Health Consultation

9053 MIDDLEBROOK PIKE

AIR SAMPLING RESULTS EVALUATION UPDATE

KNOXVILLE, KNOX COUNTY, TENNESSEE

FEBRUARY 1, 2013

Preparation of this report was supported by funds from a
Cooperative Agreement with the Agency for Toxic Substances and Disease Registry,
U.S. Department of Health and Human Services.

This document was prepared by the
Tennessee Department of Health's Environmental Epidemiology Program.
This document has not been formally reviewed and cleared by ATSDR.

Foreword

This document summarizes an environmental public health investigation performed by the Environmental Epidemiology Program of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people have the potential to be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of the Environmental Epidemiology Program in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be action items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

Please write to: Environmental Epidemiology Program
Tennessee Department of Health
1st Floor, Cordell Hull Building
425 5th Avenue North
Nashville, TN 37243

Or call us at: 615-741-7247 or 1-800-404-3006 during normal business hours

Or e-mail us at: eep.health@tn.gov

Table of Contents

Introduction

The Tennessee Department of Environment and Conservation (TDEC) Division of Remediation's (DoR) State Remediation Program (SRP) asked the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) to review the results of vapor intrusion testing at 9053 Middlebrook Pike in Knoxville, Tennessee (the site). The building on the site has undergone redevelopment. Its reuse will likely be different from its previous use. There are no tenants in the building. The environmental consultant for the property buyer, S&ME of Louisville, Tennessee, collected sub-slab soil-gas samples in March 2012. Follow-up indoor air samples were collected on May 4, 2012 (S&ME 2012). A second indoor air sampling event was conducted on December 7, 2012. This evaluation is intended to understand what, if any risk, site contamination might have on future users of the site building.

A Phase 1 Environmental Site Assessment (ESA) indicated past tenants at the property included a gas station and at least two different drycleaners (Partner 2011a). The Phase 1 ESA was prepared in October 2011 as part of a potential sale of the 9053 Middlebrook Pike property. Two Phase 2 ESAs were conducted at the site in October and December 2011 based on the information learned from the Phase 1 ESA (Partner 2011a and 2011b). The volatile organic compounds (VOCs) tetrachloroethylene (PCE) and its breakdown products trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis-1,2-DCE) were found in site soil. Vinyl chloride nor petroleum-related chemicals such as benzene, toluene, ethylbenzene, and xylene were not found in site soil. Levels of PCE were above its U.S. Environmental Protection Agency residential soil screening level. One groundwater sample was collected in the later Phase 2 ESA. No VOCs were found in the groundwater sample tested.

As a result of the soil testing, TDEC was contacted by the potential property buyer's environmental consultant to discuss data requirements for a Brownfield Agreement. The agreement would be administered by TDEC's Voluntary Oversight and Assistance Program (VOAP). TDEC responded that one of its primary concerns was the potential health risk from onsite contamination to those occupying the site building. In response to their concern, S&ME tested both passive and active soil-gas as well as indoor air in 2012.

TDH EEP reviewed the soil-gas and indoor air investigation data and published the Health Consultation: *9053 Middlebrook Pike Air Sampling Results Evaluation, Knoxville, Knox County, Tennessee,* on October 3, 2012. The Health Consultation evaluated the results of the previous S&ME environmental investigations. The potential for chemicals in onsite soil and groundwater to affect the health of anyone working in the onsite building was also evaluated in the health consultation. Low levels of PCE, TCE, and cis-1,2-DCE were previously reported in the indoor air of the newly renovated onsite building.

The Health Consultation concluded that based on the sampling results, *'it does not appear that chemical vapors in the indoor air of the site building will harm the health of adults breathing he indoor air."* The Health Consultation further stated that *"Soil-gas testing revealed drycleaner-related chemicals and petroleum-related chemicals in soil beneath the site building. These chemicals were from the past use of the site as a drycleaner and a gas station. Indoor air testing showed low levels of these same chemicals in the indoor air. Evaluation of the indoor air*

showed the levels within EPA's accepted risk levels. Breathing air inside the 9053 Middlebrook Pike Site building having the levels of chemicals measured should not result in adverse health effects for adults." The Health Consultation continued to mention that *"it would be prudent not to establish a child care or other business in the building where sensitive populations (children, elderly, or immunocompromised) would be exposed to the measured low levels of PCE."*

Recommendations stated in the Health Consultation included sealing the floor of the building to prevent migration of sub-slab vapors into the indoor air of the building. EEP recommended sealing any utility penetrations through the floor or walls into the 3 lease spaces. Another indoor air test was recommended to be done at some point in the future, preferably during the late fall or winter season. EEP also recommended collecting an outdoor air sample at the same time as the additional indoor air samples. A building inventory was recommended to understand potential sources of chemicals stored or used in the building that could influence the follow-up indoor air test.

