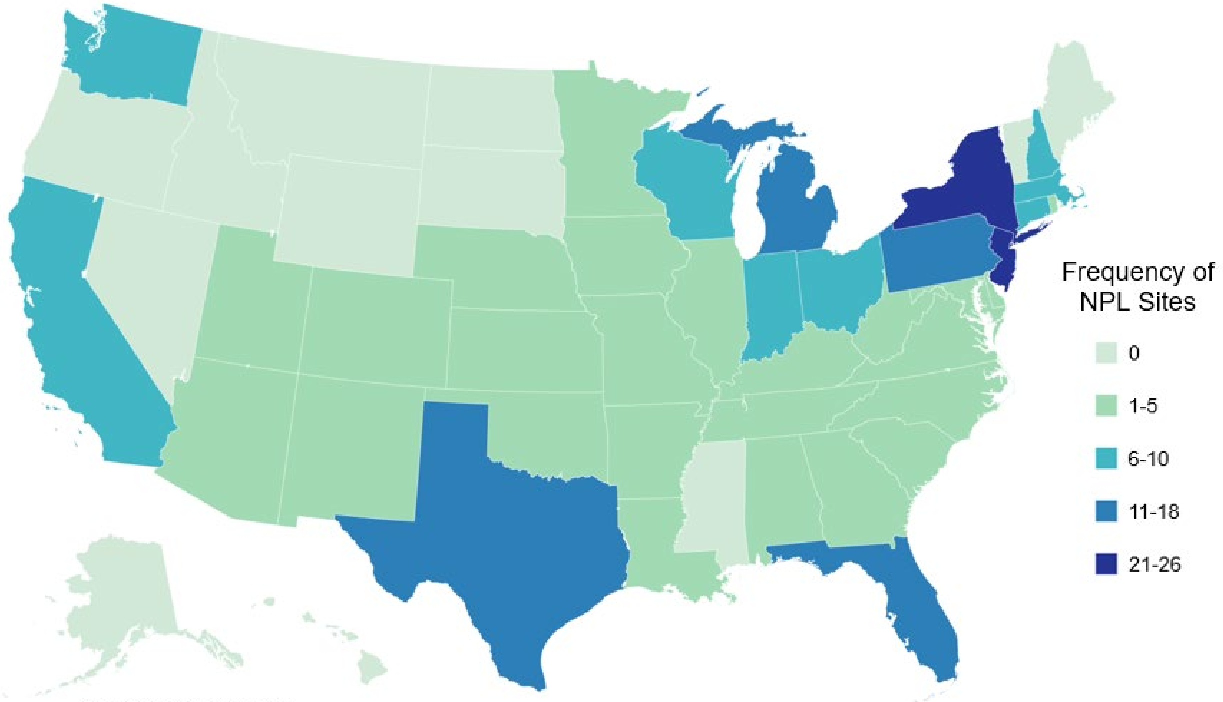
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

Carbon disulfide has been identified in at least 246 of the 1,868 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2022). However, the number of sites in which carbon disulfide has been evaluated is not known. The number of sites in each state is shown in Figure 5-1. Of these sites, 243 are located within the United States, 1 is located in the Virgin Islands, and 2 are located in Puerto Rico (not shown).

Figure 5-1. Number of NPL Sites with Carbon Disulfide Contamination



Source: ATSDR 2022

- The main route of carbon disulfide exposure for the general population would be through inhalation of ambient air; however, atmospheric concentrations of carbon disulfide are usually low.

- Inhalation exposure under occupational settings is the most prominent route of human exposure. Workers involved in the manufacture of carbon disulfide, and production of products using this compound such as regenerated cellulose materials, are exposed to much higher levels than the general population. Dermal exposure is also possible in workplace settings.

- Carbon disulfide is released to the environment in emissions from manufacturing and use facilities and is also emitted through natural processes such as composting, and volcanic and geothermal activity. Oceans, marshes, and coastal areas are important biogenic sources of carbon disulfide.
- Carbon disulfide is expected to partition mainly to the air. In air, carbon disulfide will react with photochemically generated hydroxyl radicals and has an estimated half-life of 5.5 days.
- Carbon disulfide released to water can hydrolyze slowly; however, the overwhelming portion will volatilize to air. The potential for carbon disulfide to bioconcentrate in aquatic organisms is low. Similarly, carbon disulfide released to soil will quickly volatilize to the atmosphere, but a small portion may leach into groundwater since it is mobile in soil surfaces.

Carbon disulfide has both natural and anthropogenic sources (WHO 2002). Although there is a great deal of uncertainty in the estimates, globally, at least 40%, and perhaps as much as 80%, of releases are due to natural sources (EC/HC 2000; WHO 2002). The primary anthropological disposition of carbon disulfide in the environment is related to its use as an industrial solvent and chemical intermediate. Releases from industrial processes are almost exclusively to the atmosphere. Releases of the compound to surface waters and soils are expected to partition rapidly to the atmosphere through volatilization. Hydrolysis and biodegradation do not appear to be important processes in determining the environmental fate of carbon disulfide. It has been detected at generally low levels in ambient air, surface water, groundwater, and human milk. Concentrations in environmental media are greatest near source areas (e.g., industrial point sources, oceans and marshes, volcanoes).

Inhalation of carbon disulfide in workplace air is generally the main route of human exposure to the compound, with skin exposure also important when the solvent is handled manually.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

Carbon disulfide was first manufactured commercially around 1880 (Timmerman 1978). Carbon disulfide is commercially manufactured by the reaction of sulfur with charcoal or methane (Lay et al. 2012). Ethane, propane, and propene have also been used, but to a much lower extent as compared to methane. Since the methane process was first introduced in the early 1950s, it has surpassed the older charcoal process in the production of carbon disulfide, which is no longer used in the United States, Europe, or Japan (Lay et al. 2012). In areas where natural gas or methane is not readily available or when the plant size is small, the charcoal process may still be used in the production of carbon disulfide. Carbon disulfide is normally available both in technical and reagent grades with >99% purity (Lay et al. 2012).

Historical trends in carbon disulfide production closely paralleled those of the viscose rayon industry, one of its largest users (Timmerman 1978; WHO 1981). Production increased by nearly 50% between 1941 and 1969, from 242,000 to 362,000 metric tons. This increase was partly due to a sudden rise in demand for carbon tetrachloride, an intermediate in the production of fluorocarbon propellants and refrigerants; carbon disulfide is used in the production of carbon tetrachloride. The 1969 production level remained relatively stable until about 1974 when it declined sharply to the 1975 level of 217,000 metric tons (Timmerman 1978). There are no active rayon manufacturers in the United States (EPA 2011). Carbon disulfide may still be used in the United States for the manufacturing of other regenerated cellulose products such as cellulosic films, cellulosic sponges, and food casings. National aggregate production volumes reported in more recent years, 2016–2019, for carbon disulfide were between 250 million and <500 million pounds annually (~113,000–<227,000 metric tons) for 10 reporting companies (3M [two locations]; Arkema Delaware Inc. [two locations]; Chemtrade Holdco US Inc.; Equilon Enterprises LLC; Nouryon Chemicals LLC; Nouryon Functional Chemicals LLC; Tessenderlo Kerley, Inc; Viscofan USA); more precise information is not available based on confidential business information (CBI) (EPA 2022c).

Table 5-1 summarizes information on companies that reported the production, import, or use of carbon disulfide for the Toxics Release Inventory (TRI) in 2023 (TRI23 2025). TRI data should be used with caution since only certain types of industrial facilities are required to report. This is not an exhaustive list.

