6. POTENTIAL FOR HUMAN EXPOSURE

6.1 OVERVIEW

1,1,1-Trichloroethane has been identified in at least 823 of the 1,662 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (HazDat 2005). However, the number of sites evaluated for 1,1,1-trichloroethane is not known. The frequency of these sites can be seen in Figure 6-1. Of these sites, 815 are located within the United States, 5 are located in the Commonwealth of Puerto Rico (not shown), 2 are located in the Virgin Islands (not shown), and 1 is located in Guam (not shown).

1,1,1-Trichloroethane is a synthetic compound that is released to the environment by human industrial activity. It was released to the environment by process and fugitive emissions during its manufacture, formulation, and use in both consumer and industrial products. Because 1,1,1-trichloroethane is volatile and was used as a solvent in many products, it was most frequently found in the atmosphere due to volatilization during production and use. 1,1,1-Trichloroethane is an ozone depleting substance and has been listed as a class I substance under Section 602 of the Clean Air Act. Class I substances have an ozone depletion potential (ODP) of \( \geq 0.2 \) and include chlorofluorocarbons (CFCs), halons, carbon tetrachloride, 1,1,1-trichloroethane, and methyl bromide. Although recent estimates have yielded an ODP of 0.12 for 1,1,1-trichloroethane, it is still listed as a class I substance. Under Section 604 of the Clean Air Act as amended in 1990, all production and use of 1,1,1-trichloroethane was scheduled to cease as of January 1, 2002. However, 1,1,1-trichloroethene may still be used for essential applications such as medical devices and aviation safety (for the testing of metal fatigue and corrosion of existing airplane engines and other parts susceptible to corrosion) until January 1, 2005. 1,1,1-Trichloroethane (and other class I substances) may also be produced domestically for export to developing countries as specified in Section 604(e) of the Clean Air Act. This exception to the phase-out is scheduled to end by January 1, 2012 for 1,1,1-trichloroethane (EPA 2004m). In 2002, 1,1,1-trichloroethane was still being manufactured in the United States in 2002 in a production volume range of 100–500 million pounds. The projected amount of 1,1,1-trichloroethane has decreased from 300 million pounds in 2000 to 125 million pounds in 2005 (HSIA 2004). 1,1,1-Trichloroethane is no longer used in common household products. The current likelihood of exposure of the general population to 1,1,1-trichloroethane is remote. Possible routes of exposure to 1,1,1-trichloroethane were inhalation, dermal contact, or through the ingestion of either contaminated water or food. Exposure by inhalation was expected to predominate.
Figure 6-1. Frequency of NPL Sites with 1,1,1-Trichloroethane Contamination

Derived from HazDat 2005
6. POTENTIAL FOR HUMAN EXPOSURE

The general population was exposed to 1,1,1-trichloroethane because of its prevalence in common household products. Indoor air concentrations were determined to be greater than nearby outdoor concentrations, probably as a result of its presence in a myriad of consumer products in the past. Occupational exposure to 1,1,1-trichloroethane could have occurred by inhalation or dermal contact during its manufacture and formulation, during its use as a cleaner of manufactured components, and during the application of the numerous paints, resins, adhesives, and cleaners containing it as a solvent. At hazardous waste sites, inhalation is expected to be the predominant route of exposure; however, ingestion of contaminated water may occur also.

The dominant environmental fate process for 1,1,1-trichloroethane is volatilization to the atmosphere. Once in the atmosphere, reaction with photochemically-produced hydroxyl radicals is expected to be the most important transformation process for 1,1,1-trichloroethane; the estimated atmospheric lifetime for this process is about 6 years. This long atmospheric lifetime allows about 15% of 1,1,1-trichloroethane to migrate to the stratosphere, where it may be degraded by lower wavelength ultraviolet light, not available in the troposphere, to produce atomic chlorine. The chlorine atoms produced in the stratosphere by this process may react with ozone causing the erosion of the ozone layer. However, direct photochemical degradation of 1,1,1-trichloroethane in the troposphere should not occur. The moderate water solubility of 1,1,1-trichloroethane suggests that rain washout can occur; however, 1,1,1-trichloroethane removed from the atmosphere by this process would be expected to re-volatilize. The lengthy half-life for 1,1,1-trichloroethane in the troposphere allows it to be carried great distances from its original point of release, and it has been found in remote places far from any known source of release.

If released to soil, 1,1,1-trichloroethane should display high mobility and the potential for leaching into groundwater. Volatilization from soil surfaces to the atmosphere is expected to be an important fate process. Although data regarding biodegradation of 1,1,1-trichloroethane in soil are lacking, it is not expected to be an important fate process. 1,1,1-Trichloroethane is not expected to undergo aerobic biodegradation, but there is some experimental evidence that biodegradation may occur under anaerobic conditions.

Once released to surface water, 1,1,1-trichloroethane is expected to undergo volatilization to the atmosphere. Neither adsorption to sediment nor bioconcentration in aquatic organisms is recognized as an important removal process. Aerobic biodegradation of 1,1,1-trichloroethane can occur in the presence of methane-oxidizing bacteria. If released to groundwater, biodegradation of 1,1,1-trichloroethane under
6. POTENTIAL FOR HUMAN EXPOSURE

Anaerobic conditions is known to occur; however, it appears to be a slow process under most environmental conditions.

1,1,1-Trichloroethane may very slowly undergo abiotic degradation in soil or water by elimination of hydrochloric acid (HCl) to form 1,1-dichloroethene, which also can be considered a pollutant, or it can undergo hydrolysis to form the naturally occurring acetic acid. Direct photochemical degradation is not expected to be an important fate process.

6.2 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).

The manufacture and use of 1,1,1-trichloroethane was scheduled to be phased out by 2002. Since the declines in emissions closely follow the declines in production and use, the emissions of 1,1,1-trichloroethane to the atmosphere should show a corresponding decline (EPA 2004m).

6.2.1 Air

Estimated releases of 114,373 pounds (~51.9 metric tons) of 1,1,1-trichloroethane to the atmosphere from 46 domestic manufacturing and processing facilities in 2003, accounted for about 86% of the estimated
6. POTENTIAL FOR HUMAN EXPOSURE

total environmental releases from facilities required to report to the TRI (TRI03 2005). These releases are summarized in Table 6-1.

A correlation of data from the EPA Air Toxics Emission Inventory with industrial source codes (SIC codes), shows that volatile emissions of 1,1,1-trichloroethane are associated with 122 different industrial classifications that run the gamut from manufacturing and formulation to secondary uses (Pacific Environmental Services, Inc. 1987). Release of 1,1,1-trichloroethane, in most cases, is an expected result of its use (Spence and Hanst 1978). Small amounts of 1,1,1-trichloroethane are also released to the atmosphere from coal-fired power plants (Garcia et al. 1992), from incineration of hospital wastes (Green et al. 1992; Walker and Cooper 1992), incineration of military nerve agents (Mart and Henke 1992), incineration of industrial wastes containing certain plastics and waste solvents (Nishikawa et al. 1992, 1993), and incineration of municipal waste water sludge (Vancil et al. 1991). 1,1,1-Trichloroethane contained in consumer products was released into the atmosphere during the application, drying, or curing of these products. 1,1,1-Trichloroethane can enter the atmosphere via the air-stripping treatment of waste water. Volatilization, which accounts for ≈100% of removal in waste water, occurs during this process (Kincannon et al. 1983a). Volatilization from waste lagoons is also likely (Shen 1982).

Precise quantitative data on 1,1,1-trichloroethane air emissions are lacking. A large proportion of total production probably found its way into the atmosphere. Estimates for 1984 suggest that 100.4 kilotons (220 million pounds) were released during use by the European Economic Community (EEC) and other western European countries, a figure representing some 70% of total consumption in Europe (Herbert et al. 1986). Global estimates indicate that 1,497 million pounds (679 million kg) of 1,1,1-trichloroethane were released to the atmosphere in 1988 (Midgley 1989). A comparison of TRI data for 1992 and 2003 (115 million pounds and 114,373 pounds, respectively) shows that the nationwide emission of 1,1,1-trichloroethane in the atmosphere has decreased by over 98% during this period. A 36% reduction in atmospheric emissions was observed in Irvine, California, from 1989 to 1990 (Brown and Hart 1992). Most processes that use 1,1,1-trichloroethane result in some fugitive emissions. For example, the release of 1,1,1-trichloroethane from an industrial solvent recycling facility was 16.7% of the throughput (Balfour et al. 1985).
### 6. POTENTIAL FOR HUMAN EXPOSURE

#### Table 6-1. Releases to the Environment from Facilities that Produce, Process, or Use 1,1,1-Trichloroethane

<table>
<thead>
<tr>
<th>State</th>
<th>RF</th>
<th>Air</th>
<th>Water</th>
<th>Land</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>On-site</td>
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<td>338</td>
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<td>250</td>
<td>10</td>
</tr>
<tr>
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<td>513</td>
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</tr>
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<td>LA</td>
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<td>0</td>
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<td>OH</td>
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<td>3,231</td>
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<td>0</td>
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<td>PA</td>
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<td>486</td>
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<td>No data</td>
<td>No data</td>
<td>No data</td>
</tr>
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<td>TX</td>
<td>4</td>
<td>789</td>
<td>3</td>
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<td>0</td>
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</tr>
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<td>UT</td>
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<td>25,209</td>
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<td>833</td>
<td>25,209</td>
</tr>
<tr>
<td>VA</td>
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<td>81</td>
<td>No data</td>
<td>0</td>
<td>0</td>
<td>81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
<td><strong>114,373</strong></td>
<td><strong>40</strong></td>
<td><strong>1,572</strong></td>
<td><strong>1,084</strong></td>
<td><strong>114,972</strong></td>
</tr>
</tbody>
</table>

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**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.

**Air** The sum of fugitive and point source releases are included in releases to air by a given facility.

**Water** Surface water discharges, waste water treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).

**Land** Class I wells, Class II-V wells, and underground injection.

**Other** Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other on-site landfills, land treatment, surface impoundments, other land disposal, other landfills.

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

**On-site** The sum of all releases of the chemical to air, land, water, and underground injection wells.

**Off-site** Total amount of chemical transferred off-site, including to POTWs.

**RF** = reporting facilities; **UI** = underground injection

Source: TRI03 2005 (Data are from 2003)
6.2.2 Water

Estimated releases of 40 pounds of 1,1,1-trichloroethane to surface water from 46 domestic manufacturing and processing facilities in 2003, accounted for about 0.04% of the estimated total environmental releases from facilities required to report to the TRI (TRI03 2005). These releases are summarized in Table 6-1.

1,1,1-Trichloroethane can be released to surface water from the waste water of industries in any of the numerous industrial classifications that used or produced this compound. The STORET database for values registered in the years 1980–1988 shows that 1,1,1-trichloroethane tested positive in 12% of effluent samples with maximum, median, and mean concentrations of 6,500, 8.0, and 171 mg/L, respectively (STORET 1988). Higher concentrations of 1,1,1-trichloroethane have been found in surface waters near known industrial sources, such as effluent outfalls or disposal sites, compared to the levels found upstream from these sources (see Table 6-2) (Dreisch et al. 1980; Hall 1984; Kaiser and Comba 1986; Kaiser et al. 1983; Wakeham et al. 1983a).

