Letter Health Consultation

GRANT MILL APARTMENT COMPLEX:
TRICHLOROETHYLENE VAPOR INTRUSION, APRIL 2022

PROVIDENCE, PROVIDENCE COUNTY, RHODE ISLAND

Prepared by the
Rhode Island Department of Health

APRIL 4, 2022

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Community Health and Hazard Assessment
Atlanta, Georgia 30333

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A health consultation is a verbal or written response from the Agency of Toxic Substances and Disease Registry (ATSDR) or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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Department of Health
Three Capitol Hill
Providence, RI 02908-5097
TTY: 711
www.health.ri.gov

Kelly J. Owens, Associate Supervising Engineer
Rhode Island Department of Environmental Management
Office of Land Revitalization and Sustainable Materials Management
235 Promenade Street
Providence, RI 02908-5767
kelly.owens@dem.ri.gov

CC: Ashley Blauvelt, RIDEM
Susan Forcier, RIDEM
Leo Hellested, RIDEM

April 4, 2022

Subject: Vapor Intrusion Assessment and Mitigation
Grant Mill, 295-299 Carpenter Street
Providence, RI 02909

Dear Ms. Owens and Ms. Blauvelt,

In February 2022, the Rhode Island Department of Environmental Management (RIDEM) requested the Rhode Island Department of Health (RIDOH) review the results of indoor air sampling (January 2022) at 34 residences within the Grant Mill property in Providence, Rhode Island. This review was prepared in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR) as a letter health consultation.

This document follows three earlier health assessments (Rhode Island Department of Health 2021a; 2021b; 2022). These were completed in June 2021, August 2021, and February 2022, which reviewed the results of indoor air sampling at 32 Grant Mill residences from February 2021, July 2021, and September/November 2021, respectively. The consultant (Boston Environmental Corporation; BEC) identified elevated indoor air levels of chlorinated volatile organic compounds (VOCs), which they attributed to soil-vapor intrusion. For remediation, BEC installed multiple sub-slab depressurization systems (SSDSs) in the basement (February 2021), repaired bathroom fans in select units (August 2021), and added activated carbon air filters in select units (December 2021).

With the carbon air filters, the maximum indoor air trichloroethylene (TCE) concentrations decreased on all floors (Table 1) between the November 2021 and January 2022 samplings. Maximum concentrations of tetrachloroethylene (PCE) and cis-1,2-dichloroethylene (DCE)

remained below Massachusetts' Department of Environmental Protection (DEP) residential indoor air threshold values (Tables 2-3). Several previous datasets showed fluctuating TCE and PCE concentrations on the second, third, and fourth floors (Tables 1-2) and suggested parallel issues of soil-vapor intrusion and building material contamination. BEC acknowledged that parallel contamination sources were possible, but maintain that commercial household products are confounding the VOC results.

RIDOH evaluated the data for potential health effects through the inhalation exposure pathway following the carbon air filter installations. RIDOH concluded that the remediation steps sufficiently lowered the risks for chronic (e.g., >1 year) TCE inhalation-related non-cancer and cancer health effects among Grant Mill tenants and short-term exposures among developing fetuses. Current TCE inhalation exposures from indoor air no longer pose a public health hazard.

In agreement with BEC's recommendation, RIDOH recommends that the current owner (Grant Mill, LLC) actively operate the SSDSs, exhaust fans, and carbon air filters as regular building maintenance to maintain lower VOC indoor air concentrations and to comply with RIDEM's Environmental Land Use Restriction (ELUR) requirements. The remainder of this letter health consultation presents detailed information supporting RIDOH's analysis, conclusions, and recommendation.

Background

In 1850, the Grant Mill building site (115,764 ft^2, 1.77 acres) was constructed as a cotton mill and later used as a jewelry manufacturer until 1986 (Figure 1). In 2007, the building was converted into 85 loft-style apartment units distributed over 4 floors. Building space also includes mechanical rooms, elevator rooms, storage areas, offices, a media room, and an exercise room. Grant Mill, LLC purchased the property in 2017, following a Phase I Environmental Site Assessment by Paragon Environmental Services (PES) Associates (December 2016). At the time, no Recognized Environmental Conditions were identified, despite the facility's prior use as a jewelry manufacturer and the likely use of solvents. Grant Mill, LLC planned to refinance the building in late 2020.