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AL	5	100	49,999,999	1, 3, 4, 5, 6, 12, 13
AR	2	10,000	999,999	1, 2, 3, 5, 9, 10, 12
CA	12	0	999,999	1, 3, 5, 6, 12, 13, 14
CT	1	10,000	99,999	6
DE	1	1,000,000	9,999,999	1, 3, 6
FL	1	0	99	1, 13
GA	1	100,000	999,999	6
ID	1	1,000,000	9,999,999	2, 3, 6
IL	8	0	9,999,999	1, 3, 5, 6, 12, 13, 14
IN	3	0	9,999	1, 5, 7, 12, 13, 14
KS	5	0 (or N/A)	999,999 (or N/A)	1, 5, 10, 14

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
KY	3	100 (or N/A)	999,999 (or N/A)	1, 5, 6, 14
LA	17	0	9,999,999	1, 3, 5, 6, 12, 13, 14
MI	1	1,000	9,999	1, 5
MN	2	0	9,999	1, 2, 3, 5, 6, 9, 10, 13
MO	2	100,000	999,999	6, 12
MS	1	100	999	1, 5, 6
MT	1	0	99	1, 6, 13, 14
ND	3	0	999,999	1, 5, 13
NJ	1	0	99	12
NM	1	0	99	1, 5
NY	2	1,000	999,999	1, 3, 5, 6, 12
OH	10	0 (or N/A)	99,999 (or N/A)	1, 5, 6, 12, 14
OK	6	0 (or N/A)	999,999 (or N/A)	1, 5, 7, 8, 14
PA	3	10,000	999,999	1, 5, 10, 13
TN	4	1,000 (or N/A)	999,999 (or N/A)	1, 5, 6, 10
TX	34	0 (or N/A)	9,999,999 (or N/A)	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14
UT	3	0	9,999	1, 3, 5, 6, 7, 14
WA	4	0	9,999,999	1, 2, 3, 5, 6, 13, 14
WY	1	1,000	9,999	1, 5, 6

[a] Post office state abbreviations used.

[b] Amounts on site reported by facilities in each state. Facilities may report N/A (not applicable) instead of a numeric value "if the waste stream that contains or contained the EPCRA Section 313 chemical is not directed to the relevant environmental medium, or if leaks, spills, and fugitive emissions cannot occur" (EPA 2022d).

[c] Activities/uses:

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

Note: Facilities that report N/A for amounts on site do not report activities/uses.

EPCRA = Emergency Planning and Community Right-to-Know Act

Source: TRI23 2025 (Data are from 2023)

5.2.2 Import/Export

Viscofan USA Inc. and Chemtrade Holdco US Inc. reported that approximately 3 and 1 million pounds of carbon disulfide were imported in 2018, and 2019, respectively (EPA 2022c). Five other manufacturers declared this information as CBI and three manufacturers declared no imports. Between 2019 and 2024, the top importers of carbon disulfide to the United States were Canada (approximately 1–2 million pounds), Indonesia (approximately 0–500 thousand pounds), and Germany (approximately 0–55 thousand pounds) (USITC 2024). Nine of the domestic chemical companies reporting to the CDR declared zero exports or that information as CBI in 2019. Nouryon Functional Chemicals LLC reported exports of 41 million pounds of carbon disulfide for 2019 (EPA 2022c). Between 2019 and 2024, the highest exports of carbon disulfide from the United States were to Columbia (approximately 36–54 million pounds), Mexico (approximately 1–10 million pounds), and Peru (approximately 0–6 million pounds) (USITC 2024).

5.2.3 Use

Carbon disulfide has been an important industrial chemical since the 1800s because of its many useful properties, including its ability to solubilize fats, rubbers, phosphorus, sulfur, and other elements (Sine 1989; Timmerman 1978; Windholz 1983). Because of its ability to dissolve phosphorus, it was once widely used to produce matches but was later replaced by another chemical. Carbon disulfide's fat solvent properties also made it indispensable in preparing fats, lacquers, and camphor; refining petroleum jelly and paraffin; and extracting oil from bones, palm stones, olives, and rags. It was also used in processing India rubber sap from tropical trees. In all these extraction processes, however, carbon disulfide has been replaced by other solvents (Davidson and Feinleib 1972).

Its fat, rubber, and metal solvent properties have made carbon disulfide highly suitable for a variety of other continuing industrial applications including the following: vulcanization and manufacture of rubber and rubber accessories; production of resins, xanthates, thiocyanates, plywood adhesives, and flotation agents; solvent and spinning-solution applications primarily in the manufacture of rayon; polymerization inhibition of vinyl chloride; conversion and processing of hydrocarbons; petroleum-well cleaning; brightening of precious metals in electroplating; thin film deposition of nickel; as an agent to increase corrosion and wear-resistance in metals; rust removal from metals; and removal and recovery of metals and other elements from wastewater and other media (Davidson and Feinleib 1972; EPA 1978; Sine 1989; WHO 1981; Windholz 1983). It has also been used in industry as a means to promote sulfation in the synthesis of rare earth sulfides used in semiconductors, as a regenerator for transition metal sulfide catalysts, as a development restrainer in photography and lithography, and as a solvent to remove printing on recycled plastics (Timmerman 1978).

Carbon disulfide's most important industrial use has been in the manufacture of regenerated cellulose rayon by the viscose process (viscose rayon) (Davidson and Feinleib 1972; EPA 1978; NIOSH 1977; Timmerman 1978; WHO 1981). Historically in the United States, the approximate end uses of carbon disulfide were rayon production (44%); agriculture and other chemicals (35%); rubber chemicals (18%); and cellophane and other regenerated cellulosics such as sponges (3%) (Smith and Timmerman 2003). Currently, there are no operating manufacturers of rayon in the United States, although other regenerated cellulose products are still produced (EPA 2011). More recent end use data were not available. Carbon disulfide is also used in the production in dithiocarbamate pesticides (Campanale et al. 2023; Lay et al. 2012).

Another historic industrial use for carbon disulfide has been as a feedstock for carbon tetrachloride production (NIOSH 1977; Timmerman 1978). While only 10% of U.S. carbon disulfide production was used to produce carbon tetrachloride in 1960, this increased to 32% in 1974, largely because of a rapid increase in the demand for carbon tetrachloride for the production of fluorocarbon propellants and refrigerants (Timmerman 1978). Environmental and toxicity concerns related to the manufacture and use of carbon tetrachloride have led to a decrease in demand for carbon disulfide for this purpose. In 1991, the last remaining carbon tetrachloride plant in the United States that employed the carbon disulfide synthetic route was closed permanently (Smith and Timmerman 2003).

In agriculture, carbon disulfide was previously used as a fumigant to control insects in stored grain, normally mixed with carbon tetrachloride to reduce the fire hazard (Sine 1989; Worthing 1987). It was also previously used to remove botfly larva infestations from the stomachs of horses and ectoparasites from swine (Rossoff 1974). However, use of carbon disulfide as a grain fumigant was voluntarily cancelled after 1985 (EPA 1985). Carbon disulfide is not currently registered for use as a pesticide in the United States (EPA 2023a).

An intensive specialty use is to desorb charcoal sampling tubes in National Institute for Occupational Safety and Health (NIOSH) methods for airborne organics (NIOSH 1984b). Carbon disulfide is used extensively in research laboratory chemical synthetics methods (Dunn and Rudorf 1989).

5.2.4 Disposal

Carbon disulfide is a very flammable liquid that burns to produce carbon dioxide and sulfur dioxide. Therefore, it is a good candidate for controlled incineration, provided that a sulfur dioxide scrubber is used. Some methods proposed by the EPA (1981b) include liquid injection incineration at a temperature range of 650–1,600°C, rotary kiln incineration at a temperature range of 820–1,600°C, and fluidized bed incineration at a temperature range of 450–980°C. Adsorption to activated coal with hydrogen sulfide in the absence of free oxygen yields a process that can regenerate large percentages of sulfur for reuse (UNEP 1985). It is not recommended that landfills be used as a disposal method because of the high flammability of this compound (UNEP 1985). No information was found on quantities and locations of disposal. The EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guideline for reportable quantities is 100 pounds (EPA 2022a).

5.3 RELEASES TO THE ENVIRONMENT

The Toxics Release Inventory (TRI) data should be used with caution because only certain types of facilities are required to report (EPA 2022d). 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's North American Industry Classification System (NAICS) codes is covered under EPCRA Section 313 or is a federal facility; and if their facility manufactures (defined to include importing) or processes any TRI chemical in excess of 25,000 pounds, or otherwise uses any TRI chemical in excess of 10,000 pounds, in a calendar year (EPA 2022d).

5.3.1 Air

Estimated releases of 7,205,362 pounds (~3,268 metric tons) of carbon disulfide to the atmosphere from 137 domestic manufacturing and processing facilities in 2023, accounted for about 97% of the estimated total environmental releases from facilities required to report to the TRI (TRI23 2025). These releases are summarized in Table 5-2.

