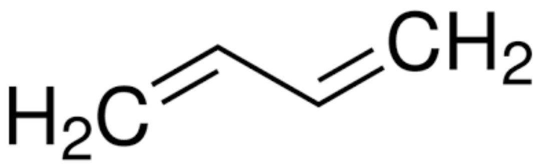
EPA Document# EPA-740-R-25-059
December 2025
Office of Chemical Safety and
Pollution Prevention

United States
Environmental Protection Agency

Environmental Media Concentrations for 1,3-Butadiene

Technical Support Document for the Risk Evaluation

CASRN 106-99-0



December 2025

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

KEY ABBREVIATIONS AND ACRONYMS

AERMOD	American Meteorological Society (AMS)/EPA Regulatory Model
AMA	Ambient Monitoring Archive
AMCV	Air Monitoring Comparison Value
AMTIC	Ambient Monitoring Technology Information Center
AQS	Air Quality System
CASRN	Chemical Abstracts Service Registry Number
CDR	Chemical Data Reporting
COU	Condition of use
DMR	Discharge Monitoring Report
EIMS	Environmental Information Management System
EPA	Environmental Protection Agency
GC/MS	Gas chromatograph mass spectrometer
HAP	Hazardous Air Pollutant
HRM	Houston Regional Monitoring
K_{OA}	Octanol-air partition coefficient
K_{OC}	Organic carbon-water partition coefficient
K_{OW}	Octanol-water partition coefficient
LOD	Limit of detection
MDL	Method detection limit
NADP	National Atmospheric Deposition Program
NAWQA	National Water-Quality Assessment
ND	Non-detect
NEI	National Emissions Inventory
NOAA	National Oceanic and Atmospheric Administration
NWIS	National Water Information System
OAR	Office of Air and Radiation (EPA)
OPPT	Office of Pollution Prevention and Toxics (EPA)
PWS	Public water system
RL	Reporting Limit
SDWA	Safe Drinking Water Act
SCAQMD	South Coast Air Quality Management District
TCEQ	Texas Commission on Environmental Quality
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TSD	Technical support document
UCMR3	Third Unregulated Contaminant Monitoring Rule
USGS	U.S. Geological Survey
U.S.	United States
VOC	Volatile organic compound
WQP	Water Quality Portal
WQX	Water Quality Exchange

SUMMARY

This technical support document (TSD) accompanies the Toxic Substances Control Act (TSCA) *Risk Evaluation for 1,3-Butadiene* (also called the "risk evaluation") (U.S. EPA, 2025e). This assessment presents the measured and monitoring data for 1,3-butadiene that was reasonably available to EPA (or the Agency) to support the risk evaluation. This TSD aids in determining the type of exposure assessment (quantitative or qualitative) that would be appropriate for each exposure media pathway (air, water and land). Based on measurements from monitoring databases and concentrations reported in the literature, EPA conducted a quantitative assessment of exposure to 1,3-butadiene in ambient air for the general population (see *General Population Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2025c)).

1,3-Butadiene – Environmental Media Concentration: Key Points

EPA quantitatively or qualitatively evaluated the reasonably available information for air, water, and land to quantify the presence of 1,3-butadiene in the environment and inform the environmental exposure and general population exposure assessment. The key points are summarized below:

- For the air pathway, 1,3-butadiene releases are not expected to undergo air deposition or long-range transport based on a low octanol-air partition coefficient (log K_{OA}) of 1.5 and a short half-life in the atmosphere.
- For the water pathway, biodegradation is expected to be rapid in aerobic sediments and slower under anaerobic conditions. Based on both a high Henry's Law constant (0.076 atm·m^3/mol at 25 °C) and a vapor pressure (1,900 mm Hg at 20 °C), volatilization of 1,3-butadiene is expected to be the most important removal process in aquatic environments.
  - Due to its high volatility and low sorption potential to organic matter, 1,3-butadiene is not expected to significantly partition into sediments in water.
- For the land pathway, 1,3-butadiene is not expected to be appreciably released to soil, and air to soil deposition is not expected to be significant because 1,3-butadiene is volatile and has low affinity for organic matter with a log K_{OC} (organic carbon-water partition coefficient) of 1.73 and log K_{OW} (octanol-water partition coefficient) of 1.99.
  - Any release of 1,3-butadiene to soil (such as air deposition) is expected to volatilize rapidly; therefore, *soil and groundwater concentrations were not quantified but are discussed qualitatively*.

- Based on the physical and chemical properties, as well as concentrations reported from monitoring databases and scientific literature, the air pathway is expected to be the main pathway contributing to general population exposures to 1,3-butadiene.Therefore, *a quantitative assessment was conducted for the air pathway.*
- Based on the low amounts of releases to land and water as well as high frequencies of non-detects reported in several federal databases (*e.g.*, Water Quality Portal or WQP) and the scientific literature, water and land pathways are not expected to contribute to general population exposures to 1,3-butadiene due to its high volatility and biodegradation process. Therefore, *a qualitative assessment was conducted for the water and land pathways*.

1 INTRODUCTION

1,3-Butadiene is a colorless gas that is produced during petroleum processing and is primarily used for synthetic rubber production; however, small amounts can be found in plastics and fuel. It is released into the environment by industrial operations involved with manufacturing, processing, formulation, disposal, and other practices. 1,3-Butadiene is also released into the ambient air by constant motor vehicle emissions as well as from combustion and other activities related to fuel use and products. For detailed information on 1,3-butadiene releases to the environment, see the *Environmental Release and Occupational Assessment for 1,3-Butadiene* (U.S. EPA, 2025b).

1,3-Butadiene is a high priority chemical undergoing the TSCA risk evaluation process for existing chemicals following passage of the Frank R. Lautenberg Chemical Safety for the 21st Century Act in 2016, and is subject to the TSCA regulations as described in Table 2-1 of the *Risk Evaluation for 1,3-Butadiene* (U.S. EPA, 2025e). This assessment (TSD) serves the risk management needs of EPA's Office of Pollution Prevention and Toxics (OPPT) and is one of many documents, spreadsheets, and other files supporting the 1,3-butadiene risk evaluation (U.S. EPA, 2025e) (see Appendix C of the risk evaluation for a complete list).

1.1 Risk Evaluation Scope

The TSCA risk evaluation of 1,3-butadiene includes several human health, environmental, fate, and exposure assessment TSDs in addition to the risk evaluation itself. A diagram showing the relationships between assessments is provided in Figure 1-1. This environmental media concentrations assessment (highlighted in blue) is one of the five TSDs that are outlined in green.

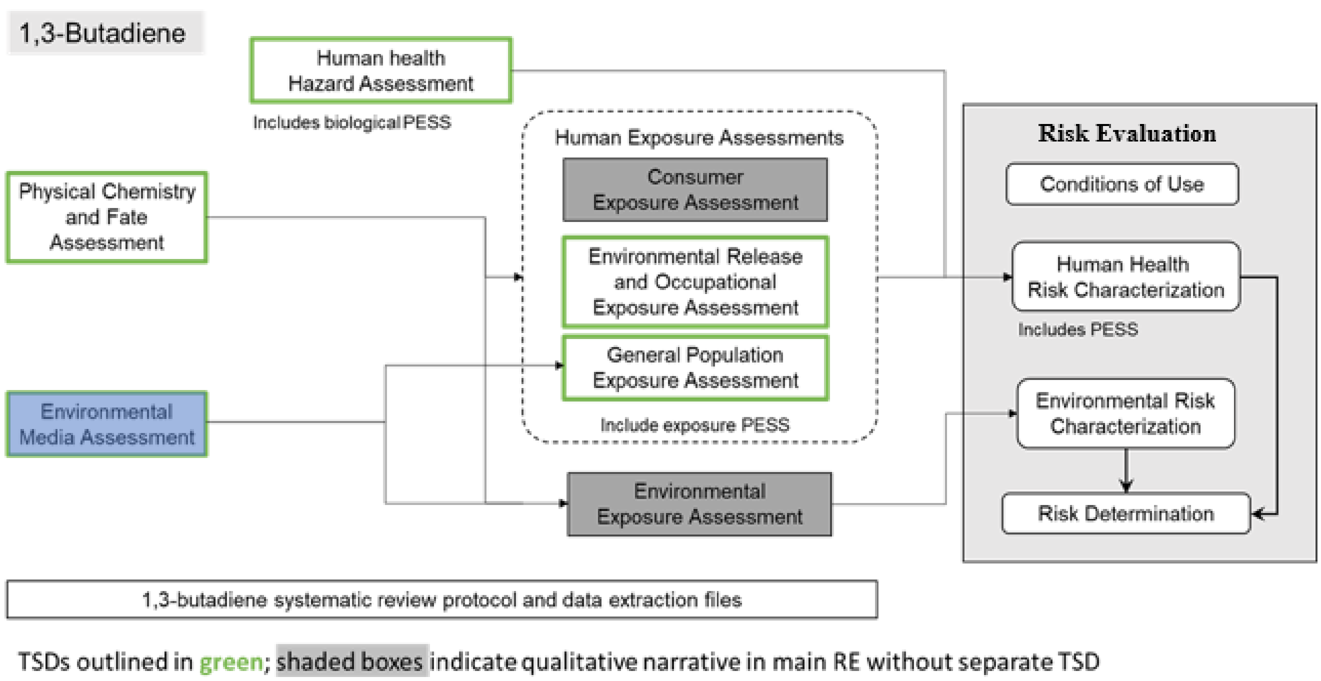


Figure 1-1. Risk Assessment Document Map Summary for 1,3-Butadiene

The purpose of this TSD is to (1) evaluate concentrations of 1,3-butadiene in the following environmental media pathways—air, water, and land—based on measurements reported in peer-reviewed literature, gray literature, and available databases ; and (2) determine whether EPA needs to conduct a quantitative or qualitative assessment accordingly for the risk evaluation (U.S. EPA, 2025e).

1.2 Summary of the Chemistry, Fate, and Transport Assessment

1,3-Butadiene is a colorless gas with a mildly aromatic, gasoline-like odor. 1,3-Butadiene is primarily transformed in ambient air by indirect photolysis through reaction with ozone, nitrates, and hydroxyl radicals (·OH). Studies indicate 1,3-butadiene has a half-life range of 0.76 to 9 hours, with the longer half-lives corresponding to periods without sunlight. Industrial releases and vehicular emissions are major sources of 1,3-butadiene (Bereznicki et al., 2012; Logue et al., 2010). It can also be formed in ambient air as a product of combustion of organic matter such as petroleum products, wood, and coal. 1,3-Butadiene is volatile and will evaporate from water and soil and does not sorb to sediment. Therefore, air is expected to be the major pathway of concern for 1,3-butadiene in the environment, whereas water, sediment and soil are expected to comprise minor pathways. Figure 1-2 depicts the transportation and partitioning of 1,3-butadiene in the environment. For more details, see the *Physical Chemistry and Fate Assessment for 1,3-Butadiene* (U.S. EPA, 2025d).

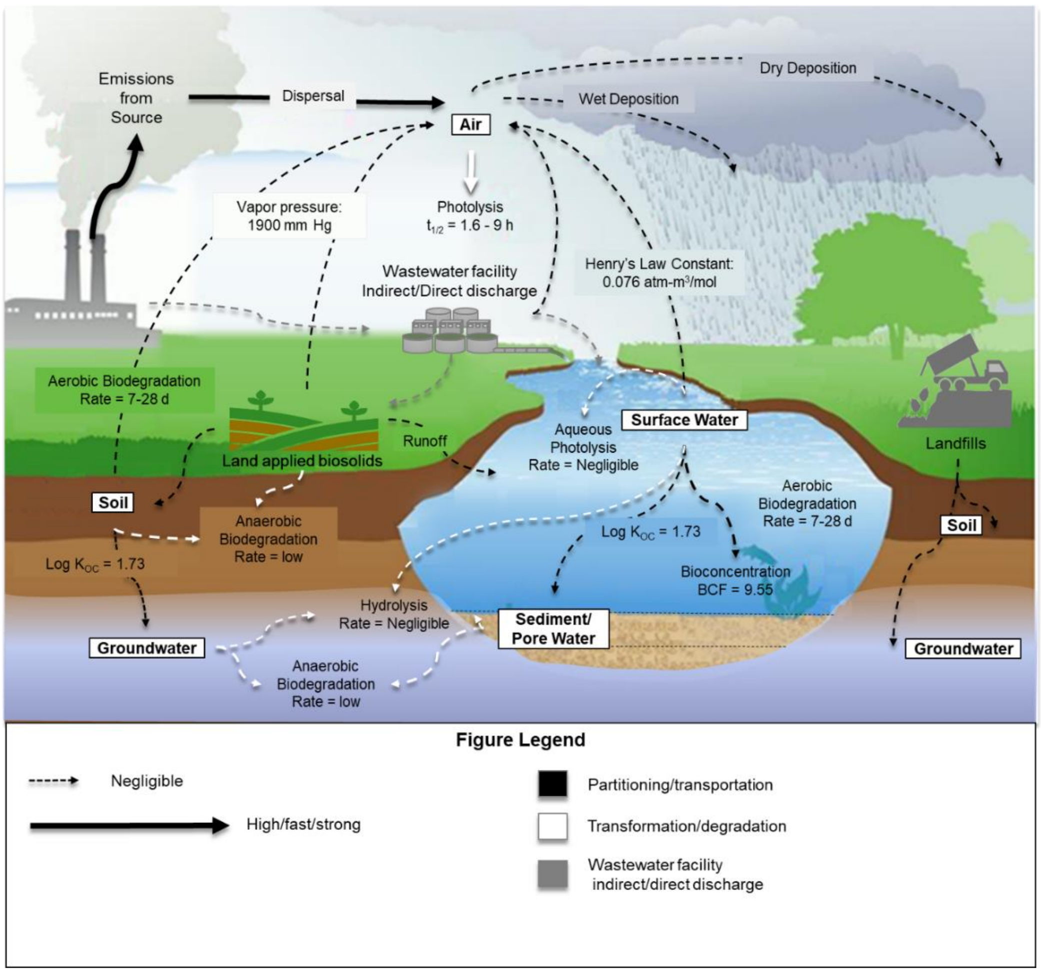


Figure 1-2. Transport, Partitioning, and Degradation of 1,3-Butadiene in the Environment

The diagram depicts the distribution (grey arrows), transport and partitioning (black arrows) as well as the transformation and degradation (white arrows) of 1,3-butadiene in the environment. The width of the arrow is a qualitative indication of the likelihood that the indicated partitioning will occur or the rate at which the indicated degradation will occur (*i.e.*, wider arrows indicate more likely partitioning or more rapid degradation).