A November 2020 Phase I Environmental Site Assessment (Consultant: GRS-Global) recommended additional investigations based on the site's previous use as a cotton mill and jewelry manufacturer. In December 2020, Grant Mill, LLC hired BEC (Team Consultants: Woodard & Curran, EA Engineering, Lockwood Remedial Technologies, LLC) to conduct a Limited Phase II Environmental Site Investigation.

Discussion

Environmental Data

In December 2020 and January 2021, BEC assessed the site for potential soil-vapor intrusion from chlorinated VOCs at various locations on the property, not including apartment units. In February 2021 (Appendix A), June 2021 (Appendix B), September 2021 (Appendix C),

November 2021 (Appendix D; partial dataset, n=8), and January 2022 (Appendix E), BEC took additional indoor air samples from the apartment units on all four floors with tenant consent. Prior to sampling (24h indoor air concentrations, pre-cleaned Summa® 6L cannisters), tenants removed consumer products that might contain VOCs.

RIDOH focused on these five datasets because tenants spent the majority of their time in the apartment units (ATSDR 2020). RIDOH used the maximum VOC concentrations on each floor (Tables 1-3) for the exposure assessment. The 95th upper confidence level (95UCL) of the mean was also applied to the first floor apartment samples as an additional exposure point concentration when more than 8 samples were taken (ATSDR 2005). This included all the first-floor apartment datasets except November 2021.

Between February and June 2021, BEC installed SSDSs in the basement as initial remedial actions. Between June and September 2021, the bathroom ventilation fans on the western end of the building were repaired. Between September 2021 and January 2022, BEC installed activated carbon air filters to select apartment units. If these remediation steps sufficiently reduced VOC indoor air concentrations, then the indoor air concentrations would have decreased over time.

Table 1. Unadjusted 24-hour TCE concentrations in indoor air by floor from 2021-2022.

	TCE (ug/m^3)[&]									
Floor	Feb max	June max	Sept max	Nov max	Jan max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL	Jan 95UCL
MassDEP^	0.4									
1992 IA[#]	0.8									
1st (n=17)	**1.4**	**6.3**	**30**	**0.96**	**0.41**	**0.53**	**0.92**	**1.9**	NA	0.28
2nd (n=5)	**1.2**	**2.1**	**5.6**	**2.0**	0.30					
3rd (n=5)	**2.3**	**4.3**	**1.2**	**4.1**	**1.4**					
4th (n=5)	**2.6**	**1.6**	**0.41**	**3.6**	**0.74**					

[&]ug/m^3: microgram of VOC per cubic meter
^Massachusetts Department of Environmental Protection (DEP) Residential Indoor Air Threshold Values. Data in **bold** indicated the level was equal to or higher than the threshold.
[#]IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

Table 2. Unadjusted 24-hour PCE concentrations in indoor air by floor from 2021-2022.

	PCE (ug/m^3)									
Floor	Feb max	June max	Sept max	Nov max	Jan max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL	Jan 95UCL
MassDEP^	1.4									
1992 IA[#]	4.1									
1st (n=17)	**11**	**34**	**4.8**	1.2	1.0	**2.8**	**2.1**	**4.2**	NA	0.38
2nd (n=5)	**3.7**	0.8	**1.4**	0.78	1.1					
3rd (n=5)	**12**	**1.8**	0.79	1.2	0.74					
4th (n=5)	**15**	0.9	0.76	0.83	0.8					

^Massachusetts DEP Residential Indoor Air Threshold Values. Data in **bold** indicated the level was equal to or higher than the threshold.
[#]IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

Table 3. Unadjusted 24-hour DCE concentrations in indoor air by floor from 2021-2022.

	PCE (ug/m^3)									
Floor	Feb max	June max	Sept max	Nov max	Jan max	Feb 95UCL	June 95UCL	Sept 95UCL	Nov 95UCL	Jan 95UCL
MassDEP^	0.8									
1992 IA[#]	0.8									
1st (n=17)	0.25	<0.14[±]	<0.14	<0.14	<0.14	NA	NA	NA	NA	NA
2nd (n=5)	0.65	<0.14	<0.14	<0.14	<0.14					
3rd (n=5)	**2.3**	<0.14	<0.14	<0.14	<0.14					
4th (n=5)	**2.8**	<0.14	<0.14	<0.14	<0.14					

^Massachusetts DEP Residential Indoor Air Threshold Values. Data in **bold** indicated the level were equal to or higher than the threshold.

[#]IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

[±]If the DCE concentration was below the limit of detection (LOD) of 0.14 ug/m^3, then the concentration was reported as <0.14

A previous letter health consultation (Rhode Island Department of Health 2022) included specific details on TCE and PCE indoor air concentration trends between February 2021 and November 2021.