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

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
AL	5	55,126	22	0[l]	1	0	55,148	1	55,149
AR	2	1,345,784	393	0	0	0	1,346,177	0	1,346,177

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

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
CA	11	12,663	917	0	3,011	110	12,665	4,036	16,701
CT	1	718	0	0	0	0	718	0	718
DE	1	1,386	0	0	0	0	1,386	0	1,386
FL	1	330	0	0	0	0	330	0	330
GA	1	1,084	0	0	0	0	1,084	0	1,084
ID	1	970	0	0	0	0	970	0	970
IL	8	2,461,661	114,027	0	4	0	2,461,672	114,020	2,575,692
IN	3	3,996	0	0	1	0	3,996	1	3,997
KS	4	717,846	18,754	0	0	0	736,600	0	736,600
KY	3	1,037	0	0	0	0	1,037	0	1,037
LA	17	318,244	88	0	6	0	318,332	6	318,338
MI	1	62	3	0	0	7	62	10	72
MN	2	935	0	0	0	0	935	0	935
MO	2	367	191	0	0	0	367	191	558
MS	1	1,970	50	0	56	0	2,020	56	2,076
MT	1	1,230	0	0	0	0	1,230	0	1,230
ND	2	3,369	6	6	0	0	3,381	0	3,381
NJ	1	10	0	0	0	5	10	5	15
NM	1	2,500	0	1	0	0	2,501	0	2,501
NY	2	293,009	591	0	445	0	293,011	1,033	294,045
OH	10	24,769	3	0	0	0	24,769	3	24,772
OK	6	11,629	255	3,500	0	0	11,884	3,500	15,385
PA	3	75,454	0	0	0	0	75,454	0	75,454
TN	4	1,760,076	99,000	0	0	0	1,760,076	99,000	1,859,076
TX	35	102,415	6	980	2	0	103,402	2	103,404
UT	3	730	15	0	12	0	730	27	757
WA	4	5,680	14	0	0	0	5,694	0	5,694

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

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
WY	1	311	0	0	0	0	311	0	311
Total	137	7,205,362	234,335	4,488	3,539	122	7,225,954	221,892	7,447,846

[a] The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.

[b] Data in TRI are maximum amounts released by each facility.

[c] Post office state abbreviations are used.

[d] Number of reporting facilities.

[e] The sum of fugitive and point source releases are included in releases to air by a given facility.

[f] Surface water discharges, wastewater treatment (metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).

[g] Class I wells, Class II-V wells, and underground injection.

[h] Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.

[i] Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown.

[j] The sum of all releases of the chemical to air, land, water, and underground injection wells.

[k] Total amount of chemical transferred off-site, including to POTWs.

[l] Due to reporting guidelines, a zero may represent that the facility or facilities in each state's row reported "0," and "NA," or left the cell blank in their Form R submission.

RF = reporting facilities; UI = underground injection

Source: TRI23 2025 (Data are from 2023)

EPA's National Emission Inventory (NEI) database contains information regarding sources that emit criteria air pollutants (CAPs) and their precursors, and hazardous air pollutants (HAPs) for the 50 United States, Washington DC, Puerto Rico, and the U.S. Virgin Islands. Emissions are estimated from multiple sources, including state and local environmental agencies; the TRI database; computer models for on- and off-road emissions; and databases related to EPA's Maximum Achievable Control Technology (MACT) programs to reduce emissions of HAPs. Carbon disulfide emissions estimated from the 2020 inventory are summarized in Table 5-3 (EPA 2020).

Table 5-3. Carbon Disulfide Emissions to the Air Based on 2020 National Emissions Inventory

Emission sector	Pounds emitted
Industrial processes; chemical manufacturing	4,034,570
Industrial processes; NEC	3,887,846

Table 5-3. Carbon Disulfide Emissions to the Air Based on 2020 National Emissions Inventory

Emission sector	Pounds emitted
Agriculture; livestock waste	277,299
Industrial processes; pulp and paper	152,282
Industrial processes; petroleum refineries	120,376
Waste disposal	60,573
Industrial processes; storage and transfer	57,204
Fuel combustion; industrial boilers, ICEs; natural gas	35,000
Industrial processes; non-ferrous metals	30,530
Fuel combustion; industrial boilers, ICEs; other	20,737
Industrial processes; cement manufacture	18,937
Fuel combustion; electric generation; coal	13,958
Solvent; industrial surface coating and solvent use	9,718
Fuel combustion; industrial boilers, ICEs; biomass	4,532
Fuel combustion; industrial boilers, ICEs; coal	3,449
Industrial processes - ferrous metals	1,510
Fuel combustion; electric generation; natural gas	570
Fuel combustion; commercial/institutional; biomass	383
Fuel combustion; electric generation - other	348
Fuel combustion; commercial/institutional; other	89
Fuel combustion; electric generation; biomass	80
Industrial processes; oil and gas production	79
Fuel combustion; industrial boilers, ICEs; oil	33
Solvent - degreasing	31
Fuel combustion; comm/institutional; coal	13
Bulk gasoline terminals	11
Fuel combustion; commercial/institutional; natural gas	4
Industrial processes - mining	1
Gas stations	1

ICE = internal combustion engine; NEC = not elsewhere classified

Source: EPA 2020

The largest single source of anthropogenic release of carbon disulfide has been in the viscose rayon industry. Zumkehr et al. (2017) reported emissions of carbon disulfide from rayon production as 23±12 Gg S per year (gigagrams sulfur per year). However, additional anthropogenic sources of carbon disulfide release have been reported. Small amounts of carbon disulfide have also been detected in a landfill simulator (Vogt and Walsh 1985) and in the odoriferous emissions from a sewage treatment plant (Ruby et al. 1987). Carbon disulfide emissions were measured in the combustion of 15 barbeque charcoal products from five countries (6 in Korea, 4 in China, 3 in Indonesia, 1 in Malaysia, and 1 in the United States) at rates of 0.22–125 μg/m^3 (mean of 12 μg/m^3); the highest level was measured in Korean products while the lowest level was measured in the product from the United States (Mahmudur Rahman and Kim 2012).

Additional sources of anthropogenic releases of carbon disulfide may include environmental breakdown of dithiocarbamate pesticides in the environment (Campanale et al. 2023). For example, usage of metab potassium, dazomet, and thiram in the United States in 2018 were approximately 50 million tons, <1 million tons, and <0.2 million tons, respectively (USGS 2018a, 2018b, 2018c). However, no estimates of the amount of carbon disulfide released into the atmosphere from these pesticide usages were available.

Carbon disulfide was one of seven sulfur-gas emission rates assessed from problem drywall installed in U.S. homes (LBNL 2011). Historically, carbon disulfide was used in the processing of rubber, but changing technology made the old practices outmoded. Nevertheless, carbon disulfide was measured as 6.88, 3.37, 29.72, and 1.69% of the volatile emissions in mixing, shaping, vulcanization, and storage, respectively, in the production of rubber products (Huang et al. 2022). Automotive tire wear has been suggested as a potential source of atmospheric carbon disulfide. The emission of carbon disulfide from pyrolysis of scrap tires decreased with increasing temperature (650–1,050°C) and decreased with an increase in oxygen supply (Fullana et al. 2000).

Emissions of carbon disulfide in aerobic and anaerobic/aerobic composting were measured as 0.4 and <0.1 g/ton of compost, respectively (Smet et al. 1999). Degradation occurring in a wastewater treatment plant (WWTP) also contributes to carbon disulfide emissions; an emission factor of 17±5 μg/ton wastewater was determined from a full-scale sequencing batch reactor WWTP (Li et al. 2021b).

