

Letter Health Consultation

VAPOR INTRUSION INVESTIGATION OF NOTTINGHAM APARTMENTS
AND MARKET STREET STORAGE SITES

GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

Prepared by the

North Carolina Department of Health and Human Services

January 5, 2016

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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.

January 5, 2016

Sharon Eckard
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Dear Ms. Eckard,

The Health Assessment, Consultation and Education Program (HACE) in the North Carolina Division of Public Health (DPH) was contacted by N.C. Department of Environmental Quality (DEQ) regarding the Market Street Storage site located at 3939 W. Market Street in Greensboro, North Carolina. This site formerly contained a Flav-O-Rich Dairy facility that included a vehicle maintenance area. Groundwater and soil vapor samples revealed trichloroethylene (TCE) concentrations in excess of North Carolina's residential vapor intrusion screening levels. The highest concentrations were detected on the eastern portion of the site, along the border with the neighboring property. The DEQ requested assistance from DPH because the neighboring property is an apartment complex and the potential for vapor intrusion. DEQ requested assistance in communicating with residents, determining appropriate TCE action levels for indoor air samples, and performing a risk assessment based on indoor air sample results.

Indoor air sampling was performed in May 2015 by a DEQ contractor, who determined that TCE levels in two ground-level apartments exceeded DPH's recommended action level of 2 µg/L. Staff from DPH, DEQ, local health department, and U.S. Environmental Protection Agency (EPA) notified residents of the sampling results within 24 hours. DPH recommended immediate action to remove residents from continuous exposure, either by immediately reducing the TCE levels below the suggested action level or evacuating the residents until site contamination was addressed. EPA assisted with the response, providing follow-up air sampling and activated carbon filtration systems for the two affected apartments. Further testing indicated that the filtration units were successful in reducing TCE concentrations in indoor air to safe levels within six days of deployment. EPA continues to replace the activated carbon cartridges in each filtration unit on a monthly basis until an appropriate permanent solution is implemented to mitigate vapor intrusion at this site. The remainder of this letter will describe our assessment process and how we arrived at our conclusions and recommendations.

Background and Statement of Issues

The Market Street Storage facility located at 3939 W. Market Street in Greensboro, NC is an active participant in the N.C. DEQ Brownfields Program. The site was formerly occupied by a dairy operation with an on-site maintenance building. A multi-unit apartment complex (Nottingham Apartments) is located adjacent, downgradient, and to the east of the storage

facility. Previous assessment activities conducted at the site indicate that chlorinated solvents, including trichloroethylene (TCE), were detected in shallow groundwater above North Carolina groundwater standards. There are no known well users in the vicinity of the site, so exposure via well water is not expected. The highest TCE concentration detected was 2,100 $\mu\text{g/L}$ (H&H 2015), exceeding the residential vapor intrusion screening level of 1.04 $\mu\text{g/L}$ (DWM 2015). Subsequent soil vapor samples collected at the adjacent apartment complex property revealed TCE concentrations as high as 13,000 $\mu\text{g/m}^3$ (H&H 2015) in excess of the residential vapor intrusion screening level of 13.9 $\mu\text{g/m}^3$ (DWM 2015). DEQ contacted DPH to inform them that a follow up vapor intrusion study was planned, involving collection of indoor air samples from eight ground-level apartments closest to the groundwater plume. DPH staff worked with DEQ to inform residents of the potential for vapor intrusion and to obtain permission to sample indoor air at each apartment. Additionally, DPH staff provided a recommended action level for TCE of 2 $\mu\text{g/L}$, above which action should be taken to immediately remove residents from continuous exposure. Indoor and outdoor ambient air samples were collected by DEQ contractor Hart & Hickman in early May 2015. Confirmatory samples were collected by EPA on May 20, 2015. DPH used the data to evaluate potential public health effects for Nottingham Apartments' residents exposed to the air on a daily basis.

Discussion

Environmental Analytical Data

Radiello sampling devices were deployed in eight ground-level apartments on May 6, 2015, and remained in place until collection on May 13, 2015. Two apartments had TCE levels above both the screening level (0.24 $\mu\text{g/m}^3$) and the recommended action level (2 $\mu\text{g/m}^3$) (Table 1). No TCE was detected in outdoor ambient air, providing further evidence for the vapor intrusion pathway. Tetrachloroethylene (PCE) was detected above the screening level in one apartment.