2 APPROACH AND METHODOLOGY

EPA conducted a systematic review to identify peer-reviewed, gray literature,[1] and database sources of 1,3-butadiene measured concentrations in various media pathways (air, water, and land) to characterize environmental media concentrations. Pertinent data from studies and databases identified through systematic review were evaluated and assigned an overall quality determination according to the 2021 *Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* (also called the "2021 Systematic Review Protocol" (U.S. EPA, 2021b). Studies assigned to medium- and high-quality determinations were extracted and integrated as part of the risk evaluation. For more details on the systematic review process as applied to 1,3-butadiene, see Section 2.3 of the *Risk Evaluation of 1,3-Butadiene* (U.S. EPA, 2025e) and the *Systematic Review Protocol for 1,3-Butadiene* (U.S. EPA, 2025f). Several references reported environmental media concentrations outside the United States and are included for global context throughout Section 3. All studies identified—U.S. and non-U.S.—support the conclusion that air is the major exposure pathway for 1,3-butadiene.

3 AIR PATHWAY

EPA searched peer-reviewed and gray literature published through 2019 and databases through 2022, to obtain concentrations of 1,3-butadiene in ambient air. Sections 3.1 through 3.5 describe the aggregated results of measured and modeled concentrations of 1,3-butadiene in air; comparisons to modeled data found from the literature search are provided for context. Although the systematic review included studies conducted outside of the United States, discussion herein is focused on U.S. studies as these studies are most informative for this assessment. Studies conducted outside of the United States are presented for context but are not discussed further. Tables in Appendix B list all studies and summarizes the 1,3-butadiene concentrations extracted from systematic review for the air pathway (ambient air, indoor air, landfill gas, and personal exposure monitoring). For more details on the systematic review for 1,3-butadiene, see the *Systematic Review Protocol for 1,3-Butadiene* (U.S. EPA, 2025f). Measured data from monitoring databases, including EPA's Ambient Monitoring Technology Information Center (AMTIC) (U.S. EPA, 2022a) and other monitoring networks are presented in Section 3.1.2.

3.1 Measured Concentrations in Ambient Air

3.1.1 Peer-Reviewed Literature

3.1.1.1 Measured Concentrations

Measured concentrations of 1,3-butadiene in ambient air were extracted from five U.S. studies published between 1999 and 2015. These measured concentrations were classified as representing general population exposures (*i.e.*, ambient measurements taken in areas near residential populations with no known facility sources nearby) or near facility (*i.e.*, measurements collected in areas with industrial and/or commercial activities). These are denoted by blue and red, respectively, in Figure 3-1. Detailed information on how to read and interpret the figures is provided in Appendix A. Within the United States, Logue, et al. (2010) collected measurements in Pittsburgh, Pennsylvania, and reported measurements from both near facility (0.01–0.33 µg/m^3) and general population (0.04–0.35 µg/m^3;

[1] Gray literature is defined as the broad category of data or information sources not found in the standard, peer-reviewed literature databases such as PubMed and Web of Science (both accessed November 21, 2025). It is produced by organizations outside of traditional academic publishing channels. Gray literature includes data/information sources such as white papers, conference proceedings, technical reports, reference books, dissertations, information on various stakeholder websites, and various databases. Modeled data are acknowledged when available.

downtown Pittsburgh) sites. For near facility measurements, 1,3-butadiene concentrations were attributed to emissions from chemical plants and metallurgic coke plants, while 1,3-butadiene concentrations at downtown, general population sites were attributed to mobile emissions from vehicular traffic. Measurements collected at an exurban (*i.e.*, a region situated beyond the suburbs) background site outside of Pittsburgh had a range of 0.0 to 0.15 µg/m^3. Bereznicki, et al. (2012) reported a residential general population concentration range of non-detect (ND) to 1.91 µg/m^3 in Detroit, Michigan. Yu et al. (2014) reported a range of 0.01 to 1.35 µg/m^3 near industrial areas in Paterson, New Jersey, with 14 percent of the 209 samples being NDs.

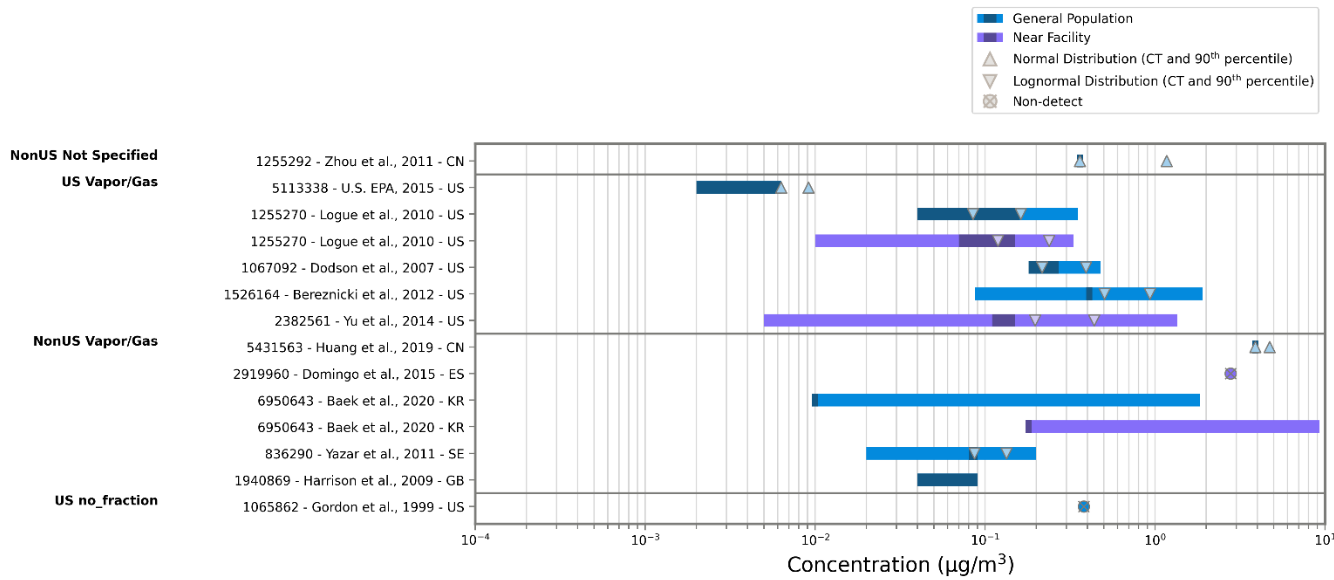


Figure 3-1. Measured Concentrations of 1,3-Butadiene (µg/m^3) in Ambient Air from 1998–2017

3.1.1.2 Modeled Concentrations

Modeled concentrations of 1,3-butadiene in ambient air were also captured during systematic review from five studies (4 in the United States and 1 in Japan) with concentration results of a similar range as measured concentrations (Yu and Stuart, 2016; Loh et al., 2007; Luecken et al., 2006; Suzuki et al., 2004; Radian Engineering, 1997).

3.1.2 Monitoring Data

3.1.2.1 AMTIC Ambient Monitoring Archive

To complement measurements available in peer-reviewed literature, measured ambient air concentrations of 1,3-butadiene were obtained from the EPA's AMTIC[2] Ambient Monitoring Archive (AMA) for Hazardous Air Pollutants (HAPs) database (U.S. EPA, 2022a). The AMTIC-AMA houses data from over 5,000 ambient air monitoring sites across the United States collected from 1990 to 2022. Contributing data sources include the EPA's Air Quality System (AQS), the Texas Commission on Environmental Quality (TCEQ), the South Coast Air Quality Management District (SCAQMD), the National Atmospheric Deposition Program (NADP), the National Oceanic and Atmospheric Administration (NOAA), the Massachusetts Institute of Technology (MIT), the Louisiana Department of Environmental Quality (LDEQ), other state, local, Tribal, and federal monitoring agencies, and academic, community, and short-term studies. EPA evaluated monitoring data for samples collected from January 2016 through December 2022. It is important to note that monitoring data represent total ambient concentrations from all contributing sources, both sources associated with conditions of use

[2] See https://www.epa.gov/amtic/air-toxics-ambient-monitoring (accessed November 19, 2025) for more information.

(COUs) under TSCA and other sources not associated with COUs or within the scope of this assessment (*e.g.*, vehicular mobile sources, tobacco smoke, residential wood burning, and fires).

3.1.2.1.1 Monitoring Data: 24-Hour

The 1,3-butadiene AMTIC monitoring data from January 2016 to December 2022 included over 89,000 24-hour sampling entries. Samples were collected using pressurized canisters over 24-hour durations and analyzed using gas chromatograph mass spectrometer (GC/MS) with the resulting 1,3-butadiene concentrations converted to μg/m^3. The 24-hour monitored concentrations from the AMTIC archive ranged from ND to 267.3 μg/m^3 with the method detection limit (MDL) ranging from 0.002 to 1.106 μg/m^3. A total of 51.5 percent of monitoring data between 2016 through 2022 were reported as NDs; 13.9 percent were reported as below the MDL (*i.e.*, <MDL). The highest 24-hour concentration was reported in 2019 from a monitoring station in Port Neches, Texas (AMA site code 482450017), located near industrial facilities. That specific monitoring site reported 24-hour measurements every 6 days (barring maintenance and other issues) for a total of 350 measurements from 2016 to 2022, of which 90 (25.7%) of the measurements were reported as either ND or below the MDL. Based on the 260 detected measurements for this monitoring site (*i.e.*, measurements that were not flagged as ND or <MDL), the arithmetic mean concentration was 5.41 μg/m^3, the geometric mean was 1.79 μg/m^3, and the median was 2.0 μg/m^3, indicating a positive skewness in the distribution with 90.7 percent of the values reporting 10 μg/m^3 and lower.

Overall, the 24-hour samples with detected measured concentrations of 1,3-butadiene for all monitoring stations between 2016 to 2022 had an arithmetic mean of 0.31 μg/m^3, a geometric mean of 0.11 μg/m^3, and a median of 0.09 μg/m^3. This indicates a positive skewness in the distribution of the monitoring data, with 94.9 percent of the concentrations less than 1 μg/m^3 and a range of 0.001 to 0.33 μg/m^3 (Figure 3-2).

When including all NDs and findings less than MDLs across the 2016 to 2022 monitoring years, the mean 24-hour concentration (including NDs / <MDLs), ranged from 0.08 to 0.15 μg/m^3 (0.22–0.43 μg/m^3, excluding NDs / <MDLs). The median 24-hour concentration (including NDs / <MDLs), ranged from 0.00 to 0.02 μg/m3 (0.08–0.11 μg/m^3, excluding NDs / <MDLs). The minimum concentration, including NDs and findings below the MDLs, is 0.0 μg/m3 (0.002 μg/m3, excluding NDs / <MDLs).

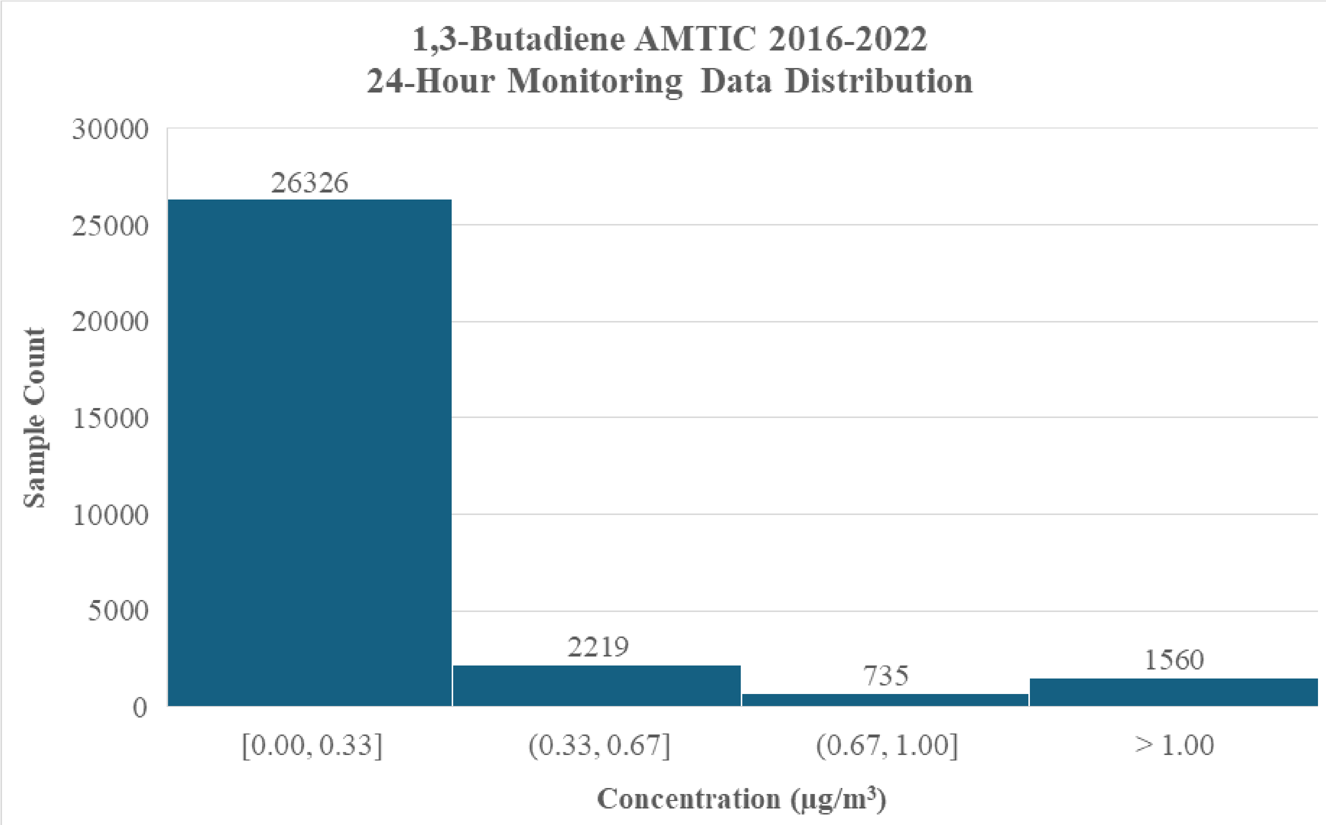


Figure 3-2. Histogram of AMTIC 1,3-Butadiene 24-Hour Monitoring Concentrations

3.1.2.1.2 Monitoring Data: 1-Hour

The 1,3-butadiene AMTIC monitoring data from January 2016 to December 2022 included over 1.7 million 1-hour sampling entries. Samples were collected and reported on an hourly basis using automated gas chromatography (auto-GC) with the resulting 1,3-butadiene concentrations converted to µg/m^3. One-hour monitored concentrations from the AMTIC archive ranged from ND to 3,045.3 µg/m^3, with the MDL ranging from 0.013 to 0.276 µg/m^3. A total of 22.6 percent of samples collected between 2016 through 2022 were reported as NDs; 36.9 percent were reported below the MDL. The highest 1-hour concentration was reported in 2022 from a monitoring station in La Porte, Texas (AMA site code 482011015), located near industrial facilities that report air releases of 1,3-butadiene. This specific monitoring site recorded 1-hour measurements daily (barring maintenance and other issues) for a total of 38,640 measurements from 2016 to 2022, of which, 19,489 (50.4%) of the measurements were reported as either ND or below the MDL. Based on the 19,151 detected measurements for this monitoring site, *i.e.*, measurements that were not flagged as ND or below the MDL, the arithmetic mean concentration was 0.72 µg/m^3, the geometric mean was 0.23 µg/m^3 and the median was 0.22 µg/m^3 indicating a positive skewness in the distribution with 91.1 percent of the values reporting 1 µg/m^3 and lower.

