Health Consultation

REVIEW AND EVALUATION OF

INDOOR AIR DATA FROM 2012 TO 2015

574 SOUTH MAIN STREET PROPERTY

MEMPHIS, SHELBY COUNTY, TENNESSEE

October 14, 2015

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Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR),
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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.

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Introduction

The 574 South Main Street Property (the Property) has been impacted by contaminated soil and diffusion of vapors from the soil at an adjacent site. A fitness business (gym) uses a major portion of the building on the property to provide clients supervised exercise programs. TDEC had concerns about indoor air quality inside the building. Representatives from the Tennessee Department of Environment and Conservation (TDEC) Division of Remediation's (DoR) Central Office and Memphis Field Office (MFO) asked the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) to review the results of indoor air testing at the property located at 574 South Main Street in Memphis, Shelby County, Tennessee, 38103 (DoR ID No. 79-897). The review was done to evaluate whether the air quality posed a health concern to occupants of the building. The evaluation was also done to provide useful information on site conditions to the property owner, the tenant of the building, or those who may be involved with any future building renovation.

The concern about the indoor air in the property building stemmed from investigations that have taken place on the adjacent land parcel to the north, the John Little Drum (JLD) Site. The National Paper and Chemical Company began operations at 568 South Main Street immediately north of the Property in approximately 1946. The company expanded operations to include 568-564 South Main Street in 1948. Mr. John Little operated the National Paper and Chemical Company at the site from approximately 1958 to the mid-1970s. The company was reportedly a laundry and dry cleaning parts, supplies, and equipment company. Additionally, Mr. Little owned additional dry cleaning facilities during that time period in the Memphis area (TDEC 1995, ENSAFE 2012a, 2012b).

After the National Paper and Chemical Company closed, Mr. Little used the vacant building to store dry cleaning chemicals and detergents in 55-gallon drums and several smaller containers. TDEC received a notification from the Memphis Fire Department in October 1986 concerning abandoned drums in the JLD building. Testing of the contents of the drums revealed the presence of dry cleaning chemicals, solvents, and pesticides. After repeated failed attempts at contacting the JLD building owner, a Commissioner's Order was issued to the owner in July 1987. In August 1987, TDEC conducted removal activities of 25 drums remaining in the building using an emergency response contractor. The JLD Site building was demolished thereafter, in April 1988 (TDEC 1995, ENSAFE 2012a, 2012b).

Today the JLD Site is an undeveloped, vegetated, and vacant property. No structures are left. Groundwater and soil-gas has been investigated for several years on the site. The improper storage of drums and containers on the JLD Site was determined to be the source of contaminated soil (TDEC 1995). Volatile organic compounds (VOCs) including tetrachloroethylene (PCE) and trichloroethylene (TCE) have been found in groundwater and PCE, TCE, and benzene have been found in soil-gas on the JLD Site and the adjacent, non-industrial 574 South Main Street Property.

TCE, PCE, and benzene have also been found in indoor air inside the current building located on the 574 South Main Street Property. In the first indoor air test, done during November 2012, one PCE indoor air level and all TCE indoor air levels measured were above the Agency for Toxic Substances and Disease Registry's (ATSDR) residential non-cancer health screening levels.

Benzene results were all below its residential non-cancer screening level. Indoor air in various locations in the building has been tested four more times since the initial test.

The Property is in a residential and commercial area of south Memphis. The Property has one building that covers nearly the entire Property parcel (Figure 1). The one story building was constructed in 1943 and comprises approximately 8,500 square feet (TDEC 2014a). The property is bounded on the north by the former JLD Site that is divided into two property parcels – a northern parcel and a southern parcel, on the west by South Main Street, on the south by St. Paul Street, and on the east by an alley and a vacant lot farther to the east.

The western portion of the Property building was recently used as a law office. The central and eastern portions are being used as a fitness business. In 2015, the fitness business anticipated to expand into a portion of the western part of the building.

Site Demographics

No people live on the contaminated property. The Property building was used as an office for a law firm in the past five years. That law firm lawyer was the only person occupying the building up until 2013. In approximately June 2013, a second tenant, a gym established a fitness workout facility in the central and eastern portions of the building. In late 2014, the law firm tenant moved out of the building. The gym has six employees, three male and three female, who work in the facility. Employees work a 40 hour work week. The gym holds work-out sessions Monday through Friday from 6 to 10 am, 12 to 1 pm, and from 4 to 8 pm. Additional work-out sessions are held for 3 hours on Saturday and for 2 hours on Sunday. About 150 people are clients of the gym. The clients' ages range from 21 to 60 with the average age in the mid-20's. Some clients bring their children with them to the gym. The children do not generally participate in workouts.

