

# Letter Health Consultation

Evaluation of Indoor Air Sampling Events

FORMER WALKER MACHINE PRODUCTS

COLLIERVILLE, SHELBY COUNTY, TENNESSEE

Prepared by  
Tennessee Department of Health

JULY 28, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Agency for Toxic Substances and Disease Registry  
Division of Community Health Investigations  
Atlanta, Georgia 30333

## **Health Consultation: A Note of Explanation**

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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COLLIERVILLE, SHELBY COUNTY, TENNESSEE

Prepared By: Tennessee

Department of Health  
Under a cooperative agreement with the  
Agency for Toxic Substances and Disease Registry





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RE: Letter Health Consultation  
Former Walker Machine Products, Evaluation of Indoor Air Sampling Events,  
459 Washington Street, Collierville, Shelby County, Tennessee 37017

Tennessee Department of Health's (TDH), Environmental Epidemiology Program (EEP) evaluated indoor air results from two sampling events at the former Walker Machine Products (WMP) facility in Collierville, Tennessee, 37017 at the request of the Tennessee Department of Environment and Conservation's (TDEC) West Tennessee Regional Office (WTRO) to determine if workers from the Langley Wire Cloth Products (Langley), which currently occupies the building, are at risk for harmful effects from exposures trichloroethylene (TCE) and tetrachloroethylene (PCE) measured in indoor air samples collected on October 10, 2014 (pre-mitigation), and March 27, 2015 (post-mitigation). The initial sampling identified vapor intrusion occurring and led to an emergency action to reduce chemical vapors in the indoor air. Confirmatory sampling took place approximately three weeks after the installation of a sub-slab mitigation system.

EEP has reached three conclusions about the former Walker Machine Products (WMP) site.

- Based on the evaluation of October 2014 data, EEP concludes that breathing indoor air containing trichloroethylene (TCE) in the WMP building may have harmed Langley worker's health. Pregnant workers may have been exposed to TCE at levels that put them at risk for fetal heart malformation among their babies. All workers may have been at risk for immune effects. This was a public health hazard for past exposures.
- Based on the evaluation of March 2015 data, EEP concludes that a sub-slab mitigation system has reduced indoor air levels of TCE and PCE inside the former WMP building. However, a section of the manufacturing area continues to have TCE levels that have not been reduced by the mitigation system and may be harmful to pregnant workers who spend their day in this area of the building (See Table 1, Location SG405 north central area).

- EEP concludes that there has not been adequate delineation of the groundwater plume beneath the site and indoor air samples have not been collected from other occupied buildings in proximity to the site. Therefore, there is not enough data to determine whether soil vapor intrusion (SVI) is occurring in nearby buildings that include a children's gymnasium, homes, and other businesses and whether there is risk to the people who currently occupy these buildings.

EEP strongly recommends the following:

- EPA continue operating the sub-slab mitigation system installed in the WMP building to reduce to below health concerns or remove the threat of vapor intrusion of TCE, PCE, and any other soil gas contaminants for Langley Workers currently working in the building.
- EPA investigate the possible source of the TCE in indoor air in the north central area of the WMP building (SG405 north central area) where TCE levels remain elevated in indoor air based on post-migration sampling. It is recommended that EPA resample the indoor air of the WMP building, as necessary, to evaluate the effectiveness of the mitigation system, particularly the north central area.
- EPA further delineate the groundwater plume to determine the potential exposures for occupants of nearby buildings, in particular the children, visitors, and workers in the children's gymnastic and dance studio businesses and workers in the other businesses in the adjacent Witt International building, as well as other businesses and nearby homes.
- In the absence of full groundwater plume delineation, it is recommended that EPA perform an indoor air investigation including the collection of indoor air samples from the adjacent Witt International building (west; children's gymnastic center, fastener business, dance studio, and party rental business). In addition to this investigation, we recommend that EPA evaluate the WMP Site further to understand potential exposures in the nearby (southwest) residential area and industrial buildings to the north of the WMP Site.

The remainder of this letter presents background information as well as the evaluation of the indoor air data to support the conclusions and recommendations for the WMP site.

