Letter Health Consultation

GRANT MILL APARTMENT COMPLEX:
TRICHLOROETHYLENE VAPOR INTRUSION, AUGUST 2021

PROVIDENCE, PROVIDENCE COUNTY, RHODE ISLAND

Prepared by the
Rhode Island Department of Health

AUGUST 6, 2021

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 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.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Trichloroethylene Vapor Intrusion, August 2021

Providence, Providence County, Rhode Island

Prepared By:

Environmental Health Risk Assessment Program
Rhode Island Department of Health
Under Cooperative Agreement with
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August 6, 2021

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

Dear Ms. Owens and Ms. Blauvelt,

In July 2021, the Rhode Island Department of Environmental Management (RIDEM) requested the Rhode Island Department of Health (RIDOH) review the results of indoor air sampling at 34 residences within the Grant Mill property in Providence, RI. This review was prepared in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR) as a letter health consultation. This document followed an earlier health assessment (Rhode Island Department of Health 2021) completed in June 2021, which reviewed the results of indoor air sampling for at 32 Grant Mill residences (February 2021). The consultant (Boston Environmental Corporation; BEC) identified elevated indoor air levels of chlorinated volatile organic compounds (VOCs), possibly related to soil-vapor intrusion, and installed multiple sub-slab depressurization systems (SSDSs) in the basement before sampling again in June 2021.

Despite the remedial actions, the maximum indoor air trichloroethylene (TCE) concentrations unexpectedly increased on the first, second, and third floor apartment units (Table 1) between February 2021 and June 2021. Although maximum concentrations of tetrachloroethylene (PCE) and cis-1,2-dichloroethylene (DCE) decreased between these time periods, the June 2021 results suggested that the SSDSs were less effective at reducing TCE indoor air concentrations. Given this result, there may be parallel issues of soil-vapor intrusion and building material contamination. RIDOH evaluated the data for potential health effects through the inhalation exposure pathway following initial remediation steps.

RIDOH concluded that increased risks for non-cancer and cancer health effects could result from trichloroethylene (TCE) inhalation over long-term exposure periods (e.g. >1 year) among Grant Mill tenants and short-term exposures among developing fetuses. Current TCE inhalation exposures from indoor air thus posed a public health hazard. Levels of tetrachloroethylene (PCE) and cis-1,2-dichloroethene (DCE), on their own, were below concerning levels for non-cancer health effects among tenants. However, the combined PCE, DCE, and TCE levels detected could have additive toxic effects because they act through the same adverse outcome pathways.

RIDOH recommends that the current owner (Grant Mill, LLC) take additional steps to reduce tenant chlorinated solvent exposure levels by increasing ventilation because previous remediation steps (e.g. SSDS installation in basement) have not sufficiently lowered maximum TCE indoor air levels. BEC and Grant Mill, LLC should assess the site for contaminated building materials and continue to remediate as necessary to reduce future tenant exposure. Lastly, BEC and Grant Mill, LLC should reiterate the potential risks of chronic TCE inhalation exposure to tenants and continue to keep tenants updated about remediation efforts. The remainder of this letter health consultation presents detailed information supporting RIDOH's analysis, conclusions, and recommendations.

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 four 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 PES Associates (December 2016). At the time, no Recognized Environmental Conditions were identified, despite the facility's prior use as a jewelry manufacturer and 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), April 2021 (partial dataset, five units only), and June 2021 (Appendix B), 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 both the February (Appendix A) and June datasets (Appendix B) because tenants spent the majority of their time in the apartment units (ATSDR 2020). RIDOH used the maximum VOC concentrations on each floor (Table 1) for the exposure assessment. The 95th upper confidence level (95UCL) of the mean was also applied to the first floor apartment samples (n=19) as an additional exposure point concentration (ATSDR 2005).

Between February and June, BEC installed SSDSs in the building's basement as initial remedial actions. If the SSDS remediation steps were sufficiently reducing VOC indoor air concentrations, the June indoor air results would be lower than the February results (Rhode Island Department of Health 2021).

