5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

Chlorobenzene is used as a solvent and as an intermediate in industry. A portion of that is lost to the environment in water and air discharges. Chlorobenzene adsorbs moderately to soil and is biodegraded comparatively rapidly. With a moderate index of bioaccumulation, chlorobenzene was found in almost every individual tested for it in the United States. The EPA has identified 1,177 NPL sites. Chlorobenzene has been found at 97 of the sites evaluated for the presence of this chemical. As more sites are evaluated by the EPA, the number may change. The frequency of these sites within the United States can be seen in Figure 5-l.

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

The production of chlorobenzene by seven major producers was reported to be 112,000 kkg in 1987. Estimates of environmental releases vary widely. The EPA (1982d) estimated the release of chlorobenzene to be about 200 tons, or 0.2% of production, while Dow Chemical Company estimated that about 50,000 tons, or 30% to 50% of their annual production was released to the air (EPA 1980a).

5.2.2 Water

The principal source of chlorobenzene in water is release from chemical manufacturing facilities. Dow Chemical Company estimated that 0.1% of its annual production enters waters (EPA 1980a). Perry et al. (1979) found chlorobenzene in 6/63 industrial effluent in concentrations up to 100 μg/L. Based on 1,338 samples collected from about 1980 to 1983, the medium concentration of chlorobenzene in waste effluent was < 3 ppb and was detected in 54 samples. The total amount released to the environment was not reported (Staples et al. 1985). Chlorobenzene has been detected in both surface and groundwater samples at hazardous waste sites. Data from the Contract Laboratory Program (CLP) Statistical Database indicate that chlorobenzene occurred in surface water at 13 sites at a geometric mean concentration of 17 ppb in positive samples and in groundwater at 28 sites at a geometric mean concentration of 62 ppb in positive samples (CLPSD 1988). It should be noted that the CLP Statistical Database includes data from both NPL and non-NPL sites.