With the carbon air filter installations in December 2021, the TCE indoor air concentrations decreased on all four floors of Grant Mill Apartments between the final two sampling datasets. Although TCE concentrations on the first, third, and fourth floor were still above the Massachusetts DEP Residential Indoor Air Threshold Values (Table 1), they were comparable to BEC's indoor air remedial goals.[1]

The January 2022 TCE results of higher concentrations on the upper floors were still inconsistent with the soil-vapor intrusion hypothesis. In that scenario, higher VOC concentrations would be detected on the lower floors (Ma et al. 2020; ATSDR 2016). Given the building's history as a cotton mill and jewelry manufacturer, the TCE source(s) may be the building materials, potentially resulting from past chemical spills soaking into the floorboards and now evaporating. BEC has also acknowledged that multiple VOC sources may be present beyond soil-vapor intrusion.

PCE maximum and 95UCL concentrations remained below the Massachusetts DEP Residential Indoor Air Threshold Values during the final two sampling datasets (Table 2). Unlike the TCE trend, PCE concentrations were generally highest on the first floor (Table 2), which was consistent with the soil-vapor intrusion hypothesis (Ma et al. 2020; ATSDR 2016). Due to the decreasing concentrations below the threshold value, PCE was not assessed for human health risks in this letter health consultation.

[1] Because Rhode Island does not have residential indoor air threshold values, BEC selected Massachusetts DEP "Typical Residential Indoor Air Concentration" 90th percentile values (TIAC90) as the remedial goals. The TIAC90 concentrations, denoted as "1992 IA" in Tables 1-3, are representative of VOC indoor air concentrations typically detected in a residential home that doesn't have a known source of vapor intrusion.

DCE was only detected in February 2021 and was not detected in any subsequent datasets (Table 3). Due to the continued non-detects in the sampled apartment units, DCE was not assessed for human health risks in this letter health consultation.

Exposure Scenario: Tenant Inhalation
In compliance with ATSDR guidance (ATSDR 2016), RIDOH assumed a chronic inhalation exposure scenario of 24 hours per day (h/d), 7 days per week (d/wk), and 52.14 weeks per year (wk/y). For evaluating the cancer health endpoints, a 50th percentile (*central tendency exposure* or CTE) residential occupancy period of 1.2 years and a 95th percentile (*reasonable maximum exposure* or RME) residential occupancy period of 8.0 years were used (US EPA 2011).

The equations (ATSDR 2020) for the hazard quotient (HQ) and elevated lifetime cancer risk (ELCR) are

$$HQ\ (unitless) = \frac{Exposure\ Point\ Concentration * Exposure\ Factor_{noncancer}}{Inhalation\ Minimum\ Risk\ Level}$$

$$ELCR\ (unitless) = Inhalation\ Unit\ Risk * Exposure\ Point\ Concentration * Exposure\ Factor_{cancer}$$

An HQ>1.0 and/or an ELCR>1.0*10^{-6} are cause for concern,[2] or "elevated risk." For the tenant exposure scenario, a non-cancer exposure factor of 1 and cancer exposure factors of 0.015 (CTE) and 0.103 (RME) were used. ATSDR inhalation minimum risk levels and cancer inhalation unit risks are reported in Table 4. Table 5 reported the HQs and ELCRs by floor, for both the CTE and RME of the residential occupancy period.

Table 4. Inhalation minimum risk level by VOC and concentration unit.

	TCE~		
	ppm	ug/m^3 ^	IUR (ug/m^3)
Chronic	0.0004	2.1	4.1*10^{-6}
Intermediate	0.0004	2.1	
Acute	0.0004	2.1	

(Stevens 1997; ATSDR 2019; Harper, Chessin, and Goldhaber 1996)
~ATSDR has adopted the chronic inhalation minimum risk level for TCE as both the intermediate and acute minimum risk levels, based on available data.
^Conversion from ppm to ug/m^3 accounts for the ideal gas law

Seven apartment units had indoor air samples taken at all five timepoints (Table 6), and these samples were suitable to assess long-term, or chronic (>1 y), exposures. The indoor air TCE concentration averages were used to calculate additional HQs and ELCRs.