EEP recommended extra ventilation be provided to prevent PCE and TCE vapor concentrations from increasing in the indoor air if future excavations or drilling into the building's floor slab were to be done in the area of the known soil vapor contamination. A crack repair and floor slab inspection and maintenance program was also recommended.

Deed restrictions were recommended to be placed on the property, unless corrective actions were taken, to avoid establishment of a business involving immunocompromised or sensitive populations.

S&ME took EEP's recommendations and conducted a second indoor air test on December 7, 2012. This second Health Consultation is an updated review. It specifically evaluated the second indoor air sampling event. Indoor air samples were collected in each of the 3 lease spaces within the building. An outdoor air sample was also collected. EEP's intention of this Health Consultation was to provide useful information on site conditions to TDEC SRP, the property owner through S&ME, and to those who may work in the building in the future.

Background

Further background information for the site can be found in the initial Health Consultation document: *9053 Middlebrook Pike, Air Sampling Results Evaluation, Knoxville, Knox County, Tennessee.* This report was published on October 3, 2012. The background discussion provides the location of the site, its operational history, information on the historic chemical use at the site, and details about the surrounding area.

Figure 1 shows the location of the 9053 Middlebrook Pike Site in Knoxville, Tennessee, and the surrounding area.

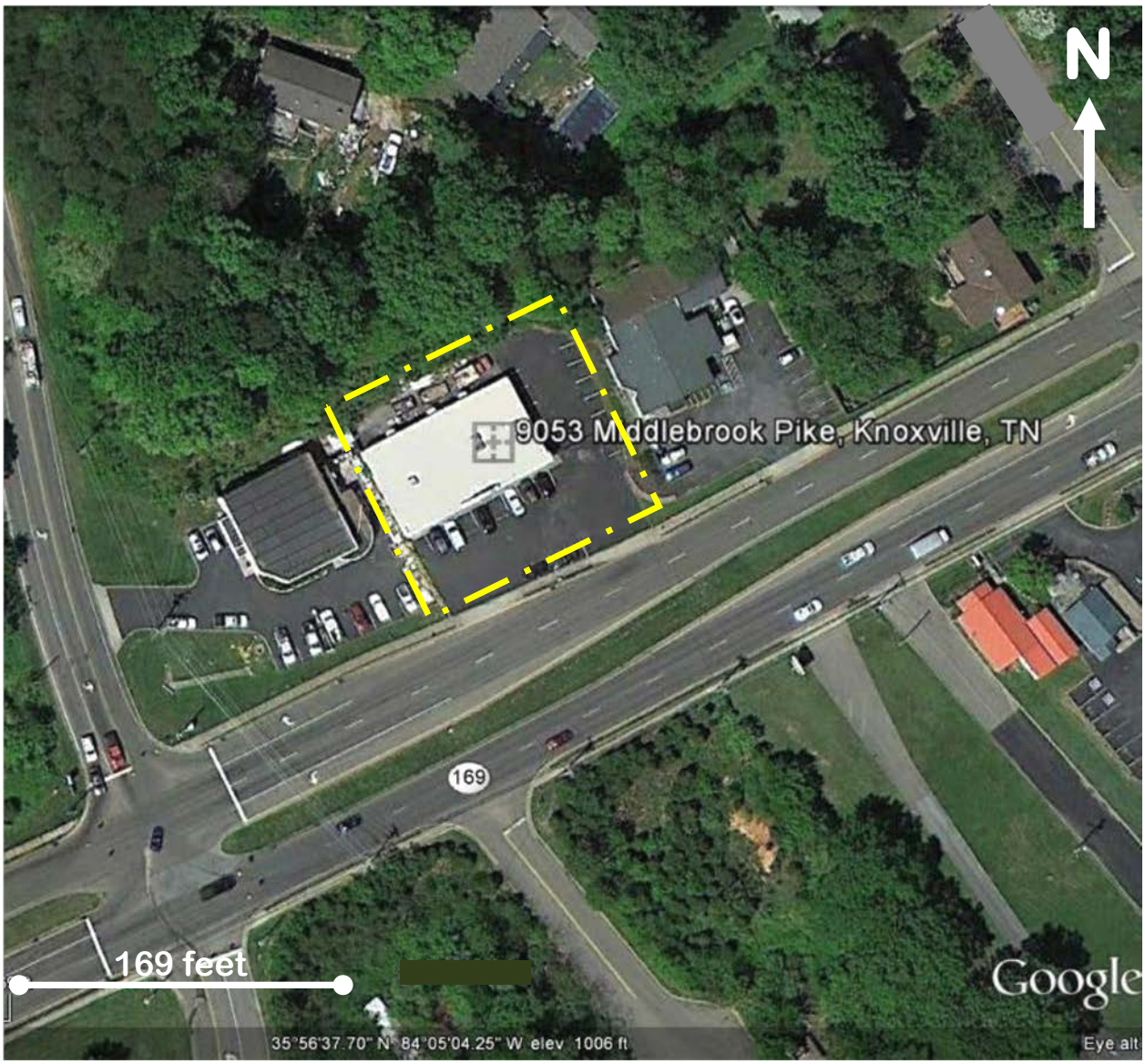

Figure 1. 9053 Middlebrook Pike Site location in Knoxville, Knox County, Tennessee 37923. The building at this address is currently vacant. The building was formerly a gas station and drycleaner. The dashed yellow line is the approximate site property boundary. Single family homes are located north of the site. An animal clinic is located to the east. Vacant land and single family homes are located to the south. Its closest neighbor is an exterior siding company that is located to the west. Environmental investigations showed that there is VOC soil contamination in the northwest corner of the site property. Much of the site is paved with asphalt. The groundwater flow direction at the site is unknown. (Source: Google Earth 2012).

Findings of Previous Investigations

As part of the potential sale of the property, the site has transitioned from being managed by the Division of Underground Storage Tanks to TDEC SRP. The site was designated State Remediation Program Site SRS-01251. Soil and groundwater investigations have been performed at the site over the last 1.5 years.

PCE was found in soil beneath the western portion of the site building at the levels above soil-screening values (Partner 2011b). Breakdown products, TCE and cis-1,2-DCE, were found at levels below their respective soil screening levels. Vinyl chloride was not found in site soil samples. Petroleum-hydrocarbon chemicals were also not found in soil samples. None of these chemicals were found in the single groundwater sample collected from the site (Partner 2011b).

