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July 14, 2021

Monmouth County Health Department
Attn: Mr. Christopher Merkel, M.P.H.
Public Health Coordinator and Health Officer
50 East Main Street
Freehold, NJ 07728

Dear Mr. Merkel:

The New Jersey Department of Health (NJDOH) has prepared this Letter Health Consultation (LHC) to address health concerns from possible indoor air exposures to dry cleaning chemicals at the Marlboro Mall, located at 8 South Main Street in Marlboro. As set forth in more detail below, the LHC provides NJDOH's recommendations for future actions to be taken in light of the potential health concerns.

This LHC was prepared under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This evaluation is based on indoor air data collected at the strip mall during site remediation and vapor intrusion investigations by Licensed Site Remediation Professionals (LSRP) hired by the property owner, the details of which are described below. The work of an LSRP must comply with the Site Remediation Reform Act of 2009 and regulations promulgated by the New Jersey Department of Environmental Protection (NJDEP). Submittals of an LSRP are subject to NJDEP's review and inspection to ensure that remediation work is completed in accordance with the NJDEP's applicable standards and regulations and defines remediation timeframes to ensure that responsible parties remediate sites in a timely manner (NJDEP 2014).

Background and Statement of Issues

In April 2021, the NJDOH was contacted by a tenant in the strip mall who had been concerned about odors coming from the co-located dry cleaner and potential health effects based on sampling results. The Marlboro Mall currently has several tenant spaces, including a Chinese food restaurant, pizza restaurant, insurance office, bagel shop, nail salon, and a dry cleaner. On the day the building occupant contacted NJDOH, we contacted the NJDEP to request all available indoor air data, indoor air building surveys, and site history for this building.

According to information provided by the NJDEP, a groundwater investigation identified elevated levels of tetrachloroethylene (PCE) and trichloroethylene (TCE) in the groundwater in the spring of 2010. This triggered a vapor intrusion investigation which determined the indoor air

was impacted by the presence of PCE and TCE in the soil gas, confirming a vapor intrusion pathway was present. Installation of sub-slab depressurization systems (SSDS) at four tenant spaces commenced in November 2010 to address vapor intrusion impacts to the building. Between 2010 to 2014, the five leaseholds co-located with the dry cleaner were sampled during the vapor intrusion investigation. The primary contaminants detected in the indoor air were PCE and TCE, which are associated with dry cleaning activities. The SSDS was decommissioned in February 2015 due to results indicating the levels of PCE and TCE beneath the building were below the NJDEP's sub-slab soil gas standards.

In November 2020, a new LSRP retained by the property owner for the site conducted additional rounds of indoor air and sub-slab soil gas sampling. Results identified elevated levels of PCE and TCE in the indoor air of several tenant spaces and the dry cleaner space, while the soil gas levels were below NJDEP's standards. This indicated there is no current vapor intrusion pathway, which means the elevated indoor air concentrations are not being impacted from vapors coming from the environment below the building and an indoor source is suspected.

The LSRP took corrective actions including sealing cracks in walls, floors and ceiling of the dry cleaner space to reduce impacts from dry cleaning operations to surrounding leasehold spaces. Follow-up indoor air samples collected in February 2021 still showed elevated levels of PCE and TCE in several tenant spaces, including the dry cleaner.

Addressing the potential of an indoor air contamination source, in early April 2021, the dry-cleaning machine was removed and replaced with a machine that uses a petroleum-based solvent instead of PCE. Follow-up indoor air sampling was conducted in late April to verify PCE and TCE levels were decreasing after the removal of the old dry-cleaning machine. Although results indicated the levels of PCE and TCE had decreased since the February sampling event, the levels remained elevated above the indoor air screening levels in two of the tenant spaces and in the dry cleaner space.

The LSRP has indicated there are ongoing efforts to address the heating, ventilation, and air conditioning (HVAC) system of the building after an evaluation determined that the HVAC ducts installed is a closed loop system that may be sharing the air distribution between all leaseholds.

ATSDR Evaluation Process

An evaluation of site-related environmental contamination follows a two-tiered approach:

1. a screening analysis;
2. an in-depth analysis to determine public health implications of site-specific exposures.

First, maximum concentrations of detected substances are compared to environmental media-specific health-based guideline comparison values. If contaminant concentrations exceed the environmental comparison value, these substances are selected for further evaluation. These are considered contaminants of concern. ATSDR does not use screening values to predict the

occurrence of adverse health effects, but rather to serve as a health protective first step in the evaluation process.