Table 1. Unadjusted 24h VOC concentration in indoor air by floor.

Floor	PCE (ug/m^3)				TCE (ug/m^3)				DCE (ug/m^3)			
	Feb max	June max	Feb 95UCL	June 95UCL	Feb max	June max	Feb 95UCL	June 95UCL	Feb max	June max	Feb 95UCL	June 95UCL
MassDEP*	1.4				0.4				0.8			
1992 IA**	4.1				0.8				0.8			
1st (n=19)	**11**	**34**	**2.8**	**2.1**	**1.4**	**6.3**	**0.53**	**0.92**	0.25	<0.14	NA	NA
2nd (n=5)	**3.7**	0.8			**1.2**	**2.1**			0.65	<0.14		
3rd (n=5)	**12**	**1.8**			**2.3**	**4.3**			**2.3**	<0.14		
4th (n=5)	**15**	0.9			**2.6**	**1.6**			**2.8**	<0.14		

*Massachusetts Department of Environmental Protection (DEP) Residential Indoor Air Threshold Values. Data in **bold** indicated the level was higher than the threshold.
**IA: Typical indoor air concentrations in 1992 (RIDEM internal data)

Notably, not all of the indoor air concentrations lowered between the sampling events, which would be expected following the SSDS installation. Between February and June, maximum PCE concentrations increased on the first and third floors, and maximum TCE concentrations increased on the first, second, and third floors. DCE was not detected in the June dataset.

In February, the maximum VOC indoor air concentrations were higher on the third and fourth floors than the first and second floors. The June trend for TCE was slightly different (first>third>second>fourth), but elevated concentrations were still detected on the upper floors. This result was inconsistent with the soil-vapor intrusion hypothesis because 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 VOC source(s) may be the building materials, potentially following a chemical spill soaking into the floorboards and now evaporating. Additional remedial actions beyond SSDS installation will likely be needed to sufficiently reduce VOC levels in the apartment units.

Exposure Scenario: Tenant Inhalation
In compliance with ATSDR guidance (ATSDR 2016), RIDOH assumed a chronic inhalation exposure scenario of 24 h/d, 7 d/wk, and 52.14 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.[1] 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 2. Tables 3-5 reported the HQs and ELCRs by floor and VOC, for both the CTE and RME of the residential occupancy period.

Table 2. Inhalation minimum risk level by VOC and concentration unit.

	PCE~			TCE~			DCE+		
	ppm	ug/m^3 ^	IUR (ug/m^3)	ppm	ug/m^3 ^	IUR (ug/m^3)	ppm	ug/m^3 ^	IUR (ug/m^3)
Chronic	0.006	41	$2.6*10^{-7}$	0.0004	2.1	$4.1*10^{-6}$	NA	NA	NA
Intermediate	0.006	41		0.0004	2.1		0.2	800	
Acute	0.006	41		0.0004	2.1		0.2	800	

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

Table 3. PCE hazard quotient and excess lifetime cancer risk by floor. Value in **bold** denote an increase in risk from February to June.

Floor	HQ (max)		HQ (95UCL)		ELCR (CTE)		ELCR (RME)	
	Feb	June	Feb	June	Feb	June	Feb	June
1st	0.27	***0.83***	0.07	0.05	$4.3*10^{-8}$	***$1.3*10^{-7}$***	$3.0*10^{-7}$	***$9.1*10^{-7}$***
2nd	0.09	0.02			$1.4*10^{-8}$	$3.1*10^{-9}$	$9.9*10^{-8}$	$2.1*10^{-8}$
3rd	0.29	0.04			$4.7*10^{-8}$	$7.0*10^{-9}$	$3.2*10^{-7}$	$4.8*10^{-8}$
4th	0.37	0.02			$5.9*10^{-8}$	$3.3*10^{-9}$	$4.0*10^{-7}$	$2.3*10^{-8}$

[1] 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 4. TCE hazard quotient and excess lifetime cancer risk by floor. Value in **bold** denote an increase in risk from February to June. Highlighted boxes denote elevated risk.