Most of the gym clients are participating in work-out sessions 3 to 4 times each week, according to the gym owner. Each work-out session is an hour long with an approximate half-hour high-intensity level training followed by an approximate half-hour lower intensity training. Clients are approximately 55 percent female and 45 percent male. It is not known how many people have remained clients of the gym since the facility opened. The property is commercial zoned.

Figure 1. Aerial image property map showing the former John Little Drum Site property composed of two property parcels GCI LLC and SCG. The 574 South Main Street Property lies immediately south of the JLD Site. Site groundwater monitoring wells MW01S and D – MW03 are also shown. Source of image: ENSAFE 2012.

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 of the contamination is the place where the chemical was released. For the property, the potential source is the likely past releases that have occurred on the adjacent former JLD Site, as both soil-gas and indoor air on the Property have been impacted by the JLD Site releases. The environmental media (such as, soil, surface water, groundwater, or air) transport the contaminants. For this site, chemical vapors are likely diffusing from contaminated soil and migrating beneath the Property building. Chemical vapors are then transported through vapor intrusion of the chemicals into 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 the property as most of the onsite building is used as a fitness business. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. For this site, the route of exposure would be breathing the indoor air in the gym during work-out sessions.

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.

Building clients and employees are the people who would be exposed if vapor intrusion was occurring. The employees of the fitness business would likely be exposed more than clients as they are in the building longer and usually physically working their bodies, causing them to

breathe more air, similar to their clients. The clients of the facility would also be exposed but to somewhat a lesser degree as they would be in the building less time than the employees. Whether an employee or client of the gym, inhaling more air into one's body would allow higher amounts of chemicals present to enter their body.

Vapor Intrusion

Volatile and semi-volatile chemicals can evaporate from impacted subsurface soil and 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.

Chemicals of Potential Concern

Levels of benzene, carbon tetrachloride, chloroform, ethylbenzene, methylene chloride, 1,1,1-trichloroethane (1,1,1-TCA), PCE, and TCE have been measured in the various indoor air sampling events. For the purposes of this Health Consultation we will focus on benzene, PCE, and TCE. These chemicals have the highest toxicity and potential for health effects from breathing air containing these chemicals, and are ones found most often in the site indoor air tests.

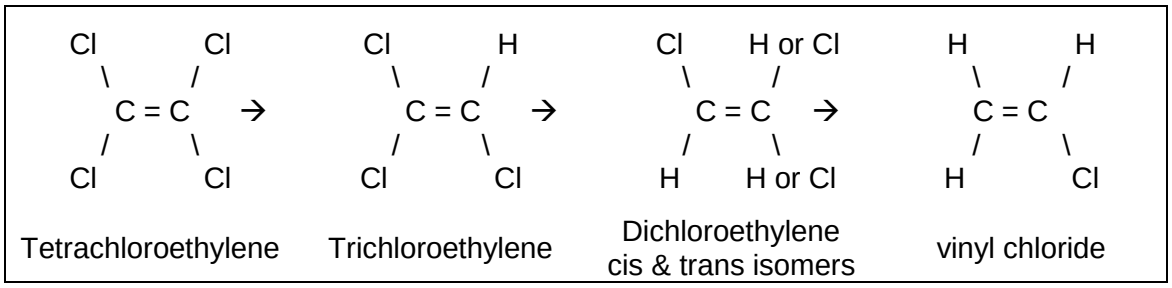
Chemical Explanation

Chemicals found in indoor air of the Property building may be related to what was stored and potentially spilled at the JLD Site. Benzene is a colorless liquid with a sweet odor (ATSDR 2007). Some industries use benzene to make other chemicals used to make nylon and resins. Benzene is also used to make some types of rubbers, lubricants, and pesticides. Benzene is also a part of crude oil, gasoline, and cigarette smoke (ATSDR 2007) and found in many consumer products. PCE is a synthetic compound used as a metal degreaser and fabric dry cleaner. PCE is nonflammable liquid with a sweet odor (ATSDR 2014a). There are no natural sources of PCE. TCE is a non-flammable liquid that has a sweet odor. This man-made compound is not detected

naturally in the environment. TCE is used as a metal degreaser, paint thinner, spot remover and in the manufacture of adhesives (ATSDR 2014b).