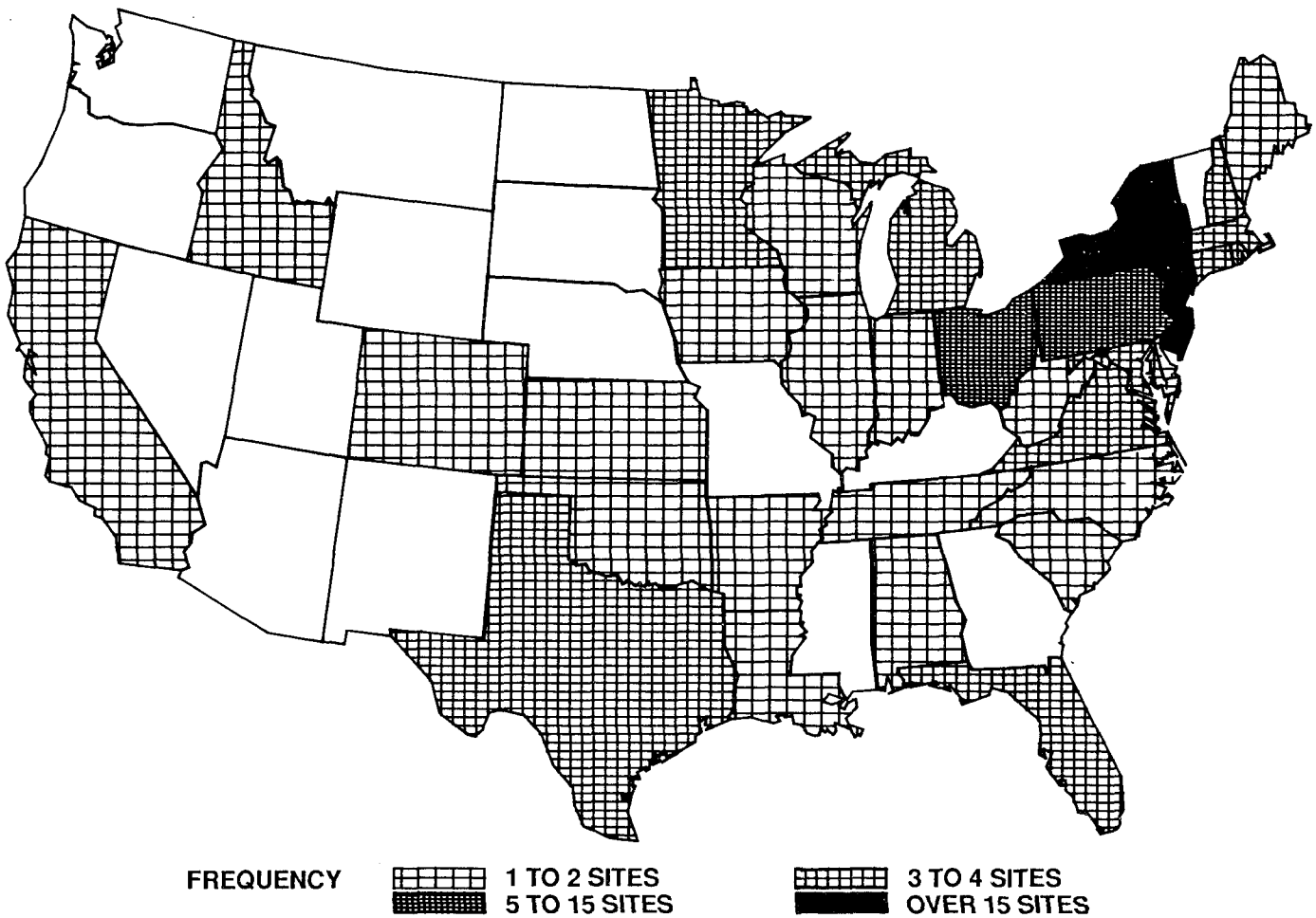

FIGURE 5-1. Frequency of Sites with Chlorobenzene Contamination

5.2.3 Soil

Chlorobenzene was detected at 34 sites at a geometric mean concentration of 37 ppm in positive soil samples (CLPSD 1988). It should be noted that the CLP Statistical Database includes data from both NPL and non-NPL sites.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

Chlorobenzene is volatile and has only moderate solubility in water (500 mg/L). Chlorobenzene was observed to evaporate ($\geq$ 99%) from an unaerated aqueous solution in 72 hrs (Garrison and Hill 1972). The air, undoubtedly, plays a large role in the environmental transport and degradation of chlorobenzene, although studies addressing this aspect were not found.

5.3.2 Transformation and Degradation

5.3.2.1 Air

Physical constants for chlorobenzene, especially its vapor pressure and water solubility, indicate that the air is an important and perhaps the dominant medium for the transport and transformation of chlorobenzene. As an aromatic molecule with strong UV-absorption, chlorobenzene has a half-life of 20 to 40 hrs under simulated atmospheric conditions (Dilling et al. 1976). This appears to be confirmed by the large difference between chlorobenzene measurements in urban air (3,000 ng/m^3) and in rural air (not detected) in 1982 (Brodzinsky and Singh 1983).

5.3.2.2 Water

Biodegradation in a waste water inoculum was studied by Tabak et al. (1981). Among 57 environmental pollutants tested, chlorobenzene at 5 mg/L was among the more rapidly biodegraded substances with 89% degradation in a week and 100% after adaptation. Biodegradation is therefore a major degradation process in oxygenated waters while evaporation will play an additional role in surface waters.

5.3.2.3 Soil

Biodegradation of chlorobenzene is rapid, leaving no detectable residues after 1 or 2 weeks. Adaptation is also rapid (Tabak et al. 1981).

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

Air samples at 56 localities in the United States in 1982 had mean chlorobenzene concentrations of about 3,000 ng/m^3; the highest concentrations in urban and suburban areas, at much lower levels at the sites of production, but was not detectable in rural and remote areas (Brodzinsky and Singh 1983). This suggests a substantial contribution to urban air levels by small industry and consumer products but also a short residence time in the air. A study of New Jersey waste sites found similar air levels of chlorobenzene (2,500 ng/m^3) (Harkov et al. 1985). However, air levels found by another study done for the United States EPA (Pellizzari 1978a) were an order of magnitude lower, with only the air over a waste site approaching the mean urban concentrations reported above. Ambient air outside homes of "Old Love Canal" (Niagara Falls, New York) contained chlorobenzene ranging from not detectable (4 sites) to traces (4 sites) and 120 ng/m^3 (1 site) (Barkley et al. 1980).

5.4.2 Water

Chlorobenzene, along with other chlorinated chemicals, was found in United States' rivers at levels up to and exceeding 10,000 ng/L (Shackelford and Keith 1976; Sheldon and Hites 1978). Private wells near a hazardous waste site contained as much as 41 μg/L (Clark 1982) and tap water at Love Canal contained 10 to 60 ng/L of chlorobenzene (Barkley et al. 1980).