Floor	HQ (max)		HQ (95UCL)		ELCR (CTE)		ELCR (RME)	
	Feb	June	Feb	June	Feb	June	Feb	June
1st	0.64	***2.88***	0.24	***0.42***	$8.6*10^{-8}$	$\mathbf{3.9*10^{-7}}$	$5.9*10^{-7}$	$\mathbf{2.7*10^{-6}}$
2nd	0.55	***0.96***			$7.4*10^{-8}$	$\mathbf{1.3*10^{-7}}$	$5.1*10^{-7}$	$\mathbf{8.9*10^{-7}}$
3rd	1.1	***1.96***			$1.4*10^{-7}$	$\mathbf{2.6*10^{-7}}$	$9.7*10^{-7}$	$\mathbf{1.8*10^{-6}}$
4th	1.2	0.73			$1.6*10^{-7}$	$9.8*10^{-8}$	$1.1*10^{-6}$	$6.8*10^{-7}$

Table 5. DCE hazard quotient and excess lifetime cancer risk by floor.

Floor	HQ (max)		HQ (95UCL)	
	Feb	June	Feb	June
1st	0.0003	<0.001	NA	NA
2nd	0.0008	<0.001		
3rd	0.0029	<0.001		
4th	0.0035	<0.001		

From Table 4, increased risks for non-cancer health effects would be expected from chronic TCE inhalation exposures. Under the RME exposure scenario (8.0 y tenancy), increased risks for cancer health effects were above the level of concern (1 per 10^6, or one in one million people) for TCE inhalation. Levels of PCE (Table 3) and DCE (Table 5), on their own, were below the levels of concern for non-cancer and cancer health effects.

Between February 2021 and June 2021, the risks for TCE-related non-cancer and cancer health effects increased on the first, second, and third floors at Grant Mill. This should be cause for concern because the remediation steps (e.g. SSDSs in the basement) took place between the sampling events; however, the estimated health risks increased regardless.

Notably, maximum concentrations of PCE and DCE decreased in the units' indoor air between these time periods, such that there may be parallel issues of soil-vapor intrusion and building material contamination. As of July 2021, remediation efforts have focused on vapor intrusion in the basement, but BEC should assess the site for other potential VOC sources (ex: building materials) and remediate as necessary to reduce future tenant exposures.[2]

Public Health Implications

A wide range of adverse non-cancer health effects have been associated with low levels of TCE inhalation exposures (Appendix C). The developing fetus is a particularly sensitive target of TCE toxicity, with the ATSDR TCE MRL of 2.1 ug/m^3 based on fetal heart malformations observed in rodents (ATSDR 2019). The Massachusetts Department of Environmental Protection has issued an Imminent Hazard value for TCE residential indoor air of 6 µg/m^3 for women early in pregnancy ("Trichloroethylene (TCE) in Indoor Air" 2017). The 24h TCE indoor air levels at Grant Mill exceeded 6 µg/m^3 at one first floor apartment in June (Appendix B), such that the

[2] RIDOH does not have the jurisdiction to compel potentially responsible parties to investigate construction materials inside residential buildings for VOC contamination.

unborn babies may experience elevated risks of non-cancer health effects, should the mother be exposed during the first trimester.

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), although fetal heart malformation is considered the most sensitive health endpoint.

In human occupational exposure studies, acute TCE inhalation exposure has led to central nervous system depression, loss of consciousness, and death (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).

PCE and DCE inhalation exposures have similar adverse health effects (Stevens 1997; Harper, Chessin, and Goldhaber 1996), although PCE- and DCE-related risks for non-cancer health effects were not expected at Grant Mill. However, ATSDR assumes the health effect risks from TCE, PCE, and DCE exposures will be additive (ATSDR 2004). At Grant Mill, the risks for non-cancer health effects may be further increased when considering the combined TCE, PCE, and DCE inhalation exposures.