1,1,1-Trichloroethane has been found in samples from four U.S. cities measured in the National Urban Runoff Program (Cole et al. 1984). 1,1,1-Trichloroethane has been found in the effluent from water treatment plants and municipal waste water (Comba and Kaiser 1985; Corsi et al. 1987; DeWees et al. 1992; Feiler et al. 1979; Lue-Hing et al. 1981; McCarty and Reinhard 1980; Namkung and Rittman 1987; Otson 1987; Pincince 1988; Rogers et al. 1987; Vancil et al. 1991; Young 1978; Young et al. 1983).

1,1,1-Trichloroethane can enter groundwater from various sources. Contamination as a result of industrial activity has occurred (Dever 1986; Hall 1984). Leachate from landfills has percolated into groundwater (Barker 1987; Plumb 1987). The measured soil sorption coefficient (Koc) value of 2.02 (Chiou et al. 1980; Gossett 1987) suggests that 1,1,1-trichloroethane released to soil can leach into groundwater. Measurements of 1,1,1-trichloroethane in drinking water from probability-based population studies (Wallace et al. 1984a, 1987a, 1988), indicate the potential for exposure from drinking water.
### Table 6-2. Detection of 1,1,1-Trichloroethane in Water and Sediments

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of Samples</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface water:</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Ohio River (Huntington, WV)</td>
<td>1978–1979</td>
<td>22</td>
<td>ND–0.57(^a)</td>
<td>NS</td>
</tr>
<tr>
<td>Schuylkill Creek (Philadelphia, PA)</td>
<td></td>
<td>33</td>
<td>ND–0.28</td>
<td>NS</td>
</tr>
<tr>
<td>Niagara River</td>
<td>1981</td>
<td>17</td>
<td>ND–0.017(^b)</td>
<td>0.007</td>
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<tr>
<td>Lake Ontario</td>
<td>1984</td>
<td>82</td>
<td>ND–0.180</td>
<td>NS</td>
</tr>
<tr>
<td>Lake St. Clair, Canada</td>
<td></td>
<td>64</td>
<td>0–0.112(^b)</td>
<td>0.052</td>
</tr>
<tr>
<td>Brazos River, TX</td>
<td>1981–1982</td>
<td>10</td>
<td>ND–0.61(^a)</td>
<td>0.1</td>
</tr>
<tr>
<td>Quinnipiac River (Southport, CT)</td>
<td>1980</td>
<td>5</td>
<td>ND–9.7(^a)</td>
<td>2.6</td>
</tr>
<tr>
<td>Valley of the Drums, KY (on-site standing water)</td>
<td>1979</td>
<td>NS</td>
<td>ND–9.4(^a)</td>
<td></td>
</tr>
<tr>
<td>Lang Property, NJ</td>
<td>1985</td>
<td>NS</td>
<td>9(^a)</td>
<td></td>
</tr>
<tr>
<td>Pacific Ocean</td>
<td>1975</td>
<td>NS</td>
<td>0.00062–0.0105(^c)</td>
<td></td>
</tr>
<tr>
<td>Summit National, OH (NPL site)</td>
<td>1987</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on-site</td>
<td>3</td>
<td>5–66</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>off-site</td>
<td>6</td>
<td>ND–29</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td><strong>Sediments:</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lake Pontchartrain, LA</td>
<td>1980</td>
<td>NS</td>
<td>ND–0.01(^d)</td>
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<tr>
<td>Pacific Ocean (Los Angeles)</td>
<td>1981</td>
<td>2</td>
<td>&lt;0.5</td>
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<tr>
<td>Detroit River, MI</td>
<td>1982</td>
<td>2</td>
<td>1–2(^e)</td>
<td>NS</td>
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<tr>
<td>Summit National, OH (NPL site) on-site pond sediment</td>
<td>1987</td>
<td>7</td>
<td>50–2,500(^f)</td>
<td>670(^f)</td>
</tr>
<tr>
<td><strong>Groundwater:</strong></td>
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<td>CERCLA(^g) hazardous waste sites</td>
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<td>178</td>
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<tr>
<td>Landfill Sites, Ontario, Canada</td>
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<td>NS</td>
<td>ND–2.8(^a)</td>
<td>NS</td>
</tr>
<tr>
<td>Southington, CT</td>
<td>1980</td>
<td>28</td>
<td>ND–11,000(^a)</td>
<td>NS</td>
</tr>
</tbody>
</table>
# Table 6-2. Detection of 1,1,1-Trichloroethane in Water and Sediments

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of Samples</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1980–1982</td>
<td>315</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Montgomery County, MD</td>
<td>1983</td>
<td>4</td>
<td>&lt;10–1,600&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NS</td>
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<tr>
<td>Hastings, NE</td>
<td>1984</td>
<td>15</td>
<td>ND–12.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NS</td>
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<td>Hastings, NE</td>
<td>1984</td>
<td>15</td>
<td>ND–12.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NS</td>
</tr>
<tr>
<td>U.S. cities</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population &lt;10,000 (random samples)</td>
<td>1981–1982</td>
<td>280</td>
<td>ND–18&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>Population &lt;10,000 (nonrandom)&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
<td>321</td>
<td>ND–8.2</td>
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<tr>
<td>Population &gt;10,000 (random samples)</td>
<td></td>
<td>186</td>
<td>ND–3.1</td>
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<td></td>
<td>158</td>
<td>ND–21</td>
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</tr>
<tr>
<td>Minnesota&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>ND–470&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Marshall landfill, CO&lt;sup&gt;l&lt;/sup&gt;</td>
<td>1983</td>
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<td>ND–350&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Forest Waste Disposal Site</td>
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<td>130&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Palmer, MA PSC Resources, Inc. (NPL site)</td>
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<td>9 Urban land-use studies</td>
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<td>208</td>
<td>ND–230&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Old Love Canal, NY</td>
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<td>9</td>
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### Table 6-2. Detection of 1,1,1-Trichloroethane in Water and Sediments

<table>
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<td>North Carolina 1982</td>
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<td>NS–1,600</td>
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<tr>
<td>New Jersey</td>
<td>NS–965</td>
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<td>Nassau County, NY</td>
<td>NS–310</td>
<td>9</td>
<td></td>
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<td>Suffolk County, NY 1976–1986</td>
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<td>public wells</td>
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<td>23–99&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Feiler et al. 1980</td>
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### Table 6-2. Detection of 1,1,1-Trichloroethane in Water and Sediments

<table>
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<th>Media type/location</th>
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<th>Number of Samples</th>
<th>Concentration (ppb)</th>
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<td>Forest Waste Disposal Site, MI&lt;sup&gt;i&lt;/sup&gt;</td>
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<td>NS</td>
<td>25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>EPA 1986c</td>
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<td>Vestal, NY&lt;sup&gt;j&lt;/sup&gt;</td>
<td>1985–1986</td>
<td>2</td>
<td>25–47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>ATSDR 1988</td>
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<td>Urban runoff:</td>
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<td>Washington, DC; Denver, CO</td>
<td>NS–1982</td>
<td>NS</td>
<td>1.6–10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Cole et al. 1984</td>
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<tr>
<td>Rapid City, SD Lake Quinsigamond, MA</td>
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<tr>
<td>Rain:</td>
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<tr>
<td>Los Angeles, CA</td>
<td>1982</td>
<td>1</td>
<td>0.069&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Kawamura and Kaplan 1983</td>
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<tr>
<td>Beaverton, OR</td>
<td>1982</td>
<td>21</td>
<td>0.128–0.924&lt;sup&gt;m&lt;/sup&gt;</td>
<td>Rasmussen et al. 1983</td>
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<td>Snow:</td>
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<td>Mt. Hood, OR</td>
<td>1981–1982</td>
<td>25</td>
<td>0.063–0.128&lt;sup&gt;m&lt;/sup&gt;</td>
<td>Rasmussen et al. 1983</td>
</tr>
<tr>
<td>California</td>
<td>1975</td>
<td>2</td>
<td>0.0006–0.0062&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Su and Goldberg 1976</td>
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<tr>
<td>Alaska</td>
<td>1</td>
<td></td>
<td>0.027</td>
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<sup>a</sup>Data reported in μg/L; converted to ppb using the conversion factor 1 ppb=1 μg/L
<sup>b</sup>Data reported in ng/L; converted to ppb using the conversion factor 1 ppb=1,000 ng/L
<sup>c</sup>Data reported in pg/mL; converted to ppb using the conversion factor 1 ppb=1,000 pg/mL
<sup>d</sup>Data reported in ng/g; converted to ppb using the conversion factor 1 ppb=1 ng/g
<sup>e</sup>Data reported in mg/kg; converted to ppb using the conversion factor 1 ppb=0.001 mg/kg
<sup>f</sup>Data reported in μg/kg; converted to ppb using the conversion factor 1 ppb=1 μg/kg
<sup>g</sup>Comprehensive Emergency Response, Compensation, and Liability Act
<sup>h</sup>Nonrandom sites were chosen by states/municipalities in an attempt to identify problem areas.
<sup>i</sup>Site near municipal solid waste site
<sup>j</sup>Nonrandom sites were chosen by states/municipalities in an attempt to identify problem areas.
<sup>k</sup>Data reported in ppm; converted to ppb using the conversion factor 1 ppb=0.001 ppm
<sup>l</sup>Data reported in ng/mL; converted to ppb using the conversion factor 1 ppb=1 ng/mL
<sup>m</sup>Data reported in ppt; converted to ppb using the conversion factor 1 ppb=1,000 ppt

Post office state abbreviations used

ND = not detected; NPL = National Priorities List; NS = not specified
6.2.3 Soil

Estimated releases of 1,572 pounds (~0.71 metric tons) of 1,1,1-trichloroethane to soils from 46 domestic manufacturing and processing facilities in 2003, accounted for about 14.4% of the estimated total environmental releases from facilities required to report to the TRI (TRI03 2005). These releases are summarized in Table 6-1.

Data on soil contamination by 1,1,1-trichloroethane are lacking in the literature, which is what one would expect based on the TRI03 (2005) data given in Table 6-1. Due to its decreased production because of the impending phase-out of 1,1,1-trichloroethane, there should be few emissions to soils. Land application of sewage sludge that may contain minute amounts of 1,1,1-trichloroethane may slightly elevate the level of 1,1,1-trichloroethane in agricultural soil, but the level is not expected to be of environmental concern in the majority of cases (Wilson et al. 1994). The most likely routes for soil contamination are through accidental spills, the contamination of soil by landfill leachates, leaching of contaminated surface waters from treatment/storage lagoons, wet deposition, and possibly by the percolation of contaminated rainwater through soil.

6.3 ENVIRONMENTAL FATE

6.3.1 Transport and Partitioning

1,1,1-Trichloroethane is a volatile organic compound with moderate water solubility (1,500 mg/L at 25 °C) (Horvath 1982). The experimental Henry's law constants measured for this compound range from 6.3x10^-3 to 17.2x10^-3 atm m^3/mol at 25 °C (Chiou et al. 1980; Gossett 1987; Tse et al. 1992); this suggests that volatilization from water should be the dominant fate process. Volatilization of 1,1,1-trichloroethane from water has readily occurred in the laboratory, in the field, and during waste water treatment (Dilling 1977; Dilling et al. 1975; Kincannon et al. 1983b; Piwoni et al. 1986; Wakeham et al. 1983b). Volatilization of 1,1,1-trichloroethane also has occurred from soil and from the groundwater of unconfined aquifers to the soil (Kreamer 1984; Piwoni et al. 1986).

