water or water/sediment systems will result in the formation of 1,1-dichloroethene, although it is a very slow process, with a half-life of 350 days at 25°C (Haag and Mill 1988). Total releases of 1,1-dichloroethene from these sources have not been quantified or estimated.

Surface water was analyzed after 39,000 tons of coal ash from an industrial steam station was spilled into the Dan River in Eden, North Carolina on February 2, 2014 (EPA 2017c). Surface water samples taken from the intake waters and river waters between the Danville Water Treatment Plant and South Boston Water Treatment Plant on February 6th, 7th, and 11th 2014 did not contain concentrations of 1,1-dichloroethene above the detection limit of 0.5 μg/L (EPA 2014b, 2014c, 2014d).

5.3.3 Soil

Estimated releases of 1 pound (~0.0004 metric tons) of 1,1-dichloroethene to soils from 22 domestic manufacturing and processing facilities in 2018, accounted for 0.004% of the estimated total environmental releases from facilities required to report to the TRI (TRI18 2020). These releases are summarized in Table 5-2.

Limited information is available on the releases of 1,1-dichloroethene to soil. An estimated total of 180 pounds/year of 1,1-dichloroethene are disposed of in municipal landfills as residual monomer in some consumer products on a national basis (EPA 1977b). Under certain conditions, 1,1-dichloroethene may be released into the environment as a degradation product of other chemicals such as the hydrolysis of 1,1,1-trichloroethane and the dechlorination of trichloroethene under anaerobic conditions (Haag Mill 1988; McNab and Narasimhan 1994; USGS 2006; Zhang et al. 2006).

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

The tendency of a chemical to partition between soil, water, sediment, air, and biota can be inferred from its physical/chemical properties. Based on a vapor pressure of 600 mm Hg (Boublik et al. 1984), most of the 1,1-dichloroethene released into the environment will ultimately partition into the atmospheric compartment as shown by the vapor partitioning model of Mackay and Paterson (1981), although other factors such as water solubility may affect the rate at which the partitioning will occur. In localized situations, intervening processes such as biotransformation, may alter this outcome.

Air. Based on its high vapor pressure, 1,1-dichloroethene will exist entirely in the vapor phase in the ambient atmosphere. Studies on atmospheric removal processes indicate that once in the atmosphere, 1,1-dichloroethene is unlikely to be removed by physical processes such as wet deposition (e.g., rain) or by adsorption to atmospheric particulates (EPA 1980a). An atmospheric residence time of 2.9 days (EPA 1980a) suggests that the potential for limited atmospheric transport from point sources may be possible.

Water. The dominant removal process for 1,1-dichloroethene from surface waters is expected to be volatilization. As the magnitude of the Henry’s law constant for 1,1-dichloroethene, 2.61×10^{-2} atm-m^3/mole at 24°C (Gossett 1987) indicates, 1,1-dichloroethene is likely to volatilize rapidly into the atmosphere from water. Because of this, 1,1-dichloroethene is generally not found in surface water in high concentrations. Based on its Henry’s Law constant, the volatilization half-life in a model lake 1 m deep with a 0.05 m/second current and a 0.5 m/second wind is estimated to be 3.9 days; the volatilization half-life of 1,1-dichloroethene in a model river 1 m deep flowing 1 m/second with a wind speed of 3 m/second is estimated to be 1 hour (EPA 2012).

Sediment and Soil. 1,1-Dichloroethene spilled onto surface soil will also tend to partition to the atmosphere, while some of the chemical may percolate into the subsurface soil. Once in the subsurface soil, 1,1-dichloroethene will partition between soil and water. 1,1-Dichloroethene has relatively high water solubility and a small log soil organic carbon sorption coefficient (K_{oc}) value of 1.81 (EPA 1982), indicating that 1,1-dichloroethene has high mobility and will migrate through soil without significant retardation by adsorption to organic carbon. Similarly, 1,1-dichloroethene will migrate relatively freely within groundwater.