S&ME in 2012, performed a passive soil-gas survey. PCE, TCE, cis-1,2-DCE, benzene-toluene-ethylbenzene-xylene (BTEX), and total petroleum hydrocarbons (TPH) were found in soil-gas beneath the site. The levels of these chemicals measured through passive soil-gas sampling techniques could not be compared to soil screening levels. Further active sub-slab soil-gas and active indoor air testing was done by S&ME. These active tests allowed for comparison of the results to health risk screening values published by both the Agency for Toxic Substances and Disease Registry (ATSDR) and U.S. Environmental Protection Agency (EPA). Sub-slab concentrations of PCE were found to be elevated. Levels of PCE were found in low concentrations in the indoor air of the onsite building. These concentrations were above ATSDR and EPA cancer risk comparison values.

Vapor Intrusion

Volatile and semi-volatile chemicals can evaporate from impacted subsurface soil and/or groundwater beneath a building and move toward areas of lower chemical levels such as in the atmosphere, utility conduits, or basements. This process is called vapor intrusion. Subsurface vapors can enter a building due to two main factors: environmental effects and building effects. Some examples of these effects are barometric pressure changes, wind load, temperature currents, or depressurization from building exhaust fans. Chemicals can migrate up and enter indoor air through foundation slabs, crawl spaces, or basements. The chemical migration depends on the construction of the building, unsealed joints or cracks in the foundation, the building's heating and ventilation characteristics, and other building design and operational elements. The amount of movement of the vapors into the building is difficult to measure and depends on soil type, chemical properties, building design and condition, and pressure differences between the outside and inside air (ITRC 2007). Upon entry into a structure, chemical vapors mix with the existing air through the natural or mechanical ventilation of the building.

Vapors may accumulate in buildings to levels that pose safety hazards, health risks, or odor problems. Vapor intrusion has been documented in buildings with basement, crawlspace, or slab-on-grade foundation types. Vapor intrusion can be an acute health hazard. Usually, indoor vapor levels are low. Low levels of vapors, breathed over a long period of time, may or may not be a chronic health concern.

Indoor Air Investigation Work Plan

S&ME designed the December 2012 indoor air testing similar to that of the original testing performed in May 2012. For this investigation, samples of indoor air were collected at 3 locations inside the redeveloped building and 1 location outside, west of the building.