Overall, across all detected 1-hour concentrations from all monitoring stations between 2016 to 2022, the arithmetic mean was 0.42 µg/m^3, the geometric mean was 0.15 µg/m^3, and the median was 0.11 µg/m^3, indicating a positive skewness in the distribution of monitored data with 94.4 percent of the detected concentrations being below 1 µg/m^3 with most of the samples reporting between 0.001 to 0.34 µg/m^3 (Figure 3-3).

When including all NDs and readings below the MDLs across the 2016 to 2022 monitoring years, the mean 1-hour concentration, including NDs and readings below the MDLs, ranged from 0.12 to 0.28

μg/m^3 (0.23–0.56 μg/m^3, excluding NDs / <MDLs). The median 1-hour concentration, including NDs and readings below the MDLs, ranged from 0.04 to 0.05 μg/m^3 (0.09–0.16 μg/m^3, excluding NDs / <MDLs). The minimum concentration, including NDs / <MDLs is 0.0 μg/m^3 (0.004 μg/m^3, excluding NDs / <MDLs).

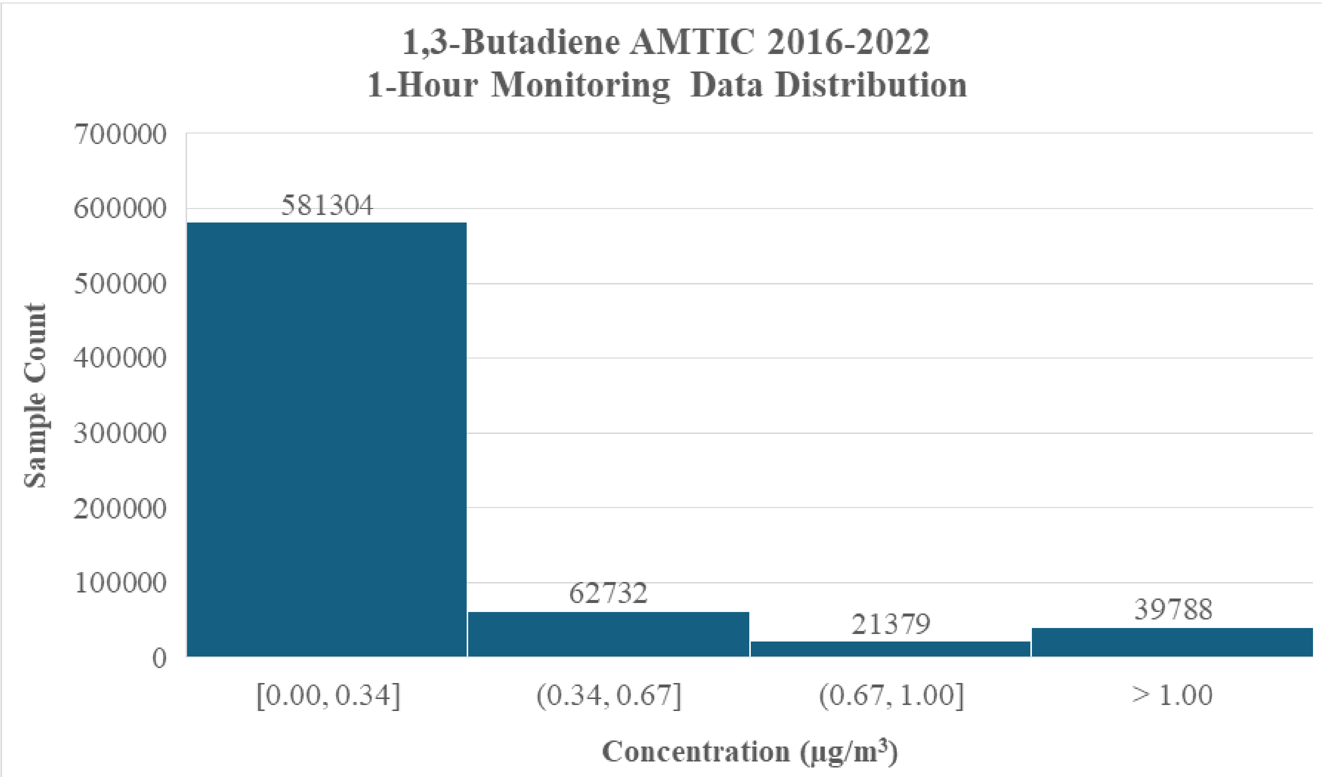


Figure 3-3. Histogram of AMTIC 1,3-Butadiene 1-Hour Monitoring Concentrations

See Appendix C for a summary of the AMTIC monitoring data, which includes other sampling durations and figures for the 24-hour and 1-hour concentrations by year. For more information on 1,3-butadiene ambient air monitoring data, see the supplemental file *Ambient Monitoring Technology Information Center (AMTIC) Monitoring Data 2016 to 2022 for 1,3-Butadiene* (U.S. EPA, 2025a). Data for this supplemental file was downloaded from the AMTIC Ambient Monitoring Archive for HAPs Database (U.S. EPA, 2022a).

3.1.2.2 Houston Regional Monitoring Network

The Houston Regional Monitoring Corporation (HRM) is one of the largest privately sponsored ambient air monitoring networks in the United States and is supported by 40 individual companies operating in east Harris County and west Chambers County. The HRM has been collecting and monitoring air quality with 10 monitoring stations in the Houston Area in full compliance with EPA-approved methods since 1980 (Figure 3-4).

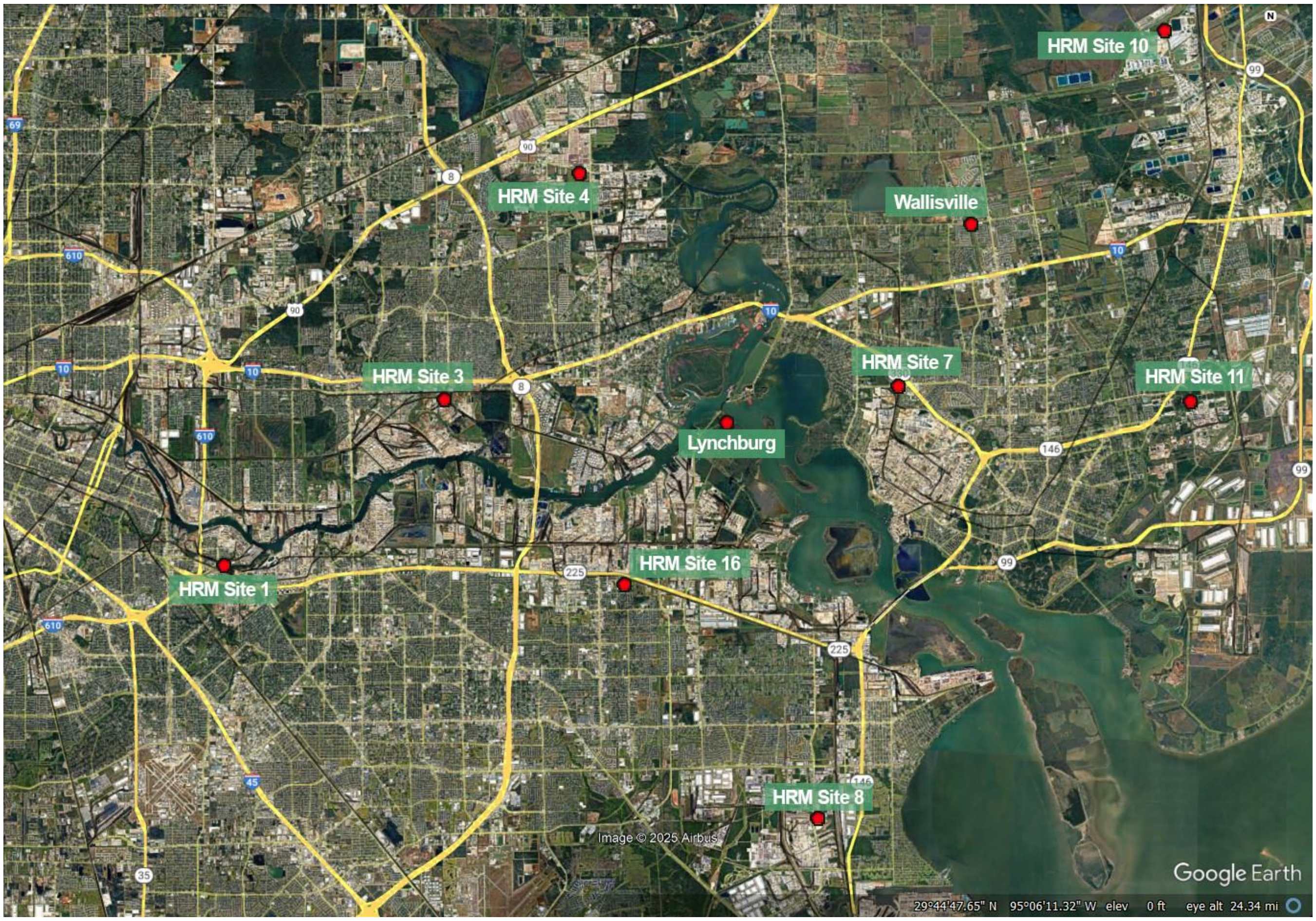


Figure 3-4. Houston Regional Monitoring Network Ambient Air Stations

For the 10 HRM monitoring stations, 24-hour canister samples are collected for volatile organic compounds (VOCs). HRM monitors 156 VOCs emitted by vegetation, utilities, industrial sources, small businesses, motor vehicles and household sources. Based on the 24-hour canister samples, 1,3-butadiene levels have remained below the TCEQ Air Monitoring Comparison Value (AMCV) of 9.1 ppb (20.1 $\mu g/m^3$) since 1988 with an annual average of 0.41 ppb (0.91 $\mu g/m^3$) in 2024 (Figure 3-5).

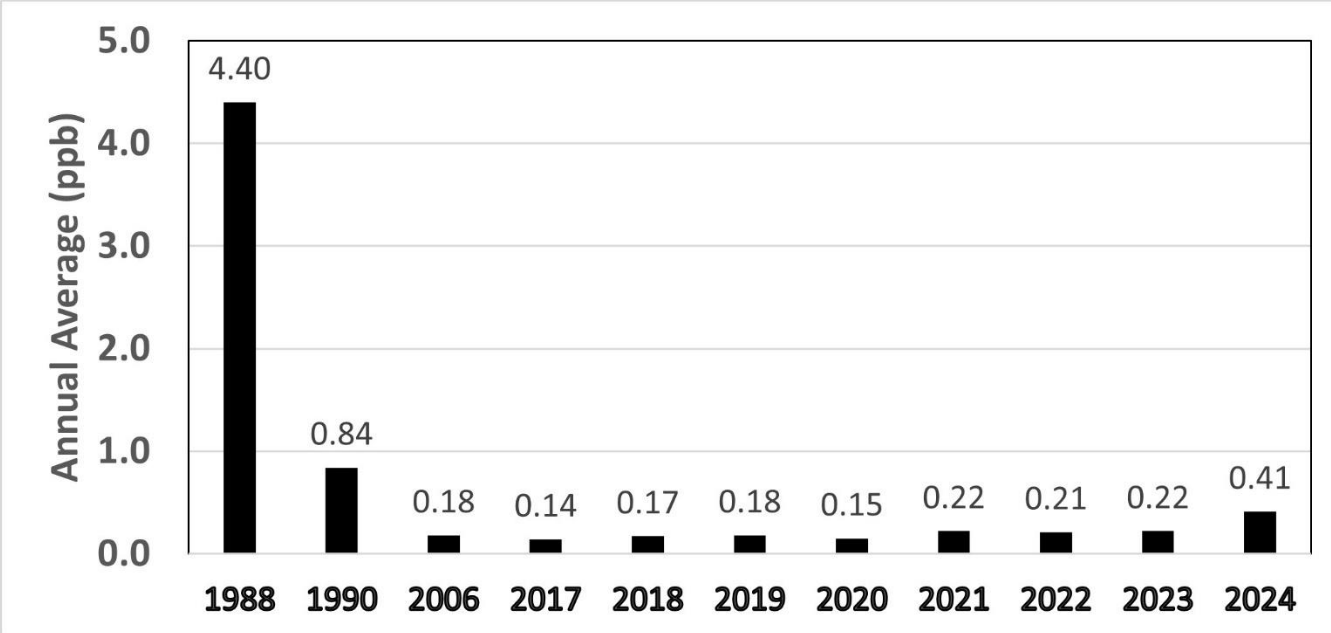


Figure 3-5. Houston Regional Monitors 24-Hour Canister Annual Average Concentrations

In addition, the HRM, in collaboration with TCEQ, operates continuous automated gas chromatography (Auto-GC) monitors that report on an hourly basis, documenting long-term concentration trends of VOCs. The network of Auto-GC monitors operated by both HRM and TCEQ reached 15 monitoring locations as of 2024 in the Houston area (Figure 3-6).