It should be noted that this evaluation is incomplete due to the limited sampling that has occurred. The groundwater plume has not been fully delineated; there is a concern for migration of the plume to other off-site areas. There is a potential for additional vapor intrusion concerns depending on whether the plume has migrated under other nearby commercial buildings and homes. There have been only two sampling events for indoor air. Additional sampling in the nearby Witt International building would help to determine whether vapor intrusion is a concern outside of the WMP building.

## **Background**

The former WMP Site property is 5 acres in size. The site is almost square in shape and is situated on the south side of Washington Street east of downtown Collierville, Tennessee 37017 (Figure 1). The property consists of a single story metal and concrete building (the

manufacturing building), approximately 15,000 square feet in size, surrounded by concrete parking/storage pads to the north and south. Another metal building to the east is used for storage. There is grass cover to the west and gravel cover in between the two buildings (Figure 1). There is a circular shaped concrete pad that once was the location of an above ground storage tank (AST) and an adjacent drainage pit used to contain spills from the AST. An oil/water separator is located south of the manufacturing building (Figure 1) adjacent to an intermittent stream running along the southern property boundary (TDEC 2010).

Walker Machine Products produced automated machine screw products. The company was in operation from 1953 until approximately 2002 (TDEC 2012). WMP used mineral spirits to clean the finished products. Brass parts were cleaned in 1,1,1 trichloroethane (1,1,1-TCA). The used solvent was placed in the AST after use (TDEC 2008). The mineral spirits were filtered and reused. There may also have been other solvents used as the levels of TCE and PCE in sub-slab vapor and indoor air suggest past use of these solvents.

Langley has been operating for about ten years on the former WMP Site. It is not related to Walker Machine Products. Langley makes filters from wire cloth (TDEC 2008). Langley does not use chlorinated solvent chemicals (TDEC 2012) at present but used small amounts of TCE until 2012 that was reclaimed and recycled (Black & Veatch 2015).

Environmental investigations have been conducted on the former WMP Site since 2007. There is a groundwater PCE contaminant plume migrating off-site northwestward approaching Well Plant #1 operated by the City of Collierville. Well Plant #1 is used as a groundwater source for municipal water provided by the City's water treatment plant to over 12,000 citizens of Collierville. The former WMP Site was placed on EPA's National Priority List (NPL) because of the groundwater contaminant plume migrating to the nearby Well Plant. EEP prepared a Public Health Assessment for the groundwater issue at the WMP Site which is being reviewed by ATSDR. As the groundwater plume has not been fully delineated, there is also a concern for migration of the plume to other off-site areas.