Discussion

Introduction to Chemical Exposure

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates mechanisms that could lead to human exposure. Chemicals released into the environment have the potential to cause harmful health effects. Nevertheless, a release does not always result in exposure. People can only be exposed to a contaminant if they come into contact with it. If there is no contact with a contaminant, no exposure occurs. Therefore, no exposure-related health effects could occur. An exposure pathway contains five parts:

- a source of contamination,
- contaminant transport through an environmental medium,
- a point of exposure,
- a route of human exposure, and
- a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements have been, are, or will be present at the site. An exposure pathway is considered incomplete if one of the five elements is missing.

The source is the place where the chemical was released. For this site, the source is spills from past activities performed at the site. The environmental media (such as, soil, surface water, groundwater, or air) transport the contaminants. For this site, the chemicals are transported through the soil and indoor air. The point of exposure is the place where persons come into contact with the contaminated media. Indoor air is the potential point of exposure for this site. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. For this site, if the indoor air has measureable levels of VOCs, the route of exposure would be breathing of indoor air.

Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will be harmed. A chemical's ability to affect health is controlled by a number of other factors, including:

- the amount of the chemical that a person is exposed to (dose),
- the length of time that a person is exposed to the chemical (duration),
- the number of times a person is exposed to the chemical (frequency),
- the person's age and health status, and
- the person's diet and nutritional habits.

For this project, the people who would be exposed if vapor intrusion was occurring are the workers and customers of the future businesses that may be located in the site building.

Environmental Sampling

Previous environmental investigations and details about soil-gas and indoor air sampling performed at the site were described in the Health Consultation dated October 3, 2012. The discussion in this section will concentrate on the December 7, 2012, indoor air sampling event.

Indoor Air Sampling

Following recommendations in the previous Health Consultation, a walk-through of the building was completed before the indoor air sampling was begun. The walk-through was intended to:

1.) identify potential sources of chemicals stored or used in the building that could influence indoor air quality,
2.) evaluate the condition of the floor slab for cracks or other utility penetrations through the floor slab and walls of the building, and
3.) seal any penetrations that were required.

Containers of paints, solvents, cleaners, and equipment that contained liquid fuels were removed from the building prior to the sampling. The containers and equipment were stored outside during the testing. The floors of the building were evaluated and no significant cracking or deterioration was noted. Three indoor air samples were collected by S&ME inside the site building on December 7, 2012 (S&ME 2012b). Samples were collected inside the building in the west, middle, and east lease spaces. One sample was collected outside, west of the building, to serve as a background sample allowing comparison of indoor air chemical levels to outside air background levels.

S&ME used Summa canisters to collect the indoor air samples. One canister was placed in each of the 3 lease spaces of the building. The canisters were placed at breathing height approximately 5 feet above the floor and were fitted with 8-hour flow control devices provided by the testing laboratory. The building's heating, ventilation, and air conditioning (HVAC) system had been operating approximately 72-hours before the start of the indoor air testing. Samples were tested for a total of 68 different volatile organic compounds (VOCs) using EPA method TO-15. Samples were shipped in their appropriate containers under chain-of-custody procedures to the testing laboratory, ESC Lab Sciences, of Mount Juliet, Tennessee.

Comparison Values

To evaluate exposure to a hazardous substance, health assessors often use health comparison values (CVs). If the chemical concentrations are below the CV, then health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the CV (ATSDR 2012) for a particular chemical, then further evaluation is needed. The chemicals evaluated in this health consultation were PCE, TCE, and benzene.

ATSDR CVs

The Agency for Toxic Substances and Disease Registry's (ATSDR) develops Minimal Risk Levels (MRLs) using conservative assumptions. ATSDR uses the term 'conservative' to refer to values that are protective of public health in essentially all situations. Environmental Media Evaluation Guidelines (EMEGs) are calculated by ATSDR from their MRLs. EMEGs consider non-cancer adverse health effects (ATSDR 2012) and are used for comparison to the indoor air data that was collected. Exposure durations are defined as acute (14 days or less), intermediate (15–365 days), and chronic (365 days or more) exposures. ATSDR does not use serious health effects, such as irreparable damage to the liver or kidneys, or birth defects, as a basis for establishing EMEGs. Chronic EMEGs assume exposure for 24 hours per day, 7 days per week, 52 weeks, 365 days per year, over a 70-year lifetime exposure. It should be noted that chemicals found at levels above their respective comparison values do not necessarily represent a health threat. Instead the results of the comparison value screening identify those chemicals that warrant a more detailed, site-specific evaluation (ATSDR 2012). ATSDR also has cancer risk evaluation guides (CREGs) for cancer health effects evaluation. ATSDR residential indoor air comparison values are shown in Table 1.

EPA CVs

EPA's Regional Screening Levels (RSLs) for residential air inhalation were also used in evaluating the results of the indoor air testing (EPA 2012). EPA residential indoor air comparison values are also shown in Table 1. EPA RSLs for both non-cancer and cancer health effects were used as comparison values.