Chlorobenzene contamination of industrial waste waters up to and exceeding 100 μg/L was found in 6/63 samples (Perry et al. 1979) and in 147/31,194 samples with a mean concentration of 667 μg/L (EPA 1985a).

5.4.3 Soil

Staples et al. (1985) reported that the median concentration of chlorobenzene in the United States was estimated to be less than 5 ppb dry sediments. In 347 measurements recorded in the STORET data base, 2% of the samples contained detectable concentrations of chlorobenzene.

5.4.4 Other Media

No studies of chlorobenzene in food or other media are available.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

Chlorobenzene was found in 98/100 human adipose tissue samples from all regions of the United States at levels ranging from 1 to 9 ng/g (Stanley 1986). At Love Canal, Niagara Falls, chlorobenzene could be

detected in the breath of one of nine people evaluated for exposure and in the urine of six of nine persons at 20 to 120 ng/L (Barkley et al. 1980).

Personal sampling at chemical companies (Cohen et al. 1981) indicated that chlorobenzene levels (up to 18 mg/m^3) in work place air did not exceed the current federal level (350 mg/m^3).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Occupational settings provide the greatest potential for high exposures to chlorobenzene. Since chlorobenzene is a volatile compound and is used extensively as a solvent, large quantities may be released to the workplace air. Other populations who might be exposed include persons living near industrial facilities where chlorobenzene emissions are not properly controlled.

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of chlorobenzene is available. Where adequate information is not available, ATSDR, in conjunction with the 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 chlorobenzene.

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 or eliminate the uncertainties of human health assessment. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Identification of Data Needs

Physical and Chemical Properties. Physical and chemical properties of chlorobenzene have been thoroughly measured.

Production, Use, Release, and Disposal. Data indicate that chlorobenzene production has declined dramatically over the past two decades, but current quantitative data on use (especially solvent uses) and disposal practices would be helpful in evaluating the effect of current industrial practices on environmental levels of chlorobenzene.

5. POTENTIAL FOR HUMAN EXPOSURE

According to the Emergency Planning and Community Right to Know Act of 1986 (EPCRTKA), (§313), (Pub. L. 99-499, Title III, §313), industries are required to submit release information to the EPA. The Toxic Release Inventory (TRI), which contains release information for 1987, became available in May of 1989. This database will be updated yearly and should provide a more reliable estimate of industrial production and emission.

Environmental Fate. Information on biodegradation in soil under aerobic conditions exists, but degradation products were not identified. Anaerobic biodegradation, as might occur in river bottoms and in Superfund sites, has not been studied and would be valuable. Emissions from waste lagoons have been modelled and measured in bench-top experiments and are measured as part of many Superfund Remedial Investigation/Feasibility studies, but those were not located.

Bioavailability from Environmental Media. Chlorobenzene is absorbed primarily following inhalation of contaminated air. There is also some potential for exposure from water and soil. Chlorobenzene has been detected at low levels in surface, ground, and drinking water, but no information was found on levels in food. Since chlorobenzene binds tightly to soil particles, skin contact with or ingestion of contaminated soil may be an important source of exposure, particularly in children living near hazardous waste sites. Additional studies would be useful to determine if soil-bound chlorobenzene is bioavailable.

Food Chain Bioaccumulation. No information is available regarding biomagnification within aquatic or terrestrial food chains. Additional studies would be useful in assessing potential for human exposure to chlorobenzene.

Exposure Levels in Environmental Media. There are studies on concentrations of chlorobenzene in air and water, but many of the samples measured had low levels or did not have detectable levels. Additional studies using more sensitive analytical methods would be useful.

Exposure Levels in Humans. Studies have been conducted measuring chlorobenzene levels in drinking water and air (including indoor air). Conflicting data on chlorobenzene air levels point to a need for confirmation and, possibly, validation of analytical methods. Less conflicting estimates of environmental emissions are the prerequisite for any attempt to prioritize control measures.

Exposure Registries. No exposure registries for chlorobenzene were located. This compound is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry.

The compound 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 the exposure to this compound.

5.7.2 On-going studies

Studies on the migration and in situ biodegradation of chlorobenzene in hazardous waste sites are being conducted in the laboratory of Perry McCarty and others.

As part of the Third National Health and Nutrition Evaluation Survey (NHANES III), the Environmental Health Laboratory Sciences Division of the Center for Environmental Health and Injury Control, Centers for Disease Control, will be analyzing human blood samples for chlorobenzene and other volatile organic compounds. These data will give an indication of the frequency of occurrence and background levels of these compounds in the general population.