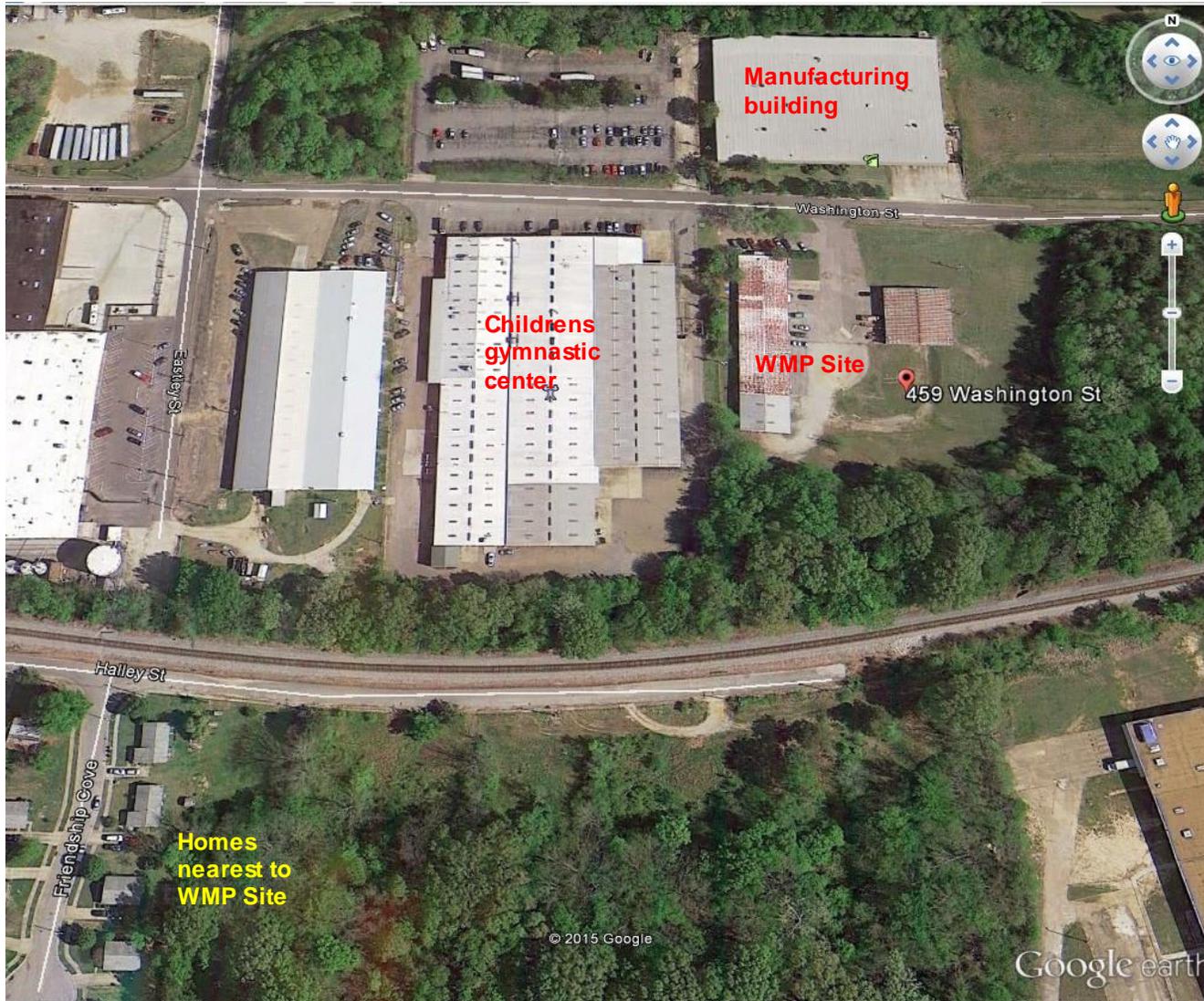


Figure 1. Walker Machine Products (WMP) Site Map. The former WMP Site property is noted, along with the children’s gymnastic center to the west, the nearest homes to the southwest, and a manufacturing building to the north. The westward groundwater flow direction is also shown. Source: Google Earth 2015.

## **Exposed Population**

There are 15 employees that work within the WMP building. Langley has operated in the building since 2005. Langley operates ten hours a day for four days per week. Both male and female employees work in the building. The majority of female employees work in the manufacturing portion of the building but at least one works in the office area. A few of the Langley employees worked for Walker Machine Products and have been employed at the same location for an extended time, although no specific information is available. TCE and PCE were found in the indoor air in the manufacturing area which makes up about the rear three-fourths of the building. Langley does not use TCE or PCE in its processes. Drinking water is provided by the city of Collierville and is not an issue of concern. The Public Health Assessment referenced above provides more information concerning the impact of groundwater contamination on the municipal water supply.

## **Potentially Exposed Population**

There are adjacent commercial buildings including the Witt International building, closest to the Walker Machine Products Site which houses a youth gymnastics academy, where children and workers are present (Figure 1) a children's dance studio, a party rental business, a building supply, and specialty fastener businesses, and a newspaper distribution location. Currently, there are sensitive receptors (exercising children in the gym and dance studio) and workers with elevated breathing rates in the gym and dance facilities. There is also a commercial building to the north (Figure 1). The latter is an active business that employs between 50 and 100 workers. A small group of homes is located southwest of the site, on Friendship Cove (Figure 1). Due to the proximity of these nearby buildings and the groundwater plume delineation limitations, EEP recommends collecting indoor air samples from the Witt International building. Further, EEP recommends EPA evaluate the site further to better understand potential exposures in the commercial building to the north and residences southwest of the site.