PCE and its breakdown chemical TCE were of special interest at the site. PCE and TCE were evaluated because they are thought to be *"reasonably anticipated to be human carcinogens"* (IARC 1995, NTP 2011). Benzene was also of special interest at the site because it is "*known to be a human carcinogen"* (NTP 2011) based on sufficient evidence of carcinogenicity from studies in humans. Benzene was found in very small amounts in the indoor air in all lease spaces in the building.

Previous reports identified several VOCs in sub-slab soil-gas samples. PCE and benzene were found in the indoor air during the first indoor air sampling and this was the case again in the second indoor air test. PCE is readily absorbed following inhalation and oral exposure and from direct exposure to the skin. For this site, we are concerned with the inhalation of PCE from vapor intrusion into indoor air. Compared to pulmonary and ingestion exposure, uptake of PCE vapors by the skin is minimal (ATSDR 1997a, 1997b).

Results

Indoor air testing measured levels of 18 VOCs in the December 2012 test (S&ME 2012). Many of these 18 chemicals are found in building products and in normal household chemicals. All measured amounts of chemicals in the indoor air of the building were below their respective ATSDR non-cancer CVs. Two of the 18 chemicals detected were legacy chemicals previously used at the site when the gas station and drycleaner operated. These chemicals were PCE and

benzene. Therefore, only the measured concentrations of these 2 chemicals will be evaluated further. TCE was not measured in any of the indoor or outside samples. The outdoor air sample was collected for comparison purposes and to measure background levels of chemicals in the vicinity of the site. Measureable amounts of 12 chemicals were found in the outside air sample. Table 1 shows the site's legacy chemicals found in the indoor and outdoor air. Sample detection limits were very low, at 0.2 parts per billion (ppb). Overall, the results for both PCE and benzene were lower for the December 2012 indoor air sampling when compared to the results of the May 2012 sampling. PCE levels were highest in the western-most lease space and decreased to the east, away from the known soil contamination at the site.

Health Risk Evaluation

The evaluation of the health risk at the site will consider the chemicals that have been confirmed to be present in the indoor air and have been related to the site. These chemicals include PCE and benzene. The previous Health Consultation also considered TCE which is a breakdown chemical of PCE. TCE was not found in measureable amounts in the May 3, 2012, indoor air sampling, nor was it found in the December 7, 2012, sampling. Because it was evaluated and discussed in the previous Health Consultation and not found again during the latest indoor air sampling, it will not considered further in this document.

Benzene concentrations found in the indoor air were below those found in the outside air at the site. As in the previous indoor air investigation, the indoor benzene levels were again found to be in the range of normal concentrations of both indoor and outside air across the United States. Schuver (2004) published a memorandum listing benzene levels in both ambient and indoor air. For indoor air, a best estimate of background levels ranged from 1.5 to 2.0 ppb. EPA (1998) published a value of 1.6 ppb for average benzene levels for U.S. homes. Benzene levels in the ambient air of urban environments of the U.S. referenced in this document ranged from 4 to 160 ppb. In remote and rural areas of the U.S., ambient air benzene levels ranged from 0.35 to 1.6 ppb. A best estimate of benzene levels in ambient urban air ranged from 0.5 to 1.0 ppb. The measured levels of benzene for the December 2012 sampling ranged from 0.24 to 0.30 ppb. These measured levels were below the documented outside air ranges. As noted in the October 3, 2012, Health Consultation, the location of the site is on a busy state highway near an intersection. The benzene levels may be associated with traffic exhaust. Benzene will not be considered further for evaluation in this Health Consultation.

Indoor Air Non-Cancer Evaluation

Levels of PCE (Table 1) were below their respective non-cancer indoor air health CVs published by the ATSDR (2012).

Building Indoor Air Cancer Evaluation

PCE was detected in indoor air in all 3 lease spaces within the building in December 2012 (Table 1). PCE was not detected in the outside air sample. The measured PCE results ranged from 1.3 ppb in the western-most lease space, to 0.53 ppb in the center lease space, to 0.43 ppb in the

TABLE 1. Indoor air sampling results, with ATSDR and EPA comparison values for the 9053 Middlebrook Pike Site, Knoxville, Knox County, TN. Site-related chemicals are shown. The samples were collected on May 4, 2012 and December 7, 2012, over 8 hours using Summa canisters (S&ME 2012a and 2012b). Values reported in parts per billion (ppb). ATSDR and EPA residential indoor air comparison values are also reported in ppb.