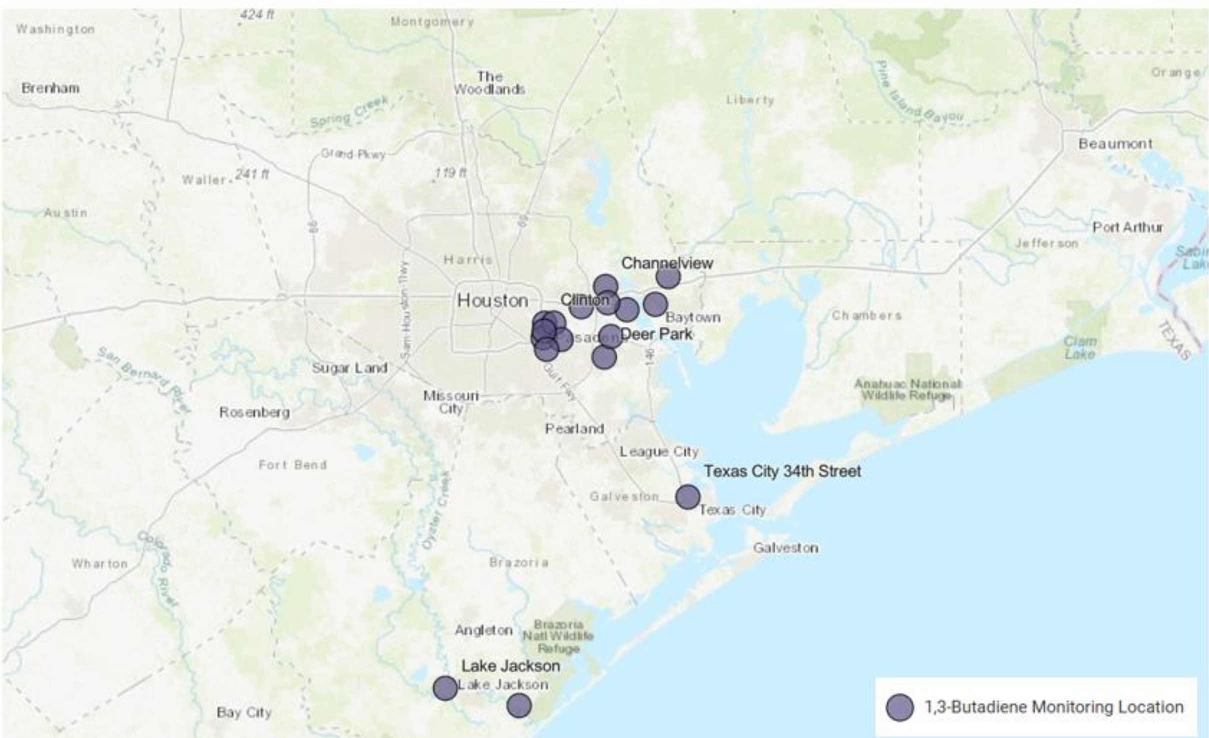


Figure 3-6. HRM and TCEQ Auto-GC Monitoring Stations for 1,3-Butadiene in the Houston Area

Based on continuous Auto-GC samples, the 2024 annual average butadiene concentration for the Houston area network was 0.26 ppb (0.57 $\mu g/m^3$).

See the public website (https://hrm.aecom.com/index.htm; accessed November 19, 2025) and the 2021 Houston Air Quality Trends report (accessed November 19, 2025) for more information on the HRM monitoring network and data.

3.1.2.3 Norco Community Ambient Monitoring Network

Shell Chemical LLC sponsors the Norco Community Ambient Monitoring Network with three monitoring stations in Norco, Louisiana (Figure 3-7). The purpose of this monitoring network is to measure the compounds frequently associated with emissions from refinery and chemical processes. The three monitoring stations have been collecting 24-hour canister samples every 12th day in accordance with EPA Method TO-15 (accessed November 19, 2025) for VOCs, including 1,3-butadiene, since 2020. EPA accessed the Norco Community website on July 21, 2025. Based on the 173 sampling dates from 3 monitoring stations between January 2020 and June 2025, resulting in 519 sample measurements, the majority of the 1,3-butadiene samples were reported as NDs, detected below the MDL, or detected between the MDL and the reporting limit (RL). See the public website (https://norco-air.info/pls/raqis/rnw.home; accessed November 19, 2025) for more information on the Norco Community Ambient Monitoring Network and data.

Figure 3-7. Shell Norco Community Ambient Monitoring Network

3.1.2.4 Office of Air and Radiation Fenceline Monitoring Data

EPA's Office of Air and Radiation (OAR) conducted modeling of 2017 National Emissions Inventory (NEI) and reported releases from select facilities (EPA-HQ-OAR-2022-0730-0091). Fenceline monitoring data was reported for nine facilities that collected biweekly samples. Eight of the nine facilities collected 14-day samples for three consecutive sampling periods for a total of 42 days between April and July 2022. One facility collected biweekly samples from January 2022 to December 2024. compared fenceline monitoring concentrations to information submitted to EPA in accordance with the information requests to model concentrations using American Meteorological Society (AMS)/EPA Regulatory Model (AERMOD) and the NEI emissions. The results showed that fenceline monitoring concentrations obtained and submitted by industry facilities tended to be higher than EPA's modeled concentrations using AERMOD and based on the 2017 NEI release dataset. The mean fenceline monitoring concentrations ranged from ND to 0.70 µg/m^3 compared to the mean AMTIC 24-hour monitoring concentrations that ranged from 0.08 to 0.15 µg/m^3 (0.22–0.43 µg/m^3, excluding NDs / <MDLs). For additional information, see Section 2.3.3.1 of the *General Population Exposures for 1,3-Butadiene*. Although these data reflect fenceline air concentrations of 1,3-butadiene, they are not the best available data upon which to estimate exposure to 1,3-butadiene from TSCA facility releases for the following reasons: (1) data are reported for only 9 of 225 Toxics Release Inventory (TRI) facilities; (2) air monitoring stations represent a "snapshot" concentration and cannot be extrapolated to annual concentrations; and (3) monitoring stations detect 1,3-butadiene from all sources, including mobile vehicle exhaust and combusted organic matter (*i.e.*, fires). Therefore, OAR data supports use of modeled data for general population exposure estimates.

3.2 Measured Concentrations in Indoor Air

3.2.1 Peer-Reviewed Literature

3.2.1.1 Measured Concentrations

Measured concentrations of 1,3-butadiene in indoor air were extracted from four U.S. studies published between the years 1999 and 2007 (Figure 3-8). Loh et. al (2006) reported a geometric mean concentration of 1.05 µg/m^3 and a maximum concentration of 35.5 µg/m^3 from measurements collected in a public dining space in Boston, Massachusetts, and a geometric mean concentration of 0.21 µg/m^3 and a maximum concentration of 2.20 µg/m^3 in retail stores. The study attributed 1,3-butadiene in the dining spaces to cooking and tobacco smoke. Sax et al. (2006) reported a mean concentration of 1.01 µg/m^3 and a maximum concentration of 9.02 µg/m^3 in homes throughout New York City, New York, and a mean concentration of 0.41 µg/m^3 and maximum concentration of 1.47 µg/m^3 in homes in Los Angeles, California.

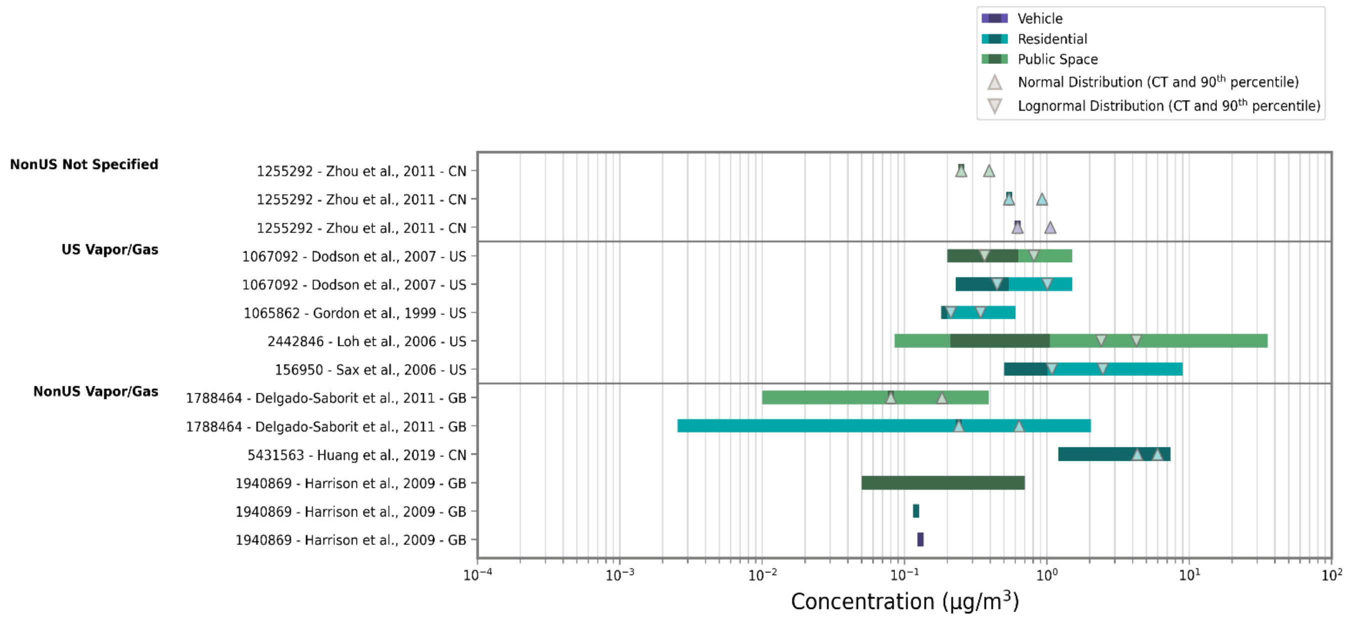


Figure 3-8. Concentrations of 1,3-Butadiene (μg/m^3) in Indoor Air from 1998–2011

3.2.1.2 Modeled Concentrations

Modeled concentrations of 1,3-butadiene in indoor air were also captured during systematic review from one study in the United States with results that were within range of measured concentrations (Loh et al., 2007).

3.3 Measured Concentrations in Landfill Gas

3.3.1 Peer-Reviewed Literature

Measured concentrations of 1,3-butadiene in landfill gas were extracted from 1 U.S. study with 12 samples collected in 1998 (Figure 3-9). The average concentration of 3.98 ppm (8,800 μg/m^3) was reported from measurements collected at a municipal solid-waste landfill in New York City, New York (Eklund et al., 1998). Notably, in this study that landfill gas is collected by an on-site gas collection system and treated for impurities before being sold to utility services. Therefore, exposure to the general population from landfill gas is not expected.

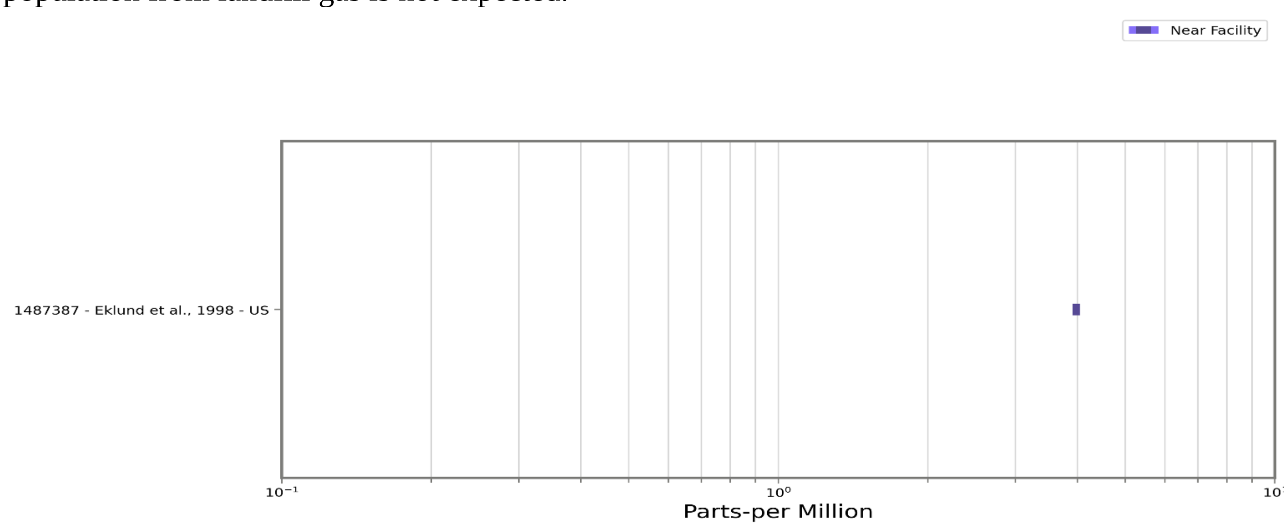


Figure 3-9. Concentrations of 1,3-Butadiene (ppm) in Landfill Gas from 1998

3.4 Personal Exposure Monitoring

3.4.1 Peer-Reviewed Literature

Measured concentrations of 1,3-butadiene from personal monitoring samples were available from four U.S. studies conducted from 1996 and 2015 (Figure 3-10) (Shin et al., 2015; Dodson et al., 2007; Sax et al., 2006; Heavner et al., 1996). Heavner and colleagues reported a mean of 0.54 µg/m^3 and 0.57 µg/m^3 in non-smoking homes and non-smoking workplaces, respectively, in New Jersey, with samples collected in November 1992. Shin et al. (2015) reported a mean concentration of 1.38 µg/m^3 based on data collected from the Detroit Exposure and Aerosol Research Study (DEARS), which collected personal monitoring samples throughout six Detroit area neighborhoods during summer and winter periods over 3 years between 2004 and 2007. Sax et al. (2006) reported a mean of 0.97 µg/m^3 and 0.47 µg/m^3 for personal monitoring samples collected from residential homes in New York City and Los Angeles, respectively, with about 40 percent of sample measurements reported as below limit of detection (LOD). Sampling was conducted in two seasons, winter (February–April 1999) and summer (June–August 1999) in New York City and winter (February–March 2000) and fall (September–October 2000) in Los Angeles. Dodson et al. (2007), as part of the Boston Exposure Assessment in Microenvironments (BEAM) study, resulted in a substantial number of measurements below the LOD. The measurements from these personal monitoring studies are similar to the measurements reported in the ambient air and indoor air peer-reviewed literature and also attribute sources of 1,3-butadiene to industrial facilities, vehicular emissions, and tobacco smoke. However, due to the relatively small sample sizes across these studies (which ranged from 46–104 participants) and varying exposure factors (*e.g.*, smoking, behavioral, activity patterns), it is difficult to extrapolate results from individual exposures to expected population-based exposures.