If contaminant concentrations are above these health-based guideline comparison values, ATSDR reviews exposure variables (such as duration and frequency), the toxicology of the contaminant, and epidemiology studies to determine likelihood of possible health effects. During this part of the evaluation process, ATSDR estimates site-specific exposure doses and compares those to health guideline values.

For indoor air exposures, ATSDR uses the measured air concentrations adjusted for the exposure frequency (i.e., worker, school, residential). This comparison allows ATSDR to assess the possible public health effects of site-specific conditions. Health-based comparison values are developed based on data drawn from the epidemiologic and toxicological literature. Many uncertainty factors, sometimes known as safety factors, are applied to ensure that the health-based comparison values amply protect human health.

1) **Screening Analysis**

Environmental Comparison Values

Screening values are ATSDR's health-based comparison values. ATSDR develops these comparison values to screen environmental contamination for further evaluation.
Many environmental comparison values are available to screen contaminants to identify contaminants of concern.

One example is ATSDR's Environmental Media Evaluation Guides (EMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-cancer health effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) are considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million (10^{-6}) persons exposed over their lifetime (78 years).

In addition to ATSDR environmental comparison values, other comparison values may also be used when relevant. In this evaluation, we used the NJDEP's non-residential indoor air screening levels (NRIASLs), which are health-based benchmarks derived from the evaluation of cancer and other health effects besides cancer (non-cancer) using current toxicity criteria. The indoor air health-based criterion for each contaminant is determined as the more stringent of the cancer or non-cancer-based value (NJDEP 2021a). The NRIASLs are established to ensure that building occupants are not exposed to levels of contaminants which may cause adverse health effects. NJDEP also has Rapid Action Levels (RALs) which are higher than the NRIASL and require actions to be taken more quickly to reduce levels.

When vapor intrusion is present, NJDEP requires actions be taken to reduce levels within 14 days of a RAL exceedance and within 120 days of a NRIASL exceedance that is below a RAL (NJDEP 2021b).

For the purposes of this evaluation, the NJDEP NRIASLs were used to screen for contaminants of concern. PCE and TCE levels in all spaces exceeded NJDEP NRIASLs and NJDEP's Rapid Action Levels (RALs).

Indoor air samples were collected between 2010 and 2014 and then again between November 2020 and April 2021 at the dry cleaner and five co-located tenant spaces. **Table 1** shows the indoor air data used for this evaluation prior to the removal of the PCE dry cleaning machine. **Table 2** shows indoor air sample results in each tenant space after the PCE dry cleaning machine was removed in April 2021. As reflected in the table, the concentrations of PCE and TCE were significantly reduced after machine removal but remain above the DEP NRIASL in some occupied spaces.

As shown in the tables, both PCE and TCE are contaminants of concern and were evaluated further for adverse health effects.

Table 1. Indoor Air Data Before Removal of the Dry-Cleaning Machine

Tenant Space	**Number of Samples**	**Sample Dates**	**PCE Concentration Range (µg/m^3)**	**Contaminant of Concern?** ***[NJDEP NRIASL Level = 47 µg/m^3]^***	**TCE Concentration Range (µg/m^3)**	**Contaminant of Concern?** ***[NJDEP NRIASL Level = 3 µg/m^3] ^***
Chinese Food Restaurant	3	Dec 2010, Nov 2020, Feb 2021	1,020 - 1,660	**Yes**	ND - 23	**Yes**
Pizza Restaurant	2	April 2011, February 2021	22 - 676	**Yes**	ND - 9.7	**Yes**
Dry Cleaner	2	November 2020, February 2021	10,300 – 27,600	**Yes**	49 - 236	**Yes**
Insurance Office*	4	May 2010, February 2014, November 2020, February 2021	911 - 9,970	**Yes**	6.4 - 34	**Yes**
Bagel Shop	3	May 2010, November 2020, February 2021	281 - 1,330	**Yes**	2.3 - 24	**Yes**
Nail Salon	3	May 2010, November 2020, February 2021	761 - 1,650	**Yes**	9.1 - 90.8	**Yes**

Definitions: ND = Not Detected; µg/m^3 = micrograms of contaminant per cubic meter of air; ^ NRIASL= NJDEP Non-Residential Indoor Air Screening Level

* Number of samples includes prior convenience store tenant. Maximum TCE and PCE reflect current tenant.