There are several known natural sources of carbon disulfide, including wetlands (Hines et al. 1993), oceans (Chin and Davis 1993), plant roots (Piluk et al. 1998), and microbial activity in soils (Banwart and Bremner 1975; Kanda et al. 1995). The emission rate estimated for microbial degradation of algae in a eutrophic lake was 0.35 mg/$m^2 \cdot$day (Wang et al. 2023). Estimates from the 1980s suggested that natural sources of carbon disulfide were 4–5 times greater than anthropogenic releases; however, later modeling results suggest that the major source of carbon disulfide derives from industrial emissions (58%), while the oceans contribute about 34%, and the remainder comes from terrestrial sources (EC/HC 2000). Lennartz et al. (2021) produced monthly resolved modelled oceanic emissions of carbonyl sulfide and carbon disulfide over the period of 2000–2019, reported in terms of their sulfur content. Maximum monthly mean concentrations of carbon disulfide were shown to vary the most in the summer months in the northern temperate regions (23–66°N) from 4.3 Gg S per month (gigagrams sulfur per month) in June 2011 and 6.0 Gg S per month in June 2018 but show less variability in the winter months (e.g., between 0.8 and 1.2 Gg S per month in December). An average flux of 0.068±0.068 μmol/m$^2\cdot$day was estimated in sampled areas in the Western Pacific Ocean (Xu et al. 2023).

During analytical measurements of sulfur compounds at five wetland areas in Florida, carbon disulfide was often not detected, while large amounts of dimethylsulfide were found (Cooper et al. 1987). However, low levels of carbon disulfide were consistently detected in samples collected from the same area using a slightly modified procedure (Hines et al. 1993). Based on their measurements and assumptions in the study of sulfur emissions from a North Carolina salt marsh, Aneja et al. (1980) estimated that carbon disulfide produced by marshes (0.022 g sulfur/m^2 per year) contributes <0.07% of biogenic sulfur and <8% to the stratospheric aerosol layer. DeMello et al. (1987) speculated that carbon disulfide generation from coastal areas in Florida was related to the concentration of organic matter in the sediment. Staubes et al. (1987) found that humic soils were stronger sources for biogenic sulfur than soils with lower organic content; however, a low humic content coupled with high moisture favors the production of carbon disulfide over dimethylsulfide.

5.3.2 Water

Estimated releases of 234,335 pounds (~106 metric tons) of carbon disulfide to surface water from 137 domestic manufacturing and processing facilities in 2023, accounted for about 3.2% of the estimated total environmental releases from facilities required to report to the TRI (TRI23 2025). This estimate includes releases to wastewater treatment and publicly owned treatment works (POTWs) (TRI23 2025). These releases are summarized in Table 5-2.

Carbon disulfide is widely found in coastal and ocean waters and extensive study has been done to determine levels over the different types of water bodies. In ocean surface water, carbon disulfide may be produced through photochemical reactions with dissolved organic matter during daylight conditions and through abiotic reactions involving sulfur radicals and microbial processes during nighttime conditions (Xu et al. 2024a, 2024b). Photochemical production rates in surface seawater of the Bay of Bengal and the East Indian Ocean were 2.77±0.231 ng/L·day ($3.64\text{x}10^{-2}\pm3.03\text{x}10^{-3}$ nmol/L·day) and 1.32±0.526 ng/L·day ($1.74\text{x}10^{-2}\pm6.91\text{x}10^{-3}$ nmol/L·day), respectively (Xu et al. 2024a). In the West North Pacific Ocean, the production rate was 1.91±0.0.349 ng/L·day ($2.51\text{x}10^{-2}\pm4.58\text{x}10^{-3}$ nmol/L·day) (Xu et al.

2024b). Estimated rates of dark/biological production of carbon disulfide in surface water were 0.190±0.0193 ng/L·day ($2.50x10^{-3}$±$2.53x10^{-4}$ nmol/L·day) in the Bay of Bengal, 0.065±0.0258 ng/L·day ($8.52x10^{-4}$±$3.39x10^{-4}$ nmol/L·day) in the East Indian Ocean, and 0.102±0.0.0792 ng/L·day ($1.34x10^{-3}$±$1.04x10^{-3}$ nmol/L·day) in the West North Pacific Ocean (Xu et al. 2024a, Xu et al. 2024b). Carbon disulfide has also been detected in the vent fluids and sediment surface waters of undersea hydrothermal sites (Marchand et al. 1994).

Lennartz et al. (2021) estimated the globally integrated annual emissions of carbonyl sulfide and carbon disulfide from the world's oceans from 2000 to 2019, reported in terms of their sulfur content. The results for carbon disulfide are shown in Table 5-4.

Table 5-4. Global Annual Emissions of Carbon Disulfide from Oceans

Year	Emissions (Gg S)[a]
2000	160.8
2001	160.0
2002	161.2
2003	160.3
2004	172.0
2005	169.1
2006	175.3
2007	173.4
2008	175.0
2009	179.7
2010	189.2
2011	179.5
2012	181.2
2013	181.3
2014	170.1
2015	175.0
2016	181.5
2017	189.7
2018	187.8
2019	177.3
Mean (standard deviation)	174.97 (9.3)

[a] Carbon disulfide emissions were reported in terms of their sulfur content (Gg S). 1 Gg (Gigagram) =1,000 metric tons.

Source: Lennartz et al. 2021

5.3.3 Soil

Estimated releases of 3,539 pounds (~1.6 metric tons) of carbon disulfide to soil from 137 domestic manufacturing and processing facilities in 2023, accounted for <1% of the estimated total environmental releases from facilities required to report to the TRI (TRI23 2025). An additional 4,488 pounds (~2.0 metric tons), constituting <1% of the total environmental emissions, were released via underground injection (TRI23 2025). These releases are summarized in Table 5-2.

Emissions of carbon disulfide from soil and plant material occurs naturally due to the metabolism of organic substances from soil bacteria and plants during the growing season (EC/HC 2000). Increases in soil moisture, temperature, organic content, and light increase the rate of carbon disulfide production from soil. The Canadian government estimated that 35,000 metric tons of carbon disulfide are released to the Canadian environment from its production in soil (EC/HC 2000). Fain et al. (1987) reported 0.9 mg/L carbon disulfide (dry weight basis) in a typical refinery oily waste applied to a land treatment unit.

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

Air. Releases of carbon disulfide to the environment as a result of industrial activity are expected to be primarily to the atmosphere. Any carbon disulfide released to surface waters in effluent streams is expected to partition rapidly to the atmosphere as a result of the high ratio of vapor pressure to the solubility (Henry's law constant=1.33×10^{-2} atm m^3/mol) of the compound. Hydrolysis is not a significant removal mechanism since the evaporation half-life from a saturated solution is estimated to be 11 minutes (EPA 1978).

Water. Although no information was found evaluating the partitioning of carbon disulfide from water onto sediments, it is not expected to be removed significantly from the aquatic phase through adsorption. The low K_{oc} value, determined from a log K_{ow} of 1.94 and a regression-derived equation, is 48 (EPA 2012). This indicates high soil mobility, but carbon disulfide will probably be less mobile in soils of high organic content.

Sediment and Soil. Although Roy and Griffin (1985) did not conduct adsorption studies, they classified carbon disulfide as a mobile solvent exhibiting a low tendency to be retained by soils. Carbon disulfide released to soils in spills should rapidly volatilize to the atmosphere, but a portion of the compound remaining on soil surfaces could be available for transport into groundwater since it does not have much affinity for soil particles. Farwell et al. (1979) indicated that carbon disulfide volatilizes from a variety of soils, although rates were not provided.

Other Media. The bioconcentration of carbon disulfide was measured in carp (*Cyprinus carpio*); at starting concentrations of 50 and 5 μg/L, the respective bioconcentration factors (BCFs) were <6.1 and <60 (J-CHECK 2025a). Estimated BCF and bioaccumulation factors were 8.9 and 6.6, respectively (EPA 2012). These values indicate that carbon disulfide is not expected to bioaccumulate in aquatic organisms.

5.4.2 Transformation and Degradation

Air. Carbon disulfide reacts with hydroxyl radicals in the troposphere to produce carbonyl sulfide. The lifetime of carbon disulfide in the troposphere, assuming a reaction rate constant of 4.3×10^{-13} cm^3/molecule-second, is 73 days (Cox and Sheppard 1980). The half-life for this same reaction is estimated to be 5.5 days, calculated from an experimental rate constant of 2.9×10^{-12} cm^3/molecule-second (Arnts et al. 1989).