Based on the experimental values for the log octanol/water partition coefficient (K_{ow}), 2.49 (Hansch and Leo 1985), and log K_{oc}, in the range of 2.02–2.26 (Chiou et al. 1979; Friesel et al. 1984; Park and Lee 1993), 1,1,1-trichloroethane would be expected to show high mobility in soil and readily leach into
groundwater (Lyman et al. 1990; Swann et al. 1983). In surface waters, 1,1,1-trichloroethane would not be expected to show appreciable adsorption to sediment or suspended organic material. An experimental bioconcentration factor (BCF) of 9 (bluegill sunfish) has been determined for 1,1,1-trichloroethane (Barrows et al. 1980), suggesting that in fish and other aquatic organisms, uptake from water should not be an important fate process.

1,1,1-Trichloroethane has a vapor pressure of 123 mm Hg at 20 °C (see Table 4-2), which means that it exists in the vapor phase in the atmosphere (Eisenreich et al. 1983). Since this compound has moderate water solubility (see Table 4-2), vapor phase 1,1,1-trichloroethane will be removed from the air via washout by rain and transported to the terrestrial surface. It has been identified in rainwater (Jung et al. 1992; Kawamura and Kaplan 1983; Pluemacher and Renner 1993; Rasmussen et al. 1983). 1,1,1-Trichloroethane removed by rain water would be expected to re-volatilize rapidly to the atmosphere. Because of its long half-life of ≈4 years in the atmosphere (see Section 6.3.2.1), tropospheric 1,1,1-trichloroethane will be transported to the stratosphere, where it will participate in the destruction of the ozone layer. It will also undergo long-distance transport from its sources of emissions to other remote and rural sites. This is confirmed by the detection of this synthetic chemical in forest areas of Northern and Southern Europe and in remote sites (Ciccioli et al. 1993).

6.3.2 Transformation and Degradation

6.3.2.1 Air

The dominant atmospheric fate process for 1,1,1-trichloroethane is predicted to be degradation by interaction with photochemically-produced hydroxyl radicals. Earlier experimental rate constants for this gas-phase reaction ranged from 2.8x10^{-14} to 1.06x10^{-14} cm^3/mol-sec (20–30 °C) (Butler et al. 1978; Chang and Kaufman 1977; Cox et al. 1976; Crutzen et al. 1978; Howard and Evenson 1976; Jeong et al. 1984). More recent work indicates that this rate constant ranges from 0.95x10^{-14} cm^3/mol-sec to 1.2x10^{-14} cm^3/mol-sec (Finlayson-Pitts et al. 1992; Jiang et al. 1992; Lancar et al. 1993; Talukdar et al. 1992). 1,1,1-Trichloroethane is degraded via H-atom abstraction to CCl_3CH_2· and reacts with O_2 to yield the peroxy radical (CCl_3CH_2O_2) (DeMore 1992; Spence and Hanst 1978). Using an estimated atmospheric hydroxyl (OH·) radical concentration of 5.0x10^5 mol/cm^3 (Atkinson 1985), the more recent rate constants translate to a calculated lifetime or residence time of ≈6 years. The estimated atmospheric lifetime of 1,1,1-trichloroethane which incorporates all removal processes, was also estimated to be
≈6 years (Prinn et al. 1987; Prinn et al. 1992). This indicates that the predominant tropospheric sink of 1,1,1-trichloroethane is through its reaction with OH radicals.

Photolytic degradation experiments have been performed in the presence of NO and NO₂; 1,1,1-trichloroethane underwent <5% degradation in 24 hours in the presence of NO (Dilling et al. 1976). In a smog chamber experiment in the presence of NOₓ, 1,1,1-trichloroethane showed a disappearance rate of 0.1% per hour (Dimitriades and Joshi 1977). Other studies have also concluded that 1,1,1-trichloroethane has low potential to form ozone as a result of photochemical reaction in the presence of NOₓ (Andersson-Skoeld et al. 1992; Derwent and Jenkin 1991).

Under laboratory conditions designed to mimic atmospheric smog conditions, direct photochemical irradiation of 1,1,1-trichloroethane in the presence of elemental chlorine was performed. 1,1,1-Trichloroethane was the least reactive and thus the most stable of all chloroethanes under these conditions (Spence and Hanst 1978).

Direct photochemical degradation of 1,1,1-trichloroethane in the troposphere is not expected to be an important fate process, because there is no chromophore for absorption of ultraviolet light (>290 nm) found in sunlight at tropospheric altitudes (Hubrich and Stuhl 1980; VanLaethem-Meuree et al. 1979). A laboratory experiment performed in sealed Pyrex ampules showed loss of 1,1,1-trichloroethane in 2 weeks under the influence of sunlight; however, catalysis by the Pyrex surface was probably responsible for the enhanced reactivity (Buchardt and Manscher 1978).

The relatively long tropospheric residence time for 1,1,1-trichloroethane suggests that migration to the stratosphere should be important. An estimated 11–15% of 1,1,1-trichloroethane released to the atmosphere is expected to survive and migrate to the stratosphere (Prinn et al. 1987; Singh et al. 1992). In the stratosphere, chlorine atoms produced from 1,1,1-trichloroethane by ultraviolet light may interact with ozone contributing to the destruction of the stratospheric ozone layer. Compared to CFC-11 (trichlorofluoromethane), the steady-state ozone depletion potential of 1,1,1-trichloroethane has been estimated to be 0.1–0.16 (Gibbs et al. 1992; Solomon and Albritton 1992).
6. POTENTIAL FOR HUMAN EXPOSURE

6.3.2.2 Water

Slow biodegradation of 1,1,1-trichloroethane can occur under both anaerobic and aerobic conditions. Anaerobic degradation of 1,1,1-trichloroethane is thought to occur predominantly through reductive dechlorination by methane-producing bacteria (Vargas and Ahlert 1987; Vogel and McCarty 1987) and by sulfate-reducing organisms (Cobb and Bouwer 1991; Klecka 1990). Determined experimental half-lives for anaerobic degradation using mixed culture bacteria ranged from 1 day to 16 weeks in the laboratory (Bouwer and McCarty 1983a, 1984; Hallen et al. 1986; Parsons et al. 1985; Vogel and McCarty 1987; Wood et al. 1985), based on a study from an injection well, after 3 months of injection, the predicted half-life of 1,1,1-trichloroethane in an aquifer was 200–300 days (Bouwer and McCarty 1984). Results obtained in a grab sample study of an aquifer suggest that anaerobic biodegradation of 1,1,1-trichloroethane will not occur (Wilson et al. 1983); however, the spiked concentration of 1,1,1-trichloroethane in the study, 1 mg/L, was in a range determined to be toxic to microorganisms (Barth and Bunch 1979; Benson and Hunter 1977; Vargas and Ahlert 1987). Another grab sample study, performed using more realistic concentrations, indicates that 1,1,1-trichloroethane slowly degrades under anaerobic conditions to 1,1-dichloroethane in groundwater (Parsons and Lage 1985; Parsons et al. 1985). However, when mixed anaerobic cultures were provided with acetate as primary substrate, the biodegradation of secondary substrate 1,1,1-trichloroethane occurred even without acclimation at concentrations exceeding 1 mg/L (Hughes and Parkin 1992). A laboratory study showed that anaerobic biodegradation of 1,1,1-trichloroethane did not occur under denitrification conditions even after 8 weeks of incubation (Bouwer and McCarty 1983b).

Aerobic biodegradation in surface water and groundwater is not likely to be an important fate process since experimental studies did not indicate significant aerobic degradation of 1,1,1-trichloroethane (Klecka et al. 1990; Mudder and Musterman 1982; Nielson et al. 1990; Wilson and Pogue 1987). One study showed that 1,1,1-trichloroethane underwent aerobic degradation in the presence of Fe^{2+}/porphyrin solution (82% in 21 days), thought to be a catalyzed reductive chlorination (Klecka and Gonsior 1984). It is difficult to interpret these results in terms of the potential for environmental significance. One study reported that 1,1,1-trichloroethane underwent moderate biodegradation with significant concomitant volatilization (Tabak et al. 1981); however, experimental details are not sufficient to rule out loss due solely to volatilization. Halogenated aliphatic hydrocarbons, including 1,1,1-trichloroethane, act as cometabolic substrates for certain aerobic chemotrophs. In such cases, the organisms grow on another substrate and the enzymes induced under the particular growth conditions fortuitously biodegrade the halogenated aliphatics (Leisinger 1992). Such aerobic biodegradation of 1,1,1-trichloroethane up to a
concentration of 1.2 mg/L was observed with methane-oxidizing (methanotrophic) bacteria isolated from an aquifer (Arvin 1991).

Anaerobic biodegradation proceeds via reductive dechlorination (Leisinger 1992; McCarty 1993). The major product from the anaerobic degradation of 1,1,1-trichloroethane has been identified as 1,1-dichloroethane, which slowly degrades to chloroethane in a secondary reaction (Hallen et al. 1986; Vogel and McCarty 1987). Therefore, total biodegradation of 1,1,1-trichloroethane is feasible by combining anaerobic dehalogenation with subsequent aerobic treatment (Leisinger 1992). Aerobic biodegradation of 1,1,1-trichloroethane, on the other hand, proceeds via substitutive and oxidative mechanisms with the production of trichloroethyl alcohol, which is further oxidized to chloride, carbon dioxide, and water (McCarty 1993).

Products from the abiotic degradation of 1,1,1-trichloroethane have also been identified. Acetic acid can arise from the hydrolysis of 1,1,1-trichloroethane (calculated half-life of 1.2 years at 25 °C and pH 7). Elimination of HCl can produce 1,1-dichloroethene (Hallen et al. 1986; Parsons et al. 1985; Vogel and McCarty 1987). The calculated half-life for this reaction is 4.8 years at 25 °C and pH 7 (Ellenrieder and Reinhard 1988). The half-lives of abiotic degradation of 1,1,1-trichloroethane by reaction with nucleophiles, such as $\text{HS}^-$ and $\text{S}_2\text{O}_2^-$, which might be present in water, should be insignificant compared to the other processes described (Haag and Mill 1988). A 2.8 mmol aqueous solution of 1,1,1-trichloroethane reacted with ozone (concentration 1 mg/L) with a half-life of >32 days at 22 °C and a pH of 7 (Yao and Haag 1991). Therefore, reaction with ozone will not be an important process for the transformation of 1,1,1-trichloroethane present in natural bodies of water.

6.3.2.3 Sediment and Soil

Data are lacking on the degradation of 1,1,1-trichloroethane in soil. In a grab sample experiment, anaerobic degradation of 1,1,1-trichloroethane occurred slowly in soil (16% in 6 days) (Henson et al. 1988). If the microorganisms in the soil were first activated by using methane as a nutrient source, 46% of 1,1,1-trichloroethane degraded during the same period under aerobic conditions (Henson et al. 1988). Incubation of 1,1,1-trichloroethane in soil under aerobic conditions resulted in no measurable biodegradation (Klecka 1990).
6.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to 1,1,1-trichloroethane depends in part on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of 1,1,1-trichloroethane in unpolluted atmospheres and in pristine surface waters are often so low as to be near the limits of current analytical methods. In reviewing data on 1,1,1-trichloroethane levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable. The analytical methods available for monitoring 1,1,1-trichloroethane in a variety of environmental media are detailed in Chapter 7.

The manufacture and use of 1,1,1-trichloroethane was scheduled to be phased out by 2002 under the Clean Air Act (EPA 2004m). Since it is no longer in use domestically, the levels estimated in the environment, other than near point sources, should drop to insignificant amounts.