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 found at Grant Mill at the RME residential occupancy period of 8.0 years (US EPA 2011). As with the non-cancer health effects, ATSDR assumes the cancer risks from TCE and PCE to be additive (ATSDR 2004) and the risks for cancer health effects may be further increased when considering the combined TCE and PCE inhalation exposures. The above-listed health effects have been included in a site-specific frequently asked questions document with current tenants as the target audience (Appendix D).

Limitations of Analysis

The indoor air VOC concentrations accounted for two 24h 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). Increased risks for adverse health effects may be expected from chronic, intermediate, and acute TCE inhalation exposures at Grant Mill.

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 February 2021 and June 2021 data, RIDOH reached the following conclusions.

1. Increased risks for non-cancer and cancer health effects would be expected from chronic TCE inhalation exposures among Grant Mill tenants.
2. Increased risks for non-cancer and cancer health effected were not expected from chronic PCE and DCE inhalation exposures among Grant Mill tenants.

From these conclusions, RIDOH made the following recommendations, which were also provided in the earlier letter health consultation completed in June (Rhode Island Department of Health 2021).

1. Grant Mill, LLC should take steps, beyond SSDS installation, to reduce tenant TCE inhalation exposures by increasing ventilation.
2. Grant Mill, LLC and BEC should assess the site for contaminated building materials and remediate as necessary to reduce future tenant exposures.
3. Grant Mill, LLC and BEC should reiterate the potential risks of chronic TCE inhalation exposure to tenants and continue to keep tenants updated about remediation efforts.

Additional Considerations

BEC has scheduled additional rounds of indoor air sampling within the Grant Mill apartment units for September 2021 and January 2022. Continuing remediation plans include an additional SSDS to be installed on the first floor, within a common wall of the western apartment units. BEC does not currently plan to install an SSDS on the second or third floors, where the maximum TCE concentrations were also detected. When the September sampling event is completed, 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

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References

ATSDR. 2004. “Interaction Profile for 1,1,1-Trichloroethane, 1,1-Dichloroethane, Trichloroethylene, and Tetrachloroethylene.” https://www.atsdr.cdc.gov/interactionprofiles/ip02.html.

———. 2005. “Public Health Assessment Guidance Manual.” US Department of Health and Human Services. https://www.atsdr.cdc.gov/hac/phamanual/pdfs/phagm_final1-27-05.pdf.

———. 2016. “Evaluating Vapor Intrusion Pathways: Guidance for ATSDR’s Division of Community Health Investigations.” https://stacks.cdc.gov/view/cdc/79266.

———. 2019. “Toxicological Profile for Trichloroethylene (TCE).” file:///C:/Users/carolyn.poutasse/Downloads/cdc_79528_DS1.pdf.

———. 2020. “Guidance for Inhalation Exposures.”

Dhanantwari, Preeta, Elaine Lee, Anita Krishnan, Rajeev Samtani, Shigehito Yamada, Stasia Anderson, Elizabeth Lockett, Mary Donofrio, Kohei Shiota, and Linda Leatherbury. 2009. “Human Cardiac Development in the First Trimester: A High-Resolution Magnetic Resonance Imaging and Episcopic Fluorescence Image Capture Atlas.” *Circulation* 120 (4): 343–51.

Harper, Carolyn, Robert Chessin, and Susan Goldhaber. 1996. “Toxicological Profile for 1,2-Dichloroethene (DCE).” https://www.atsdr.cdc.gov/toxprofiles/tp87.pdf.

Ma, Jie, Thomas McHugh, Lila Beckley, Matthew Lahvis, George DeVaull, and Lin Jiang. 2020. “Vapor Intrusion Investigations and Decision-Making: A Critical Review.” *Environmental Science & Technology* 54 (12): 7050–69.

Rhode Island Department of Health. 2021. “Grant Mill Apartment Complex: Trichloroethylene Vapor Intrusion.” Rhode Island Department of Health. https://health.ri.gov/publications/healthconsultations/Grant-Mill-Apartments.pdf.