Table 1. Indoor air data summary and screening values for compounds of concern detected in the first round of air sampling at Nottingham Apartments from May 6 to May 13, 2015. Eight apartments were sampled in total.

Chemical	Number of Detections	Number of Detections > SL	Range of Detections ($\mu\text{g/m}^3$)	Screening Level ($\mu\text{g/m}^3$)	Screening level type
Trichloroethylene	6	2	0.031 - 4.4	0.24	CREG
Tetrachloroethylene	8	1	0.07 - 9.8	3.8	CREG

Notes: $\mu\text{g/m}^3$ = microgram of substance per cubed meter of air
 CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide, health-based screening level
 SL = Screening Level
 > = greater than

Using 24-hour SUMMA canisters deployed on May 19, 2015, EPA provided confirmatory sampling in four apartments, including the two that showed elevated TCE levels. TCE was detected in three of these apartments, exceeding screening levels in the same two apartments as

the first round of sampling, but exceeding action levels in only one of these apartments (Table 2). No apartment showed elevated concentrations of PCE.

Table 2. Indoor air data summary and screening values for compounds of concern detected in the confirmatory samples at Nottingham Apartments from May 19 to May 20, 2015. Four apartments were sampled in total, with two apartments sampled in duplicate, for a total of six indoor air samples.

Chemical	Number of Detections	Number of Detections >SL	Range of Detections ($\mu\text{g}/\text{m}^3$)	Screening Level ($\mu\text{g}/\text{m}^3$)	Screening level type
Vinyl Chloride	1	0	0.0577	0.11	CREG
Trichloroethylene	5	4 ^a	0.129 - 8.7	0.24	CREG
Tetrachloroethylene	6	0	0.27 - 2.44	3.8	CREG

a. Only 2 apartments exceeded the screening level, and duplicate samples were taken at both apartments
 Notes: $\mu\text{g}/\text{m}^3$ = microgram of substance per cubed meter of air
 CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide, health-based screening level
 SL = Screening Level
 > = greater than

Immediately after collecting the confirmatory indoor air samples on May 20, 2015, EPA staff placed activated carbon filtration units in the two affected apartments. On May 26, 2015, 24-hour SUMMA canisters were deployed in the two apartments to ensure that the air filtration units successfully reduced TCE levels. TCE was not detected in either apartment, with a laboratory reporting limit of $1.1 \mu\text{g}/\text{m}^3$. It is important to note that the reporting limit is above the health-based screening level of $0.24 \mu\text{g}/\text{m}^3$, but remains below the recommended action level.

Health Effect Evaluation

Non-Cancer Adverse Health Effects

The ATSDR health effects evaluation process involves screening environmental analytical data from the site by comparing site contaminant concentrations to comparison values. Comparison values (CVs) are screening levels developed by ATSDR as chemical concentrations in environmental media such as air. CVs are set at levels that are highly health protective, well below concentrations known or anticipated to result in adverse health effects. Contaminant concentrations at or below the CV may reasonably be considered safe and require no additional evaluation. When chemicals are found on a site at concentrations greater than the CV, it does not mean that adverse health effects would be expected, but it does identify that a more in-depth evaluation is warranted, such as comparing exposure concentrations to levels studied in human health effect and animal laboratory studies for the chemicals of concern.

Levels of TCE measured in the indoor air of two apartments during the first sampling event exceeded the non-cancer CV, ATSDR's chronic Environmental Media Guideline (EMEG) of $2.1 \mu\text{g}/\text{m}^3$. The TCE EMEG was exceeded in one apartment during the second sampling event. Inhalation of TCE at high concentrations over a long period of time may result in adverse

immunological health effects, such as decreased thymus weight and decreased numbers of lymphocytes in the blood. Long term TCE exposure may also result in kidney toxicity. Additionally, exposure to elevated levels of TCE during the first trimester of pregnancy may cause fetal heart malformations. Adverse health effects in animal studies generally are observed at exposure doses approximately 10-100 times greater than the highest observed indoor air concentration during these sampling events (EPA 2011). Data on adverse health effects from long-term human exposure is lacking, but evidence from limited studies support the adverse health effect endpoints observed in animal studies. There may be a small risk for adverse immunological, kidney, or developmental effects for residents exposed to TCE at the concentrations observed at the two affected apartments prior to placement of activated carbon air filtration units. Operation of these air filtration units in the affected apartments eliminated the risks of adverse non-cancer health effects from exposure to TCE by reducing TCE concentrations to health-protective levels.