6.4.1 Air

1,1,1-Trichloroethane has been identified in urban, rural, and indoor air throughout the United States at concentrations shown in Table 6-3. Due to the nature of 1,1,1-trichloroethane's use, volatilization to the atmosphere is a predictable outcome, and thus, its widespread detection is not unexpected. It is the only chlorinated ethane regularly seen as a background pollutant in the troposphere (Spence and Hanst 1978). For the year 1980, an estimated global atmospheric quantity of 1,1,1-trichloroethane, based on absolute concentrations obtained over a 3-year period, was \(2.58 \times 10^9\) kg (5,690 million pounds) (Prinn et al. 1983). An estimated average concentration of 0.14 ppb in 1980, based on a characterization of its sources, abundance, and atmospheric sinks, was also reported (Ramanathan et al. 1985). The data indicate that the average atmospheric concentration of 1,1,1-trichloroethane was 0.13 ppb for the middle of 1988 (Khalil and Rasmussen 1989). Based on absolute concentrations obtained over a 12-year period, a global atmospheric concentration of 157 ppt (0.157 ppb) was estimated for 1,1,1-trichloroethane in the middle of 1990 (Prinn et al. 1992). Atmospheric measurements at several surface stations made between 1978 and 1990 indicated that the global average concentration of 1,1,1-trichloroethane increased at a rate of 4.4±0.2% over this time period (Prinn et al. 1992).

The measured concentration of 1,1,1-trichloroethane in urban air have typically ranged from 0.1 to 1 ppb; however, levels ≤1,000 ppb have been observed in large urban areas or near hazardous waste sites.
### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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<th>Media type/location</th>
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<td>El Monte, CA</td>
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<td>Shikiya et al. 1984</td>
</tr>
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<td>Los Angeles, CA</td>
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<td>NS</td>
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<td>Dominguez Hills, CA</td>
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<td></td>
<td>0.6–2</td>
<td>NS</td>
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### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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<td>incubator air in an intensive care nursery</td>
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<td>Waterside Mall</td>
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### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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<th>Media type/location</th>
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<td>Shields and Weschler 1992</td>
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<td>Southern California museums</td>
<td>1986</td>
<td></td>
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<td>Hisham and Grosjean 1991</td>
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<td>New Jersey</td>
<td>1981 346–48 ND–6,040&lt;sup&gt;b&lt;/sup&gt; 3.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Wallace et al. 1987a</td>
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<td>Bayonne/Elizabeth, NJ</td>
<td>1980 165 (9) 0.13–130&lt;sup&gt;b&lt;/sup&gt; 1.7</td>
<td>Wallace et al. 1984a</td>
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<td>Research Triangle Park, NC</td>
<td>1987 61 (3) 0.024–43.2 0.82</td>
<td>Wallace et al. 1984b, 1985</td>
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<td>Devils Lake, ND</td>
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## Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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<td>274</td>
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### Table 6-3. Detection of 1,1,1-Trichloroethane in Air

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<th>Media type/location</th>
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<th>Number of samples</th>
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<td>454</td>
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<td>2–7 km</td>
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<td>0.127&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Monthly mean
<sup>b</sup> Data reported in μg/m<sup>3</sup>; converted to ppb using the conversion factor 1 ppb=5.4 μg/m<sup>3</sup>
<sup>c</sup> Data reported in ppt; converted to ppb using the conversion factor 1 ppb=1,000 ppt
<sup>d</sup> Weighted geometric mean
<sup>e</sup> Date of study not given
<sup>f</sup> Data reported as median
<sup>g</sup> Summer (winter)
<sup>h</sup> Data reported in ng/m<sup>3</sup>; converted to ppb using the conversion factor 5,400 ng/m<sup>3</sup>=1 ppb
<sup>i</sup> Data reported in ppm; converted to ppb using the conversion factor 0.001 ppm=1 ppb

Post office state abbreviations used

ND = not detected; NS = not specified
Representative monitoring data on the concentration of 1,1,1-trichloroethane in air can be found in Table 6-3. These historic levels measured in the ambient atmosphere are expected to drop over time as the ban on the production and use of 1,1,1-trichloroethane is phased in. Rural levels of 1,1,1-trichloroethane are typically <0.2 ppb. The long atmospheric lifetime of 1,1,1-trichloroethane allows the compound to be carried a considerable distance from its initial point of release; detectable levels have been measured in numerous remote areas throughout the world and are shown in Table 6-3 (Class and Ballschmiter 1986; DeBortoli et al. 1986; Guicherit and Schulting 1985; Hov et al. 1984; Ohta et al. 1976; Rasmussen et al. 1982). The mean background concentration of 1,1,1-trichloroethane over subarctic North America in the summer of 1990 was 0.155 ppb (Wofsy et al. 1994). During a period of arctic haze, the concentration of 1,1,1-trichloroethane in the polluted Arctic air was 2–15% higher than in clean air over the Arctic (Khalil and Rasmussen 1993). The mean concentration of 1,1,1-trichloroethane in the troposphere over northwestern Pacific region (114–165 °E longitude) was found to range from 0.12 to 0.13 ppb (Blake et al. 1997, Table 6-3 Mohamed et al. 2002). The concentrations of 1,1,1-trichloroethane near industrial facilities emitting 1,1,1-trichloroethane were found to be only marginally higher than those measured at sites away from facilities emitting 1,1,1-trichloroethane.

The concentration of 1,1,1-trichloroethane in indoor air is variable, and seems to depend on individual practices, season, outdoor concentration, age of building, and building air-exchange characteristics (Cohen et al. 1989; Hartwell et al. 1987a, 1987b, 1992; Hisham and Grosjean 1991; Lioy et al. 1991; Wallace 1986; Wallace et al. 1986a, 1986b, 1988, 1989, 1991). For example, college students monitored simultaneously on the same campus were found to have levels of personal exposure varying by as much as two orders of magnitude (Wallace et al. 1982; Zweidinger et al. 1983). Further, two studies suggest that buildings with air conditioning may have higher levels of 1,1,1-trichloroethane in indoor air (Cohen et al. 1989; Hisham and Grosjean 1991). 1,1,1-Trichloroethane has been found at levels ≤70 ppb in newly constructed buildings (Wallace et al. 1987b). The concentration of 1,1,1-trichloroethane in new and recently renovated buildings was as high as 290 ppb (Rothweiler et al. 1992). New carpet and other new building materials that contain 1,1,1-trichloroethane may be responsible for higher levels in new and renovated buildings. During normal periods (no renovation or construction), the levels of total volatile organics are inversely proportional to the air exchange rate of the building (Shields and Weschler 1992). Higher levels of 1,1,1-trichloroethane are expected to be found in indoor air during winter than any other season (Wallace et al. 1991). The effect of outdoor air on indoor air was demonstrated by the detection of higher levels of 1,1,1-trichloroethane during outdoor stagnation conditions when the levels were higher compared to levels under non-stagnation conditions (Lioy et al. 1991). Representative data taken from five geographic areas located throughout the United States report indoor concentrations of 0.3–4.4 ppb.
and outdoor concentrations of 0.11–0.92 ppb (Pellizzari et al. 1986). Several studies have determined the presence of 1,1,1-trichloroethane in products expected to be in most households (Section 6.5) (EPA 1987l; Maklan et al. 1987; Sack et al. 1992; Spicer et al. 1987). An EPA Region V (Minnesota, Wisconsin, Michigan, Illinois, Indiana, and Ohio) National Human Exposure Assessment Survey (NHEXAS) detected a mean concentration of 1,1,1-trichloroethane to be 1.15 ppb in indoor air samples collected from residential areas from July 1995 to May 1997 (Bonanno et al. 2001). The maximum concentration of trichloroethane detected in the same study was 34 ppb.

A study of air toxics in New York City showed levels of 1,1,1-trichloroethane ranging from 0.093 to 0.139 ppb for outdoor air with the highest concentrations in the summer. Indoor home and personal air had higher concentrations in the winter with ranges of 0.242–0.990 and 0.203–0.368 ppb, respectively (Kinney et al. 2002).

1,1,1-Trichloroethane has also been a contaminant of air in many other countries. A recent study in India found 1,1,1-trichloroethane in the air at various residential, traffic intersections, and gasoline stations in Delhi (Srivastava 2005). Mean concentrations of 1,1,1-trichloroethane in indoor air of Nagoya, Japan and indoor and outdoor air of Uppsala, Sweden were 0.803, 0.123, and 0.318, respectively (Sakai 2004).

### 6.4.2 Water

1,1,1-Trichloroethane has been identified in surface water, groundwater, drinking water, effluent, rain, snow, and urban runoff. The amount of the chemical detected in surface and groundwater depends upon the location of the sampling point. Concentrations in surface water removed from point-source emissions such as industrial waste water, hazardous waste sites, and spill locations are usually <1 ppb. In random samples of groundwater taken in the United States, concentrations have ranged from 0 to 18 ppb. Groundwater samples obtained near sources of release to soil or the ground have been as high as 11,000 ppb. Drinking water from surface or groundwater sources contained 1,1,1-trichloroethane concentrations of 0.01–3.5 ppb.

Data on the occurrence of 1,1,1-trichloroethane in water are presented in Table 6-2. Data on the concentration of 1,1,1-trichloroethane in effluent can be found in Table 6-4.
### Table 6-4. Detection of 1,1,1-Trichloroethane in Effluent

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of samples</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Industrial waste water:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textile plants</td>
<td>1975</td>
<td>64</td>
<td>2–300&lt;sup&gt;a&lt;/sup&gt;</td>
<td>NS</td>
</tr>
<tr>
<td>Municipal waste water:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles, CA primary</td>
<td>1978</td>
<td>NS</td>
<td></td>
<td>340&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Los Angeles, CA secondary</td>
<td></td>
<td></td>
<td></td>
<td>&lt;10</td>
</tr>
<tr>
<td>Orange County, CA primary</td>
<td>1978</td>
<td>NS</td>
<td></td>
<td>4,000</td>
</tr>
<tr>
<td>Orange County, CA secondary</td>
<td></td>
<td></td>
<td></td>
<td>&lt;10</td>
</tr>
<tr>
<td>San Diego, CA primary</td>
<td>1978</td>
<td></td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>Water factory 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>influent</td>
<td>1976</td>
<td>50</td>
<td>&lt;0.3–38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.794</td>
</tr>
<tr>
<td>Orange County, CA</td>
<td>1978</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>effluent</td>
<td>51</td>
<td>0.1–1.2</td>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>influent</td>
<td>28</td>
<td>0.3–15</td>
<td></td>
<td>2.9</td>
</tr>
<tr>
<td>effluent</td>
<td>17</td>
<td>&lt;0.1–41</td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>Chicago, IL, Calumet plant</td>
<td>1980</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>influent</td>
<td></td>
<td></td>
<td></td>
<td>14&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>effluent</td>
<td></td>
<td></td>
<td></td>
<td>&lt;10</td>
</tr>
<tr>
<td>John Egan plant</td>
<td>1</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>influent</td>
<td></td>
<td></td>
<td></td>
<td>&lt;10</td>
</tr>
<tr>
<td>Denver, CO</td>
<td>1985–1986</td>
<td>14</td>
<td>1.70–6.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.74</td>
</tr>
<tr>
<td>Landfill leachates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collegeville, PA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1983</td>
<td>NS</td>
<td>1–60</td>
<td>NS</td>
</tr>
<tr>
<td>Minnesota&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1983</td>
<td>6</td>
<td>ND–7.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>
Table 6-4. Detection of 1,1,1-Trichloroethane in Effluent

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of samples</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear power plant emissions:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denver, CO</td>
<td>1989</td>
<td>6</td>
<td>0.06–0.623e</td>
<td>Sturges and Taylor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.27e</td>
<td>1990</td>
</tr>
<tr>
<td>downwind</td>
<td></td>
<td>6</td>
<td>0.06–0.623e</td>
<td></td>
</tr>
<tr>
<td>upwind</td>
<td></td>
<td>8</td>
<td>0.088–0.251e</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.137e</td>
<td></td>
</tr>
</tbody>
</table>

\( ^a \text{Data reported in } \mu \text{g/L; converted to ppb using the conversion factor } 1 \text{ ppb}=1 \mu \text{g/L} \)

\( ^b\text{National Priority Hazardous Waste Site} \)

\( ^c\text{Date of study not given} \)

\( ^d\text{Municipal Solid Waste site} \)

\( ^e \text{Data reported in ppt; converted to ppb using the conversion factor } 1 \text{ ppb}=1,000 \text{ ppt} \)

Post office state abbreviations used

ND = not detected; NS = not specified
1,1,1-Trichloroethane was found in groundwater at hazardous waste sites in 18.9% of 178 sites from the Comprehensive Emergency Response, Compensation and Liability Act (CERCLA) database, making it the seventh most frequently detected compound in this study (Plumb 1987). It was found in water samples from 42 of 357 Contract Laboratory Program (CLP) sites; the concentration range of the mean values was 1.75–1,100 ppb (Viar 1987).