The photo-oxidation products of carbon disulfide in the laboratory were identified as carbon monoxide, carbonyl sulfide, sulfur dioxide, and a polymer that adhered to the sides of the reaction vessel (Heicklen et al. 1971). Although carbon disulfide absorbs light at wavelengths of 280–350 nm, dissociation does not occur under environmental conditions because of low molar absorptivity (Atkinson et al. 1978; Wood and Heicklen 1971) and direct photolysis of carbon disulfide in the atmosphere does not appear to be significant. EPA (1978) stated that the information available indicated that carbon disulfide is relatively persistent in the atmosphere. For the atmospheric oxidation of carbon disulfide to sulfur dioxide, carbonyl sulfide, and carbon monoxide, the half-life was estimated to be about 12 days.

According to Wine et al. (1981), electronically excited carbon disulfide is rapidly produced in the troposphere from absorption of solar photons. This excited carbon disulfide reacts with oxygen on a time scale of 1–2 weeks to yield carbony1 sulfide, the predominant sulfur-containing compound in the troposphere.

The lifetime of carbon disulfide in the atmosphere has been estimated to be 12 days, too short a time to reach the stratosphere. Removal was suggested to occur by a hydroxyl radical reaction or an oxygen atom reaction, but not by dissociation (Khalil and Rasmussen 1984).

Based on the estimates of a lifetime in the troposphere for carbon disulfide on the order of weeks and the troposphere to stratosphere turnover time on the order of years, very little tropospheric carbon disulfide is expected to be transported to the stratosphere (EPA 1986).

Water. Carbon disulfide is stable to hydrolysis in the pH region of environmental concern (pH 4–10). At pH 13, carbon disulfide has a hydrolysis half-life at of about 1 hour at 25°C; by extrapolation, at pH 9, carbon disulfide has a half-life of 1.1 years (EPA 1978). In oxygenated seawater, carbon disulfide was found to be stable for >10 days (Lovelock 1974). The volatilization half-life from a saturated water solution has been estimated to be 11 minutes (EPA 1978). Based on data from the East Indian Ocean and the Bay of Bengal, removal timeframes of 3–7 days were determined for carbon disulfide in surface water; variation in removal was related to seawater temperature and dissolved oxygen concentrations (Xu et al. 2024a). The compound apparently does not undergo biodegradation at rates that are competitive with its volatilization from surface waters. In a biodegradation study with 30 mg/L sludge and 100 mg/L carbon disulfide, only 2% of degradation measured by gas chromatography analysis was observed after 28 days (J-CHECK 2025b).

Sediment and Soil. No data were found in the available literature on the biodegradation of carbon disulfide in soil. However, since the chemical is rapidly volatilized (high Henry's law constant) and probably highly mobile in soil (low K_{oc}), it is unlikely that it remains in the soil long enough to be significantly biodegraded.

Microbial degradation of large amounts of carbon disulfide in soil would not be expected to be significant since this compound is a soil disinfectant and toxic to bacteria. Hydrolysis of carbon disulfide on wet soil surfaces is also unlikely (EPA 1986). Oxidation of carbon disulfide by a *Thiobacillus* species isolated from soil has been observed (Plas et al. 1993).

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to carbon disulfide depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens.

Concentrations of carbon disulfide 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 carbon disulfide levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable.

Table 5-5 shows the lowest limit of detections that are achieved by analytical analysis in environmental media. An overview summary of the range of concentrations detected in environmental media is presented in Table 5-6.

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

Media	Detection limit[a,b]	Reference
Air	0.01–0.5 ppbv (0.03-1.6 μg/m^3)	EPA 2024a
Drinking water	0.026 μg/L	NEMI 2023
Surface water and groundwater	0.026 μg/L	NEMI 2023
Soil	87 μg/kg	WQP 2025
Sediment	0.96 μg/kg	WQP (2025)
Urine[c]	11.2 μg/L	CDC (2022)

[a] Detection limits based on using appropriate preparation and analytics. These limits may not be possible in all situations.

[b] Unit conversion: ppb = μg/L (aqueous); = μg/kg (sediment and soil); ppbv = 24.45 concentration μg/m^3/76.14 g/mol (air).

[c] Metabolite: 2-thiothiazolidine-4-carboxylic acid (TTCA).

Table 5-6. Summary of Environmental Levels of Carbon Disulfide[a]

Media	Low	High	For more information
Outdoor air	0.002 ppbv (0.007 μg/m^3)	22 ppbv (68.5 μg/m^3)	Section 5.5.1
Indoor air, nonoccupational	0.005 ppbv (0.015 μg/m^3)	1.06 ppbv (3.29 μg/m^3)	Section 5.5.1
Surface water (μg/L	0.0125	0.99	Section 5.5.2
Groundwater (μg/L)	0.062	60	Section 5.5.2
Soil (μg/kg)	–	–	Section 5.5.3
Sediment (μg/kg)	1.6	32.9	Section 5.5.3

[a] Unit conversion: ppb = μg/L (aqueous); = μg/kg (sediment and soil); ppbv = 24.45 concentration μg/m^3/76.14 g/mol (air). Summary values represent most recent ambient data available. Ranges do not reflect values below the limit of detection.

Detections of carbon disulfide in air, water, and soil at NPL sites are summarized in Table 5-7.

Table 5-7. Carbon Disulfide Levels in Water, Soil, and Air of National Priorities List (NPL) Sites

Medium	Median[a]	Geometric mean[a]	Geometric standard deviation[a]	Number of quantitative measurements	NPL sites
Water (μg/L)	19	29.3	65.7	37	26
Soil (μg/kg)	21.5	30.8	23.6	30	23
Air (ppbv)	2.81	4.92	10.4	17	12

[a] Concentrations found in ATSDR site documents from 1981 to 2022 for 1,868 NPL sites (ATSDR 2022). Maximum concentrations were abstracted for types of environmental media for which exposure is likely. Pathways do not necessarily involve exposure or levels of concern.

5.5.1 Air

Data for 2019–2024 obtained from EPA's Air Quality System (AQS) database are presented in Table 5-8 (EPA 2024a). Median air concentrations reported in the AQS between 2019 and 2024 were 0.1–0.3 μg/m^3 (0.03–0.09 ppbv), and maximum values were 12.1–68.5 μg/m^3 (3.9–22 ppbv). Logue et al. (2010, 2011) studied air pollutant concentrations at four sites in Pennsylvania from 2006 to 2008 and found carbon disulfide arithmetic mean concentrations of 0.07–0.14 μg/m^3 (0.02–0.045 ppbv); 81% of the samples did not contain carbon disulfide. Carbon disulfide contributed 4.2% of volatile organic compounds (VOCs) measured in the atmosphere at one of five urban sites in Texas (Conley et al. 2005). Analysis of outdoor air at 74 residential homes in Ottawa Canada during 2002–2003 found carbon disulfide in 22% of all samples at a concentration range of 0.015–0.38 μg/m^3 (0.0048–0.12 ppbv) and an arithmetic mean of 0.04 μg/m^3 (0.01 ppbv) (Zhu et al. 2005). The estimated global background level of carbon disulfide has been reported as 1.2 μg/m^3 (0.38 ppbv) (Rosenbaum et al. 1999). Fresh and aged smoke from western U.S. wildfires contained low levels of carbon disulfide (<0.01 μg/m^3) (O'Dell et al. 2020). A summary of the available outdoor air monitoring data is presented in Table 5-9.

Table 5-8. Percentile Distribution of Annual Mean Carbon Disulfide Concentrations (µg/m^3) Measured in Ambient Air at Locations Across the United States[a,b]

Year	Number of U.S. locations	10th	50th	75th	95th	Maximum
2019	77	0.039	0.189	0.868	1.65	35.2
2020	67	0.046	0.123	0.236	0.874	68.5
2021	71	0.007	0.052	0.203	0.691	50.4
2022	70	0	0.089	0.281	0.984	12.1
2023	54	0	0.130	0.328	1.29	38.3
2024[c]	46	0.206	0.318	0.405	0.696	17.4

[a] Values were originally reported in parts per billion carbon (ppbC) and converted to µg/m^3.
[b] 24-hour sampling period.
[c] As of November 19, 2024.