Other Media. 1,1-Dichloroethene in surface water is unlikely to partition significantly into aquatic organisms. Partitioning of 1,1-dichloroethene from water into aquatic organisms can be predicted in part by the magnitude of the octanol/water partition coefficient (K_{ow}) value. Chemicals with a log K_{ow} of <4.0 are unlikely to bioaccumulate to hazardous levels in human food chains (Veith et al. 1985). The log K_{ow} is 2.13 (Veith et al. 1985) and based upon this calculation, bioaccumulation in the human food chain is not expected to be significant for this compound. An experimental bioconcentration factor (BCF) of 3.1–4.9 L/kg at 0.5 mg/L and ≤13 at 0.5 mg/L measured in carp indicates that the potential for bioconcentration in aquatic organisms is low (CITI 1992).

5.4.2 Transformation and Degradation

Transformations of 1,1-dichloroethene can occur from the reaction with radical species in the atmosphere and from biodegradation under anaerobic conditions in soil or water.

Air. Atmospheric degradation of 1,1-dichloroethene is expected to be dominated by gas-phase oxidation with photochemically produced hydroxyl radicals. An experimental rate constant for this process of 1.09×10^{-11} cm^3/molecule-second at 25°C has been determined (Kwok and Atkinson 1995). Based on a 12-hour day of sunlight, using an average atmospheric hydroxyl radical concentration of 5×10^5 molecule/cm^3, a half-life of 1.5 days can be calculated for this process. A higher atmospheric concentration of hydroxyl radicals (5×10^6 molecules/cm^3) will reduce the half-life of 1,1-dichloroethene from 1.5 days to 3.5 hours (Grosjean 1990). The products expected from this reaction are phosgene, formaldehyde, and chloroacetyl chloride (Tuazon et al. 1988). Pearson and McConnell (1975) reported a tropospheric half-life for 1,1-dichloroethene of 8 weeks, resulting from an experiment with limitations such as non-ideal air characteristics and ±50% reproducibility due to climate parameters noted.

Atmospheric degradation of 1,1-dichloroethene may also occur by a gas-phase reaction with other atmospheric oxidants, namely ozone and nitrate radicals, although these processes are slower than the reaction of 1,1-dichloroethene with hydroxyl radicals (Grosjean 1990). An experimental rate constant for the gas-phase reaction of ozone with 1,1-dichloroethene of 3.7×10^{-21} cm^3/molecule-second at 25°C (Atkinson and Carter 1984) translates to an atmospheric half-life of >8 years for this process using an average atmospheric ozone concentration of 7×10^{11} molecule/cm^3. Nitrate radicals are destroyed by sunlight, and the oxidation of organic compounds by this oxidant is only important at night. The rate constant for the oxidation of 1,1-dichloroethene by nitrate radicals, 1.78×10^{-15} cm^3/molecule-second at 25°C (Sabljic and Gusten 1990), translates to a half-life of 19 days in a moderately polluted atmosphere, although at nitrate concentrations of 50 ppt the half-life may be reduced to 6 days (Grosjean 1990). Using Fourier transform infrared spectroscopy (FTIR) spectrometry, 1,1-dichloroethene reaction with hydroxyl radicals and nitrates was observed; reaction products of 1,1-dichloroethene with hydroxyl radicals and nitrates in air include chloroacetyl chloride, phosgene, formaldehyde, carbon monoxide, and nitric acid; a hydroxyl radical reaction rate constant of $12\text{x}10^{-12}$ cm^3/molecule-second was calculated corresponding to an atmospheric half-life of approximately 16 hours (EPA 1983). Lacking chromophores that absorb radiation at wavelengths >290 nm, direct vapor phase photolysis is not expected to be an important fate process for 1,1-dichloroethene (Lyman et al. 1990).