In 1997, 1,1,1-trichloroethane was found in the Colorado River Basin in 6 of the 25 sites tested, with a maximum concentration of 4.51 μg/L (Apodaca 2002).

### 6.4.3 Sediment and Soil

Monitoring data on the occurrence of 1,1,1-trichloroethane in soil are not as extensive as for water or air, which precludes an estimate of typical levels found in soil. The reported levels of 1,1,1-trichloroethane in soils are shown in Table 6-5. In two grab soil samples taken in 1980 from two former sludge lagoons of a solvent recovery operation at Southington, Connecticut, the measured concentrations of 1,1,1-trichloroethane were 23,000 and 120,000 ppb (Hall 1984). The limited data on the concentration of 1,1,1-trichloroethane in soil may be due to its rapid volatilization from soil, its ability to leach through soil, or both. The concentrations of 1,1,1-trichloroethane in sediments are shown in Table 6-2. The mean concentration of 1,1,1-trichloroethane in sediments from a river passing through an industrial area in Japan was 0.4 ppb, although it was not detected in the river water or in the sediment of a river passing through a non-industrial area (Grotoh et al. 1992).

### 6.4.4 Other Environmental Media

Limited data on the occurrence of 1,1,1-trichloroethane in other media were located. 1,1,1-Trichloroethane has been found in raw, processed, and prepared food products. These data are presented in Table 6-6. 1,1,1-Trichloroethane has been found in fish and shrimp taken from the Pacific Ocean at average concentrations of 2.7 and <0.3 ppm, respectively (Young et al. 1983). It has also been detected in clams and oysters from Lake Pontchartrain, Louisiana, with mean concentrations ranging from 39 to 310 ppm (Ferrario et al. 1985) and from a polluted river in Japan at concentrations ranging from 0.6 to 1.8 ppb wet weight (wt/wt) (Grotoh et al. 1992). 1,1,1-Trichloroethane was detected in 2 of 265 table-ready foods of FDA Total Diet Study at an average concentration of 12.7 ppb (Heikes et al. 1995).
### Table 6-5. Detection of 1,1,1-Trichloroethane in Soils

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of samples</th>
<th>Concentration (ppb) Range</th>
<th>Mean</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southington, CT</td>
<td>1980</td>
<td>2</td>
<td>23,000–120,000&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>Hall 1984</td>
</tr>
<tr>
<td>National Priorities List:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lang property, NJ</td>
<td>1985</td>
<td>NS</td>
<td>ND–980&lt;sup&gt;b&lt;/sup&gt;</td>
<td>322</td>
<td>EPA 1987e</td>
</tr>
<tr>
<td>surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsurface</td>
<td></td>
<td>NS</td>
<td>ND–140</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Gallaway Ponds site, TN</td>
<td>1984</td>
<td>NS</td>
<td>13,000&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td>EPA 1987d</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane producer/user:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant A</td>
<td>1976–1977</td>
<td>4</td>
<td>0.06–0.68</td>
<td></td>
<td>Battelle Labs 1977</td>
</tr>
<tr>
<td>Plant B</td>
<td>2</td>
<td></td>
<td>0.45–0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant C</td>
<td>2</td>
<td></td>
<td>0.13–0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant D</td>
<td>2</td>
<td></td>
<td>0.14–1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User A</td>
<td>2</td>
<td></td>
<td>0.40–0.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summit National, OH (NPL site)</td>
<td>1987</td>
<td></td>
<td></td>
<td></td>
<td>EPA 1988b</td>
</tr>
<tr>
<td>on-site surface</td>
<td>31</td>
<td></td>
<td>3&lt;sup&gt;d&lt;/sup&gt;–51,000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2,216&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>on-site subsurface</td>
<td>5</td>
<td></td>
<td>10–43,000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8,391&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>(2–4 feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on-site subsurface</td>
<td>2</td>
<td></td>
<td>5–2,800&lt;sup&gt;d,b&lt;/sup&gt;</td>
<td>561&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>(4–6 feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on-site subsurface</td>
<td>15</td>
<td></td>
<td>4&lt;sup&gt;d&lt;/sup&gt;–230,000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10,252&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>(6–8 feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence near a landfill:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanislaus County, CA</td>
<td>September 1987</td>
<td>NS</td>
<td>1.4–11</td>
<td>4.9</td>
<td>Hodgson et al. 1992</td>
</tr>
<tr>
<td></td>
<td>October 1987</td>
<td></td>
<td>2.8–9.4</td>
<td>6.1</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Data reported in μg/L; converted to ppb using the conversion factor 1 ppb=1 μg/L  
<sup>b</sup>Data reported in μg/kg; converted to ppb using the conversion factor 1 ppb=1 μg/kg  
<sup>c</sup>Data reported in ppm; converted to ppb using the conversion factor 1 ppb=0.001 ppm  
<sup>d</sup>Data were estimated.

Post office state abbreviations used

ND = not detected; NS = not specified
### Table 6-6. Detection of 1,1,1-Trichloroethane in Foods

<table>
<thead>
<tr>
<th>Type</th>
<th>Food</th>
<th>Sampling dates</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Unprepared, uncooked, off-the-shelf</td>
<td>Split peas</td>
<td>NS</td>
<td>3</td>
<td>Daft 1987</td>
</tr>
<tr>
<td></td>
<td>Allspice</td>
<td>16,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pickling spice</td>
<td>549</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Celery seed</td>
<td>909</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tea</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dumplings (dry)</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant hot cereal</td>
<td>421</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ready-to-eat cereals</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cake mix (golden)</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cake mix (yellow)</td>
<td>87</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pancake mix</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaded fish</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onion rings (precooked)</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>Yellow corn meal</td>
<td>1984</td>
<td>3.8</td>
<td>Heikes and Hopper 1986</td>
</tr>
<tr>
<td></td>
<td>Fudge brownie mix</td>
<td>2.9–3.0</td>
<td>0.74</td>
<td>Daft 1988</td>
</tr>
<tr>
<td></td>
<td>Yellow cake mix</td>
<td>7.3</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>Nectarine</td>
<td>1985–1986</td>
<td>NS(^a)</td>
<td>Takeoka et al. 1988</td>
</tr>
<tr>
<td>Cooked, aroma</td>
<td>Beef</td>
<td>NS</td>
<td>NS(^a)</td>
<td>Galt and MacLeod 1984</td>
</tr>
<tr>
<td>Prepared</td>
<td>Bakers cheese</td>
<td>NS</td>
<td>1.3(^b)</td>
<td>Uhler and Diachenko 1987</td>
</tr>
<tr>
<td></td>
<td>Cottage cheese</td>
<td>NS</td>
<td>2.7–10.6</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Ricotta cheese</td>
<td>ND–30.6</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mozzarella (skim milk)</td>
<td>9.5–37.3</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vanilla ice cream</td>
<td>2.7–10.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chocolate ice cream</td>
<td>ND–30.6</td>
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<td>Butter pecan ice cream</td>
<td>9.5–37.3</td>
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<td>Butter</td>
<td>ND–7,500</td>
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<td></td>
<td>Baked potatoes</td>
<td>NS</td>
<td>ND</td>
<td>Coleman et al. 1981</td>
</tr>
<tr>
<td></td>
<td>Commercial machine</td>
<td>1975 (NS)</td>
<td>0.0039(^c)</td>
<td>Su and Goldberg 1976</td>
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### Table 6-6. Detection of 1,1,1-Trichloroethane in Foods

<table>
<thead>
<tr>
<th>Type</th>
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<th>Sampling dates</th>
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<tr>
<td></td>
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<td>Cereals</td>
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<td>Raisin bran</td>
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<td>Granola, plain</td>
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<td>Oat ring</td>
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<td>Rolled oats, cooked</td>
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<td>Farina, cooked</td>
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<td>Corn grits, cooked</td>
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<tr>
<td>Vegetables</td>
<td>Peas, cooked</td>
<td>NS</td>
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<td>Sweet potatoes, candied</td>
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<td>Cream of potato soup</td>
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<td>Biscuits, baking powder</td>
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<td>Blueberry muffins</td>
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<td>Saltine crackers</td>
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<td>Corn chips</td>
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<td>Potato chips</td>
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<td></td>
<td>Macaroni and cheese</td>
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<tr>
<td></td>
<td>Yellow cake</td>
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</tr>
<tr>
<td></td>
<td>Coffee cake, frozen</td>
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<td>14</td>
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<td></td>
<td>Donuts, cake, plain</td>
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<td>Sweet roll, Danish</td>
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<td></td>
<td>Cookies, chocolate chip</td>
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<td>Cookies, sandwich</td>
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<td>Apple pie, frozen</td>
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<td>Nuts/nut products</td>
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<td>Dairy products</td>
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<tr>
<td></td>
<td>Milkshake, chocolate</td>
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<td>152</td>
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<td>Yogurt, strawberry</td>
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<td>Cheese, processed</td>
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<td>Cheese, cheddar</td>
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<td>White sauce</td>
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### Table 6-6. Detection of 1,1,1-Trichloroethane in Foods

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<td>Cream, half &amp; half</td>
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<td>Instant pudding, chocolate</td>
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<td>Ice cream sandwich</td>
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<td>Sugars, jams, candy</td>
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<td>Candy, milk chocolate</td>
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<td>15&lt;sup&gt;b&lt;/sup&gt;</td>
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<td></td>
<td>Meats, meat dishes</td>
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<td></td>
<td>Beef, ground, fried</td>
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<td>8&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Beef, chuck roast</td>
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<td>Pork, sausage, cooked</td>
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<td></td>
<td>Pork, bacon, cooked</td>
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<td>Pork roast, loin, cooked</td>
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<td>Veal cutlet, cooked</td>
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<td>Chicken, pieced, fried</td>
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<td>Frankfurters, cooked</td>
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<td></td>
<td>Bologna</td>
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<td>8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Daft 1988</td>
</tr>
<tr>
<td></td>
<td>Salami</td>
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<td>Tuna, canned in oil</td>
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<td>Shrimp, breaded, fried</td>
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<td>Fish sticks, cooked</td>
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<td>Pizza, cheese, cooked</td>
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<tr>
<td></td>
<td>One-fourth pound hamburger</td>
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<td>Meatloaf, beef</td>
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<td>Chicken noodle casserole</td>
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<td></td>
<td>Lasagna</td>
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<td></td>
<td>Potpie, chicken</td>
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<td>6</td>
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<td>Frozen dinner, chicken</td>
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<td></td>
<td>Brown gravy</td>
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<td>Infant/toddler blends</td>
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<td>Oatmeal, applesauce, banana</td>
<td>NS</td>
<td>6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Daft 1988</td>
</tr>
<tr>
<td></td>
<td>Fruits</td>
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</tr>
<tr>
<td></td>
<td>Apple, red, raw</td>
<td>NS</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Daft 1988</td>
</tr>
<tr>
<td></td>
<td>Grapes, purple/green</td>
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### Table 6-6. Detection of 1,1,1-Trichloroethane in Foods