Table 2. Indoor Air Data After Removal of Dry-Cleaning Machine

Tenant Space	Number of Samples	Sample Date	PCE Concentration (µg/m^3)	TCE Concentration (µg/m^3)	NJDEP NRIASL^ (µg/m^3)	Contaminant Exceeds NRIASL^
Chinese Food Restaurant	1	April 2021	21	3.2*	PCE = 47 TCE = 3	No
Pizza Restaurant	1	April 2021	2.4	0.21	PCE = 47 TCE = 3	No
Dry Cleaner	1	April 2021	434	59	PCE = 47 TCE = 3	**Yes**
Insurance Office	1	April 2021	108	15	PCE = 47 TCE = 3	**Yes**
Bagel Shop	1	April 2021	8.8	1.6	PCE = 47 TCE = 3	No
Nail Salon	1	April 2021	52	8.1	PCE = 47 TCE = 3	**Yes**

Definitions: µg/m^3 = micrograms of contaminant per cubic meter of air; ^ NRIASL= NJDEP Non-Residential Indoor Air Screening Level.
*Levels must be present at 4 µg/m^3 or above for qualifying as an exceedance of the NRIASL for TCE

Identifying Exposure

People are exposed to an environmental contaminant only through contact with a contaminant (e.g., breathing air, skin contact with a substance, or drinking a substance containing the contaminant).

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. Source of contamination (in this evaluation, the dry cleaner);
2. Environmental media and transport mechanisms (indoor air);
3. Point of exposure (leasehold spaces in the strip mall);
4. Route of exposure (inhalation); and
5. Exposed population (workers and patrons of the strip mall businesses)

Generally, ATSDR considers three exposure categories:

a. completed exposure pathways — all five elements of a pathway are present;
b. potential exposure pathways — one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element; and
c. eliminated exposure pathways —one or more of the elements is absent.

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Completed Exposure Pathways

Inhalation of contaminated indoor air: For the past, there was a completed exposure pathway for all people working in the six tenant spaces prior to the removal of the PCE dry cleaning machine. Since the removal of this machine, people working in three tenant spaces are still being exposed to elevated levels of PCE and TCE. These tenant spaces include the dry cleaner and the two adjoining leaseholds. It should be noted that the exposures to PCE and TCE were evaluated for people working in these spaces. Customers and visitors who spent minimal time in these spaces are not at risk from exposures to these contaminants.

Steps are currently being taken to further reduce PCE and TCE levels in the tenant spaces. These measures include increasing ventilation in all tenant spaces and modifications of the HVAC system. Additional sampling was conducted in May 2021 (see Appendix A).

2) **Exposure and Health Effects**

Public Health Implications of Completed Exposure Pathways

Since a completed exposure pathway was determined for the leasehold spaces in Marlboro Mall as PCE and TCE exceeded the NRIASL, we calculated an estimated exposure dose, which is compared to Minimal Risk Levels (MRL).

MRLs identify exposures that could be potentially hazardous to human health. MRLs can be set for 3 different time periods depending on the length of time people are exposed to the substance:

- acute (about 1 to 14 days),
- intermediate (from 15-364 days), and
- chronic (exposure for more than 365 days)

Exposure above the MRLs (for the relevant time period) does not necessarily mean that health problems will occur. An MRL is an estimate of the amount of a chemical a person can breathe, eat, or drink each day without a detectable non-cancer risk to health.

MRLs are based on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies. They are adjusted by a series of uncertainty factors or through the use of statistical models. In toxicological literature, observations might be reported as

- No-observed-adverse-effect level (NOAEL): A NOAEL is the ***highest*** tested dose of a substance that has been reported to have ***no*** harmful health effects on people or animals.
- Lowest-observed-adverse-effect level (LOAEL): A LOAEL is the ***lowest*** tested dose of a substance that has been reported to ***cause*** harmful health effects in people or animals.

To provide perspective on the potential for health effects, a calculated exposure dose is

compared to the MRL and the applicable NOAEL or LOAEL. As the exposure dose increases beyond the MRL and approaches the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

It should be noted that workers in the dry cleaner business are covered under Occupational Safety and Health Administration (OSHA) (OSHA Dry Cleaning Standards). There are currently no specific OSHA standards for dry cleaning. However, due to most dry cleaning industries using PCE, exposures related to dry cleaning hazards are addressed in specific OSHA standards for general industry, specifically the section that limits for air contaminants under toxic and hazardous substances (OSHA Dry Cleaning Standards; OSHA Standards Air Contaminants).

OSHA recognizes that many of its permissible exposure limits (PELs) are outdated and inadequate for ensuring protection of worker health (OSHA PEL). Therefore, since the purpose of this health consultation is to evaluate the potential for health effects from exposures to TCE and PCE, the ATSDR risk assessment approach which incorporates the most updated toxicological data was used even in the dry cleaner space.