## **Environmental Data**

EPA contractors sampled indoor air in October 2014 as part of a remedial investigation and discovered levels of TCE at  $340 \mu\text{g}/\text{m}^3$  and PCE at  $320 \mu\text{g}/\text{m}^3$  in the indoor air (Black & Veatch 2015a). Levels of both chemicals were above those of health concern. Past and current indoor air TCE and PCE exposures appear to be associated with onsite contaminated sub-slab soil and groundwater resulting in vapor migration from the subsurface into the indoor air of the former WMP building. A sub-slab mitigation system was installed by EPA contractors in March 2015 which decreased indoor air levels of the two compounds (Black & Veatch 2015b). A summary of the indoor air results collected by Black & Veatch (2015a, b) in the former WMP building on October 10, 2014, and March 27, 2015, are shown in Table 1.

EPA recommends health risk assessors not use the Occupational Safety and Health Administration (OSHA) workplace standards to evaluate the health risk from vapor intrusion where the vapor intrusion has been identified in commercial/industrial settings and where the chemicals of concern for the vapor intrusion pathway are not used in the work place (EPA 2015).

**Table 1.** Measured indoor air sampling results (10-hour) for PCE and TCE for the manufacturing building, former Walker Machine Products Site, Collierville, Shelby County, Tennessee. Initial sampling performed on October 10, 2014. Confirmation sampling performed on March 27, 2015, three weeks after installation of a vapor intrusion mitigation system. All results reported in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). Both indoor air sampling events were performed by Black & Veatch as a contractor to EPA.

Location	Initial Sampling October 10, 2014		Confirmation Sampling March 27, 2015	
	TCE	PCE	TCE	PCE
SG400 (southeast corner)	<b>29</b>	<b>320</b>	<b>0.43 J</b>	<b>0.56 J</b>
SG401(southwest corner)	<b>20</b>	<b>32</b>	<2.7	<b>0.51 J</b>
SG402 (east central area)	<b>340</b>	<3.4	<b>1 J</b>	1 J
SG403 (west central area)	<b>25</b>	<3.4	<b>0.61 J</b>	1 J
SG404 (northwest area)	<b>20</b>	<3.4	<b>0.46 J</b>	0.52 J
SG405 (north central area)	<b>30</b>	<3.4	<b>28</b>	1.1 J
SG406 (northwest corner – office area)	<b>11</b>	<3.4	<b>&lt;2.7</b>	0.9 J
SG407 (ambient air sample)	<b>&lt;2.7</b>	<3.4	<b>&lt;2.7</b>	<3.4
SG407 DUP (ambient air sample duplicate)	<b>&lt;2.7</b>	<3.4	<b>&lt;2.7</b>	<3.4
EPA industrial air RSL for cancer risk of $10^{-6}$	3	47	3	47
EPA industrial RSL for non-cancer health risk for HI of 1	8	180	8	180
ATSDR CREG	0.24	3.9	0.24	3.9
ATSDR EMEG	2	40	2	40

Notes:  
 <2.7 = Chemical not detected above the posted detection limit of the analysis.  
 J = estimated concentration that is below the method detection level for the analysis.  
**BOLD** result = measured level of chemical exceeds ATSDR or EPA cancer effects screening value for one additional cancer in 1 million people.

EPP compared results to ATSDR's chronic inhalation Environmental Media Evaluation Guides (EMEGs) and EPA's reference concentrations (RfCs) for non-cancer health effects and to ATSDR Cancer Risk Evaluation Guides (CREGs) and EPA's cancer regional screening levels (RSLs) for cancer risk estimation.