Source: EPA 2024a

Table 5-9. Outdoor Air Monitoring Data for Carbon Disulfide

Location	Geographic type	Date(s)	Range (µg/m^3)	Mean (µg/m^3)	Notes	Reference
Four sites near Pittsburgh, Pennsylvania	Urban, industrial	2006–2008	–	0.07–0.14 (arithmetic mean)	n=56; 19% detection frequency	Logue et al. 2010, 2011
Ottawa, Canada	Residential	2002–2003	0.015–0.38	0.04 (arithmetic mean)	n=74; 22% detection frequency	Zhu et al. 2005
Western United States	Wildfire smoke plume	July–August 2018	–	ND (median, <1 to >3-day-old smoke)	n=902; 73% detection frequency (fresh smoke, <1 day old), 27% detection frequency (aged smoke, >3 days old)	O'Dell et al. 2020
East Palestine, Ohio	Hazardous waste train derailment site	March–November 2023	2.10–2.20	2.30	n=2,146; 0.1% detection frequency	EPA 2024b

ND = not detected

In a study of indoor air in suburban and rural homes in New Jersey between December 2003 and April 2006, carbon disulfide was detected in 3 of 100 samples at a 95th percentile of <1.6 µg/m^3 and maximum of 4.4 µg/m^3 (1.4 ppbv) (Weisel et al. 2008). Analysis of indoor air at 75 residential homes in Ottawa

Canada during 2002–2003 detected carbon disulfide in 67% of all samples at a concentration range of 0.015–3.29 μg/m^3 (0.0048–1.05 ppbv) and an arithmetic mean of 0.34 μg/m^3 (0.11 ppbv) (Zhu et al. 2005). Carbon disulfide has been detected in the air inside passenger cars and buses (Besis et al. 2023). A summary of the available indoor air monitoring data is presented in Table 5-10.

Table 5-10. Indoor Air Monitoring Data for Carbon Disulfide

Location	Geographic type	Date(s)	Range (μg/m^3)	Mean (μg/m^3)	Notes	Reference
13 counties across New Jersey	Suburban and rural residences	December 2003–April 2006	<1.6–4.4	–	n=100; 3% detection frequency	Weisel et al. 2008
Ottawa, Canada	Residential	2002–2003	0.015–3.29	0.34 (arithmetic mean)	n=75; 67% detection frequency	Zhu et al. 2005

ND = not detected

Air levels of carbon disulfide in occupational exposure settings are much higher than ambient exposure levels. Historical occupational exposure levels in viscose rayon factories were typically >10 ppm (Wägar et al. 1981), with brief exposures as high as 254.4 ppm reported for specific jobs (Liss and Finkelstein 1996). However, improvements in working conditions, processes, and other technical improvements have reduced occupational air levels. For example, occupational exposure to carbon disulfide in a viscose rayon factory was reduced by nearly 50% between 1992 and 2009, with median (95th percentile) exposure levels of 4.15 (12.5) ppm in 1992 and 2.48 (6.74) ppm in 2009 (Göen et al. 2014). Additional exposure level details for different departments in this factory can be found in Section 5.7.

In a similar study, Bulat et al. (2002) measured carbon disulfide air concentrations before and after technical improvements in a viscose rayon factory. Exposure was reduced up to 95% for employees with the highest initial exposure levels (see Table 5-11).

Table 5-11. Personal Air Exposure Measurements by Job Type Before and After Technical Improvements[a]

Job title	Viscose preparator	Spinner	First spinner
Before improvement, inside mask[b]	14.7 (9.2–20.2) mg/m^3 4.72 (2.9–6.49) ppm	NR	NR
Before improvement, outside mask[c]	90.2 (62.8–139.5) mg/m^3 28.0 (20.2–44.8) ppm	111.5 (93.8–132.6) mg/m^3 35.8 (30.1–42.58) ppm	100.9 (75.3–185.3) mg/m^3 32.4 (24.2–59.5) ppm

Table 5-11. Personal Air Exposure Measurements by Job Type Before and After Technical Improvements[a]

Job title	Viscose preparator	Spinner	First spinner
After improvement, inside mask	10.1 (6.0–17.0) mg/m^3 3.24 (1.93–5.46) ppm	5.4 (3.95–7.37) mg/m^3 1.7 (1.28–2.37) ppm	6.3 (3.3–11.9) mg/m^3 2.0 (1.1–3.82) ppm
After improvement, outside mask	20.8 (1.3–34.44) mg/m^3 6.68 (0.42–11.06) ppm	8.11 (5.71–11.53) mg/m^3 2.6 (1.83–3.7) ppm	40.27[d] mg/m^3 12.93 ppm

[a] Geometric means and 95% confidence intervals. Unit conversion: ppm = 24.45 concentration mg/m^3/76.14 g/mol.
[b] Air measurements were sampled from inside the respirator via flexible tubing fitted through the facemask and affixed to workers face with adhesive tape.
[c] Air measurements were sampled outside the mask via tubes fixed on either the shoulder or collar of the worker.
[d] Only one measurement available.

NR = not reported

Source: Bulat et al. 2002

Limited data regarding the presence of carbon disulfide at hazardous waste sites were located. On February 3, 2023, a freight train carrying hazardous materials derailed in East Palestine, Ohio. Some of the cars caught fire, while others spilled their loads into an adjacent stream. In air samples collected at the train derailment site between March and November 2023, carbon disulfide was reported at 0.706, 0.867, and 0.674 ppb (2.20, 2.70, and 2.10 μg/m^3) in three samples collected at various points of the year (EPA 2024b). Carbon disulfide was below the reporting limits (ranging from 0.514 to 1.64 ppb [1.60–5.10 μg/m^3]) in the remaining samples.

5.5.2 Water

Carbon disulfide has been detected at <1–160 μg/L in surface water, groundwater, and oceans. Reported concentrations are typically higher in groundwater due to the volatility of carbon disulfide. Summaries of the available surface and groundwater monitoring data are reported in Tables 5-12 and 5-13. Municipal drinking water monitoring data were not located.

Table 5-12. Carbon Disulfide Concentrations in Surface Water

Location	Date(s)	Range (μg/L)	Mean (μg/L)	Notes	Reference
Global oceans	–	8.4×10^{-5}–0.029	0.0012	n=1,813	Lennartz et al. 2020
Global oceans	–	–	0.0014	–	Lennartz et al. 2021

Table 5-12. Carbon Disulfide Concentrations in Surface Water

Location	Date(s)	Range (µg/L)	Mean (µg/L)	Notes	Reference
34 urban/ agricultural impacted streams and 4 undeveloped sites across 24 states and Puerto Rico	November 2012–June 2014	0.0125–0.2378	0.0553	Detected in 14 streams	Bradley et al. 2017
Linsley Pond, Connecticut	July 29–30, 2004	~<0.15 – ~0.53		n=11; values estimated from figure	Hu et al. 2007
United States	2019	0.51–0.99	0.82	n=59; 5.1% quantification frequency; two below reporting limit	WQP 2025
	2020	0.1–0.3	0.07	n=68; 14% quantification frequency; seven below limit of quantification; two below reporting limit	
	2021	0.1–0.46	0.08	n = 29; 45% quantification frequency; 15 below reporting limit	
	2022	–	–	n = 16; 0% quantification frequency; four below limit of quantification; three below reporting limit	
	2023	0.01–0.02	0.015	n = 29; 14% quantification frequency; three below reporting limit	
	2024	0.01–0.03	0.018	n = 32; 16% quantification frequency	
Rhine River, the Netherlands	1992–1997	NR–0.9	–		Miermans et al. 2000
Meuse River, the Netherlands	1992–1997	NR–4.5	–		
Northern Delta Area of the Rhine-Meuse-Scheldt Rivers, the Netherlands	1992–1997	NR–0.1	–		

Table 5-12. Carbon Disulfide Concentrations in Surface Water

Location	Date(s)	Range (µg/L)	Mean (µg/L)	Notes	Reference
Westerscheldt Estuary, the Netherlands	1992–1997	NR–0.1	–		
Hazardous waste train derailment site, East Palestine, Ohio	February 2023	<1–<100	–	n=14; not detected above reporting limits	EPA 2024c