Stevens, Yee-Wan. 1997. “Toxicological Profile for Tetrachloroethylene.” https://www.atsdr.cdc.gov/toxprofiles/tp18.pdf.

“Trichloroethylene (TCE) in Indoor Air.” 2017. Massachusetts Department of Environmental Protection. https://www.mass.gov/doc/trichloroethylene-tce-in-indoor-air/download.

US EPA. 2011. “Exposure Factors Handbook: Activity Factors.” https://www.epa.gov/expobox/about-exposure-factors-handbook.

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)	
102	0.36		<0.19	U*	<0.14	U
103	8.5		1.2		0.25	
104	1.7		0.42		<0.14	U
105	7.2		1		<0.14	U
106	1.3		0.3		<0.14	U
107	2.3		0.4		<0.14	U
108	11		1.4		0.19	
109	0.97		0.33		<0.14	U
110	0.37		<0.19	U	<0.14	U
111	0.87		<0.19	U	<0.14	U
112	0.78		<0.19	U	<0.14	U
113	2.3		0.6		0.14	
114	3.9		0.72		<0.14	U
115	9.3		0.42		<0.14	U
117	4.2		0.52		<0.14	U
118	0.45		<0.19	U	<0.14	U
119	<0.24	U	<0.19	U	<0.14	U
202	0.42		<0.19	U	<0.14	U
209	3.7		0.71		0.59	
212	0.54		<0.19	U	<0.14	U
216	3.2		1.2		0.24	
223	2.2		0.41		0.65	
302	0.28		<0.19	U	<0.24	U
309	4.3		1.1		0.78	
313	1.9		0.99		0.3	
314	2.5		0.6		0.25	
319	12		2.3		2.3	
402	1.7		0.54		0.25	
409	3.9		1.1		0.65	
411	1.8		0.57		0.18	
416	4.3		1.7		0.23	
419	15		2.6		2.8	

*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)	
101	0.28		<0.19	U*	<0.14	U
102	2.8		<0.19	U	<0.14	U
103	2.1		0.52		<0.14	U
104	34		<0.19	U	<0.14	U
105	0.73		0.37		<0.14	U
106	0.81		<0.19	U	<0.14	U
107	0.58		<0.19	U	<0.14	U
108	0.93		<0.19	U	<0.14	U
109	3.0		<0.19	U	<0.14	U
110	<0.24	U	<0.19	U	<0.14	U
111	0.27		<0.19	U	<0.14	U
112	1.4		<0.19	U	<0.14	U
113	0.47		0.56		<0.14	U
114	2.9		6.3		<0.14	U
115	0.71		0.71		<0.14	U
116	1.9		<0.19	U	<0.14	U
117	3.5		0.52		<0.14	U
118	0.42		<0.19	U	<0.14	U
119	0.32		<0.19	U	<0.14	U
202	<0.24	U	<0.19	U	<0.14	U
209	0.33		0.45		<0.14	U
212	<0.24	U	<0.19	U	<0.14	U
216	0.8		2.1		<0.14	U
223	0.43		<0.19	U	<0.14	U
302	<0.24	U	0.28		<0.14	U
309	0.41		0.94		<0.14	U
313	0.62		1.8		<0.14	U
314	1.8		4.3		<0.14	U
319	1.2		0.82		<0.14	U
402	0.43		0.19		<0.14	U
409	0.38		0.6		<0.14	U
411	<0.24	U	<0.19	U	<0.14	U
416	0.62		1.6		<0.14	U
419	0.85		<0.19	U	<0.14	U

*U flag indicated that the VOC was not detected.

Appendix C. 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.

Appendix D. Trichloroethylene at Grant Mill Apartments: Frequently Asked Questions, August 2021.

What is the Environmental Issue at Grant Mill?

Grant Mill, LLC by Heritage Properties has owned and operated the building since 2017. They planned to refinance the building in late 2020, which required an environmental assessment because of its history as a jewelry manufacturer.