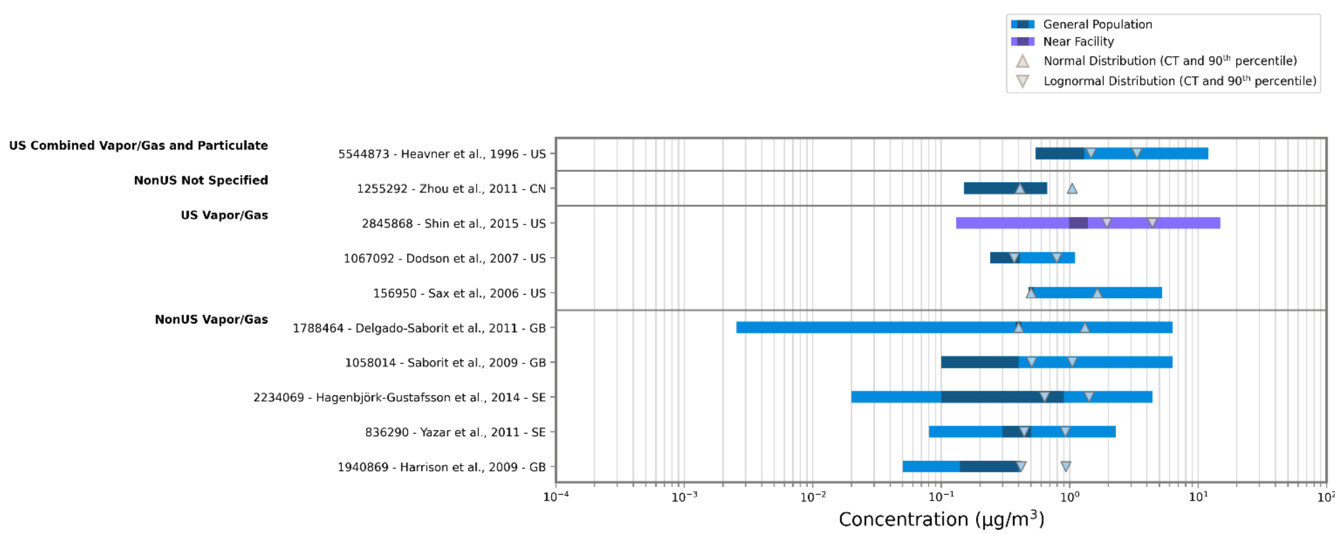


Figure 3-10. Personal Exposure Measurements of 1,3-Butadiene (µg/m^3) from 1996–2015

3.5 Evidence Integration

Measurements from monitoring databases, including the AMTIC ambient air monitoring sites database (U.S. EPA, 2022a), and concentrations reported in the literature provide evidence that exposure to 1,3-butadiene from the air pathway is expected in ambient air. Therefore, EPA conducted a quantitative assessment of exposure to 1,3-butadiene in ambient air for the general population. The Agency modeled ambient air concentrations based on releases from the TRI 2016 to 2021 database to assess general population exposure to ambient air from facility releases of 1,3-butadiene. For more details on environmental releases and general population exposure, see the *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2025b) and the *General Population Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2025c), respectively.

4 WATER PATHWAY

The DMR (U.S. EPA, 2019a) recorded no releases of 1,3-butadiene from wastewater treatment facilities to surface water bodies. The TRI (U.S. EPA, 2022b) only recorded very small releases with the maximum being about 400 kg into Mississippi River in 2020 (see *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2025b)). With average flow rate in the Mississippi River of 1.15×10^{12} L/day, the estimated surface water concentration would be about 0.96 ng/L—not accounting for volatilization that would further decrease the concentration.

1,3-Butadiene has a low water solubility of 735 mg/L. In addition, volatilization of 1,3-butadiene from water surfaces is expected to occur rapidly due to a Henry's Law constant of 0.076 atm.m^3/mol. EPI Suite™ estimates volatilization rates of hours to a few days for a surface water body of 1 m depth, wind velocities ranging from 0.5 to 5 m/s, and water current velocity ranging from 0.0 to 1 m/s. For more details on the chemical properties of 1,3-butadiene, see the *Physical Chemistry, Fate, and Transport Assessment for 1,3-Butadiene* (U.S. EPA, 2025d).

4.1 Measured Concentrations in Surface Water

The WQP (NWQMC, 2022) is a publicly available resource that integrates water quality data from the U.S. Geological Survey (USGS) National Water Information System (NWIS) (USGS, 2013) and EPA's Water Quality Exchange (WQX) Data Warehouse (U.S. EPA, 2019b). The NWIS database contains current and historical water data from more than 1.5 million sites across the nation. The WQX is the EPA's repository of water quality monitoring data collected by water resource management groups across the nation. The complete set of 1,3-butadiene monitoring results stored in the WQP (NWQMC, 2022) was retrieved in January 2024. The raw dataset included 10,206 samples collected between 2011 and 2023. A higher number of samples were from California, New York, Texas, Georgia, North Carolina, and Florida (where >39% of the U.S. population resides) compared to other states. The WQP 1,3-butadiene dataset did not contain samples from Alaska, Delaware, Rhode Island, Hawaii, or Vermont (<2% of the U.S. population live in these states).

Although the 1,3-butadiene WQP dataset exceeded 10,000 samples, the majority of the samples were groundwater samples with only 231 surface water samples. The surface water samples were from 23 states taken over the period of 2012 to 2020. Greater than 80 percent of the surface water samples were sourced from North Carolina (81), Georgia (47), Illinois (29), South Carolina (25), and Virginia (13). Most of samples were collected between 2012 to 2015 with about 75 percent of the samples being collected in 2014. The surface water samples were all from NWIS. For more information and details, see the supplemental file *Water Quality Portal (WQP) Monitoring Data 2011 to 2023 for 1,3-Butadiene* (U.S. EPA, 2025h). All 231 surface water samples reported 1,3-butadiene concentrations below the MDL of 0.08 µg/L.

4.2 Evidence Integration for Surface Water

Based on the low reported releases to surface water (U.S. EPA, 2025b), physical and chemical properties (U.S. EPA, 2025d), and monitoring data reporting a 0 percent detection frequency of 1,3-butadiene (Section 4.1), EPA was unable to conduct a quantitative assessment of risk for surface water.

After systematic review and a review of the WQP database (NWQMC, 2022), EPA did not find reported measured sediment concentrations of 1,3-butadiene in the United States. As described in Sections 4.1 and 4.2, 1,3-butadiene is not expected to be found in surface water; therefore, there is no route to enter sediments. Furthermore, 1,3-butadiene has a low estimated organic carbon:water partition coefficient (K_{OC}) value of 54 (U.S. EPA, 2012), indicating that if the chemical were to enter surface water, it would be unlikely to partition to sediment. As a result, EPA did not conduct a quantitative assessment of risk for sediments.

4.3 Measured Concentrations in Drinking Water

Public water systems (PWSs) are regulated under the Safe Drinking Water Act (SDWA)[3]. To assess concentrations of 1,3-butadiene in water that is distributed as drinking water, monitoring data collected by PWSs were evaluated. Concentrations of 1,3-butadiene found in finished (*i.e.*, treated) drinking water were extracted from the EPA's publicly available Third Unregulated Contaminant Monitoring Rule (UCMR3)[4] dataset, which includes samples collected between 2013 to 2015 (U.S. EPA, 2017). The data covers all PWSs serving more than 10,000 people and 800 representative PWSs serving 10,000 or fewer people within all U.S. states and territories. Drinking water samples were collected at the entry point into the distribution system; that is, after the drinking water treatment process but before delivery into residential homes. The data shows that all but 2 of 36,839 tested drinking water samples (>99.9%) were below the minimum RL for 1,3-butadiene (RL = 0.1 µg/L). The two samples reported 1,3-butadiene at concentrations of 0.32 and 0.54 µg/L in Florida (PWSID FL3480962) and Puerto Rico (PWSID PR0002591), respectively. The sources of the drinking water for PWSIDs FL3480962 and PR0002591 are groundwater and surface water, respectively. No additional information about the two detections in drinking water was found. EPA was not able to evaluate drinking water sourced outside the PWSs but expects no significant differences from the public drinking water based on the physical and chemical properties of 1,3-butadiene. For more details on the UCMR3 data, see the supplemental file *Third Unregulated Contaminant Monitoring Rule (UCMR3) data for 1,3-Butadiene* (U.S. EPA, 2025g).

4.4 Evidence Integration for Drinking Water

Based on the physical and chemical properties of 1,3-butadiene—that is, its low water solubility and high tendency to volatilize from water as well as the monitored data showing that 1,3-butadiene is not detected in drinking water from PWSs—EPA did not conduct a quantitative assessment of risk for drinking water.

[3] See https://www.epa.gov/sdwa (accessed November 19, 2025) for more information.
[4] See https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule (accessed November 19, 2025) for more information.

5 LAND PATHWAY

Land contamination from 1,3-butadiene may be expected to occur from releases to land, which mainly includes discharge of wastewater into underground injection wells and disposal of waste into landfills (see *Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2025b)).

According to reports in the 2016 CDR, the use of plastic and rubber products (including synthetic rubbers) were identified as consumer conditions of use for 1,3-butadiene. EPA has determined however that 1,3-butadiene, a monomer used in polymer-derived consumer products such as synthetic rubbers, is stable in these products and not expected to degrade and expose the consumer to the 1,3-butadiene monomer (U.S. EPA, 2025e). Furthermore, rubber and plastic products in landfills would not be expected to form leachates containing any significant amount of 1,3-butadiene.

Sludge from water treatment systems in polymer production facilities are not expected to contain significant amounts of 1,3-butadiene due to its volatility and low affinity for organic matter. Any release of 1,3-butadiene to soil (such as air deposition) would volatilize rapidly and is not expected to remain in soil for any significant amount of time.

Releases to land comprise less than 1 percent of releases of 1,3-butadiene to the environment (U.S. EPA, 2025b). Most releases of 1,3-butadiene to land are to class I underground injection wells. Oversight of these wells requires that the wells are designed and constructed to prevent the movement of injected waste streams into drinking water systems. Wells typically consist of three or more concentric layers of pipe including surface casing, long string casing, and injection tubing. In addition, wells must be sited at locations with geologies that mitigate any movement of contaminants outside of a confined layer if there were a well failure. Extensive pre-siting geological tests confirm that the injection zone is of sufficient lateral extent and thickness and is sufficiently porous so that fluids injected through the well can enter the rock formation without extensive buildup of pressure or possible displacement of injected fluids outside of the intended zone. Thus, it is unlikely that this disposal pathway could contaminate a drinking water source. See https://www.epa.gov/uic/class-i-industrial-and-municipal-waste-disposal-wells (accessed November 19, 2025) for more information on class I underground injection wells.

5.1 Measured Concentrations in Groundwater

The complete set of 1,3-butadiene monitoring results from theWQP (NWQMC, 2022) were retrieved in January 2024. The raw dataset included 10,206 samples from across the United States collected between 2011 and 2023. A higher number of samples were from California, New York, Texas, Georgia, North Carolina, and Florida (where >39% of the U.S. population resides) compared to other states and it did not contain samples from Alaska, Delaware, Rhode Island, Hawaii, and Vermont (<2% of the U.S. population live in these states). When samples of other types of water were excluded, there were 9,378 groundwater samples from 46 states for the period of 2011 to 2023. Greater than 50 percent of the samples were from Arizona with another 18 percent from California.

After the *Draft Environmental Media Concentrations for 1,3-Butadiene* was released in 2024, EPA queried the WQP database in July 2025. The July 2025 data contained 11,136 groundwater samples across the United States. The geographical distribution of the samples remained largely unchanged from the draft but there were over 1,500 more samples from Arizona that had been collected in 2024 and 2025. All samples were reported as NDs. The MDLs for samples reported by NWIS ranged from 0.08 to 0.16 µg/L whereas the MDLs for the samples reported by WQX varied more widely between 0.000299 to 5,000 µg/l. About 40 percent of the groundwater samples were reported in NWIS and 60 percent were reported in WQX. For more details on the monitoring data, see the supplemental file *Water Quality Portal (WQP) Monitoring Data 2004 to 2025 for 1,3-Butadiene* (U.S. EPA, 2025h).

EPA also queried the State of Washington's Environmental Information Management System (EIMS) in September 2025 for groundwater samples. There were 53 groundwater samples which were all below the LOD for 1,3-butadiene. For more details visit https://ecology.wa.gov/research-data/data-resources/environmental-information-management-database (accessed November 19, 2025).

5.2 Evidence Integration

Based on the low volume of releases to land, the low risk of failure of the predominant release scenario, the physical and chemical properties of 1,3-butadiene, as well as monitoring data indicating no detections of 1,3-butadiene, EPA did not perform a quantitative analysis for the land pathway because exposure to the general population is not expected to occur.

6 WEIGHT OF SCIENTIFIC EVIDENCE

6.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for Measured Concentrations in Ambient Air

AMTIC data has been previously reviewed and verified by the AMTICs Ambient Air Monitoring Group, which has taken various quality assurance steps to ensure data quality and has been certified in accordance with 40 CFR 58.15. Due to strictly regulated monitoring requirements, EPA has high confidence in the AMTIC ambient air dataset (U.S. EPA, 2022a), which also received a high-quality rating from EPA's systematic review process for 1,3-butadiene (U.S. EPA, 2021a).

A primary limitation of the AMTIC data, and other monitoring data, is that because the data have not been annualized, they represent a diverse collection of sampling durations (none of which are annual averages), which are not directly comparable to modeled data. Additionally, because monitoring data represents a total aggregate concentration from all sources of 1,3-butadiene contributing to ambient air concentrations, monitoring data cannot be used to characterize exposures exclusively from sources associated with COUs. See the *General Population Exposures for 1,3-Butadiene* (U.S. EPA, 2025c) for more details comparing modeled and measured data.

The 1,3-butadiene concentrations from systematic review were extracted from 31 studies from 6 countries. All media types included studies and data collected in the United States with ratings of medium- or high-quality, which are representative of exposure for the U.S. general population. Studies from non-U.S. countries may not be representative of exposure for the general population in the United States; one study was given a rating of low-quality from Spain. See Appendix A for study ratings for all peer-reviewed literature from systematic review. Notably, measured data from systematic review vary temporally, air concentrations are especially subject to season variation, and vary geospatially. Methodology for sample collection and analysis are specific to each peer-reviewed literature and vary with instrumentation and analysis. Concentrations of 1,3-butadiene across all media are attributed to many different sources, including but not limited to facility emissions, traffic emissions, heating and cooking combustion activities, and environmental tobacco smoke, and are not specific to only TSCA COUs.

6.2 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for Measured Concentrations in Water

The 1,3-butadiene data from the WQP exhibits a strong sampling bias towards California, New York, Texas, Georgia, North Carolina, and Florida, which collectively account for over 39 percent of the U.S. population. In contrast, data are missing from Alaska, Delaware, Rhode Island, Hawaii, and Vermont, representing less than 2 percent of the U.S. population and less than 1 percent of the 1,3-butadiene facilities nationwide. States with a higher number of data points generally have larger populations and include those with higher number of 1,3-butadiene facilities, such as Texas and California that are expected to have the largest releases of 1,3-butadiene. However, it remains unclear where the sampling locations are in relation to these releasing facilities. In addition, some of the data may be from states with no 1,3-butadiene facilities.

The WQP contains data from WQX. Many data fields in WQX are highly variable to accommodate the many original sources of data that WQX captures. The data also provide results based on different analytical methods and study goals (U.S. EPA, 2009). WQX data are often not nationally representative, and the data often overlap with nationally representative water data such as the USGS National Water-

Quality Assessment (NAWQA). NAWQA provides current conditions and water quality with the information stored in NWIS. Because NWIS data reflects that 1,3-butadiene is typically not detected above the detection limit in surface water or groundwater, EPA has robust confidence that in areas lacking data, which are mainly areas associated with lower releases, 1,3-butadiene will not be present in the water. In addition, based on the physical and chemical properties of 1,3-butadiene and low release quantities to water and land, EPA has confidence that the WQP data are representative of the entire United States. Furthermore, WQP is not specific to only the TSCA COUS.