Chemical / Sampling Data and Location Name	Acronym	S-1 (west end) 5/4/12	S-2 (east end) 5/4/12	Inside West 12/7/12	Inside Center 12/7/12	Inside East 12/7/12	Outside 12/7/12	ATSDR EMEG (non-cancer) (ppb)	ATSDR CREG (10^{-6} excess cancer risk) (ppb)	EPA RSL (10^{-6} excess cancer risk) (ppb)
tetrachloroethylene	PCE	*1.6*	*1.3*	*1.3*	*0.55*	*0.43*	*<0.2*	40	0.57	0.6*
trichloroethylene	TCE	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.37	0.045	0.08
benzene	—	*0.61*	*0.64*	*0.24*	*0.30*	*0.28*	*0.31*	3	0.04	0.1

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2012). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2012). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk).

EPA RSL = Environmental Protection Agency Regional Screening Level (EPA 2012). The screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are considered by EPA to be protective for humans (including sensitive groups) over a lifetime.

0.6* = PCE Integrated Risk Information System (IRIS) air concentration RSL at a $1x10^{-6}$ (1 in 1,000,000) and $1x10^{-4}$ (1 in 10,000) excess risk, March 13, 2012.

Modifiers:

0.27 = Measurement in air that is above one or more comparison values.

<0.2 = Not detected in the air sample. Numerical values represent the analytical reporting limit.

eastern-most lease space. Levels of PCE were found to be higher in the western lease space and decreased in the middle and eastern lease spaces, away from the area of soil contamination at the site.

PCE indoor air concentrations were compared to ATSDR's CREG for 1 excess cancer in 1,000,000 people health risk comparison value of 0.57 ppb (ATSDR 2012) and EPA's RSL for an excess lifetime cancer risk (ELCR) of 1 in 1,000,000 of 0.6 ppb (IRIS 2012). Measured PCE levels in the center and east least spaces were below both of these CVs. Therefore, the risk in the center and east lease spaces of the building is lower than what EPA considers to be a potential risk to public health. Breathing the indoor air in these two lease spaces should not result in any increased excess lifetime cancer risk. The measured PCE level in the west lease space is about two times higher than both its ATSDR CREG and EPA cancer health effects RSL. The measured value in the west lease space of 1.3 ppb was near the maximum 95th percentile range of PCE concentrations found in indoor air of 0.6 to 1.4 ppb (EPA 2011). Therefore, further analysis was done using the inhalation unit risk value for PCE.

An estimated risk was calculated using the highest PCE level (west lease space) and EPA's inhalation unit risk (IUR). Using the PCE concentration of 1.3 ppb (8.8 $\mu g/m^3$) and multiplying it by the IUR for PCE of $2.6x10^{-7}$ $(\mu g/m^3)^{-1}$, an ELCR of $2.3x10^{-6}$ was calculated. Therefore, the estimated ELCR due to PCE would be between 2 and 3 extra cancers in 1,000,000 people, in addition to the background cancer risk. The normal every day risk of having cancer in the U.S. is 1 in 2 for men and 1 in 3 for women (NTP 2011). This possible extra cancer risk is negligible when added to the background risk and is within EPA's target cancer risk range of 10^{-4} to 10^{-6} (1991).

Even though the process of vapor intrusion appears to be occurring in very minor amounts at the site, there should not be any concern about adults breathing the trace levels of PCE in the indoor air. The additional risk of breathing the indoor air in the building is not zero, but very low.

Child Health Considerations

The health of children was considered as part of this health consultation. The many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children have lower body weights than adults. Although children's lungs are usually smaller than adults, children breathe a greater relative volume of air compared to adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage.

There is no indication that tetrachloroethylene (PCE) or its breakdown chemicals affect children's bodies differently than adults (ATSDR 1997c). Children may be more sensitive to the carcinogenic effects of PCE than adults (IRIS 2011). ATSDR considered this increased sensitivity when they developed their CREG comparison value.

Future site workers would likely be adults. Children would likely not be part of the population that would work inside the building nor would children spend any significant time in the building. As previously suggested, to protect public health, it would be prudent not to establish a child care facility in the building where the populations would be exposed to the measured low levels of PCE. This should be ensured through deed restrictions on the property, unless corrective actions at the site are taken.

Limitations and Uncertainties in Vapor Intrusion Studies

Having and following an accepted protocol for conducting indoor air investigations is important. A general protocol was developed for this investigation. Still, even a good protocol cannot remove all limitations and uncertainties related to vapor intrusion investigations.