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<th>Concentration (ppb)</th>
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<tr>
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<td>Raisins, dried</td>
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<td>Prunes, dried</td>
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<td>Avocado, raw</td>
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<td></td>
<td>Grapefruit juice</td>
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<td></td>
<td>Lemonade</td>
<td></td>
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<tr>
<td>Clear beverages</td>
<td>Grape juice</td>
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<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>Whiskey, 80 proof</td>
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<td>2</td>
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</table>

<sup>a</sup>Detected in sample; no quantitative results given  
<sup>b</sup>Data reported in ng/g; converted to ppb using the conversion factor 1 ppb=1 ng/g  
<sup>c</sup>Data reported in pg/mL; converted to ppb using the conversion factor 1 ppb=1,000 pg/mL

ND = not detected; NS = not specified
1,1,1-Trichloroethane has been detected in four shoe and leather glues in Denmark in the concentration range 0.1–2.7% (wt/wt) (Rastogi 1992). Six samples of glues manufactured in the United States and Europe, which were used for assembling various consumer goods and toys, contained 1,1,1-trichloroethane in the concentration range of 0.002–97.5% (wt/wt) (Rastogi 1993). In various brands of imported typing correction fluids in Singapore, the equilibrium vapor phase concentration of 1,1,1-trichloroethane ranged from <1 to 95% (v/v) (Ong et al. 1993).

6.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

Although the manufacture and use of 1,1,1-trichloroethane was scheduled to be phased out by 2002 under amendments made to Section 604 of the Clean Air Act (EPA 2004m); it is still being manufactured in the United States by two producers with production volumes of at least 100 million pounds as of 2002 (EPA 2002; SRI 2003). Its relatively long atmospheric half-life and continued production suggest that the general population may be expected to have continued exposure to this compound into the foreseeable future.

The ubiquitous occurrence, in the past, of low levels of 1,1,1-trichloroethane in ambient air and other environmental samples, together with the fact that many consumer products previously used to contain this chemical, suggests that much of the general population of the United States was exposed to low levels of 1,1,1-trichloroethane. This exposure could have occurred occupationally, environmentally, or as a result of the use of commercial products that contain 1,1,1-trichloroethane. 1,1,1-Trichloroethane has been detected in the blood, milk, breath, and urine of humans. An EPA Region V (Minnesota, Wisconsin, Michigan, Illinois, Indiana, and Ohio) National Human Exposure Assessment Survey (NHEXAS) detected a mean concentration of 1,1,1-trichloroethane to be 0.05 ppb in blood samples collected from July 1995 to May 1997 (Bonanno et al. 2001). The maximum concentration of trichloroethane detected in the same study was 2.7 ppb. Data on human body burdens associated with this compound can be found in Table 6-7. Table 5-2 provides a sampling of consumer products containing 1,1,1-trichloroethane. The levels of this chemical in human breath have been correlated with its levels in personal air by probability-based population studies (Wallace et al. 1985, 1986c, 1987a, 1988).

If the average urban concentration of 1,1,1-trichloroethane is taken to be 1 ppb and the average rural concentration is taken to be 0.1 ppb, then daily non-occupational intakes of 108 and 10.8 μg/day, respectively, can be obtained based on an average human air intake of 20 m³/day. In areas where
### Table 6-7. Detection of 1,1,1-Trichloroethane in Human Samples

<table>
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<tr>
<th>Media type/location</th>
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<td>Range</td>
<td>Mean</td>
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<td>46</td>
<td>ND–830(^a)</td>
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<td>Blood/serum:</td>
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<tr>
<td>New Orleans</td>
<td>1978</td>
<td>250</td>
<td>ND–26</td>
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<tr>
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<td>9</td>
<td>0.24–1.8(^b)</td>
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<tr>
<td>Denver</td>
<td>1976</td>
<td>3</td>
<td>1,300–2,700(^c)</td>
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<td>Non-smokers</td>
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<td>ND–0.0106(^d)</td>
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<td>Smokers</td>
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<td>Non-occupationally exposed</td>
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<td>NS</td>
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<td>1981</td>
<td>322</td>
<td>1.2(^f)</td>
<td></td>
</tr>
<tr>
<td>summer</td>
<td>1982</td>
<td>110</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>winter</td>
<td>1983</td>
<td>49</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>Devils Lake, ND</td>
<td>1980</td>
<td>23</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Bayonne/Elizabeth, NJ</td>
<td>1981</td>
<td>295–339</td>
<td>ND–95</td>
<td>0.88(^g)</td>
</tr>
<tr>
<td>winter</td>
<td>17(3)</td>
<td>0.053–1.4</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>1984</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>winter</td>
<td>112–115</td>
<td>1.17(^h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>spring</td>
<td>51</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 6-7. Detection of 1,1,1-Trichloroethane in Human Samples

<table>
<thead>
<tr>
<th>Media type/location</th>
<th>Sampling dates</th>
<th>Number of samples</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth-Bayonne, NJ</td>
<td>1981</td>
<td>48</td>
<td>0.017</td>
<td>2.78</td>
</tr>
<tr>
<td>Elizabeth-Bayonne, NJ</td>
<td>1981</td>
<td>0.022–15.7</td>
<td></td>
<td>Wallace et al. 1984a</td>
</tr>
<tr>
<td>Research Triangle Park, NC</td>
<td>1981</td>
<td>17</td>
<td>0.054–1.142</td>
<td></td>
</tr>
<tr>
<td>Urine: Old Love Canal, NY</td>
<td>1978</td>
<td>9</td>
<td>0.03–0.180</td>
<td>100</td>
</tr>
</tbody>
</table>

*Data in ng/g; 1 ppb=1 ng/g
b* Data in ng/mL; 1 ppb=1 ng/mL
c Data in mg/dL; 1 ppb=0.00001 mg/dL
d Data in ng/L; 1 ppb=1000 ng/L
\(\text{e Data in ng/m}^3; 1 \text{ ppb}=5400 \text{ ng/m}^3\)
\(\text{f Data in } \mu \text{g/m}^3; 1 \text{ ppb}=5.4 \mu \text{g/m}^3\)
\(\text{g Weighted geometric mean}\)

Post office state abbreviations used

ND = not detected; NHANES = National Health and Nutrition Examination Survey; NS = not specified
1,1,1-Trichloroethane has been detected in newly constructed buildings (Wallace et al. 1987b). 1,1,1-Trichloroethane was found in 216 of 1,159 common household products preselected to contain solvents at concentrations >0.1% by weight (Sack et al. 1992). In a similar study, 1,1,1-trichloroethane was found in all 67 categories of household products (1,026 brands tested) likely to be in the average U.S. home (EPA 1987l; Maklan et al. 1987). The categories of these common household products are given in Table 5-2. The occurrence of 1,1,1-trichloroethane in 62% of the effluent samples taken from a community septic tank also suggests the presence of this compound in household products (De Walle et al. 1985).

Human exposure could occur directly via ingestion of contaminated water, but also indirectly through the inhalation of 1,1,1-trichloroethane that has volatilized from contaminated tap water. Based on a theoretical concentration of 1 mg/L (ppm) of 1,1,1-trichloroethane in tap water, the average estimated air concentrations for the entire house, bathroom, and shower stall were 2.3x10^-4, 5.1x10^-3, and 2.6x10^-2 mg/L, respectively (McKone 1987). For a tap water concentration of 20 mg/L, the estimated daily exposure to 1,1,1-trichloroethane was 20.0 mg from ingestion and 22.8 mg from inhalation while showering (Foster and Chrostowski 1986). The Total Exposure Assessment Methodology (TEAM) studies demonstrated that levels of personal air exposure determined using samples obtained on the same day could vary by orders of magnitude for subjects living in the same municipality, most likely as a result of variances in consumer practices and occupation (Hartwell et al. 1987a, 1987b, 1992; Wallace 1986, 1987; Wallace et al. 1986a, 1986b, 1988, 1989; Zweidinger et al. 1983). The maximum exposure levels of 1,1,1-trichloroethane during personal activities were: 185 ppb when visiting the dry cleaners, 18.5 ppb when working in a chemistry lab, 12 ppb when working as a lab technician, 48 ppb when using household cleaners, 20 ppb when using pesticides, and 20 ppb when using paint (Wallace et al. 1989). Exposure of the general population from the use of commercial products may be more significant than exposure resulting from industrial release.

According to the National Occupational Exposure Survey (NOES) conducted by NIOSH between 1981 and 1983, it has been statistically estimated that ≈2,528,300 workers in the United States were potentially
exposed to 1,1,1-trichloroethane (NIOSH 1990). The largest number of workers is exposed in the following types of industries/services: sewing machine operators in apparel industry; registered nurses, maids, janitors and cleaners in hospitals; electricians, technicians, assemblers, installers, machinists and repairers in electrical and electronic industry; and janitors and cleaners in building maintenance service. From the existing monitoring data, it appears that most occupational exposure occurs by inhalation.

Specific industrial applications of 1,1,1-trichloroethane that might result in elevated levels of exposure are processes involving the degreasing and cleaning of fabricated metal parts (Gunter et al. 1977; Kominsky 1976; Levy and Meyer 1977; Markel 1977), manufacture of electronic components (Giles and Philbin 1976), mixing and application of commercial resins (Giles 1976), and spray painting and spray gluing (Whitehead et al. 1984). Table 6-8 lists occupations in which 1,1,1-trichloroethane has been detected in the air. Other occupations where workers can be exposed to 1,1,1-trichloroethane include automotive assembly plants (Nelson et al. 1993), kraft pulp mills (Rosenberg et al. 1991), and fuel cell assembly plants (NIOSH 1993). In a survey (1990–1991) of a fuel cell assembly plant, the levels of 1,1,1-trichloroethane in some of the personal breathing zone and general area samples were found to exceed the NIOSH short-term exposure limit of 350 ppm (NIOSH 1993). More current worker information was not available; however, since the production and use of 1,1,1-trichloroethane is being phased out, exposures would be expected to decrease. Exposure to 1,1,1-trichloroethane should be limited to those workers who are still involved in the manufacture and production of this compound or the limited uses as allowed for essential applications in the medical industry and aviation industry or the export of 1,1,1-trichloroethane as specified under Section 604 of the Clean Air Act.

### 6.6 EXPOSURES OF CHILDREN

This section focuses on exposures from conception to maturity at 18 years in humans. Differences from adults in susceptibility to hazardous substances are discussed in Section 3.7, Children’s Susceptibility.