[2] An HQ less than 1.0 means that it is unlikely an exposed person would experience adverse non-cancer health effects, while an HQ equal to or greater than 1.0 means an increased likelihood. The ELCR measures the probability that a person may develop cancer sometime in their lifetime following exposure to a particular contaminant. An ELCR below 1.0*10^{-6} (one in one million) is very low or negligible risk, while an ELCR between 1.0*10^{-6} and 1.0*10^{-4} (one in ten thousand) is low risk and between 1.0*10^{-4} and 1.0*10^{-3} (one in one thousand) is moderate risk.

Table 5. TCE hazard quotient and excess lifetime cancer risk by floor from 2021-2022. Highlighted boxes denote elevated risk. Values in **bold** denote an increase in risk from dataset to dataset (e.g., February to June).

Floor	HQ (max)					HQ (95UCL)					ELCR (CTE)					ELCR (RME)				
	Feb	June	Sept	Nov	Jan	Feb	June	Sept	Nov	Jan	Feb	June	Sept	Nov	Jan	Feb	June	Sept	Nov	Jan
1st	0.64	**2.9**	**14**	0.44	0.19	0.24	**0.42**	**0.86**	NA	0.13	$8.6*10^{-8}$	$\mathbf{3.9*10^{-7}}$	$\mathbf{1.8*10^{-6}}$	$5.9*10^{-8}$	$2.5*10^{-8}$	$5.9*10^{-7}$	$\mathbf{2.7*10^{-6}}$	$\mathbf{1.3*10^{-5}}$	$4.1*10^{-7}$	$1.7*10^{-7}$
2nd	0.55	**0.96**	**2.6**	0.91	0.16						$7.4*10^{-8}$	$\mathbf{1.3*10^{-7}}$	$\mathbf{3.4*10^{-7}}$	$1.2*10^{-7}$	$2.1*10^{-8}$	$5.1*10^{-7}$	$\mathbf{8.9*10^{-7}}$	$\mathbf{2.4*10^{-6}}$	$8.4*10^{-7}$	$1.4*10^{-7}$
3rd	1.1	**2.0**	0.55	**1.9**	0.64						$1.4*10^{-7}$	$\mathbf{2.6*10^{-7}}$	$7.4*10^{-8}$	$\mathbf{2.5*10^{-7}}$	$8.6*10^{-8}$	$9.7*10^{-7}$	$\mathbf{1.8*10^{-6}}$	$5.1*10^{-7}$	$\mathbf{1.7*10^{-6}}$	$5.9*10^{-7}$
4th	1.2	0.73	0.19	**1.6**	0.34						$1.6*10^{-7}$	$9.8*10^{-8}$	$2.5*10^{-8}$	$\mathbf{2.2*10^{-7}}$	$4.6*10^{-8}$	$1.1*10^{-6}$	$6.8*10^{-7}$	$1.7*10^{-7}$	$\mathbf{1.5*10^{-6}}$	$3.1*10^{-7}$

Table 6. TCE average indoor air concentrations, hazard quotients, and excess lifetime cancer risk by unit, if samples were taken at all five timepoints. Highlighted boxes denote elevated risk.

Unit (deidentified)	TCE			
	Average (ug/m^3)	HQ	ELCR (CTE)	ELCR (RME)
Floor 1 – Unit A	7.6	3.5	$4.7*10^{-7}$	$3.2*10^{-6}$
Floor 1 – Unit B	1.0	0.45	$6.1*10^{-8}$	$4.2*10^{-7}$
Floor 1 – Unit C	0.54	0.25	$3.3*10^{-8}$	$2.3*10^{-7}$
Floor 2 – Unit A	2.2	1.0	$1.4*10^{-7}$	$9.5*10^{-7}$
Floor 3 – Unit A	1.1	0.52	$7.1*10^{-8}$	$4.8*10^{-7}$
Floor 3 – Unit B	2.3	1.1	$1.4*10^{-7}$	$9.8*10^{-7}$
Floor 4 – Unit A	1.6	0.72	$9.8*10^{-8}$	$6.6*10^{-7}$

Based on the maximum concentrations, between February 2021 and January 2022, the risks for TCE-related non-cancer and cancer health effects decreased on all floors at Grant Mill (Table 5). As of January 2022, no increased risks would be expected for either non-cancer or cancer health effects from chronic TCE inhalation exposures. This was the direct result of the BEC remediation steps (pg.6).