Also, it should be noted that OSHA has guidance to help dry cleaning establishments reduce employees' exposures to PCE including optimal equipment design, preventative maintenance, control of leaks, proper ventilation and good work practices to reduce PCE exposures to workers (OSHA 2005).

Calculating Exposure Factors for Indoor Air Contaminants

ATSDR's approach for evaluating inhalation exposure is to use air concentrations of the contaminant and compared to the MRL and if applicable, the LOAEL or NOAEL to evaluate the potential for health effects.

Exposed individuals are defined by site-specific exposure scenarios (e.g., workplace or residence). Default assumptions are based on a residential scenario which assumes a 24 hours per day and seven days a week exposure duration to account for people living in a home. In this case, the measured air concentration for each tenant space is adjusted for a work scenario based on individual business hours of operation.

The exposure factor (EF) for non-cancer health effects in workers is calculated as follows:

$$EF = \frac{\text{number of hours}}{\text{24 hours per day}} \times \frac{\text{number of days}}{\text{7 days per week}} \times \frac{\text{50 weeks}}{\text{52 weeks per year}}$$

This EF is then multiplied by the measured air concentration to get the Adjusted Air Concentration to be compared with the MRL.

Non-cancer health effects are assessed by comparing the Adjusted Air Concentration to the ATSDR MRL via a ratio known as the "hazard quotient." The hazard quotient is defined as follows:

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Adjusted Air Concentration}}{\textit{Chronic MRL}}$$

As the hazard quotient increases above 1.0, the potential for harmful effects increases and further evaluation is warranted.

Determining the Exposure Concentration for Contaminants of Concern

ATSDR follows a conservative approach when evaluating exposures by using the upper confidence limit of the mean of all detections of each site related contaminant. In the absence of a sufficient number of samples to calculate this confidence limit, ATSDR guidance recommends the maximum concentration to be used to represent the most conservative value.

Each tenant space had less than 8 samples and therefore, the maximum concentration was used to evaluate the contaminants of concern.

Based on information available to the DOH, adjustments were made to the detected PCE and TCE level to account for a worker scenario based on each individual businesses' hours of operation (**Tables 3 and 4**).

Table 3. Adjusted Air Concentrations and Hazard Quotients for PCE

Tenant Space	PCE - Maximum Air Concentration (µg/m^3)	Hours per day	Days per week	Weeks per year	Adjusted Air Concentration (µg/m^3) *	ATSDR Chronic MRL (µg/m3)	Hazard Quotient (HQ)	Is further evaluation needed?
Chinese Food Restaurant	1,660	10	7	50	665	41	16	**Yes**
Pizza Restaurant	676	9	6	50	209	41	5.1	**Yes**
Dry Cleaner	27,600	12	7	50	13,269	41	324	**Yes**
Insurance Office	9,970	8	5	50	2,283	41	56	**Yes**
Bagel Shop	1,330	9	7	50	480	41	12	**Yes**
Nail Salon	1,650	10	6	50	567	41	14	**Yes**

*Example Adjusted Air Concentration and Hazard Quotient (HQ) for Chinese Food Restaurant: 1,660 µg/m^3 x 10hrs/24hrs x 7 days/7 days x 50 weeks/52 weeks = 665; HQ = 665/41 = 16

Table 4. Adjusted Air Concentrations and Hazard Quotients for TCE

Tenant Space	TCE - Maximum Air Concentration (µg/m^3)	Hours per day	Days per week	Weeks per year	Adjusted Air Concentration (µg/m^3) *	ATSDR Chronic MRL (µg/m^3)	Hazard Quotient (HQ)	Is further evaluation needed?
Chinese Food Restaurant	23	10	7	50	9.2	2	4.6	**Yes**
Pizza Restaurant	9.7	9	6	50	3.0	2	1.5	**Yes**

Tenant Space	TCE - Maximum Air Concentration (µg/m^3)	Hours per day	Days per week	Weeks per year	Adjusted Air Concentration (µg/m^3) *	ATSDR Chronic MRL (µg/m^3)	Hazard Quotient (HQ)	Is further evaluation needed?
Dry Cleaner	236	12	7	50	114	2	57	**Yes**
Insurance Office	34	8	5	50	7.8	2	3.9	**Yes**
Bagel Shop	24	9	7	50	8.7	2	4.3	**Yes**
Nail Salon	90.8	10	6	50	31	2	16	**Yes**

*Example Adjusted Air Concentration and Hazard Quotient (HQ) for Chinese Food Restaurant: 23µg/m^3 x 10hrs/24hrs x 7 days/7 days x 50 weeks/52 weeks = 9.2; HQ = 9.2/2 = 4.6

As summarized above, all tenant spaces had elevated hazard quotients above 1.0 for PCE and TCE before the removal of the dry-cleaning machine. Therefore, additional evaluation for health effects is necessary and completed below.