Children are not small adults. A child’s exposure may differ from an adult’s exposure in many ways. Children drink more fluids, eat more food, breathe more air per kilogram of body weight, and have a larger skin surface in proportion to their body volume. A child’s diet often differs from that of adults. The developing human’s source of nutrition changes with age: from placental nourishment to breast milk or formula to the diet of older children who eat more of certain types of foods than adults. A child’s behavior and lifestyle also influence exposure. Children crawl on the floor, put things in their mouths,
### Table 6-8. Occupational Air Levels of 1,1,1-Trichloroethane

<table>
<thead>
<tr>
<th>Location/occupation</th>
<th>Sampling dates</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bozeman, MT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto repair garage</td>
<td>1976</td>
<td>2.2</td>
<td>Taketomo and Grimsrud 1977</td>
</tr>
<tr>
<td>Bookstore</td>
<td></td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Restaurant</td>
<td></td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Department store</td>
<td>0.8–1.7</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Newspaper press room</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grocery store</td>
<td>1.9–21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry cleaner</td>
<td>1.8–14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry building (academic)</td>
<td>0.1–1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tampa, FL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephone central office</td>
<td>1979</td>
<td>27–65</td>
<td>Oblas et al. 1979, 1980</td>
</tr>
<tr>
<td><strong>Hobbs, NM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephone business office</td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td><strong>Waltham, MA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory air</td>
<td></td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td><strong>Organic solvent recycling plant</strong></td>
<td>1984</td>
<td>ND–20,000a</td>
<td>Kupferschmid and Perkins 1986</td>
</tr>
<tr>
<td><strong>Booth spray painting/gluing</strong></td>
<td>1981</td>
<td>NS–22,000a</td>
<td>Whitehead et al. 1984</td>
</tr>
<tr>
<td><strong>Screw machine manufacturing company, AR</strong></td>
<td>1976</td>
<td>12,000–99,800b</td>
<td>Markel 1977</td>
</tr>
<tr>
<td><strong>Rifle scope producer, Denver, CO</strong></td>
<td>1976</td>
<td>7,700–478,000b</td>
<td>Gunter et al. 1977</td>
</tr>
<tr>
<td><strong>Heating and cooling coil manufacturing, IL</strong></td>
<td>1976</td>
<td>1,460–16,600b</td>
<td>Levy and Meyer 1977</td>
</tr>
<tr>
<td><strong>Electric apparatus manufacturing, PA</strong></td>
<td>1975</td>
<td>2,500–79,500a</td>
<td>Giles 1976</td>
</tr>
<tr>
<td><strong>Electrical resistor manufacturing, PA</strong></td>
<td>1976</td>
<td>6,000–83,000a</td>
<td>Giles and Philbin 1976</td>
</tr>
<tr>
<td><strong>Valve part manufacturer, IN</strong></td>
<td>1976</td>
<td>4,000–37,000a</td>
<td>Kominsky 1976</td>
</tr>
<tr>
<td><strong>Aircraft manufacturer, GA</strong></td>
<td>1983–1984</td>
<td>ND–23,000a</td>
<td>Salisbury et al. 1986</td>
</tr>
<tr>
<td><strong>Sport racket manufacturer, CO</strong></td>
<td>1985</td>
<td>NS</td>
<td>Pryor 1987</td>
</tr>
<tr>
<td><strong>Nail manufacturer, CO</strong></td>
<td>1987</td>
<td>7,510–406,000b</td>
<td>NIOSH 1987</td>
</tr>
<tr>
<td><strong>Fiber manufacturer, IL</strong></td>
<td>1986</td>
<td>59–115b</td>
<td>Daniels et al. 1988</td>
</tr>
<tr>
<td><strong>Men's shirt company, IN</strong></td>
<td>1974</td>
<td></td>
<td>Nord 1974</td>
</tr>
<tr>
<td><strong>Film optical shops, NY</strong></td>
<td>1979</td>
<td>500–1,320,000b</td>
<td>Peter and Edelbrock 1980</td>
</tr>
<tr>
<td><strong>Joint/shaft manufacturer, IN</strong></td>
<td>1979</td>
<td>800–1,300a</td>
<td>McQuilkin et al. 1979</td>
</tr>
</tbody>
</table>
### 6. POTENTIAL FOR HUMAN EXPOSURE

#### Table 6-8. Occupational Air Levels of 1,1,1-Trichloroethane

<table>
<thead>
<tr>
<th>Location/occupation</th>
<th>Sampling dates</th>
<th>Concentration (ppb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery manufacturer, CO</td>
<td>1979</td>
<td>9,160–36,400 (^a)</td>
<td>NIOSH 1980a</td>
</tr>
<tr>
<td>Typesetter/photographer, GA</td>
<td>1979</td>
<td>3,900–4,600 (^a)</td>
<td>NIOSH 1980b</td>
</tr>
<tr>
<td>Graphic services, OH</td>
<td>1979</td>
<td>&lt;1,000 (^a)</td>
<td>NIOSH 1980c</td>
</tr>
<tr>
<td>Welding shop</td>
<td>1979</td>
<td>3,200–4,799 (^a)</td>
<td>Vegella 1979</td>
</tr>
<tr>
<td>Suitcase manufacturer, CO</td>
<td>1978</td>
<td>500–756,000 (^a)</td>
<td>Apol and Singal 1979</td>
</tr>
<tr>
<td>Ski/tennis racquet manufacturing, CO</td>
<td>1979</td>
<td>22,500–85,800 (^b)</td>
<td>Gunter 1979</td>
</tr>
<tr>
<td>Sewer workers, OH</td>
<td>1981</td>
<td>1,000–40,000 (^a)</td>
<td>McGlothlin and Cone 1983</td>
</tr>
<tr>
<td>Solar cell producer, CA</td>
<td>1979</td>
<td>ND–74,000 (^b)</td>
<td>Briggs and Garrison 1982</td>
</tr>
<tr>
<td>Medical therapeutic system manufacturing, CO</td>
<td>1979</td>
<td>400–3,600 (^a)</td>
<td>NIOSH 1980d</td>
</tr>
<tr>
<td>Navigation information products, CO</td>
<td>1981</td>
<td>549–2,750 (^b)</td>
<td>Gunter 1983</td>
</tr>
<tr>
<td>Tractor manufacturer, ND</td>
<td>1979</td>
<td>ND–62,600 (^a)</td>
<td>NIOSH 1980e</td>
</tr>
<tr>
<td>U.S. Department of the Treasury, DC</td>
<td>1982</td>
<td>NS</td>
<td>Lee 1984</td>
</tr>
<tr>
<td>School district print shop, OR</td>
<td>1983</td>
<td>100 (^a)</td>
<td>Apol and Helgerson 1983</td>
</tr>
<tr>
<td>Electrical maintenance company, OH</td>
<td>1981</td>
<td>123,000–385,000 (^b)</td>
<td>Kominsky and Lipscomb 1985</td>
</tr>
<tr>
<td>Electrical commutators manufacturers, IL</td>
<td>1983</td>
<td>ND–4 (^a)</td>
<td>Almaguer 1985</td>
</tr>
<tr>
<td>Crystal fabricator, CO</td>
<td>1984</td>
<td>366–2700 (^b)</td>
<td>Gunter and Thoburn 1986</td>
</tr>
<tr>
<td>Silk screening of textiles, KS</td>
<td>1975</td>
<td>ND–75,000 (^b)</td>
<td>Hervin 1975</td>
</tr>
<tr>
<td>Aluminum vane manufacturers, OH</td>
<td>1976</td>
<td>74,000–396,000 (^a)</td>
<td>Giles 1977</td>
</tr>
<tr>
<td>Catapult cylinder manufacturers, OH</td>
<td>1975</td>
<td>2,400–18,400 (^a)</td>
<td>Giles 1977</td>
</tr>
<tr>
<td>Chemical recovery plant, OH</td>
<td>1980</td>
<td>1,900–4,500 (^b)</td>
<td>Albrecht 1980</td>
</tr>
<tr>
<td>Uranium company, WY</td>
<td>1980</td>
<td>ND–155,000 (^b)</td>
<td>Gunter 1980</td>
</tr>
<tr>
<td>Theater, NY</td>
<td>1985</td>
<td>458–10,700 (^b)</td>
<td>Fannick 1986</td>
</tr>
</tbody>
</table>

\(^a\) Data reported in ppt; converted to ppb using the conversion factor 1 ppb=1,000 ppt

\(^b\) Data reported in mg/m\(^3\); converted to ppb using the conversion factor 1 ppb=0.0054 mg/m\(^3\)

Post office state abbreviations used

ND = not detected; NS = not specified
sometimes eat inappropriate things (such as dirt or paint chips), and spend more time outdoors. Children also are closer to the ground, and they do not use the judgment of adults to avoid hazards (NRC 1993).

Exposures of the embryo or fetus to volatile organic compounds such as 1,1,1-trichloroethane may occur if the expectant mother is exposed. A newborn infant may be exposed by breathing contaminated air and through ingestion of mother’s milk that can contain small amounts of 1,1,1-trichloroethane. Children may be exposed through accidental ingestion of products containing 1,1,1-trichloroethane. Older children and adolescents may be exposed to 1,1,1-trichloroethane in their jobs or hobbies, or through deliberate solvent abuse by “sniffing”. Epidemiological studies and case reports discussing reproductive and/or developmental toxicity of 1,1,1-trichloroethane in humans have been reviewed in Chapter 3.

Young children often play close to the ground and frequently play in dirt, which increases their dermal exposure to toxicants in dust and soil. They also tend to ingest soil, either intentionally through pica or unintentionally through hand-to-mouth activity. Children, thus, may be orally and dermally exposed to 1,1,1-trichloroethane present as a contaminant in soil and dust. 1,1,1-Trichloroethane has a log organic carbon-water partition coefficient of 2.03, indicating low adsorption to soil (Chiou et al. 1979; Friesel et al. 1984). Most of the 1,1,1-trichloroethane present in the upper layers of the soil is volatilized to air within 24 hours (vapor pressure =124 mm Hg at 25 °C; Boublik et al. 1984). The rapid volatilization of 1,1,1-trichloroethane results in inhalation being the most likely route of exposure.

Children breathe in more air per kilogram of body weight than an adult. Therefore, a child in the same micro-environment as an adult is likely to be exposed to more 1,1,1-trichloroethane from ambient air. Young children are closer to the ground or floor because of their height. The 1,1,1-trichloroethane vapors being heavier than air (vapor density=4.63 g/mL; HSDB 2005) tend to concentrate near the ground. The children, therefore, are at a greater risk of exposure than adults during accidental spills of 1,1,1-trichloroethane.

Children may also be exposed to fumes of 1,1,1-trichloroethane by working with or playing near sources. Children’s exposure also occurs through accidental ingestion and inhalation of the chemicals into the lungs. Children are also exposed to higher concentrations of 1,1,1-trichloroethane (0.1–1 ppb, Table 6-3) in urban areas compared to children living in rural areas (concentrations typically <0.2 ppb, Table 6-3).
Animal studies demonstrated that, once absorbed, 1,1,1-trichloroethane is distributed by the blood to tissues and organs throughout the body, including developing fetuses, with preferential distribution to fatty tissues (Holmberg et al. 1977; Katagiri et al. 1997; Schumann et al. 1982a; Takahara 1986b).

There are no existing studies that have monitored the level of exposure from 1,1,1-trichloroethane to children. Most uses of 1,1,1-trichloroethane are associated with occupational purposes, so it is unlikely that children will receive significant doses. Under extreme conditions where products containing high concentrations of 1,1,1-trichloroethane are used in the presence of children in an enclosed area with little or no ventilation, children could receive significant exposure. There are studies that examine the exposure to children from parents' work clothes, skin, hair, tools, or other objects removed from the workplace (NIOSH 1995); however, this type of “take home” or secondary exposure is unlikely due to the high volatility of 1,1,1-trichloroethane. Additional exposure from consumer products can occur, but is unlikely to be significant, although little data are available at this time.