For the seven units with indoor air average concentrations (Table 6), three demonstrated slightly increased risks for non-cancer health effects and one for cancer health effects from chronic TCE inhalation exposures. For only one unit's average concentration, the elevated TCE-related cancer risks were specific to the RME exposure scenario (8.0 y tenancy) and did not apply to the shorter-term CTE exposure scenario (1.2 y tenancy). These reported risks were lower than the previously reported average concentrations (Rhode Island Department of Health 2022), which did not include the January 2022 results. With the successful remediation strategies, the average TCE indoor air levels will likely continue to decrease over time and, as a result, adverse health effects are no longer be expected.

Public Health Implications

A wide range of adverse non-cancer health effects have been associated with low levels of TCE inhalation exposures (Appendix F). Unborn babies are particularly sensitive to TCE toxicity, based on fetal heart malformations observed in rodents (ATSDR 2019). Major cardiac development in humans occurs over a three-week period during the first three months of pregnancy (Dhanantwari et al. 2009), and TCE inhalation exposures during this period may increase the risk of fetal heart malformations (ATSDR 2019). From animal studies, in utero TCE exposures may also lead to spontaneous abortion, small birth weight, immune system defects, and central nervous system defects (ATSDR 2019).

Massachusetts DEP has issued an Imminent Hazard value for TCE residential indoor air of 6 ug/m^3 for women in the first trimester of pregnancy ("Trichloroethylene (TCE) in Indoor Air" 2017). At one first floor Grant Mill apartment (Table 6), the average TCE air levels exceeded 6 ug/m^3, a level at which unborn babies may experience elevated risks of non-cancer health effects should the mother be exposed during the first trimester. BEC took extra steps (e.g., portable gas chromatograph) with this unit's tenants to identify potential sources, remediate appropriately, and communicate with the residents.

In human occupational exposure studies, acute TCE inhalation exposure has led to central nervous system depression, loss of consciousness, and death among adults (ATSDR 2019). Chronic TCE inhalation exposure has resulted in damage to the liver, kidneys, skin, immune system, and reproductive system (ATSDR 2019). There may also be an increased risk of developing autoimmune diseases, such as scleroderma (e.g. hardening/tightening of skin and connective tissues) (ATSDR 2019).

In this evaluation, an elevated risk of non-cancer health effects from maximum TCE concentrations was previously found at Grant Mill at the RME residential occupancy period of

8.0 y (Table 5), but was sufficiently lowered below BEC's indoor air remedial goals by their activities (US EPA 2011). As previously stated, the average TCE indoor air concentrations for the three units of concern (Table 6) are expected to decrease over time following remediation and the adverse non-cancer health effects will no longer be expected.

TCE is also a known human carcinogen, associated with kidney cancer, liver cancer, and non-Hodgkin's lymphoma (ATSDR 2019). In this evaluation, an elevated lifetime cancer risk from TCE was previously found at Grant Mill at the RME residential occupancy period of 8.0 y (Table 5), but was sufficiently lowered below the remedial goals (US EPA 2011). The above-listed health effects were previously included in a site-specific frequently asked questions document developed for current tenants (Rhode Island Department of Health 2022).

Limitations of Analysis

The indoor air VOC concentrations accounted for four 24 h time periods, which were suitable for evaluating acute inhalation exposures. However, it is important to note that ATSDR has adopted the chronic inhalation minimum risk levels for TCE as both the intermediate and acute minimum risk levels (ATSDR 2019).

RIDOH did not have access to information detailing how long current tenants have lived in their Grant Mill apartment units. RIDOH's evaluation was based on the most recent sampling events and recommended residency occupancy periods from previous research (US EPA 2011).

Conclusions and Recommendations

Based on the five available datasets, RIDOH reached the following conclusion.

1. Because of the multiple remediation steps, increased risks for non-cancer and cancer health effects would not be expected from chronic TCE inhalation exposures among Grant Mill tenants. Current TCE inhalation exposures from indoor air no longer pose a public health hazard at Grant Mill.
2. Increased risks for non-cancer and cancer health effects would not be expected from chronic PCE or DCE inhalation exposures among Grant Mill tenants.

From these conclusions, RIDOH made the following recommendation:

1. In agreement with BEC's recommendation, RIDOH recommends that the current owner (Grant Mill, LLC) actively operate the SSDSs, exhaust fans, and carbon air filters as regular building maintenance to maintain lower VOC indoor air concentrations and to comply with RIDEM's ELUR requirements.

Additional Considerations

In the most recent site investigation reports (December 2021, February 2022), BEC acknowledged that soil-vapor intrusion may not be the only TCE contamination source and that building material contamination may be a parallel source. However, the carbon air filters in

multiple apartments effectively lowered the elevated TCE air concentrations to below BEC's indoor air remediation goals. BEC is continuing to collaborate with DEM and will sample again in July 2022 to confirm that indoor air TCE concentrations remain lowered.