Health Effects Evaluation (PCE and TCE in Indoor Air)

Whether or not health effects occur depends on many factors including:
- how much contaminant a person is exposed to,
- how often and how long exposure occurs (duration),
- exposures to other chemicals,
- the age, sex, diet, genetic traits, lifestyle and health status of the person exposed.

Health Effects of PCE in indoor air:

As described above, the LOAEL is the lowest tested dose of a substance that has been reported to cause harmful health effects. At a LOAEL of 11,530 µg/m^3, an epidemiological study of dry cleaners workers showed a significant decrease in blue-yellow color vision compared to controls, and workers who experienced continued exposure demonstrated a further deterioration in color vision when evaluated two years after the initial measurements. The MRL of 2 µg/m^3 is derived from this study by applying some safety factors to account for human variability among other factors. Additionally, occupationally-exposed adults (PCE concentration ranging from approximately 76,000 to 277,000 µg/m^3) performed below expectation on tasks assessing memory, motor skills (reaction times), visual and executive function deficits following low-level exposure for one year or more [Echeverria 1995]. Another human study showed mild tubular damage to the kidneys at an adjusted LOAEL of 16,280 µg/m^3). **Table 5** summarizes these health effects.

Table 5. Health Effect Levels – PCE

Study	ATSDR MRL Derivation Study (human)	Other Studies (Human)		
LOAEL (µg/m^3)	11,530	340 - 2,170	16,280	76,000 -277,000
Health Effect	Decreased color vision	Decreased visual contrast sensitivity	Mild kidney damage	Decreased neurological functions

Source: ATSDR Toxicological Profile for PCE https://www.atsdr.cdc.gov/toxprofiles/tp18.pdf

The levels of PCE in the tenant spaces prior to the removal of the dry-cleaning machine ranged from 676 µg/m^3 in the pizza restaurant to 27,600 µg/m^3 in the dry cleaner space. When adjusted for the worker scenario, the levels ranged from 209 µg/m^3 in the pizza restaurant to 13,269 µg/m^3 in the dry cleaner.

Adjusted PCE levels were above the LOAEL in the dry cleaner space, therefore there is a potential for workers to experience color vision loss.

The adjusted PCE levels in the Insurance Office space (2,283 µg/m^3), pizza restaurant (209 µg/m^3), bagel shop (480 µg/m^3), nail salon (567 µg/m^3) and Chinese food restaurant (665µg/m^3) were below the LOAEL of 11,530 µg/m^3 and therefore adverse health effects would not be expected.

Health Effects of TCE in Indoor Air:

ATSDR adopted the US Environmental Protection Agency's (EPA)'s Reference Concentration (RfC) as the chronic, inhalation MRL. The RfC is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime.

The RfC for TCE is based on two oral rodent studies. In these studies, where animals were exposed to TCE orally via drinking water, the most sensitive adverse effects involved the immune system and the developing fetus. The EPA used physiologically based pharmacokinetic (PBPK) modeling to convert the oral dose in animals to a human equivalent concentration (HEC) of TCE in air. Based on these studies, the effect levels for TCE exposures in air are as follows:

- Mouse Study - Immunological effects = 180 µg/m^3
- Rat Study – Fetal Heart effects = 20 µg/m^3

The EPA also cites a third study conducted in 1988 by the National Toxicology Program (of lower confidence) in support of the RfC where female rats were exposed to TCE by administering the chemical in corn oil by gavage for a 104-week period. The EPA used PBPK modeling to convert the oral dose in animals to a HEC of 30 µg/m^3 TCE in air for kidney damage (**See Table 7**).

Table 7. Health Effect Levels - TCE

Study	ATSDR MRL Derivation Study based on EPA RfC		EPA Support Study (National Toxicology Program)
Effect Level (µg/m^3) *	20	180	30
Health Effect	Fetal Heart Effects (Rat Study)	Immune System Effects (Mouse Study)	Kidney Effects (Rat Study)

*The effect levels for these studies were derived using EPA models to derive "human equivalent concentrations (HECs);"
Source: Toxicological Profile for TCE: https://www.atsdr.cdc.gov/ToxProfiles/tp19.pdf

ATSDR Threshold Approach for evaluating TCE:

As noted above TCE is unique because animal studies have shown that *short-term* exposures can increase the risk of health impacts on the developing fetus in the first trimester of pregnancy. Specifically, these animal studies show that exposure to low levels of TCE during the three-week period of heart formation in the first trimester of pregnancy could result in an increased risk of a heart defect in the unborn baby.