NR = not reported

Table 5-13. Carbon Disulfide Concentrations in Groundwater

Location	Date(s)	Range (µg/L)	Mean (µg/L)	Notes	Reference
Wells across the United States	2013–2019	0.062–4.236	–	n=1,537 wells; 1.6% quantification frequency; estimated at 0.05–5.844 µg/L in 185 wells	Bexfield et al. 2022
United States	2019	0.1–11.5	1.33	52% quantification frequency; 100 below reporting limit	WQP 2025
	2020	0.1–68	1.96	46% quantification frequency; 39 below reporting limit	
	2021	0.1–68.8	1.65	63% quantification frequency; 51 below reporting limit	
	2022	0.1–61	1.72	69% quantification frequency; 104 below reporting limit	
	2023	0.978–160	2.65	67% quantification frequency; 115 below reporting limit	
	2024	0.01–4.5	0.484	51% quantification frequency; 49 below reporting limit	
Palermo Wellfield Superfund Site	2019	0.29–1	0.592	n=27; 19% quantification frequency	WQP 2025
	2020	–	–	n=4; 0% quantification frequency	

Table 5-13. Carbon Disulfide Concentrations in Groundwater

Location	Date(s)	Range (µg/L)	Mean (µg/L)	Notes	Reference
Hazardous waste train derailment site, East Palestine, Ohio	June-July 2024	<1–NA	–	n=2; not detected above reporting limits	EPA 2024c

NR = not reported

Reported average concentrations of carbon disulfide levels in ocean water collected from various locations were 15.7 picomoles/L (0.0012 µg/L) (Lennartz et al. 2020) and 18 picomoles/L (0.0014 µg/L) (Lennartz et al. 2020, 2021). Using data from the National Water-Quality Assessment project (NAWQA) and the U.S. Geological Survey (USGS), Bexfield et al. (2022) conducted a national study of VOC concentrations in 1537 wells sampled in 23 principal aquifer surveys over the span of 2013–2019. Carbon disulfide was found at less than the detection limit (0.05–0.8613 µg/L) in 1,324 wells, at estimated levels of 0.05–5.844 µg/L in 185 wells, and at measured concentrations of 0.062–4.236 µg/L in 25 wells (Bexfield et al. 2022). Thirty-eight U.S. streams were monitored from 2012 to 2014 for 719 compounds; carbon disulfide was found in 14 streams at ~0.055 µg/L (~55 ng/L) (Bradley et al. 2017). Carbon disulfide was found at a maximum concentration of <0.53 µg/L in a stratified lake in Connecticut; the highest levels were at the deepest level (Hu et al. 2007). Carbon disulfide was detected in about 40% of the 95 monitoring wells in the Glassboro study area of New Jersey; it was not detected in 30 public supply wells (Stackelberg et al. 2001).

The EPA maintains a Water Quality Portal (WQP) database that aggregates air monitoring data from the National Water Information System (NWIS) and STORage and RETrieval (STORET) system. Based on limited sampling, carbon disulfide is not typically detected in water, and concentrations are <1 µg/L. In groundwater, average concentrations are <5 µg/L, but maximums up to 160 µg/L were reported.

Miermans et al. (2000) studied Dutch surface water of the Rhine River, Meuse River, Northern Delta Area of the Rhine-Meuse-Scheldt Rivers, and Westersceldt Estuary; carbon disulfide was found at 0.9, 4.5, 0.1, and 0.1 µg/L, respectively.

Limited water monitoring data for hazardous waste sites were located. An average of 0.591 µg/L carbon disulfide (range 0.29–1 µg/L, 19% detected in 27 samples) was reported in groundwater at the Palermo Wellfield Superfund Site in 2019; carbon disulfide was not detected in four groundwater samples collected in 2020 (WQP 2025). Carbon disulfide was below the reporting limit (ranging from 1 to 100 µg/L) in surface water samples collected at the East Palestine, Ohio train derailment site collected in February 2023, and below the reporting limit (1 µg/L) in two groundwater samples collected in the summer of 2024 (EPA 2024c).

5.5.3 Sediment and Soil

Limited soil and sediment monitoring data for carbon disulfide were located, which are summarized in Table 5-14. Carbon disulfide is not expected to be commonly detected in surface soil and sediments due to its volatility. Concentrations in submerged sediments ranged from 4.6 to 32.9 µg/kg (WQP 2025).

Table 5-14. Carbon Disulfide Concentrations in Soil and Sediment

Location	Date(s)	Range (µg/kg)	Mean concentration (µg/kg)	Notes	Reference
Sediment					
United States	2019	–	–	n=37; 0% quantification frequency	WQP 2025
	2020	4.6–32.9	16.7	n=235; 1.7% quantification frequency	
	2021	5.4–23	11.8	n=124; 12% quantification frequency; 13 below the limit of quantitation	
Palermo Wellfield Superfund Site	2021	1.6–14	6.37	n=5; 60% quantification frequency	WQP 2025
Soil					
United States	2023	–	–	n=10; 0% quantification frequency	WQP 2025

5.5.4 Other Media

Carbon disulfide's previous use as a fumigant resulted in residues on grains, legumes, and other fruit and vegetable products (Daft 1987; Heikes 1987; Lovegren et al. 1979). Current studies of carbon disulfide concentrations in food products were not located. Carbon disulfide concentrations of 1,500 ppm in the root of Oriental ginseng (*Panax ginseng*), 0.2 ppm in the stem of kohlrabi (*Brassica oleracea*), and unspecified levels the fruit of shiitake (*Lentinus edodes*) have been reported (USDA 2025). Carbon disulfide was found in *Charybdis feriatus* crabs at 217.2, 203.9, and 29.8 µg/kg in the leg, body, and carapace, respectively (Chung 1999).

5.6 GENERAL POPULATION EXPOSURE

The general population may be exposed to low levels of carbon disulfide in ambient air. Reported median levels in outdoor ambient air range from 0.052 to 0.318 μg/m^3 (EPA 2024a). Limited food monitoring data were available and no municipal drinking water data were located. Carbon disulfide exposure from consumption of food products is not considered a current exposure pathway due to its discontinued use as a fumigant in agriculture. While carbon disulfide has been detected in surface and groundwater, likelihood of ingestion of carbon disulfide via drinking water is low due to the volatility of the chemical. For the general population, absorption through the skin is a much less important route of exposure than inhalation, and oral exposure is negligible.

Vapor intrusion may be a potential source of carbon disulfide exposure, although indoor and ambient sources may also contribute to indoor air levels. The EPA (2016) includes carbon disulfide in its Vapor Intrusion Screening Levels (VISL) Calculator, indicating that it is sufficiently volatile and sufficiently toxic to be considered a concern for vapor intrusion from soil and groundwater. Accordingly, ATSDR recommends that health assessors should evaluate potential health implications of vapor intrusion for carbon disulfide during site risk assessments.

Carbon disulfide may volatilize from water; thus, there is potential for inhalation exposure during showering and bathing. ATSDR's three-compartment Shower and Household-Use Exposure (SHOWER) model predicts air concentrations in the shower stall, bathroom, and main house throughout the day by estimating the contribution from showering or bathing and the contribution from other water sources in the house, such as the dishwasher, clothes washer, and faucets. This information, along with human activity patterns, is used to calculate a daily time weighted average exposure concentration via inhalation exposure and from dermal uptake from skin contact. ATSDR's SHOWER model is available by sending a request to showermodel@cdc.gov. Using median outdoor air levels (0.318 μg/m^3) (EPA 2024a) as discussed in Section 5.5.1 and groundwater levels in the absence of municipal water data (2.149 μg/L, mean of reported range) (Bexfield et al. 2022) as discussed in Section 5.5.2, Reasonable Maximum Exposure (RME) levels for carbon disulfide were calculated for different exposure groups (Table 5-15).

Table 5-15. Reasonable Maximum Exposure of Carbon Disulfide for Daily Inhalation Dose and Administered Dermal Dose for the Target Person

Exposure group	Inhalation (μg/m^3)	Dermal (μg/kg/day)
Birth–<1 year	2.3	0.0095
1–<2 years	2.3	0.0088
2–<6 years	2.3	0.0075
6–<11 years	2.3	0.0061
11–<16 years	2.3	0.0050
16–<21 years	2.3	0.0046
Adult	2.3	0.0045
Pregnant and breastfeeding women	2.3	0.0045

Source: ATSDR 2025

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Human exposure to carbon disulfide is expected to be highest among certain occupational groups (e.g., workers involved in the production of recovered cellulose products). While historical occupational exposure levels were high (>10 ppmv in workplace air), current exposure levels are lower. Occupational monitoring data obtained since the year 2000 report central estimates (medians or means) ranging from 1.86 to 5.96 ppmv in 2009 (Göen et al. 2014; Guo et al. 2016; Jhun et al. 2007, 2009; Yoshioka et al. 2017). While lower than historical values, this exposure is still approximately 2–3 orders of magnitude above ambient exposure levels (see Section 5.6). Occupations with potential for exposure to carbon disulfide include chemical manufacturing workers using carbon disulfide in producing thiocarbamates or other end products, cellophane manufacturing, viscose sponge production, and laboratory specialty workers (e.g., researchers using carbon disulfide). Viscose rayon production is no longer an occupational exposure setting of relevance for the United States (EPA 2011).