Water. Photolysis and hydrolysis of 1,1-dichloroethene in natural aquatic media are not significant environmental fate processes (EPA 1982). The estimated half-life for the hydrolysis of 1,1-dichloroethene at 25°C under neutral (or slightly basic) conditions is $1.2\text{x}10^8$ years (Jeffers et al. 1989). Estimated hydrolysis half-lives of 6–9 months at pH values ranging from 4.5 to 8.5 have also been reported (Cline and Delfino 1987). Conflicting results have been obtained for the aerobic biotransformation of 1,1-dichloroethene. Biotransformation under anaerobic conditions is likely the dominant transformation process for 1,1-dichloroethene in groundwater; however, complete mineralization has not been confirmed. 1,1-Dichloroethene and its transformation products have been postulated as toxic to microbial populations. Transformation capacities were measured for chlorinated hydrocarbons using two mixed and two pure methane-oxidizing cultures; 1,1-dichloroethene exhibited the greatest toxicity with mean transformation values of 0.11, 0.25, 0.39, and 0.36 μmol/mg being an order of magnitude lower than other similar chlorinated hydrocarbons (Chang and Alvarez 1996). Oxidation of 1,1-dichloroethene by methane and aromatic monooxygenases has been demonstrated with removal rates greater than 95% in 24 hours (Chauhan et al. 1998; Dolan and McCarty 1995). In aqueous batch studies at 20°C using aquifer material from a Superfund site under aerobic conditions, 1,1-dichloroethene was not found to be toxic at concentrations up to 1 mg/L, yet its transformation products were highly toxic; biotransformation of 1,1-dichloroethene as a result of methyl monooxygenase activity was apparent, but ceased after the first few hours of incubation with the mixed methanotrophic culture in the presence and absence of formate with transformation rates of 0.063 and 0.045 μmol 1,1-dichloroethene/mg of total suspended solids, respectively (Dolan and McCarty 1995). Pearson and McConnell (1975) found no evidence for biotransformation of 1,1-dichloroethene under aerobic conditions in water. Additionally, 0% biodegradation was observed after 28 days in an aerobic closed bottle test using an activated sludge inoculum (OECD 301D) (CITI 1992). In contrast, aerobic degradation may occur under certain conditions; Tabak et al. (1981) reported transformation of 54% of 5 mg/L and 30% of 10 mg/L test concentrations of 1,1-dichloroethene under aerobic conditions within 1 week after incubation with a domestic waste water seed; these removal figures were adjusted to account for volatilization losses from control flasks of 24% for the 5 mg/L and 15% for the 10 mg/L test concentrations. Under anaerobic conditions, Ensign et al. (1992) observed that 1,1-dichloroethene was not degraded efficiently by propylene-grown *Xanthobacter* cells (strain Py2); the environmental media was not reported. However, Wilson et al. (1986) studied the behavior of 1,1-dichloroethene in authentic aquifer material known to support methanogenesis. The disappearance of 1,1-dichloroethene was observed with an initial 16-day lag phase and vinyl chloride, the major degradation product, was found in trace amounts. Baek et al. (1990) observed the biodegradation and formation of vinyl chloride under anaerobic conditions when 1,1-dichloroethene was incubated with digested sludge under both fermentative and methanogenic conditions. In an anaerobic continuous-flow column study evaluating the reductive dechlorination of perchloroethylene, reduction of 1,1-dichloroethene also led to vinyl chloride (Vogel and McCarty 1985).

Sediment and Soil. In studies simulating anaerobic conditions in groundwater and landfills, vinyl chloride was produced from the reductive dechlorination of 1,1-dichloroethene by microorganisms in anoxic sediment microcosms after 1–3 weeks of incubation (Barrio-Lage et al. 1986; Hallen et al. 1986); reported first-order rate constants for the depletion of 1,1-dichloroethene in anoxic sediments were 3.57×10^{-4} and 1.67×10^{-4} hours^{-1} corresponding to half-lives of 81 and 173 days, respectively (Barrio-Lage et al. 1986). A methane-utilizing culture isolated from lake sediment degraded 600 ng/mL 1,1-dichloroethene to 200 ng/mL under aerobic conditions within 2 days; the degradation products were nonvolatile and did not include vinyl chloride, which is known to be formed under anaerobic conditions (Fogel et al. 1986). Under aerobic conditions in soil microcosms with aquifer material, no measurable biotransformation of 1,1-dichloroethene was observed and any loss was attributed to sorption (Dolan and McCarty 1995).

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to 1,1-dichloroethene depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of 1,1-dichloroethene 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-dichloroethene 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 5-3 shows the lowest limit of detections that are achieved by analytical analysis of environmental media. An overview summary of the range of concentrations detected in environmental media is presented in Table 5-4.