ATSDR considers a threshold of 6 µg/m^3 as a level of concern for fetal heart and kidney effects. **Table 8** shows the ATSDR threshold approach to evaluate the potential for fetal heart and kidney effects before the removal of the PCE dry cleaning machine.

Table 8. TCE Threshold Approach – Before Removal of Dry-Cleaning Machine

Tenant Space	TCE Maximum Concentration (µg/m^3)	Hours per day	Days per week	Weeks per year	Adjusted Air Concentration (µg/m^3) *	ATSDR TCE Threshold Level of Concern (µg/m^3)	Exceed Threshold for Possible Health Effects
Chinese Food Restaurant	23	10	7	50	9.2	6	**Yes**
Pizza Restaurant	9.7	9	6	50	3.0	6	No
Dry Cleaner	236	12	7	50	114	6	**Yes**
Insurance Office	34	8	5	50	7.8	6	**Yes**
Bagel Shop	24	9	7	50	8.7	6	**Yes**
Nail Salon	90.8	10	6	50	32	6	**Yes**

*Example Adjusted Air Concentration calculation using Chinese Food Restaurant: Adjusted Air Concentration = 23 x 10/24 x 7/7 x 50/52 = 9.2 µg/m^3

As shown in **Table 8** above, the TCE levels in all leasehold spaces except for the pizza restaurant exceed the threshold for fetal heart and kidney effects. Therefore, staff who may have been pregnant while working in these tenant spaces may be at increased risk for fetal heart effects in their children from short term exposures above 6 µg/m^3. There was also an increased risk for kidney effects in adult workers from chronic exposures above 6 µg/m^3.

Cancer Evaluation

NJDOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk. In New Jersey, approximately 45% of women and 49% of men (about 47% overall), will be diagnosed with cancer in their lifetime [NJDOH 2016]. This is referred to as the "background cancer risk."

The term "excess cancer risk" represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of "one-in-a-million" (1/1,000,000 or 10^{-6} cancer risk) means that if 1,000,000 people are exposed to a cancer-causing substance at a certain level for a period of time, then one cancer above the background number of cancers may develop in those 1 million people over the course of their lifetime (considered 78 years).

To put the LECR of 10^{-6} in context of New Jersey's background cancer risk, the number of cancers expected in 1 million people over their lifetime is 470,000 (47%) in New Jersey. If these 1 million people are all exposed to a cancer-causing substance for a specific duration, then 470,001 people may develop cancer instead of the expected 470,000 over the course of their lifetime (78 years). It is important to note that this is a theoretical estimate of cancer risk that ATSDR uses as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community. This theoretical cancer risk is not a prediction that cancer will occur.

The NJDOH considers estimated cancer risks of less than one additional cancer case among one million (1,000,000) persons exposed as an unlikely increased cancer risk (expressed exponentially as 10^{-6}). Health guideline comparison values are typically developed for carcinogens based on one excess cancer case per 1,000,000 individuals.

PCE - Studies in humans suggest that exposure to tetrachloroethylene might lead to a higher risk of developing bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma. In animals, tetrachloroethylene has been shown to cause cancers of the liver, kidney, and blood system.

The Department of Health and Human Services (DHHS) considers tetrachloroethylene to be reasonably anticipated to be a human carcinogen. The US Environmental Protection Agency (EPA) considers tetrachloroethylene likely to be carcinogenic to humans by all routes of exposure. The International Agency for Research on Cancer (IARC) considers tetrachloroethylene probably carcinogenic to humans.

TCE - 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.

Cancer risk can be calculated using the adjusted air concentration and the EPA inhalation unit risk (IUR) for cancer. The IUR is the incremental risk posed by a specific concentration unit in air (usually per 1 microgram per cubic meter ($\mu g/m^3$) of the pollutant in air).

The calculation yields the relative increase of cancer risk (above the background rate) from exposure to individual pollutants. Cancer risk can be calculated by multiplying the long-term air concentration by the IUR, adjusting the duration of exposure using the appropriate exposure factor calculation as noted in the following formula:

Cancer risk = Adjusted Air Concentration ($\mu g/m^3$) x ED/AT x IUR ($\mu g/m^3$) $^{-1}$

Where:

Adjusted Air Concentration = Exposure factor (EF) x measured air concentration ($\mu g/m^3$)
ED = Exposure Duration in years (number of years person may work at tenant space)
AT = Averaging Time (78-year lifetime)

Tables 9 and 10 show the calculated cancer risks (LECRs) for PCE and TCE in each tenant space. Using ATSDR's guidance for inhalation exposures, we used a conservative estimate of 20 years as the exposure duration unless otherwise specified.