It is not known whether children differ in their weight-adjusted intake of 1,1,1-trichloroethane. However, children drink more fluids per kg of body weight than adults (NRC 1993) and 1,1,1-trichloroethane has been detected in drinking water (Section 6.4.2, Table 6-2).

### 6.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

The general population is potentially exposed to low levels of 1,1,1-trichloroethane through the ingestion of contaminated water or food and by breathing air contaminated with this compound. Since most applications and uses of 1,1,1-trichloroethane have been or are currently being discontinued, human exposure is expected to decrease accordingly. The manufacture and use of 1,1,1-trichloroethane was scheduled to be phased out by 2002 under the Clean Air Act (EPA 2004m). Since it is no longer in use, the exposure of the general population should drop to insignificant levels over time. Low levels of contamination in drinking water sources have been documented (Althoff et al. 1981; Barkley et al. 1980; Burmaster 1982; EPA 1986a; Krill and Sonzogni 1986; Wallace et al. 1984a; Zaki 1986). According to Table 6-2, levels of 0.01–12,220 ppb 1,1,1-trichloroethane have been found in drinking water sources. 1,1,1-Trichloroethane was used as a component of adhesives for food packaging, and this practice may have contributed to human exposure by ingestion (Miller and Uhler 1988). Airtight, highly-insulated houses are likely to have high indoor concentrations from use of household products containing 1,1,1-tri-
chloroethane. Very high levels of exposure are expected to occur for those who intentionally inhale 1,1,1-trichloroethane for its euphoric/narcotic properties.

Workers who are still involved in processes using this compound may encounter high exposure levels. Occupations in which 1,1,1-trichloroethane has been found in the air are given in Table 6-8; however, it is noted that many of these occupational exposures are no longer expected to occur today since the production and use of 1,1,1-trichloroethane is being phased out. Analysis of these data shows that ambient air concentrations in industries using 1,1,1-trichloroethane are up to 4 orders of magnitude higher than what is typically found in urban air.

1,1,1-Trichloroethane was used in some adhesive remover pads of incubators in intensive care nurseries, and there is evidence that infants in incubators could be exposed to high concentrations of 1,1,1-trichloroethane (Gallagher and Kurt 1990). This use of 1,1,1-trichloroethane has been discontinued.

6.8 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, 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 1,1,1-trichloroethane is available. Where adequate information is not available, ATSDR, in conjunction with NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of 1,1,1-trichloroethane.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

6.8.1 Identification of Data Needs

Physical and Chemical Properties. The physical and chemical properties of 1,1,1-trichloroethane are well documented, and additional information in this area does not appear necessary. Only one BCF
for 1,1,1-trichloroethane was located in the available literature (Barrows et al. 1980). This value is, however, consistent with what would be expected based on the other physical and chemical properties of 1,1,1-trichloroethane.

**Production, Import/Export, Use, Release, and Disposal.** According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit substance release and off-site transfer information to the EPA. The TRI, which contains this information for 2003, became available in May of 2005. This database is updated yearly and should provide a list of industrial production facilities and emissions.

Historical data on the production, use, release, and disposal of 1,1,1-trichloroethane in the United States are well represented in the literature. The past production volumes of 1,1,1-trichloroethane manufactured in the United States are known. For example, total U.S. production volumes of 1,1,1-trichloroethane were 720 million pounds in 1992 and 450 million pounds in 1993 (CMR 1995). According to the 1990 amendments to the Clean Air Act and the Montreal Protocol, future U.S. production was to be cut incrementally until a total phase-out by January 1, 2002 (EPA 2004m). However, current data suggests that large quantities of 1,1,1-trichloroethane are still being produced domestically, and information regarding the current production volumes as well as export volumes are important to assess the potential for exposure. 1,1,1-Trichloroethane was still being manufactured in the United States in 2002 in a production volume range of >100–<500 million pounds (EPA 2002). Today, the only significant use of 1,1,1 trichloroethane is in the production of CFC-142. Since these laws have been passed, the projected amount of 1,1,1 trichloroethane has decreased from 300 million pounds in 2000 to a projected 125 million pounds in 2005 (HSIA 2004). The past use of 1,1,1-trichloroethane is well-documented. It was used extensively in industrial applications, and it was found in numerous consumer products for the home. Mandates on production, however, are expected to decrease the use of 1,1,1-trichloroethane and subsequent potential exposure to 1,1,1-trichloroethane. Currently, 1,1,1, trichloroethane is almost entirely used as a precursor for hydrofluorocarbons (HSIA 2004).

There are a few food monitoring studies in the literature that provide several examples of food contamination with 1,1,1-trichloroethane. The ubiquitous nature of 1,1,1-trichloroethane suggests that additional information in this area would allow a complete determination of the levels of human exposure to this chlorinated solvent. The release of 1,1,1-trichloroethane to the environment is well established since there are numerous studies that indicate the presence of this compound in environmental media. However, recent quantitative data regarding releases to air, soil, or water are lacking. 1,1,1-Trichloro-
ethane is listed on the TRI (TRI02 2004). Methods for the disposal of 1,1,1-trichloroethane exist (Carroll et al. 1992; Cheung et al. 1991; HSDB 2004; Kusakabe et al. 1991; OHM/TADS 1992. Data on the removal of 1,1,1-trichloroethane from waste streams during biological treatment processes are lacking. Information on the amount of 1,1,1-trichloroethane disposed of annually is scarce. Rules and regulations governing the disposal of 1,1,1-trichloroethane exist (EPA 1992a, 1992b, 1992c, 1992d). Because large quantities of 1,1,1-trichloroethane continue to be produced in the United States, quantitative data regarding releases to the environment may be beneficial.

Environmental Fate. Data on the environmental fate of 1,1,1-trichloroethane are well represented in the literature. The partitioning of 1,1,1-trichloroethane from soil or water to the atmosphere is well established, and there is sufficient evidence to indicate that the compound can leach into groundwater (Lyman et al. 1990; Swann et al. 1983). The relatively slow rate of degradation and the major routes of 1,1,1-trichloroethane degradation in all environmental compartments have been established. The relatively long persistence of 1,1,1-trichloroethane in the atmosphere indicates that a significant portion of this compound migrates to the stratosphere (Prinn et al. 1987; Singh et al. 1992). Data on the biodegradation of 1,1,1-trichloroethane in soil are lacking. Additional data regarding the environmental fate of 1,1,1-trichloroethane do not appear necessary.

Bioavailability from Environmental Media. Numerous toxicokinetic and toxicity studies in humans and animals have demonstrated the bioavailability of 1,1,1-trichloroethane from air and drinking water. Although some data on the bioavailability of 1,1,1-trichloroethane from air to mammalian skin (Mattie et al. 1994), and from air to other mammalian tissues (blood, muscle, liver) (Connell et al. 1993) are available, no studies on the bioavailability of 1,1,1-trichloroethane from food or soil were located. Some of the important routes of exposure to 1,1,1-trichloroethane for residents near waste sites will be inhalation of airborne dusts, ingestion of soil (children) and dermal contact with contaminated soil (mostly children). Therefore, it would be helpful to develop reliable data for the bioavailability of 1,1,1-trichloroethane from dust as a result of inhalation of contaminated airborne dust, from soil as a result of ingestion of soil, and from soil as a result of dermal contact with soil.

Food Chain Bioaccumulation. 1,1,1-Trichloroethane is not believed to bioconcentrate in fish and aquatic organisms (Barrows et al. 1980); thus, it is not expected to biomagnify in the food chain. There are limited data regarding food chain biomagnification of 1,1,1-trichloroethane.
Exposure Levels in Environmental Media. Reliable monitoring data for the levels of 1,1,1-trichloroethane in contaminated media at hazardous waste sites are needed so that the information obtained on levels of 1,1,1-trichloroethane in the environment can be used in combination with the known body burden of 1,1,1-trichloroethane to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Volumes of data exist on levels of 1,1,1-trichloroethane in environmental media, with the exception of levels in soil samples. Continued monitoring of environmental media is warranted. Blind monitoring at this stage, however, might be replaced with methods that allow both the continued determination of the environmental burden of 1,1,1-trichloroethane and correlation with human burden, like that performed in the TEAM studies (Hartwell et al. 1987a, 1987b, 1992; Wallace 1986, 1987; Wallace et al. 1986a, 1986b, 1988, 1989; Zweidinger et al. 1983). These and other studies have estimated human intake of 1,1,1-trichloroethane from environmental media. For members of the general population near hazardous waste sites, total exposure to 1,1,1-trichloroethane will include exposure from environmental media and exposure from consumer products.

Reliable monitoring data for the levels of 1,1,1-trichloroethane in contaminated media at hazardous waste sites are needed so that the information obtained on levels of 1,1,1-trichloroethane in the environment can be used in combination with the body tissue/fluid levels of 1,1,1-trichloroethane to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Exposure Levels in Humans. 1,1,1-Trichloroethane has been detected in human tissues and expired air. Due to the past use of 1,1,1-trichloroethane in common household products, the potential for exposure of the general population may have been significantly higher inside the home. However, 1,1,1-trichloroethane is no longer used in common household products and the current likelihood of exposure of the general population to 1,1,1-trichloroethane is remote. However, continued monitoring of 1,1,1-trichloroethane-exposed workers is necessary for assessing the need to conduct health studies on these populations.

Exposures of Children. Children are at a greater risk of inhalation exposure to 1,1,1-trichloroethane as they breathe in more air per kilogram of body weight than an adult. They also spend more time closer to ground because of their height. 1,1,1-Trichloroethane vapors, being heavier than air, tend to concentrate closer to the ground, thereby increasing the risk for children. No data are available on the exposure of the children to 1,1,1-trichloroethane present in the air.
6. POTENTIAL FOR HUMAN EXPOSURE

A study on usefulness of intervention methods in cases of inhalant abuse by pregnant women would be helpful. More research is needed to rule out concomitant risk factors and to identify specific chemicals and patterns of use associated with adverse effects.

Means of protecting young children from ingestion of home products containing 1,1,1-trichloroethane need study and action. Child-proof containers and clearer warnings to parents should be considered to avoid unwanted exposure.

Child health data needs relating to susceptibility are discussed in Section 3.12.2, Identification of Data Needs: Children’s Susceptibility.

**Exposure Registries.** No exposure registries for 1,1,1-trichloroethane were located. This substance is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

### 6.8.2 Ongoing Studies

The Federal Research in Progress (FEDRIP 2004) database provides additional information obtainable from a few ongoing studies that may fill in some of the data needs identified in Section 6.8.1.

Researchers at Physical Optics Corporation (POC) proposes to develop a group-specific active optical chemical sensor for halohydrocarbons (including trichloroethylene, dichloroethylene, perchloroethylene, and 1,1,1-trichloroethane) that can be interfaced with a cone penetrometer for subsurface applications. No liquid chemical substances will be used in the final sensor design, enabling simple fiber optic-based downhole deployment.

Researchers at University of Washington, College of Forest Resources propose to test the ability of several plant strains to take up and transform various chlorinated hydrocarbons, including carbon tetrachloride, chloroform, bischloromethane, 1,1,1-trichloroethane, perchloroethylenes, trichloroethylene,
dichloromethanes, and vinyl chloride using laboratory mass balance reactors. They will identify the mechanisms involved in the chlorinated hydrocarbon oxidation in poplar and use molecular methods to enhance that activity.