Nursing infants of women occupationally exposed to carbon disulfide may also be at increased risk of exposure, as carbon disulfide is excreted in breast milk, and can be detected for up to a month or more following exposure (Cai and Bao 1981; Pellizzari et al. 1982).

Persons living in certain source-dominated areas may be at risk for higher than background exposures to carbon disulfide. These may include persons living near industries and facilities that manufacture and use carbon disulfide (e.g., viscose rayon plants, sponge manufacturers). For example, measured carbon disulfide levels outside 10 residences within 1 mile of the Nylonge sponge manufacturing facility in

Elyria, Ohio over a 20-day period in September to October of 1998 ranged from <1.1 to 290 ppb (ATSDR 1999). Participants were instructed to collect samples when they perceived odors to be "significant;" some of the descriptors used for the odor included rotten eggs, sulfur, burning, sewer gas, and pungent. Of particular concern would be a worker with occupational exposure to carbon disulfide who also lives close enough to the plant to be exposed to elevated levels at home as well. Elevated biomarkers of exposure (e.g., urinary concentrations of carbon disulfide or its metabolites) have been reported in children who live close (15 km) to a factory emitting carbon disulfide into the atmosphere, compared to children living 400 km away (Helasova 1969).

In addition, members of the general population living in the vicinity of industrial point emission sources are exposed to higher than background levels of carbon disulfide. The compound has been detected in both ambient air and water in low concentrations, with somewhat higher concentrations in localized areas around industrial and disposal sites. For example, ambient air levels of carbon disulfide from October 2020 to September 2021 ranged from 1.6 to 7.4 ppbv in various community locations in Kalamazoo, Michigan near Graphic Packaging International, LLC, and the Kalamazoo Water Reclamation Plant (MDHHS 2023). The exposure levels in the upper range for these communities are more than twice the upper range exposure levels reported in ambient air across the United States in 2022 (Section 5.6). In 2008, predicted vapor intrusion for buildings near the former Industrial Chemical Supply Company (ICSC) hazardous water properties in Tampa, Florida from wells contaminated with carbon disulfide ranged from 0.16 to 0.3 ppbv; well concentrations were not reported (ATSDR 2008). No information was found regarding the number of people potentially exposed in the vicinity of hazardous waste sites. However, since carbon disulfide has been found near hazardous waste sites, people living near them may be exposed to higher than background levels.

Göen et al. (2014) studied workplace air levels of carbon disulfide and creatinine concentrations of the carbon disulfide metabolite, TTCA, in urine of factory workers of a viscose rayon manufacturing facility located in Germany. Cross-sectional studies were conducted in 1992 and 2009 and supplemented with company internal data. The results comparing personal air monitoring of carbon disulfide exposure and urinary TTCA levels from 1992 versus 2009 in different departments (job function and location) of the facility are shown in Tables 5-16 and 5-17, respectively. Personal carbon disulfide air monitoring data were significantly correlated with urinary TTCA levels in 2009; correlation analysis was not conducted for 1992 data. The study authors concluded that exposures to carbon disulfide have decreased over this time period as engineering controls and other safety measures have reduced air levels in these settings; however, the study authors noted that the data do not show a linear trend over the temporal period.

Table 5-16. Carbon Disulfide Personal Air Monitoring (ppm) in a Rayon Factory in 1992 and 2009

Department	Number of measurements	Median	95th percentile	Range
1992				
Spinning of textile rayon	109	2.95	7.23	0.52–19.3
Spinning of technical rayon	95	5.54	15.4	0.87–18.3
Washing of textile rayon spools	37	8.86	28.1	1.11–65.7
Post-treatment	95	3.83	7.07	<0.20–16.9
Rayon ageing and filter cleaning	16	1.70	–	<0.20–5.11
All exposed workers	352	4.15	15.4	<0.20–65.7
2009				
Spinning of textile rayon	52	3.36	6.46	0.480–13.2
Spinning of technical rayon	63	2.97	11.5	0.195–20.9
Washing of textile rayon spools	23	2.01	3.86	<0.20–5.65
Post-treatment	56	1.86	6.15	0.460–11.4
Rayon ageing and filter cleaning	12	2.60	3.62	1.36–3.92
All exposed workers	209	2.48	6.71	<0.20–20.9

Source Göen et al. (2014)

Table 5-17. 2-Thiothiazolidine-4-carboxylic Acid (mg/g Creatinine) Concentration in Urine of Workers in a Rayon Factory in 1992 and 2009

Department	Number of measurements	Median	95th percentile	Range
1992				
Spinning of textile rayon	112	1.31	3.29	0.03–6.37
Spinning of technical rayon	97	2.76	7.43	0.04–11.0
Washing of textile rayon spools	40	3.72	7.96	0.40–11.6
Post-treatment	96	1.49	4.26	0.05–6.72
Rayon ageing and filter cleaning	17	0.65	2.23	0.23–2.23
All exposed workers	362	1.63	5.57	0.03–11.6
2009				
Spinning of textile rayon	53	0.97	2.12	0.08–4.68
Spinning of technical rayon	65	1.02	2.78	0.09–5.27
Washing of textile rayon spools	22	0.46	1.81	0.06–2.20
Post-treatment	54	0.58	2.47	0.04–3.50
Rayon ageing and filter cleaning	12	0.80	1.54	0.48–5.27
All exposed workers	209	0.86	0.86	0.04–5.27

Source Göen et al. (2014)

In a similar study, Vermeulen et al. (2005) reported urine TTCA levels in rubber workers from nine factories (three rubber tire, five general rubber goods, and one retreading company) based on departments using biomonitoring data collected from January to July 1997; results are presented in Table 5-18.

Table 5-18. Weekday Urinary Levels of 2-Thiothiazolidine-4-carboxylic Acid in Rubber Workers by Department

Department	Number of subjects	Number of measurements	Arithmetic mean in µmol/mol creatinine (mg/g creatinine)[a]	Geometric mean in µmol/mol creatinine (mg/g creatinine)[a]
Mixing	10	30	15 (0.022)	7 (0.01)
Pre-treating	14	41	16 (0.023)	8 (0.01)
Molding	27	76	34 (0.049)	11 (0.016)[b]
Curing	24	67	27 (0.039)	16 (0.023)[b]
Finishing	9	25	42 (0.061)	13 (0.019)
Shipping	3	8	15 (0.022)	14 (0.020)
Engineer service	14	38	17 (0.025)	7 (0.01)

[a] To facilitate comparison across studies, urinary levels reported in µmol/mol creatinine were converted to mg/g creatinine based on the molecular weights of 2-thiothiazolidine-4-carboxylic acid (163.2 g/mol = 0.1632 mg/µmol; NLM 2024a) and creatinine (113.12 g/mol; NLM 2024b). 1 µmol 2-thiothiazolidine-4-carboxylic acid/1 mol creatinine = 0.1632 mg 2-thiothiazolidine-4-carboxylic acid/113.12 g creatinine = 0.001443 mg 2-thiothiazolidine-4-carboxylic acid/g creatinine. Example calculation: 15 µmol/mol creatinine x 0.001443 = 0.022 mg/g creatinine.

[b] Mean weekday urinary biomarker levels of subjects in a department significantly higher than Sunday urinary biomarker levels (paired *t*-test); $p < 0.05$.

Source: Vermeulen et al. 2005

Levels of the carbon disulfide metabolite, TTCA, were measured in the urine of individuals after completing their shift in a rayon factory (Chang et al. 2002). Levels of TTCA were excreted about 34% within the first 2 hours after exposure; the mean half-life for excretion was 8.7 hours, with total elimination by 22–24 hours.