The Washington State's EIMS groundwater database (accessed November 19, 2025), despite its limitations—such as incomplete geographic coverage, potential inaccuracies, outdated information, accessibility challenges, and limited parameters for comprehensive analysis—serves as an added line of evidence indicating that 1,3-butadiene is not present in groundwater.

The 1,3-butadiene data from EPA's UCMR3 covered all PWSs serving more than 10,000 people and 800 representative PWSs serving 10,000 or fewer people. The PWSs were monitored during a 12-month period from January 2013 through December 2015. This data may have a bias towards states with greater populations (*e.g.*, California) due to a higher number of PWSs serving 10,000 or more people, compared to the representative 800 PWSs serving 10,000 or fewer people, including Tribal nations. In addition, the UCMR3 only required samples to be collected during a 12-month period between January 2013 through December 2015, which is a timespan of approximately 3 years, so it does not consider temporal variability beyond the 12-month sampling periods. Lastly, the UCMR3 data are not specific to only TSCA COUs. Nevertheless, EPA has robust confidence in the representativeness of the UCMR3 data.

7 CONCLUSIONS

Based on the (1) physical and chemical properties of 1,3-butadiene (*i.e.*, high volatility, low solubility, and low sorption tendencies) (U.S. EPA, 2025d); (2) low release volume to land and water (U.S. EPA, 2025b); and (3) minimal detection of 1,3-butadiene in U.S. surface and groundwaters, EPA has robust confidence that air is the major pathway of exposure for 1,3-butadiene and that contributions to exposure from the land and water pathways will be infrequent and exposure would be at low levels. As a result, air is the only pathway that was assessed quantitatively for the risk evaluation.

For U.S. regions where monitoring data are available, EPA has robust confidence in the overall characterization of environmental media concentrations for 1,3-butadiene as it relies upon standard reporting databases that are reviewed with quality control and assurance protocols, such as AMTIC, WQP, and UCMR, as well as extracted data from peer-reviewed literature that received medium- to high-quality ratings from EPA's systematic review process (U.S. EPA, 2025f).

8 REFERENCES

Baek, KM; Kim, MJ; Seo, YK; Kang, BW; Kim, JH; Baek, SO. (2020). Spatiotemporal variations and health implications of hazardous air pollutants in Ulsan, a multi-industrial city in Korea. Atmosphere (Basel) 11: 547. http://dx.doi.org/10.3390/atmos11050547

Bereznicki, SD; Sobus, J; Vette, AF; Stiegel, MA; Williams, R. (2012). Assessing spatial and temporal variability of VOCs and PM-components in outdoor air during the Detroit Exposure and Aerosol Research Study (DEARS). Atmos Environ 61: 159-168. http://dx.doi.org/10.1016/j.atmosenv.2012.07.008

Delgado-Saborit, JM; Aquilina, NJ; Meddings, C; Baker, S; Harrison, RM. (2011). Relationship of personal exposure to volatile organic compounds to home, work and fixed site outdoor concentrations. Sci Total Environ 409: 478-488. http://dx.doi.org/10.1016/j.scitotenv.2010.10.014

Dodson, RE; Houseman, EA; Levy, JI; Spengler, JD; Shine, JP; Bennett, DH. (2007). Measured and modeled personal exposures to and risks from volatile organic compounds. Environ Sci Technol 41: 8498-8505. http://dx.doi.org/10.1021/es071127s

Domingo, JL; Rovira, J; Vilavert, L; Nadal, M; Figueras, MJ; Schuhmacher, M. (2015). Health risks for the population living in the vicinity of an Integrated Waste Management Facility: screening environmental pollutants. Sci Total Environ 518-519: 363-370. http://dx.doi.org/10.1016/j.scitotenv.2015.03.010

Eklund, B; Anderson, EP; Walker, BL; Burrows, DB. (1998). Characterization of landfill gas composition at the Fresh Kills municipal solid-waste landfill. Environ Sci Technol 32: 2233-2237. http://dx.doi.org/10.1021/es980004s

Gordon, SM; Callahan, PJ; Nishioka, MG; Brinkman, MC; O'Rourke, MK; Lebowitz, MD; Moschandreas, DJ. (1999). Residential environmental measurements in the National Human Exposure Assessment Survey (NHEXAS) pilot study in Arizona: Preliminary results for pesticides and VOCs. J Expo Anal Environ Epidemiol 9: 456-470. http://dx.doi.org/10.1038/sj.jea.7500042

Hagenbjörk-Gustafsson, A; Tornevi, A; Andersson, EM; Johannesson, S; Bellander, T; Merritt, AS; Tinnerberg, H; Westberg, H; Forsberg, B; Sallsten, G. (2014). Determinants of personal exposure to some carcinogenic substances and nitrogen dioxide among the general population in five Swedish cities. J Expo Sci Environ Epidemiol 24: 437-443. http://dx.doi.org/10.1038/jes.2013.57

Harrison, RM; Delgado-Saborit, JM; Baker, SJ; Aquilina, N; Meddings, C; Harrad, S; Matthews, I; Vardoulakis, S; Anderson, HR; Committee, HHR. (2009). Measurement and modeling of exposure to selected air toxics for health effects studies and verification by biomarkers. In Res Rep Health Eff Inst 2009, Jun(143):3-96; discussion 97-100 [Research report (Health Effects Institute)] (pp. 3-96; discussion 97-96100). (ISSN 1041-5505

EISSN 2688-6855). Harrison, RM; Delgado-Saborit, JM; Baker, SJ; Aquilina, N; Meddings, C; Harrad, S; Matthews, I; Vardoulakis, S; Anderson, HR; HEI Health Review Committee. https://search.proquest.com/docview/734192052?accountid=171501

Heavner, DL; Morgan, WT; Ogden, MW. (1996). Determination of volatile organic compounds and respirable suspended particulate matter in New Jersey and Pennsylvania homes and workplaces. Environ Int 22: 159-183. http://dx.doi.org/10.1016/0160-4120(96)00003-7

Huang, Y; Su, T; Wang, L; Wang, N; Xue, Y; Dai, W; Lee, SC; Cao, J; Ho, SSH. (2019). Evaluation and characterization of volatile air toxics indoors in a heavy polluted city of northwestern China in wintertime. Sci Total Environ 662: 470-480. http://dx.doi.org/10.1016/j.scitotenv.2019.01.250

Logue, JM; Small, MJ; Stern, D; Maranche, J; Robinson, AL. (2010). Spatial variation in ambient air toxics concentrations and health risks between industrial-influenced, urban, and rural sites. J Air Waste Manag Assoc 60: 271-286. http://dx.doi.org/10.3155/1047-3289.60.3.271

Loh, MM; Houseman, EA; Gray, GM; Levy, JI; Spengler, JD; Bennett, DH. (2006). Measured concentrations of VOCs in several non-residential microenvironments in the United States. Environ Sci Technol 40: 6903-6911. http://dx.doi.org/10.1021/es060197g

Loh, MM; Levy, JI; Spengler, JD; Houseman, EA; Bennett, DH. (2007). Ranking cancer risks of organic hazardous air pollutants in the United States. Environ Health Perspect 115: 1160-1168. http://dx.doi.org/10.1289/ehp.9884

Luecken, DJ; Hutzell, WT; Gipson, GL. (2006). Development and analysis of air quality modeling simulations for hazardous air pollutants. Atmos Environ 40: 5087-5096. http://dx.doi.org/10.1016/j.atmosenv.2005.12.044

NWQMC (National Water Quality Monitoring Council). (2022). Water quality portal: 1,4-Dioxane [Database]. Washington, DC. Retrieved from https://acwi.gov/monitoring/waterqualitydata.html

Radian Engineering (Radian Engineering, Inc.). (1997). General Electric Engine Services Test Cell Complex - AB 2588 air toxic "hot spots" 1991 health risk assessment, with cover letter dated 10/21/1997 [TSCA Submission] (pp. #86-980000062). (OTS0559400. 86-980000062. TSCATS/445541). GE Engine Services Incorporated. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/OTS0559400.xhtml

Saborit, JMD; Aquilina, NJ; Meddings, C; Baker, S; Vardoulakis, S; Harrison, RM. (2009). Measurement of personal exposure to volatile organic compounds and particle associated PAH in three UK regions. Environ Sci Technol 43: 4582-4588. http://dx.doi.org/10.1021/es9005042

Sax, SN; Bennett, DH; Chillrud, SN; Ross, J; Kinney, PL; Spengler, JD. (2006). A cancer risk assessment of inner-city teenagers living in New York City and Los Angeles. Environ Health Perspect 114: 1558-1566. http://dx.doi.org/10.1289/ehp.8507

Shin, HH; Jones, P; Brook, R; Bard, R; Oliver, K; Williams, R. (2015). Associations between personal exposures to VOCs and alterations in cardiovascular physiology: Detroit Exposure and Aerosol Research Study (DEARS). Atmos Environ 104: 246-255. http://dx.doi.org/10.1016/j.atmosenv.2015.01.016

Suzuki, N; Murasawa, K; Sakurai, T; Nansai, K; Matsuhashi, K; Moriguchi, Y; Tanabe, K; Nakasugi, O; Morita, M. (2004). Geo-referenced multimedia environmental fate model (G-CIEMS): Model formulation and comparison to the generic model and monitoring approaches. Sci Total Environ 38: 5682-5693. http://dx.doi.org/10.1021/es049261p

U.S. EPA. (2009). Final contaminant candidate list 3 chemicals identifying the universe. (815R09006). http://nepis.epa.gov/exe/ZyPURL.cgi?Dockey=P10056NB.txt

U.S. EPA (U.S. Environmental Protection Agency). (2012). PhysProp database. Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.11: Formaldehyde (CASRN: 50-00-0) [Fact Sheet]. Washington, DC. https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface

U.S. EPA (U.S. Environmental Protection Agency). (2015). Technical support document, EPA's 2011 National-scale Air Toxics Assessment, 2011 NATA TSD. Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards. https://www.epa.gov/sites/production/files/2015-12/documents/2011-nata-tsd.pdf

U.S. EPA (U.S. Environmental Protection Agency). (2017). The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data summary, January 2017. (EPA 815-S-17-001). Washington, DC: U.S Environmental Protection Agency, Office of Water. https://www.epa.gov/sites/production/files/2017-02/documents/ucmr3-data-summary-january-2017.pdf

U.S. EPA (U.S. Environmental Protection Agency). (2019a). Discharge Monitoring Report (DMR) data, Reporting year 2019: 1,3-Butadiene (CAS RN 106-99-0). Washington, DC. Retrieved from https://echo.epa.gov/trends/loading-tool/water-pollution-search

U.S. EPA (U.S. Environmental Protection Agency). (2019b). Storage and retrieval (STORET) data warehouse and water quality exchange (WQX) [database]: CASRNs 85-68-7, 106-99-0, 84-74-2, 75-34-3, 78-87-5, 117-81-7, 106-93-4, 107-06-2, 50-00-0, 1222-05-5, 95-50-1, 85-44-9, 106-46-7, 79-94-7, 79-00-5, 115-96-8, 156-60-5, and 115-86-6 [Database]. Washington, DC. Retrieved from https://www.waterqualitydata.us/portal/

U.S. EPA (U.S. Environmental Protection Agency). (2021a). Best practices for review and validation of ambient air monitoring data. (EPA-454/B-21-007).

U.S. EPA (U.S. Environmental Protection Agency). (2021b). Draft systematic review protocol supporting TSCA risk evaluations for chemical substances, Version 1.0: A generic TSCA systematic review protocol with chemical-specific methodologies. (EPA Document #EPA-D-20-031). Washington, DC: Office of Chemical Safety and Pollution Prevention. https://www.regulations.gov/document/EPA-HQ-OPPT-2021-0414-0005

U.S. EPA (U.S. Environmental Protection Agency). (2022a). Ambient Monitoring Technology Information Center (AMTIC) - Ambient Monitoring Archive for HAPs [Database]. Washington, DC. Retrieved from https://www.epa.gov/amtic/amtic-ambient-monitoring-archive-haps

U.S. EPA (U.S. Environmental Protection Agency). (2022b). Toxics Release Inventory (TRI) data for 1,4-dioxane, 2013-2019. Washington, DC. Retrieved from https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools

U.S. EPA (U.S. Environmental Protection Agency). (2025a). Ambient Monitoring Technology Information Center (AMTIC) Monitoring Data 2016 to 2021 for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025b). Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025c). General Population Exposure for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025d). Physical Chemistry and Fate Assessment for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025e). Risk Evaluation for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025f). Systematic Review Protocol for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025g). Third Unregulated Contaminant Monitoring Rule (UCMR3) Data for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA (U.S. Environmental Protection Agency). (2025h). Water Quality Portal (WQP) Monitoring Data 2011 to 2023 for 1,3-Butadiene. Washington, DC: Office of Pollution Prevention and Toxics.