BEC has distributed updated letters to tenants with the September and November 2021 sampling results, and provided additional tenant letters with the January 2022 results in late March 2022. BEC also hosted a virtual Zoom meeting on December 8, 2021 to answer remaining tenant questions, comments, and concerns.

Should Grant Mill, LLC continue to use BEC's environmental sampling and remediation services to comply with ELUR requirements, RIDOH is available to assess the updated indoor air VOC data for potential health effects.

If there are any questions, please contact me at carolyn.poutasse@health.ri.gov.

Sincerely,

Carolyn M. Poutasse, PhD
Environmental Health Risk Assessment Toxicologist

Report Preparation

This publication was made possible by Grant Number NU61TS000315 from the Agency for Toxic Substances and Disease Registry (CDC-RFA-TS20-2001). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Agency for Toxic Substances and Disease Registry, or the Department of Health and Human Services.

Author

Carolyn Poutasse, PhD
Environmental Health Risk Assessment Toxicologist
Rhode Island Department of Health

Reviewers

Michael Byrns, PhD
Principal Environmental Health Risk Assessment Toxicologist
Rhode Island Department of Health

Caroline Hoffman, MPH
Senior Public Health Promotion Specialist
Rhode Island Department of Health

Melissa Orpen-Tuz, ACRW, CPRW
Assistant Health Program Administrator
Rhode Island Department of Health

Robert Sucsy, MPH
Epidemiologist
Rhode Island Department of Health

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Figure 1. Satellite view of the Grant Mill building.

Appendix A. February 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	0.36		<0.19	U	<0.14	U
Floor 1	8.5		1.2		0.25	
Floor 1	1.7		0.42		<0.14	U
Floor 1	7.2		1		<0.14	U
Floor 1	1.3		0.3		<0.14	U
Floor 1	2.3		0.4		<0.14	U
Floor 1	11		1.4		0.19	
Floor 1	0.97		0.33		<0.14	U
Floor 1	0.37		<0.19	U	<0.14	U
Floor 1	0.87		<0.19	U	<0.14	U
Floor 1	0.78		<0.19	U	<0.14	U
Floor 1	2.3		0.6		0.14	
Floor 1	3.9		0.72		<0.14	U
Floor 1	9.3		0.42		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	4.2		0.52		<0.14	U
Floor 1	0.45		<0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.42		<0.19	U	<0.14	U
Floor 2	3.7		0.71		0.59	
Floor 2	0.54		<0.19	U	<0.14	U
Floor 2	3.2		1.2		0.24	
Floor 2	2.2		0.41		0.65	
Floor 3	0.28		<0.19	U	<0.24	U
Floor 3	4.3		1.1		0.78	
Floor 3	1.9		0.99		0.3	
Floor 3	2.5		0.6		0.25	
Floor 3	12		2.3		2.3	
Floor 4	1.7		0.54		0.25	
Floor 4	3.9		1.1		0.65	
Floor 4	1.8		0.57		0.18	
Floor 4	4.3		1.7		0.23	
Floor 4	15		2.6		2.8	

NS=Not Sampled.

*U flag indicated that the VOC was not detected.

Appendix B. June 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	0.28		<0.19	U	<0.14	U
Floor 1	2.8		<0.19	U	<0.14	U
Floor 1	2.1		0.52		<0.14	U
Floor 1	34		<0.19	U	<0.14	U
Floor 1	0.73		0.37		<0.14	U
Floor 1	0.81		<0.19	U	<0.14	U
Floor 1	0.58		<0.19	U	<0.14	U
Floor 1	0.93		<0.19	U	<0.14	U
Floor 1	3		<0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 1	0.27		<0.19	U	<0.14	U
Floor 1	1.4		<0.19	U	<0.14	U
Floor 1	0.47		0.56		<0.14	U
Floor 1	2.9		6.3		<0.14	U
Floor 1	0.71		0.71		<0.14	U
Floor 1	1.9		<0.19	U	<0.14	U
Floor 1	3.5		0.52		<0.14	U
Floor 1	0.42		<0.19	U	<0.14	U
Floor 1	0.32		<0.19	U	<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.33		0.45		<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 2	0.8		2.1		<0.14	U
Floor 2	0.43		<0.19	U	<0.14	U
Floor 3	<0.24	U	0.28		<0.14	U
Floor 3	0.41		0.94		<0.14	U
Floor 3	0.62		1.8		<0.14	U
Floor 3	1.8		4.3		<0.14	U
Floor 3	1.2		0.82		<0.14	U
Floor 4	0.43		0.19		<0.14	U
Floor 4	0.38		0.6		<0.14	U
Floor 4	<0.24	U	<0.19	U	<0.14	U
Floor 4	0.62		1.6		<0.14	U
Floor 4	0.85		<0.19	U	<0.14	U

NS=Not Sampled.