Table 9. PCE Cancer Risks (LECRs) – Marlboro Mall Tenant Spaces

Tenant Space	Adjusted Air Concentration ($\mu g/m^3$)	Exposure Duration (years)	Averaging Time (years)	PCE IUR ($\mu g/m^3$) $^{-1}$	LECR*
Chinese Food Restaurant	665	20	78	2.6E-07	4 in 100,000 (4.4E-05)
Pizza Restaurant	209	20	78	2.6E-07	1 in 100,000 (1.4E-05)
Dry Cleaner	13,269	20	78	2.6E-07	9 in 10,000 (8.9E-04)
Insurance Office	2,283	4	78	2.6E-07	3 in 100,000 (3.0E-05)
Bagel Shop	480	20	78	2.6E-07	3 in 100,000 (3.2E-05)
Nail Salon	567	20	78	2.6E-07	4 in 100,000 (3.8E-05)

*Example LECR Calculation for PCE at Chinese Food Restaurant: 665 x 20/78 x 2.6E-07= 4.4 E-05

As shown in **Table 9**, the calculated cancer risks for PCE in the tenant spaces near the dry cleaner range from one to four in 100,000 people. This represents a low cancer risk. The calculated LECR for dry cleaner space is approximately nine in 10,000 people. This is considered an increased cancer risk.

Table 10. TCE Cancer Risks – Marlboro Mall Tenant Spaces

Tenant Space	Adjusted Air Concentration ($\mu g/m^3$)	Exposure Duration (years)	Averaging Time (years)	TCE IUR $(\mu g/m^3)^{-1}$	LECR
Chinese Food Restaurant	9.2	20	78	4.1E-06	1 in 100,000 (1.0E-05)
Pizza Restaurant	3.0	20	78	4.1E-06	3 in 1,000,000 (3.2E-06)
Dry Cleaner	113.5	20	78	4.1E-06	1 in 10,000 (1.2E-04)
Insurance Office	7.8	4	78	4.1E-06	2 in 1,000,000 (1.6E-06)
Bagel Shop	8.7	20	78	4.1E-06	9 in 1,000,000 (9.1E-06)
Nail Salon	31.2	20	78	4.1E-06	3 in 100,000 (3.3E-05)

*Example LECR Calculation for TCE at Chinese Food Restaurant: 9.2 x 20/78 x 4.1E-06= 9.7E-06

As shown in **Table 10**, the calculated LECRs for TCE in the tenant spaces near the dry cleaner range from approximately two in one million to three in 100,000 people. This is considered to be a low cancer risk. The LECR for TCE in the dry cleaner space is approximately one in 10,000 people. This represents an increased cancer risk.

Table 11 shows the combined cancer risk for PCE and TCE in each tenant space. As shown in this table, the LECRs for the five tenant spaces near the dry cleaner range from approximately two to seven in 100,000 people. This represents a low cancer risk. However, the LECR for the dry cleaner space is one in 1,000 people, representing an increased cancer risk.

Table 11. Combined LECR for PCE and TCE– Marlboro Mall Tenant Spaces

Tenant Space	Adjusted Air Concentration ($\mu g/m^3$)	Exposure Duration (years)	Averaging Time (years)	Total LECR (PCE and TCE)
Chinese Food Restaurant	9.2	20	78	5 in 100,000 (5.4E-05)
Pizza Restaurant	3.0	20	78	2 in 100,000 (1.7E-05)
Dry Cleaner	113.5	20	78	1 in 1,000 (1.0E-03)
Insurance Office	7.8	4	78	3 in 100,000 (3.2E-05)
Bagel Shop	8.7	20	78	4 in 100,000 (4.1E-05)
Nail Salon	31.2	20	78	7 in 100,000 (7.1E-05)

The NJDEP NRIASL is based on a one in 1,000,000 (or 10^{-6}) cancer risk as being the acceptable risk level for achieving compliance when indoor air levels are elevated due to vapor intrusion. The calculated cancer risks in this evaluation are above this one in 1,000,000 excess cancer risk in all tenant spaces.

PCE and TCE Levels <u>After</u> the Removal of the Dry-Cleaning Machine

The dry-cleaning machine was removed in April 2021 resulting in reduced levels of PCE and TCE in the indoor air. However, the levels remain above the health protective MRLs and the

NJDEP's NRIASL in three of the spaces (the insurance office, nail salon, and dry cleaner have levels of PCE and TCE that exceed the NRIASL and MRL).