USGS (U.S. Geological Survey). (2013). National Water Information System (NWIS) [Database]. Retrieved from http://waterdata.usgs.gov/nwis

Yazar, M; Bellander, T; Merritt, AS. (2011). Personal exposure to carcinogenic and toxic air pollutants in Stockholm, Sweden: A comparison over time. Atmos Environ 45: 2999-3004. http://dx.doi.org/10.1016/j.atmosenv.2011.03.008

Yu, CH; Zhu, X; Fan, ZH. (2014). Spatial/temporal variations and source apportionment of VOCs monitored at community scale in an urban area. PLoS ONE 9: e95734. http://dx.doi.org/10.1371/journal.pone.0095734

Yu, H; Stuart, A. (2016). Exposure and inequality for select urban air pollutants in the Tampa Bay area. Sci Total Environ 551: 474-483. http://dx.doi.org/10.1016/j.scitotenv.2016.01.157

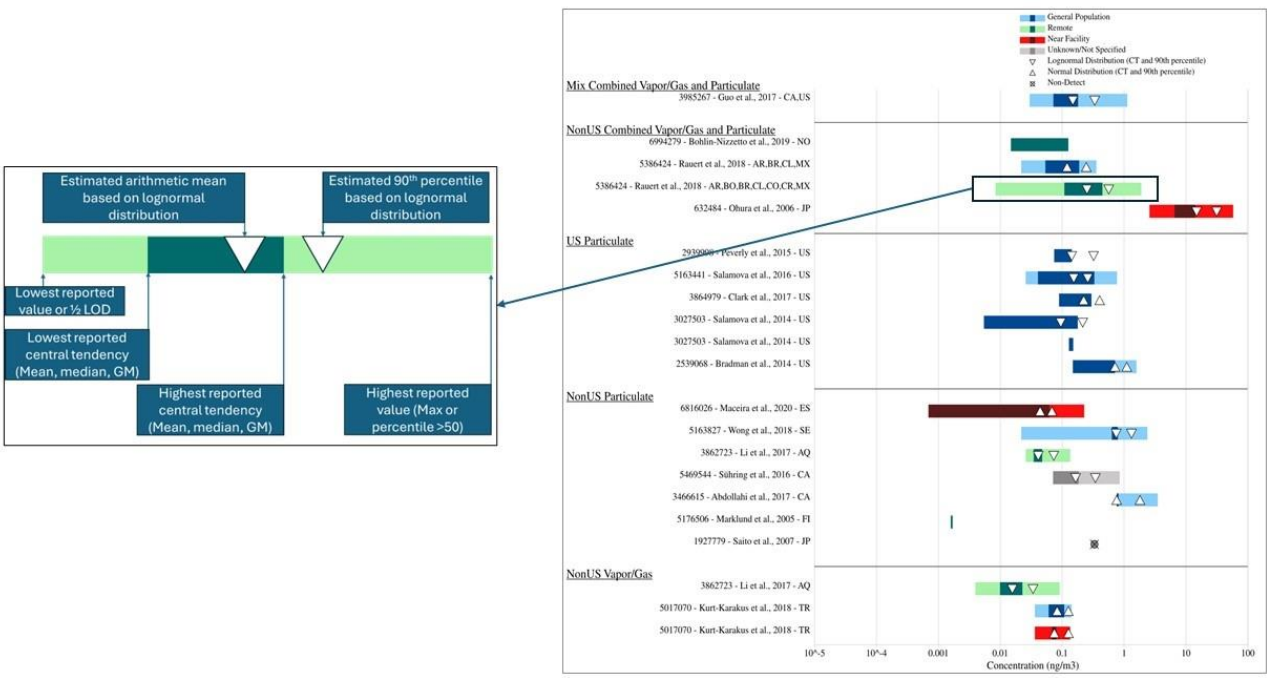
Zhou, J; You, Y; Bai, Z; Hu, Y; Zhang, J; Zhang, N. (2011). Health risk assessment of personal inhalation exposure to volatile organic compounds in Tianjin, China. Sci Total Environ 409: 452-459. http://dx.doi.org/10.1016/j.scitotenv.2010.10.022

APPENDICES

Appendix A SUPPLEMENTAL INFORMATION OF PEER-REVIEWED LITERATURE AND STUDY RATINGS FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

A.1 Environmental Monitoring Concentrations Reported by Media Type

A.1.1 Tornado Plot Interpretation and Methods



Figure_Apx A-1. Example Tornado Plot

Tornado plots display exposure data from studies identified during systematic review. An example is provided in Figure_Apx A-1. In this TSD, there is one tornado plot for every media type where 1,3-butadiene concentrations are plotted on a logarithmic scale.

The y-axis of the tornado plot is a list of each study aggregate representing a media sampled in a similar micro-environment and location and reported on the same unit/weight basis. A study may have more than one aggregate representation dependent on how it is reported data; for example, if a study reports exposure data collected at two different locations, the data would be plotted as two separate aggregates.

Exposure data are classified into a variety of location types:

Near Facility

Near Facility exposures are collected near buildings or activities that are industrial in nature (including manufacturing, mining, pulp and paper mill, wastewater treatment plants, fire training facilities, and ports), commercial activities known to use chemicals (such as dry cleaners, gas stations, and construction sites), residential areas near a facility (these areas may be referred to as "fenceline communities" or "highly-exposed communities"), or ocean samples from a port or contaminated area. Near facility samples are not strictly contaminated sites and may be site-specific or not site-specific.

General Population

General population exposures are ambient measurements taken in areas near residential populations with no known near facility sources nearby. The data often represents widely distributed releases to the environment.

Remote

Remote exposures are measurements taken in areas away from residential and industrial activity and have no known sources of contamination beyond long-range transport. Examples of remote exposures include samples collected from polar regions, samples from oceans (not including ports), and sample locations specifically described as remote.

Indoor Media Classifications

Indoor air and dust samples will have indications in the legend based on sampling location such as commercial buildings, residential homes, public buildings, and vehicles. If studies report more than one of these microenvironments, then they are classified as mixed use.

Wastewater Classifications

Wastewater samples will indicate their sampling location at the wastewater processing facility.

Each study on the y-axis is reported with its HERO ID, a short citation, and the country abbreviation of data collection. Additional details on tissue type or metabolite might also be presented as part of the label depending on the media. The studies are grouped by US, combined with US, or non-US data by unit/weight basis, and sorted in descending order by latest data collection year.

Every study has a colored bar stretching across the x-axis. The color of the bar corresponds to the location type of the exposure data. The lighter bar represents the range of the reported concentrations, and the darker bar represents the range of reported central tendencies. A study with only dark bars indicates that the only data reported was a measure of central tendency.

Using the reported exposure data, if sufficient central tendency and variance data were reported, the mean and 90th percentile were calculated directly from the study values assuming data were normally or lognormally distributed. When at least a central tendency and percentile value were provided, they were estimated by fitting the data to a lognormal distribution to all available data within the study aggregate. When fitting a lognormal distribution was not possible, a normal distribution was fit. The central tendency and 90th percentile of each distribution are plotted as triangles. Lognormal values are shown as upside-down triangles, while normal values are shown as right-side up. A study with no triangles indicates that there was insufficient data to fit a distribution.

A study may not have reported concentrations because all data are below the limit of detection. In these circumstances, the plot will show a circle with an X through it plotted at half the reported LOD. The color of the symbol will correspond to the color of the data's location type.

Appendix B SUPPLEMENTAL INFORMATION OF PEER-REVIEWED LITERATURE FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

Table_Apx B-1. Summary of Peer-Reviewed Literature That Measured 1,3-Butadiene (µg/m³) Levels in Ambient Air

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m³)	Overall Quality Level
Not specified						
Zhou et al. (2011)	CN	General Population	2008	8 (N/R)	N/R	Medium
Vapor/gas						
U.S. EPA (2015)	US	General Population	2010–2012	121 (N/R)	N/R	High
Logue et al. (2010)	US	General Population	2006–2008	244 (N/R)	N/R	High
Logue et al. (2010)	US	Near Facility	2006–2008	244 (N/R)	N/R	High
Dodson et al. (2007)	US	General Population	2007	89 (0.38)	N/R	High
Bereznicki et al. (2012)	US	General Population	2004–2007	992 (0.79)	0.174	Medium
Yu et al. (2014)	US	Near Facility	2005–2006	209 (0.84)	0.01	High
Huang et al. (2019)	CN	General Population	2016–2017	37 (N/R)	N/R	High
Domingo et al. (2015)	ES	Near Facility	2014	6 (0)	2.78	Low
Baek et al. (2020)	KR	General Population	2009–2010	384 (0.27)	N/R	Medium
Baek et al. (2020)	KR	Near Facility	2009–2010	384 (0.27)	N/R	Medium
Yazar et al. (2011)	SE	General Population	2009	9 (1)	0.01	Medium
Harrison et al. (2009)	GB	General Population	2005–2007	128 (N/R)	N/R	High
No fraction						
Gordon et al. (1999)	US	General Population	1998	14 (0)	0.38	Medium
N/R = not reported; CN = China; GB = Great Britain; SE = Spain; KR = South Korea; US = United States						

Table_Apx B-2. Summary of Peer-Reviewed Literature That Measured 1,3-Butadiene (μg/m^3) Levels in Indoor Air

Citation	Country	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (μg/m^3)	Overall Quality Level
Not specified						
Zhou et al. (2011)	CN	Public Space	2008	6 (N/R)	N/R	Medium
Zhou et al. (2011)	CN	Residential	2008	10 (0.90)	N/R	Medium
Zhou et al. (2011)	CN	Vehicle	2008	6 (N/R)	N/R	Medium
Vapor/gas						
Dodson et al. (2007)	US	Public Space	2007	178 (0.28)	N/R	High
Dodson et al. (2007)	US	Residential	2007	89 (0.31)	N/R	High
Loh et al. (2006)	US	Public Space	2004	71 (0.89)	0.17	Medium
Sax et al. (2006)	US	Residential	1999–2000	81 (0.67)	1	High
Gordon et al. (1999)	US	Residential	1998	24 (0.04)	0.38	Medium
Huang et al. (2019)	CN	Residential	2016–2017	88 (N/R)	N/R	High
Delgado-Saborit et al. (2011)	GB	Public Space	2005–2007	40 (N/R)	0.0051	High
Delgado-Saborit et al. (2011)	GB	Residential	2005–2007	155 (N/R)	0.0051	High
Harrison et al. (2009)	GB	Public Space	2005–2007	77 (N/R)	N/R	High
Harrison et al. (2009)	GB	Residential	2005–2007	152 (N/R)	N/R	High
Harrison et al. (2009)	GB	Vehicle	2005–2007	43 (N/R)	N/R	High
N/R, not reported; CN = China; GB = Great Britain; US = United States						

Table_Apx B-3. Summary of Peer-Reviewed Literature That Measured 1,3-Butadiene (ppm) Levels in Landfill Gas

Citation	Country	Exposure Scenario	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (ppm)	Overall Quality Level
Eklund et al. (1998)	US	Landfill Gas	Near Facility	1998	12 (N/R)	N/R	Medium
N/R = Not reported; US = United States							

Table_Apx B-4. Summary of Peer-Reviewed Literature That Measured 1,3-Butadiene (μg/m³) Levels in Personal Inhalation

Citation	Country	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (μg/m³)	Overall Quality Level
Combined vapor/gas and particulate						
Heavner et al. (1996)	US	General Population	1992	168 (N/R)	N/R	Medium
Not specified						
Zhou et al. (2011)	CN	General Population	2008	20 (N/R)	N/R	Medium
Vapor/gas						
Dodson et al. (2007)	US	General Population	2007	89 (0.25)	N/R	High
Shin et al. (2015)	US	Near Facility	2005–2007	239 (N/R)	N/R	Medium
Sax et al. (2006)	US	General Population	1999–2000	81 (0.70)	1	High
Yazar et al. (2011)	SE	General Population	2009	39 (1)	0.01	Medium
Hagenbjörk-Gustafsson et al. (2014)	SE	General Population	2001–2008	275 (N/R)	N/R	Medium
Saborit et al. (2009)	GB	General Population	2005–2007	500 (N/R)	N/R	Medium
Delgado-Saborit et al. (2011)	GB	General Population	2005–2007	500 (N/R)	0.0051	High
Harrison et al. (2009)	GB	General Population	2005–2007	500 (N/R)	N/R	High
N/R = not reported; CN = China; GB = Great Britain; SE = Spain; US = United States						

Table_Apx B-5. Summary Statistics of 1,3-Butadiene Concentrations Extracted from Systematic Review

Matrices	Location	Number of Studies with U.S. Data (N)	Number of Studies with Non-U.S. Data (N)	Total Number of Studies (N)	Unit	Fraction	Average of Arithmetic Mean Estimates for U.S. Data	Average of 90th Percentile Estimates for U.S. Data	Average of Arithmetic Mean Estimates for Non-U.S. Data	Average of 90th Percentile Estimates for Non-US Data	Average of Arithmetic Mean Estimates for All Data	Average of 90th Percentile Estimates for All Data
Ambient Air	General Population	4 (1,183)	3 (54)	7 (1237)	$\mu g/m^3$	Any	4.3E−01	8.0E−01	3.2E00	4.4E00	4.6E−01	7.8E−01
	Near Facility	2 (420)	0	2 (420)	$\mu g/m^3$	Any	1.51E−01	3.21E−01	–	–	1.5E−01	3.2E−01
Indoor Air	Public Spaces	2 (113)	2 (46)	4 (159)	$\mu g/m^3$	Any	1.7E00	3.1E00	3.9E00	6.9E00	1.5E00	2.3E00
	Residential	3 (83)	3 (253)	6 (335)	$\mu g/m^3$	Gas/vapor	8.6E−01	1.9E00	2.5E00	4.4E00	1.5E00	2.4E00
	Vehicles	–	1 (6)	1 (6)	$\mu g/m^3$	Any	–	–	6.2E−01	1.1E00	6.2E−01	1.1E00
Landfill Gas	Near Facility	–	–	–	ppm	Any	–	–	–	–	–	–
Personal Inhalation	General Population	4 (486)	5 (1,334)	9 (1,820)	$\mu g/m^3$	Any	1.5E00	3.5E00	1.5E00	3.5E00	6.9E−01	1.6E00

Appendix C SUPPLEMENTAL INFORMATION OF AIR MONITORING DATA FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

Table_Apx C-1. Summary of AMTIC Monitoring Data 2016–2022 for 1,3-Butadiene

Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	**Sample Duration**	**Statistic (µg/m^3)**	**Year**						
			2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1,3-Butadiene	24-Hour	Maximum	1.45E01	1.74E01	3.24E01	2.67E02	5.29E01	1.23E02	1.33E02
		Arithmetic Mean	1.05E−01	8.38E−02	9.10E−02	1.35E−01	1.13E−01	1.35E−01	1.46E−01
		Without NDs and Below MDL	2.55E−01	2.16E−01	2.49E−01	3.85E−01	3.28E−01	3.90E−01	4.26E−01
		Geometric Mean	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	1.14E−01	1.03E−01	1.09E−01	9.52E−02	1.20E−01	1.24E−01	1.13E−01
		Median	1.20E−02	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	1.83E−02
		Without NDs and Below MDL	1.10E−01	9.21E−02	9.94E−02	8.58E−02	1.03E−01	9.29E−02	8.64E−02
		Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	2.98E−03	2.19E−03	5.05E−03	1.11E−02	1.32E−02	8.85E−03	4.52E−03
		Total Samples	14,252	14,306	14,192	12,593	11,479	11,935	10,538
		Total NDs	6,987	7,468	7, 560	7,148	6,179	6,092	4,579
		ND %	49.0%	52.2%	53.3%	56.8%	53.8%	51.0%	43.5%
		MDL	0.002–1.1	0.002–1.1	0.002–1.1	0.004–1.1	0.013–0.93	0.004–0.55	0.004–1.1
		Total Below MDL	1,710	1,627	1,849	1,209	1,578	1,881	2,588
		Below MDL %	12.0%	11.4%	13.0%	9.6%	13.7%	15.8%	24.6%