*U flag indicated that the VOC was not detected.

Appendix C. September 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	0.24		<0.19	U*	<0.14	U
Floor 1	NS		NS		NS	
Floor 1	0.34		0.19		<0.14	U
Floor 1	0.71		0.95		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	1.4		<0.19	U	<0.14	U
Floor 1	0.33		0.3		<0.14	U
Floor 1	4.8		30		<0.14	U
Floor 1	1.2		3.3		<0.14	U
Floor 1	3.3		3.6		<0.14	U
Floor 1	4.2		1.2		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	0.49		0.34		<0.14	U
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	1.4		5.6		<0.14	U
Floor 2	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	0.79		1		<0.14	U
Floor 3	0.34		1.2		<0.14	U
Floor 3	0.28		1.2		<0.14	U
Floor 3	0.6		0.99		<0.14	U
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	<0.24	U	0.23		<0.14	U
Floor 4	0.76		0.41		<0.14	U

NS=Not Sampled.

*U flag indicated that the VOC was not detected.

Appendix D. November 2021 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 1	<0.24	U	0.96		<0.14	U
Floor 1	0.45		0.19		<0.14	U
Floor 1	0.83		0.25		<0.14	U
Floor 1	1.2		0.26		<0.14	U
Floor 1	NS		NS		NS	
Floor 1	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	NS		NS		NS	
Floor 2	0.78		2		<0.14	U
Floor 2	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	NS		NS		NS	
Floor 3	0.4		1.5		<0.14	U
Floor 3	1.2		4.1		<0.14	U
Floor 3	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	NS		NS		NS	
Floor 4	0.83		3.6		<0.14	U
Floor 4	NS		NS		NS	

NS=Not Sampled.

*U flag indicated that the VOC was not detected.

Appendix E. January 2022 dataset by apartment unit.

Apartment Unit	PCE (ug/m^3)		TCE (ug/m^3)		DCE (ug/m^3)	
Floor 1	<0.24	U*	0.21		<0.14	U
Floor 1	<0.24	U	0.22		<0.14	U
Floor 1	0.27		0.23		<0.14	U
Floor 1	0.34		0.25		<0.14	U
Floor 1	<0.24	U	0.41		<0.14	U
Floor 1	1.0		0.37		<0.14	U
Floor 1	0.33		0.26		<0.14	U
Floor 1	0.78		0.30		<0.14	U
Floor 1	<0.24	U	0.28		<0.14	U
Floor 1	<0.24	U	0.24		<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 1	<0.24	U	0.28		<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 1	0.24	U	0.19	U	<0.14	U
Floor 1	0.26		0.30		<0.14	U
Floor 1	0.53		0.30		<0.14	U
Floor 1	0.53		0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 1	<0.24	U	<0.19	U	<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 2	1.1		<0.19	U	<0.14	U
Floor 2	0.25		<0.19	U	<0.14	U
Floor 2	0.53		0.34		<0.14	U
Floor 2	<0.24	U	<0.19	U	<0.14	U
Floor 3	<0.24	U	<0.19	U	<0.14	U
Floor 3	0.34		<0.19	U	<0.14	U
Floor 3	0.25		0.25		<0.14	U
Floor 3	0.66		1.4		<0.14	U
Floor 3	0.74		0.31		<0.14	U
Floor 4	<0.24	U	0.43		<0.14	U
Floor 4	0.76		0.23		<0.14	U
Floor 4	0.32		0.20		<0.14	U
Floor 4	0.80		0.74		<0.14	U
Floor 4	0.72		0.20		<0.14	U

*U flag indicated that the VOC was not detected.

Appendix F. ATSDR ToxFAQs for TCE.

Trichloroethylene - ToxFAQs™

CAS # 79-01-6

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is used as a solvent for cleaning metal parts. Exposure to very high concentrations of trichloroethylene can cause dizziness headaches, sleepiness, incoordination, confusion, nausea, unconsciousness, and even death. Trichloroethylene has been found in at least 1,051 of the 1,854 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is trichloroethylene?