The levels of TCE have decreased with the removal of the dry-cleaning machine and the tenant spaces surrounding the dry cleaner space no longer exceed the ATSDR threshold for fetal heart effects from short-term exposures. The levels in the dry cleaner space still present a risk for fetal heart effects based on short-term exposures and for kidney effects based on long term exposures, as the concentration of TCE still exceeds the ATSDR threshold.

Conclusions

1. *Past exposures to TCE in all tenant spaces except for the pizza restaurant could have harmed people's health.* TCE was detected in the indoor air at the Chinese food restaurant, the dry cleaner, the insurance office, the bagel shop, and the nail salon at levels that could potentially cause fetal heart effects to the unborn children of pregnant women and kidney damage in adult workers.

   Past exposures to PCE in the dry cleaner space could have harmed people's health. PCE was detected in the indoor air in the dry cleaner at levels that could potentially cause loss in color vision.

   Past exposure to PCE and TCE in all tenant spaces except for the pizza restaurant may have increased the risk of cancer. Past exposures to PCE and TCE posed an increased cancer risk in the dry cleaner space in the range of one additional cancer case in 1,000 people. The cancer risk in the insurance office, the bagel shop, and the nail salon posed a low increase in cancer risk, in the range of two to seven excess cancer cases in 100,000 people.

2. *Current levels of TCE in the dry cleaner, insurance office and nail salon remain above the NJDEP's NRIASL and ATSDR's MRL which is associated with the potential for harmful health effects. Current levels of PCE in the dry cleaner space and insurance office remain above NJDEP's NRIASL and ATSDR's MRL, which is associated with the potential for harmful health effects.* Since the removal of the dry-cleaning machine in April 2021 the levels decreased and further actions to improve the HVAC system are ongoing.

Conclusion Uncertainties

- NJDOH had limited data for our evaluation, therefore, past levels may have been higher or lower.
- Using maximum concentrations for chronic exposures may overestimate risk.

Recommendations

Based on the technical information and conclusions set forth above, NJDOH makes the following recommendations to occupants of the Marlboro Mall:

1. Women who may have previously been pregnant while working in the following tenant spaces should consult their child's pediatrician for guidance on potential medical monitoring: Chinese food restaurant, dry cleaner, insurance office, bagel shop, and the nail salon. The NJDOH will provide physician resources.

2. Given the short critical window of time when TCE can impact fetal heart development, women who are pregnant or may become pregnant who are working in the *dry cleaner space* should reduce their exposures to TCE as soon as possible and they should discuss any health concerns with their health care provider. NJDOH has prepared a fact sheet which summarizes some health impacts to pregnant women and it is available at: https://www.nj.gov/health/ceohs/documents/tce_factsheet.pdf

3. Adults working in the Chinese food restaurant, dry cleaner, insurance office, bagel shop and the nail salon should consult their physicians regarding their exposures and the potential for health effects.

4. Additional indoor air samples should be collected in all previously sampled spaces to confirm levels of PCE and TCE continue to decrease to below the NJDEP's NRIASL to be protective of public health. Recent indoor air sampling results in May 2021 from the insurance office, nail salon, and dry cleaner spaces (as shown in Appendix A) have shown an increase in PCE and TCE concentrations from the April sampling event. Additional actions are needed to reduce the PCE and TCE levels in all spaces to remain below the NRIASL to ensure the protection of public health. It has been reported that dry-cleaned clothing and a spot cleaner product were removed from the dry-cleaning operation after the most recent May 2021 sampling results.

Please contact me with any questions or concerns at 609-826-4984 or by email at Christa.Fontecchio@doh.nj.gov. We anticipate that building occupants will have additional questions and concerns and we are available to discuss their concerns.

Sincerely,

Christa Fontecchio

Christa Fontecchio, M.P.H.
Environmental and Occupational Health Surveillance Program
New Jersey Department of Health

c: Leah Graziano, R.S. Regional Director, ATSDR Region 2

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APPENDIX A

Table A1. Indoor Air Data After Removal of Dry-Cleaning Machine

Tenant Space	Sample Date April 2021		Sample Date May 2021		NJDEP NRIASL^ ($\mu g/m^3$)
	PCE Concentration ($\mu g/m^3$)	TCE Concentration ($\mu g/m^3$)	PCE Concentration ($\mu g/m^3$)	TCE Concentration ($\mu g/m^3$)	
Nail Salon	52	8	115	14	PCE = 47 TCE = 3
Insurance Office	108	15	188	17	PCE = 47 TCE = 3
Dry Cleaner	434	59	613	72	PCE = 47 TCE = 3

^ NRIASL= NJDEP Non-Residential Indoor Air Screening Level.