Levels of PCE measured in the indoor air in one apartment during the first sampling event exceeded the screening value but did not exceed the non-cancer CV, ATSDR's EMEG of 40 $\mu\text{g}/\text{m}^3$. Exposure to PCE at the highest concentration observed in indoor air is not expected to result in adverse non-cancer health effects.

Cancer Risk

The U.S. EPA classifies TCE as “carcinogenic to humans” and classifies PCE as “likely to be carcinogenic to humans.” For this reason, DPH estimated an increased cancer risk from exposure to these compounds at the concentrations measured in the indoor air samples. For a detailed explanation of the cancer risk evaluation process, see Attachment A. Briefly, when estimating an increased cancer risk, DPH calculates what is likely an overestimation of increased cancer incidence over a lifetime for a specified exposure period, compared to expected cancer incidence (referred to as the background cancer level). The background cancer level in North Carolina is considered to be 40% in that, on average, meaning that 4 out of 10 North Carolina residents will be diagnosed with cancer during their lifetime (North Carolina Central Cancer Registry). The expression of the estimated cancer risk is not a prediction that cancer will occur, it represents the upper bound estimate of the probability of additional cancers, and merely suggests that there is a possibility. For example, a 1 in a million cancer risk means that if one million people were exposed to a given level of a chemical, one additional cancer case may be expected over the background cancer incident rate of 40%, or 400,000 in one million. The actual risk may be much lower. For this assessment, two exposure periods were considered: 12 years and 33 years, which are the average and 95th percentile¹ residence times (EPA 2011). For residential scenarios, we assume that exposure to compounds in indoor air is continuous.

TCE has a mutagenic mode of action, meaning it can permanently damage DNA in exposed cells. Children may be more susceptible to carcinogenic potential from chemical exposure to

¹ 95th percentile means that 95% of the population has residence times shorter than this value.

compounds with a mutagenic mode of action. As such, age-dependent adjustment factors (ADAF) were used to calculate cancer risk for TCE exposure at this site, with an assumed exposure to begin at birth to account for the most sensitive population (children under two years old). Assuming a 12 year residence out of a 78 year lifetime, the estimated increased cancer risk from TCE at the highest measured concentrations is low, approximately 2 in 100,000. For a resident who lived in the affected apartments from birth to age 33, the estimated cancer risk is low, approximately 4 in 100,000. Assumption of continuous exposure from birth likely overestimates the cancer risk for this site, especially since current residents of the affected apartments are adults who work outside of the home. The cancer risk level for persons exposed to the highest measured TCE concentration in the affected apartments is below the risk level of 1 in 10,000. Additionally, TCE levels in affected apartments were reduced below laboratory detection limits after activated carbon air filtration units were placed in each apartment, further reducing cancer risk.

Only one apartment had PCE levels above ATSDR's cancer screening level. There is no increased estimated cancer risk for a 12 year residence out of a 78 year lifetime. Assuming a 33 year residence time out of a 78 year lifetime, the estimated increased cancer risk from exposure to PCE is very low, approximately 1 in 1,000,000.

Sources of uncertainties

In the health assessment process there are inherent sources of uncertainty. For instance, when considering the likelihood of adverse health effects from exposure to contaminants, many substances are lacking in data of adverse human health effects, and DPH must rely on animal laboratory studies. To account for this discrepancy, large margins of safety, or uncertainty factors, are used to extrapolate from animal data to human exposures.

Other sources of uncertainty are a result of the sampling or laboratory analysis. In the case of this vapor intrusion study, one factor to consider is the lack of long-term or temporal monitoring of indoor air or soil vapor levels. The likelihood and extent of vapor intrusion can vary widely depending on weather, temperature, and other environmental factors that change over time. The assessment presented in this Letter Health Consultation considers samples taken at one specific point in time with the assumption that these concentrations are representative of average conditions. Risk of adverse health effects will increase or decrease if the actual long term chemical concentrations are greater or lesser than those measured in May 2015. The exposure period can also impact the likelihood of adverse health effects.