Table 5-3. Lowest Limit of Detection Based on Standards

Media	Detection limit	Reference
Air	7 µg/sample	Foerst 1979; NIOSH 1994
Drinking water	<0.2 µg/L	Eichelberger et al. 1990
Surface water and groundwater	0.13–2.8 µg/L	EPA 1984a, 1984c, 1986b
Soil/chemical waste	10 ppm	Deleon et al. 1980
Sediment/solids sludges/wastes	Soil, sediment, 5 µg/L; wastes 0.5 mg/kg	EPA 1986c
Whole blood	3.1 ppt	Ashley et al. 1992
Human tissue (adipose, kidney, liver brain)	~50 pg	Lin et al. 1982
Alveolar air/breath	<5–1 µg/m^3	Pellizzari et al. 1985; Raymer et al. 1990; Wallace et al. 1984
Fish tissue	10 µg/kg	Easley et al. 1981
Food	<0.005 ppm	Gilbert et al. 1980

Table 5-4. Summary of Environmental Levels of 1,1-Dichloroethene

Media	Low	High	Reference
Surface water (ppb)	<0.14	48,000	USGS 2006
Groundwater (ppb)	<0.13	<16	USGS 2006

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

Table 5-5. 1,1-Dichloroethene 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)	24	33.8	15.0	484	257
Soil (ppb)	360	279	34.8	79	57

Table 5-5. 1,1-Dichloroethene 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
Air (ppbv)	1.31	4.42	45.5	39	30

[a]Concentrations found in ATSDR site documents from 1981 to 2017 for 1,854 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

Air monitoring data for 1,1-dichloroethene have been compiled in Table 5-6.

The EPA TEAM (Total Exposure Assessment Measurement) studies measured 1,1-dichloroethene concentrations in 1,085 personal air samples collected from 350 New Jersey residents (discrepancy in the actual number of residents sampled) over three seasons. Only 77 (7%) of the samples had measurable concentrations of 1,1-dichloroethene, and 107 (10%) of the samples had trace levels. The detection limit ranged from 3 to 14 μg/m^3 (Wallace 1991). Headspace analysis of air emissions from eight different household bleach products during use detected 1,1-dichloroethene concentrations of 1.1–1,500 μg/m^3; it was suggested that sodium hypochlorite (NaOCl) in the bleach may react to generate halogenated VOCs (Odabasi 2008).

About 50% of 1,1-dichloroethene volatilizes from water while showering. Volatility from other household uses of water ranges from about 20% (sinks, toilets) to 70% (dishwashers). Thus, there is potential for inhalation exposure during showering, bathing, and other household water uses, such as dishwashers, clothes washers, toilets, and sinks. ATSDR’s three-compartment Shower and Household Water-Use Exposure (SHOWER) model predicts air concentrations in the shower stall, bathroom, and main house throughout the day for households with up to eight members. Using concentrations in water and human activity patterns, the model estimates a daily TWA exposure concentration from breathing indoor air. The model also estimates dermal doses from skin contact while bathing and washing hands. The model is a desktop application that is available by sending a request to showermodel@cdc.gov.

Table 5-6. Air Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
Palermo Wellfield Superfund Site, Washington	Ambient air monitoring sites	July 2019; September 2018; March and December 2017; May 2016; September 2015	0.12–0.16 µg/m^3	Not detected: material analyzed for, but not detected above the method LOD	Detection/quantitation limits of the methods used: 0.12, 0.13, and 0.16 µg/m^3; multiple samples collected at Superfund site	WQP 2020
Pennsylvania, Texas, Rhode Island, Ohio, Kentucky, Arizona Colorado, Florida Georgia, Illinois, Indiana, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Oklahoma, Utah Vermont, Virginia, Washington	Ambient air monitoring sites	2017		0.059 ppbv	Detected in 11 out 124 samples; Philadelphia, Pennsylvania; Deer Park, Texas; Pawtucket, Rhode Island; Cincinnati, Ohio; Calvert, Kentucky, Laredo, Texas; Denton, Texas; Dallas, Texas	EPA 2017b
Arizona, Colorado, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Texas, Utah, Virginia, Washington	Ambient air monitoring sites	2016		0.0013–0.056 ppbv	Detected in 12 out 124 samples; Pawtucket, Rhode Island; Deer Park, Texas; Candor, North Carolina; Philadelphia, Pennsylvania; Raleigh, North Carolina; Davie, Florida; Fort Lauderdale, Florida; Coconut Creek, Florida; Dania, Florida	EPA 2016a
New Jersey	Ambient air	1983–1984	Maximum: 97 ppb	0.39–38.9 ppb, measured at waste sites, and an arithmetic mean concentration of 2.6 ppb measured at the sanitary landfill		Harkov et al. 1985; LaRegina et al. 1986