Several characteristics of buildings may influence the indoor air testing. Some examples of limitations and uncertainties include the detail of the design of the building not being readily available. Another limitation is that the exact amount of contamination under the building is an unknown. The amount and frequency of vapor off-gassing is likely not constant. Containers of paints, solvents, cleaners, and equipment that contained liquid fuels were removed from the building prior to the sampling. The containers and equipment were stored outside during the testing. The floors of the building were evaluated and no significant cracking or deterioration was noted. The HVAC system was operating during the testing in December 2012. It was not during the May 2012 testing.

All conclusions and recommendations presented in this Health Consultation were based on the results of both the May and December 2012 indoor air tests. Levels of chemicals in the indoor air of the site building likely vary depending on vapor flux, precipitation events, and seasonal effects. As mentioned in the previous Health Consultation if a second indoor air test was done it may have different results. This was the case for the December 2012 test in that the average results for PCE were lower overall. The most recent test was done in the winter months to determine if the potential for vapor intrusion into the building would be greater with the HVAC system operating. Based on various vapor intrusion guidance documents, sampling performed in winter months should yield higher results, because of building stack effects, the minimal amount of water in soil pore spaces, and temperature.

What happened in the past at the site is another uncertainty. The petroleum-related chemicals were likely removed through the excavation of impacted soils during the removal of the USTs and dispensing lines at the site. Since the source of the petroleum-related chemicals is gone, any remaining contributions from these chemicals to indoor air should be minimal and decreasing. The amounts and locations of any or all spills from the former drycleaner that were not captured were likely undocumented. Basic handling practices of chemicals were also different during the time period that the businesses operated.

Neighboring Property

The groundwater flow direction is unknown. Depending on the groundwater flow direction and site conditions, the PCE contaminant plume may extend under one or more neighboring properties. A neighboring building may have a different structure, different floor slab condition, etc. The source, amount of PCE present in the subsurface, and location of the source of the PCE

release are all unknown. It would be prudent for TDEC to consider the possibility that vapor intrusion may be occurring at neighboring properties. Properties in the downgradient direction of groundwater movement potentially could have the potential for vapor intrusion.

Conclusion

TDH EEP concludes that it does not appear that the very low levels of chemical vapors in the indoor air of the site building will harm the health of adults breathing the indoor air.

Soil-gas testing revealed drycleaner-related chemicals and petroleum-related chemicals in soil beneath the site building. These chemicals were likely from the past use of the site as a drycleaner and a gas station. Two air testing events showed low levels of these chemicals. Evaluation of the indoor air showed the levels to be lower than or within EPA's target risk levels. The evaluation of the December 2012 indoor air investigation, coupled with the previous evaluation of indoor air samples collected in May 2012, suggests that breathing air inside the 9053 Middlebrook Pike Site building having the levels of chemicals measured should not result in adverse health effects for adults.

As mentioned in the Child Health Considerations section, unless corrective actions are taken at the site, it would be prudent not to establish a child care or other business in the building where sensitive populations (children, elderly, or immunocompromised) would be exposed to PCE.

Recommendations

TDH EEP has no recommendations at this time. As a caveat, institutional controls should be placed on the property unless corrective actions are taken.

Public Health Action Plan

The Public Health Action Plan for the 9053 Middlebrook Pike Site contains a list of actions that have been or will be taken by TDH EEP and other agencies. The purpose of the public health action plan is to ensure that this health consultation identifies public health concerns and offers a plan of action designed to mitigate and prevent harmful health effects that result from breathing, eating, drinking, or touching hazardous substances in the environment. Included is a commitment on the part of EEP to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken by TDH's EEP include:

- Reviewed indoor air data collected from two investigations conducted at the 9053 Middlebrook Pike Site.

- Prepared a Health Consultation on October 3, 2012.

- Prepared this follow-up Health Consultation.

Public health actions that will be taken include:

- TDH EEP will provide copies of this health consultation to state and federal government agencies interested in the site, the environmental contractor for the site, and to the property owner.

- TDH EEP will maintain dialogue with ATSDR, TDEC, EPA, and other interested stakeholders to safeguard public health. TDH EEP staff will be available to answer questions regarding the interpretation of the indoor air results and to review additional environmental data, as requested.