In January 2021, environmental consultants (Boston Environmental Corporation; BEC) collected soil, groundwater, and air samples. With these samples, Grant Mill first learned that *volatile organic compounds (VOCs)* were in the air of some apartments.

What Are These Chemicals?

Jewelry manufacturing used VOCs as solvents and degreasers. Some common VOCs are *tetrachloroethylene (PCE)*, *trichloroethylene (TCE)*, and *cis-1,2-dichloroethylene (DCE)*.

In manufacturing, VOCs were often spilled on the ground or the floor by accident. When this happens, they can stay around or in the building for years. Over time, spilled VOCs can evaporate and move into the building's air. This is called *vapor intrusion*. People in the building **may** breathe in the vapors and experience *inhalation exposures*.

Are These VOCs in My Apartment Unit?

Select Grant Mill apartment units had indoor air samples taken in February, April, and June 2021. The April and June test results have been sent to tenants, and BEC is available to answer testing-specific questions sent to the Community Manager (jmichaud@heritageprop.net).

TCE was a frequently found VOC in the apartment units. Although the levels were lower than what an occupational worker might be exposed to, some units had relatively high TCE levels for residential areas.

Do I Need to Leave My Apartment?

Tenants do not need to evacuate their apartments. So far, no Grant Mill apartment unit indoor air samples have had TCE levels above 20 micrograms per cubic meter ($\mu g/m^3$), which is the short-term Imminent Hazard value for TCE residential indoor air for the general population.

How Can TCE Affect My Health?

Both high-level short-term (*acute*; <14 days) and low-level long-term (*chronic*; >365 days) TCE exposures can lead to negative health effects. Breathing in TCE **may** lead to:

- Headache, dizziness, poor coordination, decreased concentration, loss of consciousness (neurological)
- Lung irritation
- Liver, kidney, and immune system damage

TCE exposures have also been associated with Parkinson's disease, a common neurodegenerative disorder, although other genetic and environmental factors may contribute.

Chronic exposures to low TCE levels has also been linked to cancer. Animal and epidemiological studies have also shown that breathing low levels of TCE for many years **may** lead to cancer in the liver, kidney, or lung. EPA considers TCE and PCE to be probable human carcinogens and DCE a possible human carcinogen.

Are My Children at Risk?

Developing babies are very sensitive to TCE toxicity and **may** experience birth defects, such as fetal heart malformations, if the mother is exposed. In June 2021, only one Grant Mill unit had TCE levels over 6 $\mu g/m^3$, which is the Imminent Hazard value for TCE residential indoor air for women in early pregnancy (first trimester).

NOTE: TCE levels above 6 $\mu g/m^3$ do **not** mean that birth defects will definitely happen to an unborn baby. It means that actions should be taken to lower TCE levels and reduce the health risks. Women who are pregnant or may become pregnant may want to review their unit's TCE indoor air results from the consultant as a precaution.

What's Grant Mill Doing About These Chemicals Now?

The Rhode Island Department of Environmental Management (RIDEM) supervises the assessment and *remediation*, or clean up, of these chemicals. BEC cooperates with RIDEM and the Rhode Island Department of Health (RIDOH) through the remediation process.

Between February 2021 and July 2021, BEC installed *sub-slab depressurization systems* throughout the building to limit how many VOCs enter the first floor. BEC plans to take more air samples until at least January 2022. These samples will help evaluate whether the remedial actions are effectively lowering VOC indoor air levels at Grant Mill.

What Can I Do About VOCs in My Apartment?

Increasing air ventilation can lower VOC indoor air levels. This includes simple actions like opening a window or turning on a fan (ex: kitchen or bathroom).

Who Can I Contact for More Information?

For questions about your unit's test results or the building's remediation plans, please contact the Community Manager so they can forward questions to the consultant.

For questions about potential VOC health effects, please contact RIDOH (carolyn.poutasse@health.ri.gov; michael.byrns@health.ri.gov).

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