Table 5-6. Air Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
New Jersey	Ambient air	July–August 1981		0.35–0.38 ppb	Newark, Elizabeth, and Camden New Jersey	Harkov et al. 1987
Kanawha Valley, West Virginia; Los Angeles, California; and Houston, Texas	Ambient air	1986–1987		0.84 ppb	Detected in 24 of 79 ambient air samples	Pleil et al. 1988
U.S. cities	Ambient air	Prior to 1981	0.005–0.03 ppb			Singh et al. 1981, 1982
Research Triangle Park, North Carolina	Indoor air	Prior to 1985		47.3 ppb (summer); 7.1 ppb (winter)	26 homes and apartments	EPA 1985
United States	Ambient and indoor air	1988		4.6 ppb	Daily average concentration from rural, suburban, urban, and source-dominated sites	EPA 1988a
United States	Ambient and indoor air	1988	Median 0.0 ppbv (ambient and indoor)	4.612 ppbv ambient; 19.665 ppbv indoor	Daily average ambient concentration from rural, suburban, urban, and source-dominated sites (1,275 data points); daily average indoor concentration from residential, offices, and personal (2,120 data points)	EPA 1988a
Palermo Wellfield Superfund Site, Washington	Indoor air	April and October 2013; February 2014	0.16–0.17 μg/m^3	Not detected: the analyte was analyzed for, but was not detected, at a level greater than or equal to the level of the adjusted contract required quantitation limit for sample and method	Detection/quantitation limits of the methods used: 0.16 and 0.17 μg/m^3	WQP 2020

LOD = limit of detection

Based on vapor pressure and Henry’s law constant, 1,1-dichloroethene has the potential to be a contaminant of concern for vapor intrusion into homes or other buildings (ATSDR 2016; EPA 2015). A review of vapor intrusion data from 148 ATSDR public health assessments completed between 1994 and 2010 identified 31 sites with detected concentrations of 1,1-dichloroethene in groundwater, soil gas, or air (Burk and Zarus 2013). 1,1-Dichloroethene was detected in indoor air at 9 of the 31 vapor intrusion sites. Two of the sites had measured indoor air concentrations greater than ATSDR’s MRL: the Chemical Commodities Incorporated site from Olathe, Kansas (ATSDR 2003) had a measured indoor air concentration of 4.4 μg/m^3, and the Valmont Trichloroethylene site from West Hazelton, Pennsylvania (ATSDR 2006) had a measured indoor air concentration of 7.5 μg/m^3. All of the concentrations measured were less than the BMCL used as the basis of the inhalation MRL and were not expected to be of concern for health effects.

5.5.2 Water

Water monitoring data for 1,1-dichloroethene have been compiled in Table 5-7.

1,1-Dichloroethene has been detected infrequently at low concentrations in urban runoff that will contribute to surface water concentrations. (Cole et al. 1984). 1,1-Dichloroethene has been detected in 25.2% of 178 contaminated sites monitored under the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA), making it the fifth most frequently detected organic contaminant at these sites (Plumb 1987). Contamination of groundwater at an industrial site in Waite Park, Minnesota, resulting from the mishandling of waste product, paint, and solvent led to a maximum 1,1-dichloroethene concentration of 88 μg/L in deep monitoring wells and 22 μg/L in shallow wells (ATSDR 1990). This aquifer contamination led to a maximum 1,1-dichloroethene concentration of 94 μg/L in Waite Park municipal wells, resulting in this city’s water supply being listed as an NPL site. The disposal of organic chemicals in trenches at a waste disposal site near Ottawa, Canada, resulted in 1,1-dichloroethene groundwater concentrations ranging from 0.9 to 60 μg/L in 43% of samples taken from a 37-well monitoring network in 1988 (Lesage et al. 1990). Leachate originating from the Orange County and Alachua Municipal Landfills in north central Florida resulted in groundwater contamination near the landfills. The average concentrations of 1,1-dichloroethene in wells sampled near the Orange County Landfill and the Alachua Municipal Landfill were 0.12 and <1.0 μg/L, respectively (Hallbourg et al. 1992).