Preparer of Report

Joseph P. George, PG, MS
Environmental Health Assessor

Tennessee Department of Health (TDH)
Environmental Epidemiology Program (EEP)
Communicable and Environmental Diseases and Emergency Preparedness (CEDEP)
1st Floor, Cordell Hull Building
425 5th Avenue North
Nashville TN 37243

Reviewers of Report

Internal

David M. Borowski, MS
Interim Director, Environmental Epidemiology Program
Tennessee Department of Health

External

Dana Petway
Environmental Specialist
Division of Remediation, State Remediation Program
Tennessee Department of Environment and Conservation

Albert Iannacone, MS
Environmental Epidemiologist
Knox County Health Department

References

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997a. Toxicological profile for Tetrachloroethylene. Atlanta, GA. U.S. Department of Health and Human Services. September 1997.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997b. Toxicological profile for Trichloroethylene. Atlanta, GA. U.S. Department of Health and Human Services. September 1997.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997c. Healthy children - toxic environments. Report of the Child Health Workgroup presented to the Board of Scientific Counselors. Atlanta, GA: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2004. Interaction profile for 1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethylne, and tetrachloroethylene. Atlanta, GA. U.S. Department of Health and Human Services. May 2004.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005. Public Health Assessment Guidance Manual. Atlanta, GA: U.S. Department of Health and Human Services. January 2005.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Health Assessment Guidance on Secondary Exposures. Atlanta, GA: U.S. Department of Health and Human Services. June 5, 2006.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for Benzene. Atlanta, GA. U.S. Department of Health and Human Services. August 2007.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2012. Indoor air health comparison values. Atlanta, GA: U.S. Department of Health and Human Services. February 2012.

[EPA] U.S. Environmental Protection Agency. 1991. Role of the baseline risk assessment in superfund remedy selection determination. OSWER Directive 9355.0-30. Washington, D.C.

[EPA] U.S. Environmental Protection Agency. 1998. Inside IAQ. EPA/600/N-98/002. Spring/Summer 1998. Available at: http://nepis.epa.gov/Exe/ZyNET.exe/P10009TF.TXT.

[EPA] U.S. Environmental Protection Agency. 2001. Trichloroethylene health risk assessment: synthesis and characterization. Office of Research and Development, National Center for Environmental Assessment, Washington, D.C. EPA/600/P-01/002A. August 2001.

[EPA] U.S. Environmental Protection Agency. 2002. Office of Solid Waste and Emergency Response Draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (Subsurface Vapor Intrusion Guidance). OSWER EPA530-D-02-004 November 2002.

[EPA] U.S. Environmental Protection Agency. 2011. Background indoor air concentrations of volatile organic compounds in North American residences (1990-2005): a compilation of statistics for assessing vapor intrusion. OSWER. Washington, D.C. Last accessed: January 30, 2013. Available at: www.epa.gov/oswer/vaporintrusion/documents/oswer-vapor-intrusion-background-Report-062411.pdf

[EPA] U.S. Environmental Protection Agency. 2012. Regional Screening Levels (RSL) for chemical contaminants at superfund sites. Oak Ridge TN, Oak Ridge National Laboratory. Last accessed: January 30, 2012. Available at: www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

[EPA] U.S. Environmental Protection Agency. 2012. Evaluating vapor intrusion into buildings from contaminated groundwater and soils. Last Accessed: January 4, 2012. Available at: http://www.epa.gov/athens/learn2model/part-two/onsite/JnE_lite_forward.html

[Google] Google Earth. 2012. Last accessed January 3, 2012. Available at: www.google.com/earth/download/ge/agree.html.

[ITRC] Interstate Technology and Regulatory Council. 2007. Vapor intrusion pathway a practical guideline. Washington, D.C. The Interstate Technology & Regulatory Council Vapor Intrusion Team. January 2007.

[NTP] National Toxicology Program. 2011. Report on carcinogens, 12th ed. Research Triangle Park, NC. Available at: www.ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf

[Partner] Partner Engineering and Science. 2011a. Phase I environmental site assessment report, 9053 Middlebrook Pike, Knoxville, TN 37923. El Segundo, CA. October 6, 2011.

[Partner] Partner Engineering and Science. 2011b. Phase II subsurface investigation and supplemental investigation report. El Segundo, CA. December 2011.

[S&ME] S&ME Inc. 2012a. Report of environmental services, 9053 Middlebrook Pike, Knoxville, TN 37923. Louisville, TN. May 16, 2012.

[S&ME] S&ME Inc. 2012b. Report of limited indoor air sampling, 9053 Middlebrook Pike, Knoxville, TN 37923. Louisville, TN. December 20, 2012.

Schuver, H. 2004. Memorandum – typical benzene concentrations in ambient and indoor air. Available at: https://iavi.rti.org/attachments/OtherDocuments/Benzene_concentrations_in_air_11-2004.pdf

Certification

This Public Health Consultation: *9053 Middlebrook Pike Air Sampling Results Evaluation Update, Knoxville, Knox County, Tennessee*, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun.

David M. Borowski

Interim Director of EEP, CEDEP, TDH