Pre-mitigation testing in October 2014 found elevated indoor air levels of both TCE and PCE on the east side of the former WMP building and in the central and southern portions. All seven indoor air TCE samples exceeded the EPA's RfC/ATSDR's EMEG of  $2 \mu\text{g}/\text{m}^3$ . All seven indoor air TCE samples exceeded the ATSDR's CREG of  $0.24 \mu\text{g}/\text{m}^3$  and EPA residential RSL of  $0.48 \mu\text{g}/\text{m}^3$ . For PCE, only one of seven samples exceeded ATSDR's chronic EMEG of  $40 \mu\text{g}/\text{m}^3$ . PCE is also considered a probable human carcinogen. Two PCE concentrations measured above detection levels were greater than ATSDR's CREG for PCE of  $3.9 \mu\text{g}/\text{m}^3$ .

Post-mitigation testing in March 2015 found reduced levels of TCE and PCE in the indoor air. However, TCE levels remain elevated in one sampling location in the north central manufacturing area of the WMP building at  $28 \mu\text{g}/\text{m}^3$ .

## Public Health Implications of Completed Exposure Pathways

To evaluate the levels of TCE the Langley employees would be exposed to, EEP adjusted the measured maximum TCE level to account for the employees shift duration and number of days worked each week. The adjusted maximum concentrations are shown below.

### Calculation - Adjusted TCE Maximum Concentration – October 2014 – Pre-Mitigation:

$$\text{Maximum TCE Concentration}_{\text{adjusted}} = \text{Maximum TCE Concentration} \times \text{ET} \times \text{EF}$$

where: Maximum TCE Concentration = Maximum Detected TCE Concentration ( $\mu\text{g}/\text{m}^3$ );  
ET = exposure time (hours [hrs]/day); and  
EF = exposure frequency (days/week)

$$\text{Maximum TCE Conc.}_{\text{adjusted}} = 340 \mu\text{g}/\text{m}^3 \times 10 \text{ hrs}/24 \text{ hr day} \times 4 \text{ days}/7 \text{ day week} = \mathbf{81 \mu\text{g}/\text{m}^3}$$

### Calculation - Adjusted TCE Maximum Concentration – March 2015 – Post-Mitigation:

$$\text{Maximum TCE Concentration}_{\text{adjusted}} = \text{Maximum TCE Concentration} \times \text{ET} \times \text{EF}$$

where: Maximum TCE Concentration = Maximum Detected TCE Concentration ( $\mu\text{g}/\text{m}^3$ );  
ET = exposure time (hours [hrs]/day); and  
EF = exposure frequency (days/week)

$$\text{Maximum TCE Conc.}_{\text{adjusted}} = 28 \mu\text{g}/\text{m}^3 \times 10 \text{ hrs}/24 \text{ hr day} \times 4 \text{ days}/7 \text{ day week} = \mathbf{6.7 \mu\text{g}/\text{m}^3}$$

## Non-Cancer Health Effects of TCE Inhalation

To assess the severity of exposures and the degree to which workers within the facility may develop adverse health effects from inhalation exposures to TCE, EEP compared the adjusted maximum TCE exposure concentration to the effects levels from animal studies used to derive the EPA RfC (Johnson et al. 2003, Keil et al. 2009). 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 (IRIS 2014). EPA predicts that there is a small risk of fetal heart malformations for pregnant women exposed to TCE at  $21 \mu\text{g}/\text{m}^3$  (Johnson et al. 2003). An uncertainty factor of 10 has been applied to this study to derive the RfC. Exposures during the critical period of development, during the first trimester of pregnancy, are the largest concern for cardiac effects. The EPA RfC is also based on an additional study of immune system impacts from exposure to TCE at  $190 \mu\text{g}/\text{m}^3$  which incorporated an uncertainty factor of 100 (Keil et al. 2009). In late 2014, ATSDR adopted the EPA RfC as its chronic and intermediate Minimal Risk Level/EMEGs for TCE (ATSDR 2014a).

TCE maximum levels in indoor air adjusted for workplace exposure duration ( $81 \mu\text{g}/\text{m}^3$ ) exceeded the study effect levels of  $21 \mu\text{g}/\text{m}^3$  for fetal heart effects and approach the study effect levels for immune system effects of  $190 \mu\text{g}/\text{m}^3$  in the October 2014 sampling event. March 2015 adjusted levels of TCE ( $6.7 \mu\text{g}/\text{m}^3$ ) indicated a significant reduction in the TCE concentration, but may still pose a risk for pregnant workers.