Table 5-7. Water Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
Grenada, Mississippi	Industrial-related site	January 2016	Not detected		Not detected at or above the detection limit of 0.50 ppb (0.5 μg/L)	Grenada 2016b
Arizona; Delaware; Minnesota; New Mexico; Oregon; Pennsylvania; Tennessee; Texas; Virginia; Washington	Surface water	2019	Not detected		Material analyzed for, but not detected above the lower reporting limit of 0.1–1.0 μg/L	WQP 2020
Arizona; Nevada; New Jersey; New Mexico; Pennsylvania; North Carolina; Oregon; Tennessee; Texas; Virginia; Washington	Surface water	2018	Not detected		Material analyzed for, but not detected above the lower reporting limit of 0.1–1.0 μg/L	WQP 2020
Arizona; California; New Jersey; New Mexico; New York; North Carolina; Oregon; Tennessee; Texas; Virginia; Washington	Surface water	2017	Not detected		Material analyzed for, but not detected above the Lower Reporting Limit of 0.1–1.0 μg/L	WQP 2020
USGS New Mexico Water Science Center	Groundwater	January 2020	Not detected		Material analyzed for, but not detected above the lower reporting limit of 0.6 μg/L	WQP 2020
Arizona Department of Environmental Quality; Boomsnub/Airco Superfund Site EPA Region 10; Northern Ute Indian Tribe (UT); Palermo Wellfield Superfund Site, Washington; State of Oregon Department of Environmental Quality	Groundwater; Superfund sites	2019	Not detected–170 ug/L		Activity depth: 4.13–396 feet; LOD: 0.08–5.0 μg/L	WQP 2020
USGS Water Science Centers of: Alabama; California; Colorado; Florida; Georgia; Idaho; Illinois; Indiana; Kentucky; Maine; Massachusetts; Minnesota; Mississippi; Missouri; Nebraska; New Hampshire; New Jersey; New Mexico; New York; Ohio; Pennsylvania; South Carolina; Tennessee; West Virginia; Wyoming	USGS monitoring sites	2019	Not detected– 2 μg/L		Activity depth: 5–1,414 feet; LOD: 0.1–1.0 μg/L	WQP 2020

Table 5-7. Water Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
Arizona Department of Environmental Quality; Boomsnub/Airco Superfund Site EPA Region 10; Minnesota Pollution Control Agency - Ambient Groundwater; Northern Ute Indian Tribe (UT); Palermo Wellfield Superfund Site, Washington; State of Oregon Department of Environmental Quality	Groundwater; Superfund sites	2018	Not detected-9.1 ug/L		Activity depth: 4.13–250 feet; LOD: 0.08–2.0 μg/L	WQP 2020
USGS Water Science Centers of: Arizona; California; Colorado; Georgia; Idaho; Illinois; Kansas; Maryland; Minnesota; Missouri; Montana; Nebraska; New Jersey; New Mexico; New York; North Dakota; Oklahoma; Pennsylvania; South Carolina; Tennessee; Texas; Washington	USGS monitoring sites	2018	Not detected- 16 ug/L		Activity depth: 4.3–1,414 feet; LOD: 0.1–1.0 μg/L	WQP 2020
Arizona Department of Environmental Quality; Blackfeet Nation (Montana); Boomsnub/Airco Superfund Site EPA Region 10; Minnesota Pollution Control Agency - Ambient Groundwater; Northern Ute Indian Tribe (UT); Palermo Wellfield Superfund Site, Washington; Sokaogon Chippewa Community; State of Oregon Department of Environmental Quality	Groundwater; Superfund Sites	2017	Not detected		Activity depth: 4.13–237.4 feet; LOD: 0.0046–2.0 μg/L	WQP 2020
USGS Water Science Centers of: Arizona; California; Colorado; Connecticut; Georgia; Idaho; Illinois; Iowa; Kansas; Maryland; Massachusetts; Missouri; New Hampshire; New Jersey; New Mexico; New York; Oregon; Pennsylvania; Puerto Rico; Tennessee; Texas; Utah; Wisconsin; Wyoming	USGS monitoring sites	2017	Not detected–13.8 μg/L		Activity depth: 4–1,414 feet; LOD: 0.1–1.0 μg/L	WQP 2020