Trichloroethylene is a colorless, volatile liquid. Liquid trichloroethylene evaporates quickly into the air. It is nonflammable and has a sweet odor.

The two major uses of trichloroethylene are as a solvent to remove grease from metal parts and as a chemical that is used to make other chemicals, especially the refrigerant, HFC-134a.

What happens to trichloroethylene when it enters the environment?

- Trichloroethylene can be released to air, water, and soil at places where it is produced or used.
- Trichloroethylene is broken down quickly in air.
- Trichloroethylene breaks down very slowly in soil and water and is removed mostly through evaporation to air.
- It is expected to remain in groundwater for long time since it is not able to evaporate.
- Trichloroethylene does not build up significantly in plants or animals.

How might I be exposed to trichloroethylene?

- Breathing trichloroethylene in contaminated air.
- Drinking contaminated water.
- Workers at facilities using this substance for metal degreasing are exposed to higher levels of trichloroethylene.
- If you live near such a facility or near a hazardous waste site containing trichloroethylene, you may also have higher exposure to this substance.

How can trichloroethylene affect my health?

Trichloroethylene was once used as an anesthetic for surgery. Exposure to moderate amounts of trichloroethylene may cause headaches, dizziness, and sleepiness; large amounts may cause coma and even death. Eating or breathing high levels of trichloroethylene may damage some of the nerves in the face. Exposure to high levels can also result in changes in the rhythm of the heartbeat, liver damage, and evidence of kidney damage. Skin contact with concentrated solutions of trichloroethylene can cause skin rashes. There is some evidence exposure to trichloroethylene in the work place may cause scleroderma (a systemic autoimmune disease) in some people. Some men occupationally-exposed to trichloroethylene and other chemicals showed decreases in sex drive, sperm quality, and reproductive hormone levels.

How likely is trichloroethylene to cause cancer?

There is strong evidence that trichloroethylene can cause kidney cancer in people and some evidence for trichloroethylene-induced liver cancer and malignant lymphoma. Lifetime exposure to trichloroethylene resulted in increased liver cancer in mice and increased kidney cancer and testicular cancer in rats.

The Department of Health and Human Services (DHHS) considers trichloroethylene to be a known human carcinogen. The International Agency for Research on Cancer (IARC) classified trichloroethylene as carcinogenic to humans. The EPA has characterized trichloroethylene as carcinogenic to humans by all routes of exposure.

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

Trichloroethylene

CAS # 79-01-6

How can trichloroethylene affect children?

It is not known whether children are more susceptible than adults to the effects of trichloroethylene.

Some human studies indicate that trichloroethylene may cause developmental effects such as spontaneous abortion, congenital heart defects, central nervous system defects, and small birth weight. However, these people were exposed to other chemicals as well.

In some animal studies, exposure to trichloroethylene during development caused decreases in body weight, increases in heart defects, changes to the developing nervous system, and effects on the immune system.

How can families reduce the risk of exposure to trichloroethylene?

- Avoid drinking water from sources that are known to be contaminated with trichloroethylene. Use bottled water if you have concerns about the presence of chemicals in your tap water. You may also contact local drinking water authorities and follow their advice.
- Prevent children from playing in dirt or eating dirt if you live near a waste site that has trichloroethylene.
- Trichloroethylene is used in many industrial products. Follow instructions on product labels to minimize exposure to trichloroethylene.

Is there a medical test to determine whether I've been exposed to trichloroethylene?

Trichloroethylene and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of trichloroethylene or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because trichloroethylene and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure.

Has the federal government made recommendations to protect human health?

The EPA set a maximum contaminant goal (MCL) of 0.005 milligrams per liter (mg/L; 5 ppb) as a national primary drinking standard for trichloroethylene.

The Occupational Safety and Health Administration (OSHA) set a permissible exposure limit (PEL) of 100 ppm for trichloroethylene in air averaged over an 8-hour work day, an acceptable ceiling concentration of 200 ppm provided the 8 hour PEL is not exceeded, and an acceptable maximum peak of 300 ppm for a maximum duration of 5 minutes in any 2 hours.

The National Institute for Occupational Safety and Health (NIOSH) considers trichloroethylene to be a potential occupational carcinogen and established a recommended exposure limit (REL) of 2 ppm (as a 60-minute ceiling) during its use as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures.

Reference

This ToxFAQs™ information is taken from the 2019 Toxicological Profile for Trichloroethylene produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ on the web: www.atsdr.cdc.gov/ToxFAQs

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.