Based on the October 2014 data, past exposures to TCE in indoor air may have put pregnant women at risk for having a child with heart malformations. A recently released study suggested an increased prevalence of cardiac defects associated with TCE and PCE exposure via vapor intrusion, although some study limitations exist (Forand et al. 2011). Also, all workers exposed to TCE in the past were at an increased risk for impacts to the immune system and kidneys. With the installation of the soil-vapor mitigation system beneath the building in March 2015, the adjusted post-mitigation levels of TCE indicated a significant reduction in contaminant levels in indoor air with the exception of one sample (SG405, north central area) that indicated a continuing increased risk of fetal heart malformations of pregnant women who may work at the facility. Because of the one remaining elevated TCE level in the indoor air of the building overall, the post-mitigation levels are still considered a public health hazard to the pregnant workers present in the north center manufacturing area throughout their work shift.

### **Cancer Health Effects of TCE Inhalation**

As stated earlier, the Department of Health and Human Services, National Toxicology Program classified TCE as reasonably anticipated to be a human carcinogen. In humans, occupational exposure to TCE was associated with excess incidences of several cancers, particularly liver cancer, non-Hodgkin lymphoma, and kidney cancer (NTP 2011). The International Agency for Research on Cancer (IARC) has determined TCE is a probable human carcinogen based on epidemiological studies showing increased rates of liver cancer and non-Hodgkin lymphoma (NHL), primarily in workers who were exposed to TCE on the job and animal studies showing increased numbers of liver and kidney tumors upon oral administration. The EPA characterized TCE as carcinogenic to humans by all routes of exposure. The oral slope factor estimate for TCE is calculated from route-to-route extrapolation of the inhalation unit risk estimate for kidney cancer with a factor of 5 applied to include NHL and liver cancer risks (EPA 2014).

The site-specific lifetime excess cancer risk (LECR) estimates are usually expressed in terms of excess cancer cases in an exposed population in addition to the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 4 per 10 individuals for males, and 3 per 10 for females (ACS 2015). The lifetime risk of being diagnosed with any of several common types of cancer ranges between 1 in 10 and 1 in 100 (ACS 2015). EPA's target cancer risk range from chemical exposure is between 1 in 10,000 and 1 in a million [EPA 1991].

Using the EPA's Inhalation Unit Risk Factor ( $4.1 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$ ) and the adjusted exposure point concentration of TCE in pre-mitigation indoor air obtained in October 2014, of  $81 \mu\text{g}/\text{m}^3$ , and an exposure duration for employees working at Langley since it opened in 2005 (approximately 10 years), the LECRs is estimated to be approximately 4 in 100,000 for employees working at Langley, which is considered a low increased risk when compared to the background risk of all or specific cancers.

## Non-Cancer Health Effects of PCE Inhalation

To evaluate the levels of PCE the Langley employees would be exposed to, EEP adjusted the measured maximum PCE level to account for the employees shift duration and number of days worked each week. The adjusted maximum concentrations are shown below.

### Calculation - Adjusted PCE Maximum Concentration – October 2014 – Pre-Mitigation:

$$\text{Maximum PCE Concentration}_{\text{adjusted}} = \text{Maximum PCE Concentration} \times \text{ET} \times \text{EF}$$

where: Maximum PCE Concentration = Maximum Detected PCE Concentration ( $\mu\text{g}/\text{m}^3$ );  
ET = exposure time (hours [hrs]/day); and  
EF = exposure frequency (days/week)

$$\text{Maximum PCE Conc.}_{\text{adjusted}} = 320 \mu\text{g}/\text{m}^3 \times 10 \text{ hrs}/24 \text{ hr day} \times 4 \text{ days}/7 \text{ day week} = \mathbf{77 \mu\text{g}/\text{m}^3}$$