Table 5-7. Water Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
United States	Domestic well water	1985–2002	Not reported	Not reported	Detected in 19 of 1,207 water samples; 1 of 2,400 samples above the EPA MCL	Rowe et al. 2007
South Carolina	Surface water at a VOC-contaminated site	2000–2006	<0.14–48,000 μg/L	Not reported	Solid Waste Management Unit 12, Naval Weapons Station Charleston, North Charleston, South Carolina	USGS 2006
South Carolina	Groundwater at a VOC-contaminated site	2000–2006	<0.13–<16 μg/L	Not reported	Solid Waste Management Unit 12, Naval Weapons Station Charleston, North Charleston, South Carolina	USGS 2006
United States	Domestic well water	2000–2001	Not reported	Not reported	Detected in two wells, one above the EPAs MCL	Aelion and Conte 2004
United States	Groundwater wells	1985–1995	Not reported	Not reported	Detected in 3% of urban wells, and 0.3% of rural wells	Squillace et al. 1999
United States	Domestic well water	1982	Not reported	Median concentration of 0.3 μg/L	Detected in 9 of 466 water samples	Cotruvo 1985
United States		Prior to 1984	Maximum: 6.3 μg/L	Subset median values: 0.28–1.2 μg/L	Detected in 2.3% of 945 samples of finished drinking water taken from community-based groundwater sources in a nationwide survey; quantification limit of 0.2 ppb	Rajagopal and Li 1991; Westrick et al. 1984
United States	Finished water	Prior to 1985	0.2–0.5 μg/L (estimated mean 0.3 μg/L)	Not reported	About 3% of the drinking water supplies in the United States	EPA 1985
United States	Urban storm water runoff	Prior to 1984	1.5–4 μg/L	Not reported	Nationwide Urban Runoff Program (NURP)	Cole et al. 1984

Table 5-7. Water Monitoring Data for 1,1-Dichloroethene

Location(s)	Geographic type	Date(s)	Range	Mean concentration	Notes	Reference
U.S. cities	Groundwater	Prior to 1980			Detected in 7.1% of samples	EPA 1980b
U.S. cities	Raw and finished surface water	Prior to 1980	0.2–0.51 μg/L	0.36 μg/L	Not detected in a survey of 105 raw water samples; detected in 1.9% of 103 finished water samples	EPA 1980b
United States		Prior to 1985			Detected in 6% of 8,714 surface water samples monitored nationwide	Staples et al. 1985
United States	Surface waters near industrial sites	Prior to 1977	<1–550 μg/L			Going and Spigarelli 1977c
United States		Prior to 1985			Detected in 3.3% of 1,350 effluent samples monitored nationwide	Staples et al. 1985
United States	Raw and treated waste waters from industrial related site	Prior to 1981	<1,000–>5,000 μg/L		Raw and treated waste waters: from industries involving paint and ink formulation, soap and detergent manufacturing, coil coating, battery manufacturing, coal mining, and laundries (minimum), and from the metal finishing and nonferrous metals manufacturing industries (maximum)	EPA 1981

EPA = U.S. Environmental Protection Agency; LOD = limit of detection; MCL = maximum contaminant level; USGS = U.S. Geological Survey; VOC = volatile organic compound

5.5.3 Sediment and Soil

No information is available on concentrations of 1,1-dichloroethene in surface soil, although this chemical is often found at hazardous waste sites. Because of the tendency of 1,1-dichloroethene to partition into the atmosphere, with remaining material having the potential to percolate into groundwater, ambient concentrations in surface soil are expected to be low.

Data compiled from the Retrieval (STORET) Data Warehouse reports monitoring data from EPA Great Lakes National Program, which includes monitoring of 1,1-dichloroethene. Limited information is reported with no specific concentrations listed; percent recoveries of 68–127% for were reported for 1,1-dichloroethene in 126 sediment samples taken in April, June, and October of 2011 at core depths between 0.15 and 10.3 (WQP 2017).

1,1-Dichloroethene was analyzed for, but was not detected, at a concentrations greater than or equal to the method quantitation/detection limits ranging from 0.096 to 430 mg/kg in monitoring samples of subsurface soil and sediment by the U.S. Geological Survey (USGS) Texas Water Science Center in June and August 2019 (WQP 2020).