Conclusions

The DPH reviewed the environmental data collected for the vapor intrusion study at Nottingham Apartments in May 2015 and concluded:

1. Exposure to TCE at the highest measured concentrations poses a possible health risk for residents in two affected apartments. Possible health effects include fetal heart malformations if women are exposed while pregnant, decreased thymus weight, and impaired immune function.
2. Exposure to TCE at the highest measured concentrations may result in a low increased cancer risk for long-term residents, especially those exposed during early childhood. Currently, there are no children residing in either affected apartment. The estimated cancer risk level is below EPA's acceptable risk level.
3. Use of activated carbon filtration units in the TCE-affected apartments is effective at reducing TCE levels in indoor air to levels that are health protective for the residents.
4. Exposure to PCE at the highest measured concentration poses no risk for non-cancer adverse health effects for residents at Nottingham Apartments.
5. Long-term (>30 years) continuous exposure to PCE at the highest measured concentration may result in a very low increased cancer risk for exposed residents. The estimated cancer risk level is below EPA's acceptable risk level.

Recommendations

Based on the conclusions of our evaluation, DPH recommends that:

1. U.S. EPA continues to maintain the activated carbon filtration units in the TCE-affected apartments to ensure that TCE concentrations remain at levels low enough to be health-protective.
2. U.S. EPA continues to work with the associated property owners in order to install a permanent remediation system that will eliminate the vapor intrusion pathway.
3. The property owner or management company at Nottingham Apartments discloses any and all risk associated with vapor intrusion to current and future occupants.
4. Apartment occupants continuously operate the air filtration units until the vapor intrusion pathway is eliminated.

Please do not hesitate to contact me at (919) 707-5900 if you have any questions regarding this letter.

Sincerely,

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Attachment A – Cancer Risk Evaluation Process

Estimates of increased numbers of cancers are calculated for known or suspected cancer-causing contaminants using the measured air concentration and the Inhalation Unit Risk (IUR) provided in ATSDR health guideline documents. DPH evaluates cancer health effects in terms of estimates of possible increased cancer risk over background levels. In North Carolina, approximately 30% of women and 50% of men (about 40% combined), will be diagnosed with cancer in their lifetime from a variety of causes (North Carolina Central Cancer Registry). This is referred to as the “background cancer risk”. The term “excess” or “increased cancer risk” represents the risk on top of the background cancer risk. A “one-in-a-million” excess cancer risk (1/1,000,000 or 10^{-6} cancer risk) means that if 1,000,000 people are exposed to the cancer-causing substance at a certain level every day of their lifetime (considered 78 years), then one cancer above the background number of cancers may develop in those 1 million people. In numerical terms, the background number of cancers expected in 1 million people over their lifetime is 400,000. If they are all exposed to the cancer-causing substance daily throughout their lifetime, then one additional person may get cancer, instead of the expected 400,000. The expression of the estimated cancer risk is not a prediction that cancer will occur, it represents the upper bound estimate of the statistical probability of additional cancers, and merely suggests that there is a possibility. The actual risk may be much lower, or even no risk.

The estimated increased cancer risk calculation is:

$$\text{Estimated Increased Cancer Risk} = \text{Concentration} \times \text{IUR}$$

Where:

Estimated Increased Cancer Risk = Expression of the cancer risk (unitless)

Concentration = Measured contaminant concentration in air sample (mg/m^3)

IUR = Inhalation Unit Risk [$(\text{mg}/\text{m}^3)^{-1}$]

This calculation is based on the assumption that there is no safe level of exposure to a chemical that causes cancer, which is a health-protective assumption that usually applies to mutagenic carcinogens. In order to be health-protective the calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates an increased cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime or other selected period of exposure. Qualitative assessment of the predicted increased numbers of cancers is also used.

For specific exposure situations DPH may use exposure periods of less than a lifetime to provide a more realistic estimation of the risks that are known or predicted to have occurred for a particular area. If information on the specifics of the exposure situations at a particular site is not known, then DPH will always use health protective values to estimate the maximum level of risk

that we believe to be realistic. In this assessment, exposure periods of 12 years and 33 years were considered, as these represent the average and 95th percentile residence times for residential exposure (EPA 2011).