Letter Health Consultation

GRANT MILL APARTMENT COMPLEX:
TRICHLOROETHYLENE VAPOR INTRUSION

PROVIDENCE COUNTY, RHODE ISLAND

Prepared by the
Rhode Island Department of Health

JUNE 7, 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

Health Consultation: A Note of Explanation

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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Letter Health Consultation

Grant Mill Apartments:
Trichloroethylene Vapor Intrusion

Providence, Providence County, Rhode Island

Prepared By:

Environmental Health Risk Assessment Program
Rhode Island Department of Health
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Leo Hellested, RIDEM

June 7, 2021

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

Dear Ms. Owens and Ms. Blauvelt,

In March 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 32 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. The consultant (Boston Environmental Corporation; BEC) identified elevated indoor air levels of chlorinated volatile organic compounds (VOCs), possibly related to soil-vapor intrusion. RIDOH evaluated the available data for potential health effects through the inhalation exposure pathway.

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 an urgent 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 immediate steps to temporarily reduce tenants' chlorinated solvent exposure levels by increasing ventilation, while assessing the need for more permanent solutions. BEC and Grant

Mill, LLC should assess the site for contaminated building materials and remediate as necessary to reduce future tenant exposure. 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. 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, 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 the February dataset (Appendix A) because tenants spent the majority of their time in the apartment units (ATSDR 2020), particularly during the COVID-19 pandemic. 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 1st floor apartment samples (n=17) as an additional exposure point concentration (ATSDR 2005).

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

Floor	PCE max (ug/m^3)	PCE 95UCL (ug/m^3)	TCE max (ug/m^3)	TCE 95UCL (ug/m^3)	DCE max (ug/m^3)	DCE 95UCL (ug/m^3)
MassDEP*	1.4		0.4		0.8	
1992 IA**	4.1		0.8		0.8	
1st (n=17)	**11.0**	**2.8**	**1.4**	**0.53**	0.25	NA
2nd (n=5)	**3.7**		**1.2**		0.65	
3rd (n=5)	**12**		**2.3**		**2.3**	
4th (n=5)	**15**		**2.6**		**2.8**	

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

Notably, the maximum VOC indoor air concentrations were higher on the 3rd and 4th floors than the 1st and 2nd floors. When soil-vapor intrusion is the VOC source, higher VOC concentrations are typically 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.

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

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

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

A HQ>1.0 and/or an ELCR>$1.0*10^{-6}$ are cause for concern. 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. Table 3 reported the HQs and ELCRs by floor, 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; Todd et al. 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. VOC hazard quotient and excess lifetime cancer risk by floor.

Floor	PCE				TCE				DCE	
	HQ (max)	HQ (95UCL)	ELCR (CTE)	ELCR (RME)	HQ (max)	HQ (95UCL)	ELCR (CTE)	ELCR (RME)	HQ (max)	HQ (95UCL)
1st	0.27	0.07	$4.3*10^{-8}$	$3.0*10^{-7}$	0.64	0.24	$8.6*10^{-8}$	$5.9*10^{-7}$	0.0003	NA
2nd	0.09		$1.4*10^{-8}$	$9.9*10^{-8}$	0.55		$7.4*10^{-8}$	$5.1*10^{-7}$	0.0008	
3rd	0.29		$4.7*10^{-8}$	$3.2*10^{-7}$	1.1		$1.4*10^{-7}$	$9.7*10^{-7}$	0.0029	
4th	0.37		$5.9*10^{-8}$	$4.0*10^{-7}$	1.2		$1.6*10^{-7}$	$1.1*10^{-6}$	0.0035	

From Table 3, increased risks for non-cancer health effects would be expected from chronic TCE inhalation exposures. Under the RME exposure scenario (8.0 year 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 and DCE, on their own, were below the levels of concern for non-cancer and cancer health effects.

Public Health Implications

A wide range of adverse non-cancer health effects have been associated with TCE inhalation exposures (Appendix B). The developing fetus is a particularly sensitive target of TCE toxicity, with the ATSDR TCE MRL of 2.1 ug/m^3 is based on fetal heart malformations observed in rodents (Todd et al. 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). Although the 24h TCE indoor air levels at Grant Mill remained below 6 µg/m^3 in February (Appendix B), major cardiac development in humans occurs over a three-week period during the first three months of pregnancy (Dhanantwari et al. 2009). TCE inhalation exposures during this period may increase the risk of fetal heart malformations (Todd et al. 2019).

TCE inhalation exposure has also resulted in central nervous system depression, loss of consciousness, and death, as well as damage to the liver, kidneys, skin, immune system, and reproductive system (Todd et al. 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 (Todd et al. 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.

Limitations of Analysis

The available indoor air VOC concentrations accounted for a single 24-hour time period, which is a dataset most 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 (Todd et al. 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 event (February 2021, 24h indoor air concentrations) and recommended residency occupancy periods from previous research (US EPA 2011).

Conclusions and Recommendations

Based on the February 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.

1. Grant Mill, LLC should take temporary steps to reduce tenants' TCE inhalation exposures by increasing ventilation, while assessing the need for more permanent solutions.
2. Grant Mill, LLC and BEC should assess the site for contaminated building materials and remediate as necessary to reduce future tenant exposure.

Additional Considerations

BEC has scheduled an additional round of indoor air sampling within the Grant Mill apartment units for June 2021. These samples will follow BEC's installation of a pilot sub-slab depressurization system in the building's basement to reduce soil-vapor VOC concentrations. When the Site Investigation Report is submitted to RIDEM in July 2021, RIDOH is available to assess the additional indoor air VOC data for potential health effects.

If there are any questions, please contact me at michael.byrns@health.ri.gov.

Sincerely,

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Report Preparation

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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)	
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. ATSDR ToxFAQs for trichloroethylene.

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.