5.5.4 Other Media

1,1-Dichloroethene copolymers are used in the manufacture of films used in food packaging. Residual 1,1-dichloroethene monomer has been detected at concentrations of <0.02–1.26 ppm in retail food packaging films containing polyvinylidene chloride; residues in a variety of foodstuffs wrapped with the films were in the range of ≤0.005–0.01 ppm (Gilbert et al. 1980). Concentrations of residual 1,1-dichloroethene in household films used to package food were reported by Birkel et al. (1977) to be 6.5–10.4 ppm (average 8.8 ppm). At one time, some films contained as much as 30 ppm 1,1-dichloroethene (Birkel et al. 1977).

1,1-Dichloroethene was detected in a composite sample of Rigolets clams obtained from Lake Pontchartrain, Louisiana, in 1980 at a concentration of 4.4 ppb wet weight (Ferrario et al. 1985).

5.6 GENERAL POPULATION EXPOSURE

The general population is most likely to be exposed to 1,1-dichloroethene by inhalation of contaminated air and ingestion of food and drinking water contaminated with 1,1-dichloroethene. Exposure potential is expected to be higher near hazardous waste sites containing 1,1-dichloroethene. Occupational exposure to 1,1-dichloroethene is most likely to occur via inhalation and dermal absorption during the production and processing of this chemical.

Information and experimental data on exposure of the general population to 1,1-dichloroethene are limited. An EPA TEAM study conducted from 1980 to 1987 reported that the average exposure of the general population to 1,1-dichloroethene is 6.5 $\mu g/m^3$ based on personal air samples from 350 homes in New Jersey (Wallace 1991).

The FDA estimated the cumulative daily intake of 10 polymeric materials produced with 1,1-dichloroethene used in food contact applications at 0.00035 mg/kg body weight/day (FDA 2020b).

The Fourth National Report on Human Exposures to Environmental Chemicals, published and updated by the Centers for Disease Control and Prevention reporting biomonitoring data from the NHANES shows that concentrations of 1,1-dichloroethene in whole blood were below the detection limit of 0.009 ng/mL in samples from 1,364; 3,163; and 2,810 members of the U.S. general population for the survey years 2003–2004, 2005–2006, and 2007–2008, respectively (CDC 2017).

The National Occupational Hazard Survey (NOHS), conducted by the National Institute for Occupational Safety and Health (NIOSH), estimated that 56,857 workers in 3,853 plants were potentially exposed to 1,1-dichloroethene in the workplace in 1970 (NIOSH 1976). These estimates were derived from observation of the actual use of 1,1-dichloroethene (1%), the use of trade-name products known to contain 1,1-dichloroethene (19%), and the use of generic products suspected of containing the compound (80%). The largest numbers of exposed workers were special trade contractors or in the fabricated metal products industry or wholesale trade industry. The occupational groups of exposed workers consisted of carpenters, warehousemen (not otherwise classified), and miscellaneous machine operators.

Data from a second workplace survey, the National Occupational Exposure Survey (NOES), conducted by NIOSH from 1980 to 1983, indicated that 2,679 workers, including 291 women, in 97 plants were potentially exposed to 1,1-dichloroethene in the workplace in 1980 (NIOSH 1984). The greatest number of exposed workers were chemical technicians. All estimates were derived from observations of the actual use of the compound.

1,1-Dichloroethene was produced in significant amounts that under certain conditions may approach 100%, from the thermal degradation of 1,1,1-trichloroethane (Glisson et al. 1986). This implies that inadvertent exposure to 1,1-dichloroethene may occur in many industrial situations when 1,1,1-trichloroethane is used in the vicinity of operations involving heat, such as welding or soldering and metal cleaning. 1,1-Dichloroethene has also been detected as a pyrolysis product of the pesticide endosulfan in tobacco smoke (Chopra et al. 1978).

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Human exposure to 1,1-dichloroethene is potentially highest in workplace settings and among populations residing in the vicinity of hazardous waste sites where the compound may contaminate environmental media.

The presence of residual monomeric 1,1-dichloroethene in polymeric food wraps and other consumer products is another potential source of human exposure. Exposure from these sources is difficult to estimate. However, there is no evidence in the literature to implicate consumer products as major sources of 1,1-dichloroethene exposure (EPA 1985).

In addition to releases from hazardous waste sites, ambient air and water may be contaminated with 1,1-dichloroethene by releases from industrial production and polymerization processes (EPA 1977, 1985a; Wang et al. 1985a, 1985b). Levels are significantly higher in areas surrounding production sites (EPA 1977b, 1985).