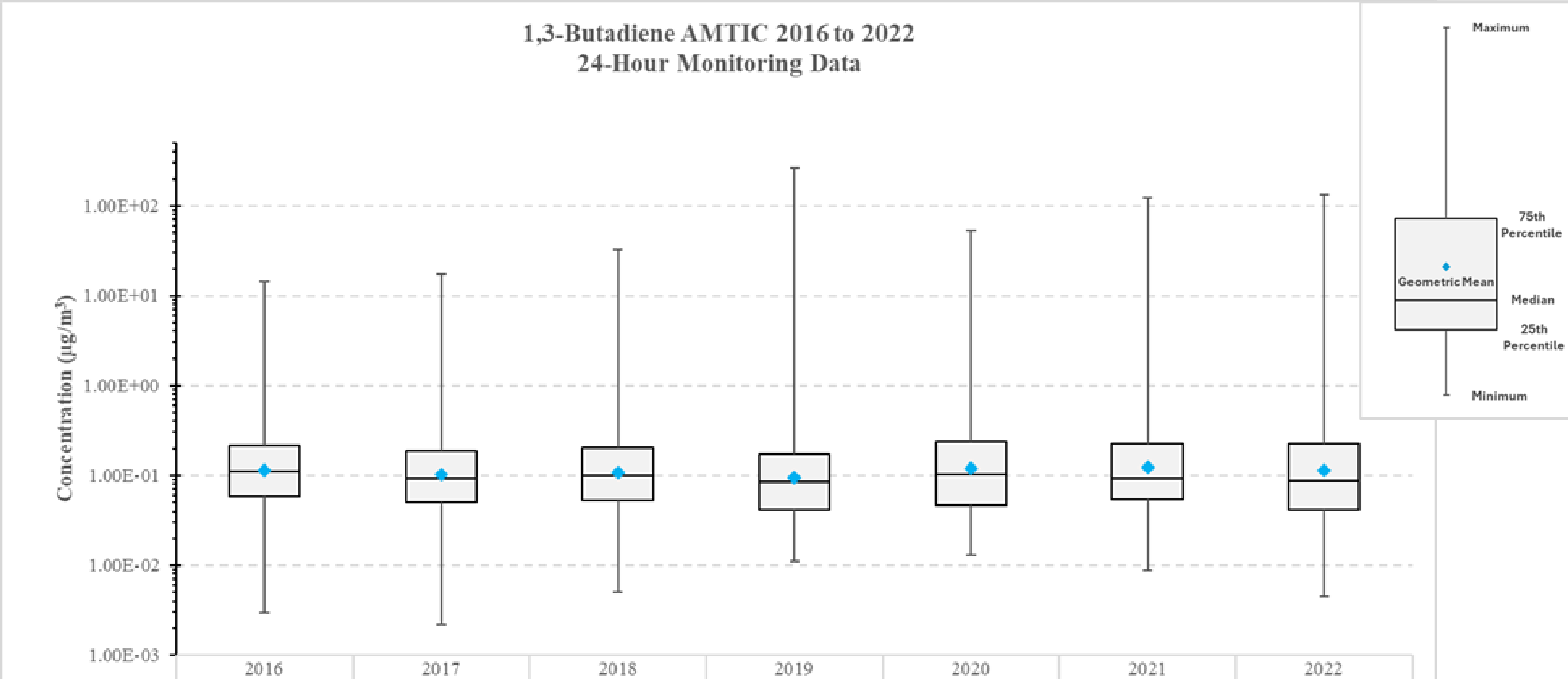
Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	**Sample Duration**	**Statistic (μg/m^3)**	**Year**						
			2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1,3-Butadiene	3-Hour	Maximum	8.21E−01	2.35E−01	3.24E00	2.38E−01	8.25E−01	6.58E−01	1.55E01
		Arithmetic Mean	4.13E−02	4.56E−03	3.43E−02	3.05E−03	1.08E−02	4.36E−02	8.04E−02
		Without NDs and Below MDL	2.11E−01	1.85E−01	8.37E−01	1.22E−01	5.56E−01	1.27E−01	5.32E−01
		Geometric Mean	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	1.71E−01	1.82E−01	3.82E−01	1.02E−01	4.41E−01	1.10E−01	2.39E−01
		Median	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	3.51E−02
		Without NDs and Below MDL	1.55E−01	1.63E−01	2.85E−01	9.75E−02	6.94E−01	9.90E−02	2.04E−01
		Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	6.62E−02	1.58E−01	1.39E−01	5.57E−02	1.50E−01	4.15E−02	6.44E−02
		Total Samples	161	122	122	181	155	271	2,112
		Total NDs	124	119	117	175	152	142	933
		ND %	77.0%	97.5%	95.9%	96.7%	98.1%	52.4%	44.2%
		MDL	0.055–0.068	0.055	0.055	0.038–0.055	0.055	0.019–0.063	0.063–0.093
		Total Below MDL	7	0	0	2	0	53	995
		Below MDL %	4.3%	0.0%	0.0%	1.1%	0.0%	19.6%	47.1%

Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	**Sample Duration**	**Statistic (µg/m³)**	**Year**						
			2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1,3-Butadiene	1-Hour	Maximum	1.81E02	4.60E01	7.23E01	3.83E02	4.23E02	5.80E02	3.05E03
		Arithmetic Mean	1.90E−01	1.24E−01	1.36E−01	1.63E−01	1.51E−01	2.78E−01	1.90E−01
		Without NDs and Below MDL	3.51E−01	2.29E−01	4.28E−01	5.62E−01	3.30E−01	5.49E−01	4.26E−01
		Geometric Mean	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	1.42E−01	1.23E−01	1.95E−01	1.99E−01	1.53E−01	1.68E−01	1.45E−01
		Median	5.64E−02	5.34E−02	5.16E−02	5.38E−02	5.37E−02	4.96E−02	4.73E−02
		Without NDs and Below MDL	1.04E−01	9.50E−02	1.60E−01	1.55E−01	1.17E−01	1.29E−01	1.11E−01
		Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	4.55E−02	4.58E−02	5.15E−02	2.48E−02	1.61E−02	4.62E−03	8.48E−03
		Total Samples	231,973	204,348	198,963	2.20E05	127,412	362,251	394,824
		Total NDs	56,637	42,244	40,865	41,979	36,122	77,536	97,594
		ND %	24.4%	20.7%	20.5%	19.1%	28.4%	21.4%	24.7%
		MDL	0.055	0.055	0.055–0.22	0.023–0.22	0.016–0.27	0.02–0.22	0.013–0.27
		Total Below MDL	55,863	61,413	111,468	129,155	40,003	108,743	134,650
		Below MDL %	24.1%	30.1%	56.0%	58.8%	31.4%	30.0%	34.1%

Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	Sample Duration	Statistic (µg/m^3)	Year						
			2016	2017	2018	2019	2020	2021	2022
1,3-Butadiene	25-Minutes	Maximum	4.27E02	1.49E01	1.49E02	8.90E02	3.41E01	2.03E02	1.98E02
		Arithmetic Mean	3.73E00	4.80E−01	1.73E00	7.68E00	9.11E−01	4.36E00	3.21E00
		Without NDs and Below MDL	7.59E00	1.16E00	5.27E00	2.13E01	3.01E00	1.17E01	6.47E00
		Geometric Mean	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	5.70E−01	5.53E−01	5.20E−01	1.41E00	8.36E−01	1.36E00	7.30E−01
		Median	1.62E−01	1.02E−01	8.83E−02	0.00E00	0.00E00	8.85E−02	1.02E−01
		Without NDs and Below MDL	4.20E−01	4.56E−01	3.45E−01	7.63E−01	5.86E−01	7.65E−01	4.86E−01
		Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	1.77E−01	1.77E−01	1.77E−01	1.72E−01	1.77E−01	1.72E−01	2.21E−02
		Total Samples	191	184	269	267	158	226	478
		Total NDs	42	55	107	149	86	91	136
		ND %	22.0%	29.9%	39.8%	55.8%	54.4%	40.3%	28.5%
		MDL	0.177	0.177	0.177	0.177	0.177	0.177	Federal MDL
		Total Below MDL	56	57	75	22	25	51	106
		Below MDL %	29.3%	31.0%	27.9%	8.2%	15.8%	22.6%	22.2%

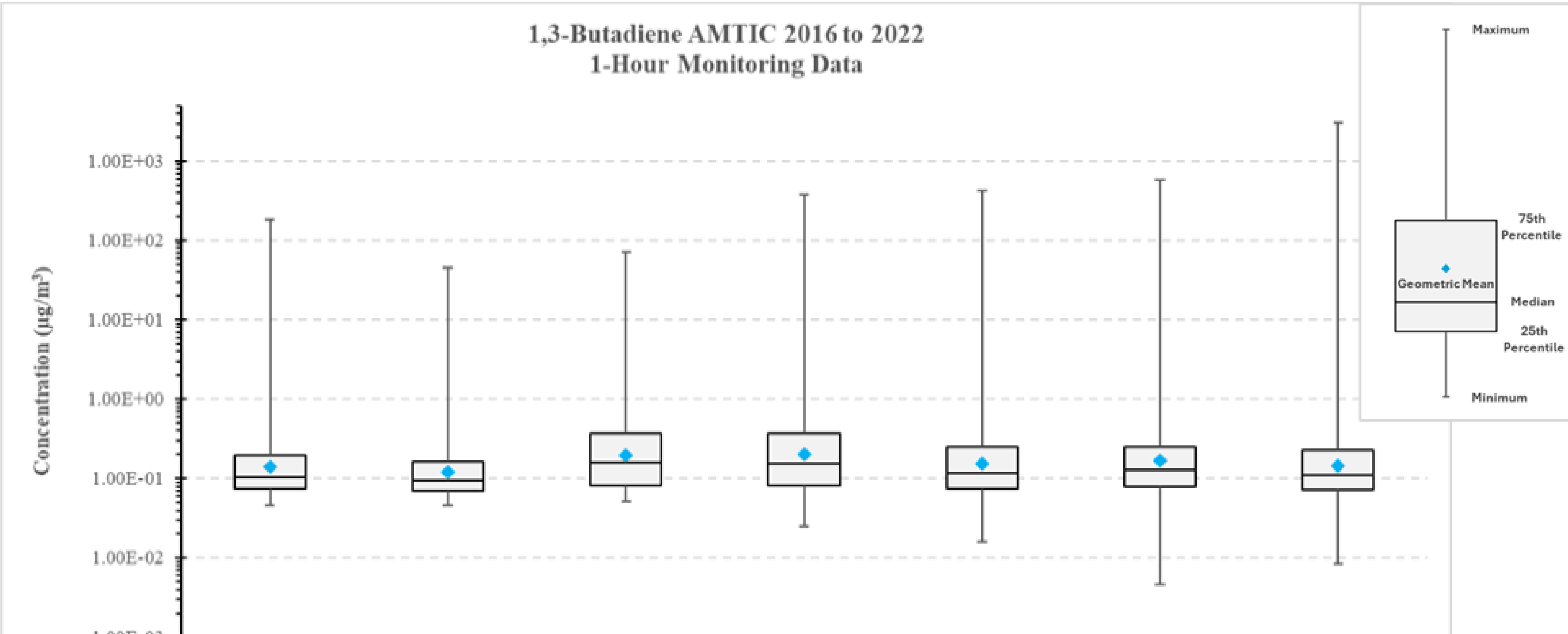
Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	Sample Duration	Statistic (μg/m^3)	Year						
			2016	2017	2018	2019	2020	2021	2022
1,3-Butadiene	10-Minutes	Maximum	–	–	–	–	4.25E00	1.42E00	2.03E00
		Arithmetic Mean	–	–	–	–	7.78E−02	2.50E−02	5.02E−02
		Without NDs and Below MDL	–	–	–	–	2.29E−01	6.11E−02	1.09E−01
		Geometric Mean	–	–	–	–	0.00E00	1.90E−02	0.00E00
		Without NDs and Below MDL	–	–	–	–	1.11E−01	5.29E−02	7.86E−02
		Median	–	–	–	–	0.00E00	1.41E−02	1.42E−02
		Without NDs and Below MDL	–	–	–	–	7.60E−02	4.80E−02	6.80E−02
		Minimum	–	–	–	–	0.00E00	1.28E−02	0.00E00
		Without NDs and Below MDL	–	–	–	–	2.79E−02	1.33E−02	2.56E−02
		Total Samples	–	–	–	–	5,681	8,282	22,127
		Total NDs	–	–	–	–	3,755	0	7,251
		ND %	–	–	–	–	66.1%	0.0%	32.8%
		MDL	–	–	–	–	0.027	0.02654737	0.026–0.028
		Total Below MDL	–	–	–	–	0	6,337	5,403
		Below MDL %	–	–	–	–	0.0%	76.5%	24.4%

Ambient Monitoring Technology Information Center Hazardous Air Pollutants									
Chemical	**Sample Duration**	**Statistic (µg/m³)**	**Year**						
			2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1,3-Butadiene	**5-**Minutes	Maximum	–	–	–	–	9.29E02	1.74E02	1.51E04
		Arithmetic Mean	–	–	–	–	3.59E00	3.43E00	3.72E00
		Without NDs and Below MDL	–	–	–	–	1.10E02	4.70E01	3.55E03
		Geometric Mean	–	–	–	–	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	–	–	–	–	6.84E01	4.65E01	2.50E01
		Median	–	–	–	–	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	–	–	–	–	4.56E01	4.48E01	1.71E00
		Minimum	–	–	–	–	0.00E00	0.00E00	0.00E00
		Without NDs and Below MDL	–	–	–	–	4.04E01	3.94E01	1.57E00
		Total Samples	–	–	–	–	141,890	427,787	85,671
		Total NDs	–	–	–	–	79,566	267,501	64,599
		ND %	–	–	–	–	56.1%	62.5%	75.4%
		MDL	–	–	–	–	39.82	39.82	39.82
		Total Below MDL	–	–	–	–	62,050	159,951	21,014
		Below MDL %	–	–	–	–	43.7%	37.4%	24.5%
MDL = minimum detection level; ND = non-detect									



	2016	2017	2018	2019	2020	2021	2022
Max	14.483	17.382	32.433	267.328	52.889	122.834	133.069
Geometric Mean	0.114	0.103	0.109	0.095	0.120	0.124	0.113
Median	0.110	0.092	0.099	0.086	0.103	0.093	0.086
Min	0.003	0.002	0.005	0.011	0.013	0.009	0.005

Figure_Apx C-1. 1,3-Butadiene 24-Hour Concentrations by Year from 2016–2022 (µg/m³)



	2016	2017	2018	2019	2020	2021	2022
Max	181.265	46.012	72.336	383.323	423.218	579.962	3045.354
Geometric Mean	0.14	0.12	0.20	0.20	0.15	0.17	0.15
Median	0.104	0.095	0.160	0.155	0.117	0.129	0.111
Min	0.045	0.046	0.051	0.025	0.016	0.005	0.008

Figure_Apx C-2. 1,3-Butadiene 1-Hour Concentrations by Year from 2016–2022 (µg/m^3)