### Calculation - Adjusted PCE Maximum Concentration – March 2015 – Post-Mitigation:

$$\text{Maximum PCE Concentration}_{\text{adjusted}} = \text{Maximum PCE Concentration} \times \text{ET} \times \text{EF}$$

where: Maximum PCE Concentration = Maximum Detected PCE Concentration ( $\mu\text{g}/\text{m}^3$ );  
ET = exposure time (hours [hrs]/day); and  
EF = exposure frequency (days/week)

$$\text{Maximum PCE Conc.}_{\text{adjusted}} = 1.1 \mu\text{g}/\text{m}^3 \times 10 \text{ hrs}/24 \text{ hr day} \times 4 \text{ days}/7 \text{ day week} = \mathbf{0.26 \mu\text{g}/\text{m}^3}$$

To evaluate the potential for non-cancer health effect, the adjusted levels of PCE found in the building ( $77 \mu\text{g}/\text{m}^3$  pre-mitigation and  $1.1 \mu\text{g}/\text{m}^3$  post-mitigation), were compared with the effect levels from two studies used to derive the EPA RfC and ATSDR EMEG of  $40 \mu\text{g}/\text{m}^3$ . The Echeverria study (1995) that reported an increased risk of color blindness among workers exposed to PCE at  $15,000 \mu\text{g}/\text{m}^3$  and the Cavelleri study (1994) reported neurological effects (delayed reaction time and cognitive effects) from exposure to PCE at levels of  $56,000 \mu\text{g}/\text{m}^3$ . An uncertainty factor of 1,000 was applied to these studies to derive the RfC and EMEG for PCE.

Based on the October 2014 and March 2015 indoor air data, workers were exposed to significantly lower levels of PCE than those associated with health effects. Therefore, Langley workers were not in the past and are not currently at risk for health effects associated with exposure to PCE in indoor air.

## Cancer Health Effects of PCE Inhalation

The U.S. EPA concluded that PCE is likely to be carcinogenic in humans by all routes of exposure based on sufficient evidence in animals and suggestive evidence of a causal association between PCE exposure in humans and bladder cancer, multiple myeloma, and non-Hodgkin's lymphoma. The National Toxicology Program (NTP) concluded that PCE is reasonably

anticipated to be a human carcinogen based on sufficient evidence in experimental animals (NTP 2011). Based on increased risks of esophageal cancer, cervical cancer, and non-Hodgkin's lymphoma in several epidemiologic studies, and increased liver tumors in mice, increased mononuclear cell leukemia in rats, and renal tumors in male rats, the IARC classified PCE as probably carcinogenic to humans.

Based on the evaluation, using the EPA's Inhalation Unit Risk Factor ( $2.6 \times 10^{-7}$  per  $\mu\text{g}/\text{m}^3$ ) and the adjusted exposure point concentrations of PCE in indoor air obtained in October 2014 of  $77 \mu\text{g}/\text{m}^3$ , the LECRs is estimated to be approximately 3 in 1,000,000 for employees working at Langley since it opened in 2005 (approximately 10 years), which is considered a very low increased risk when compared to the background risk of all or specific cancers.

### **Additional Resources and Assistance**

EEP can provide information and ATSDR fact sheets on exposure. Workers wishing to discuss health concerns related to TCE or PCE exposure may contact their personal care physician. Their physician can refer to the Tennessee Poison Center at 800-222-1222 and the American College of Occupational and Environmental Medicine ([www.acoem.org](http://www.acoem.org)). The Tennessee Poison Center has physicians specializing in environmental and occupational medicine.

The TDH EEP and ATSDR are available to review any additional data at the request of the EPA and provide further guidance as appropriate. EEP and ATSDR are also available to assist the TDEC and EPA in communicating the health risks to the facility owner and workers, as well as the community. If you have any questions regarding the findings presented in this letter, please contact me at 615-741-7247 or by email at [joseph.george@tn.gov](mailto:joseph.george@tn.gov).

Respectfully,



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cc: Tamal Chakaverty, Shelby County Health Department

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## **REPORT PREPARATION**

This Letter Health Consultation for the former Walker Machine Products NPL Site (Langley Wire Products facility), Shelby County, Tennessee, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency reviewers are listed below.

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