PCE Information

As its name implies, PCE has four chlorine anions on a two-carbon molecule. The molecule breaks down once it enters the soil or groundwater through chemical and microbial processes into other chlorinated volatile organics. Each of these breakdown chemicals has slightly different chemical properties and toxicities. The following diagram is an example of how one chemical can break down to form another.



In the example, PCE can break down to TCE, and then to dichloroethylene (DCE), and then to vinyl chloride (VC). The only way to truly know the ratio of these breakdown chemicals is to collect environmental samples. The degradation products TCE and cis-1,2-DCE, have been noted in passive soil-gas samples collected at the site. PCE appears to be the dominant chemical present in site soil-gas and indoor air.

Environmental Investigations

TDEC DoR began investigations at the JLD Site in the mid-1990s. PCE was detected at elevated concentrations of 334 milligrams per kilogram (mg/kg) in site soil. Additional chemicals detected included TCE, chloroform, ethylbenzene, toluene, xylene, and 4,4-DDD (TDEC 1995). A comparison of the historical data to current regulatory screening levels indicated only PCE exceeded soil screening standards. Four monitoring wells were installed at the site in 1999. Three wells (MW-1S, MW-02, MW-03) were shallow in depth with total depths of 38 and 40 feet below ground surface (bgs) and one (MW-1D) was deeper with a total depth of 92 feet bgs (ATC 2000). Groundwater samples were collected in 1999 (ATC), 2007 (ENSAFE), and 2012 (ENSAFE). Several VOCs were found in groundwater samples collected.

ENSAFE conducted a passive soil-gas survey on the JLD parcel in 2007. Results showed the presence of elevated levels of chlorinated VOCs, particularly in the vicinity of monitoring well MW-02 and to the south. Elevated levels of chlorinated VOCs also appeared to extend to the north and northeast of the JLD parcel (ENSAFE 2012a).

ENSAFE conducted sub-slab soil-gas sampling activities in the neighboring 574 South Main Street Property building on behalf of Shelby County in June 2012 (ENSAFE 2012b). Results (Table 1) showed elevated levels of PCE, TCE, and two petroleum hydrocarbon chemicals ethylbenzene and toluene, in soil-gas beneath the slab (ENSAFE 2012b).

Table 1. June 21, 2012 sub-slab soil-gas results beneath the 574 South Main Street Property (Gym) building. All results are reported in micrograms per cubic meter (µg/m^3). Soil-gas samples were collected from the west-central, central, and northeastern corner sections of the building.

Chemical	benzene	carbon disulfide	chloro-form	cis-1,2-DCE	ethyl-benzene	methylene chloride	PCE	toluene	TCE
SGCW01 (West-Central Area)	2.6 J	10 J	<28	<23	<25	<200	12,000	<22	45
SGCE01 (Central Area)	<960	4,100	<1,500	<1,200	330 J	2,000 J	330,000	680 J	1,300 J
SGNE01 (Northeastern Corner)	1.3 J	1.6 J	5.9	0.77	0.56 J	<6.4	530	1.4	890

Notes:
cis-1,2-DCE = cis-1,2-dichloroethylene
PCE = tetrachloroethylene
TCE = trichloroethylene

Modifiers:
J = result is an approximate value less than the reporting limit but greater than or equal to the method detection limit.
<960 = chemical not detected in the sample at or above the method detection limit for the analysis which is shown.

Based on the 2012 elevated levels of PCE and TCE, TDEC DoR subsequently conducted indoor air sampling inside the Property building using SUMMA canisters in November 2012 to identify if chemicals were present in indoor air at the Property. The November 2012 indoor air sampling event results showed the presence of JLD Site-related chemicals in indoor air (ESC 2012). The levels found were approximately equal to or below the EPA's regional screening levels (RSLs) for industrial air at a carcinogenic risk level of one excess cancer in one million people but were above EPA's residential indoor air RSLs at the same level of risk (summarized in Table 2).

TDEC DoR concluded, based upon the results of the November 2012 indoor air sampling event, that the building was safe at the time for its use as a law office and storage area. TDEC DoR decided additional indoor air sampling events were warranted to assess the effects of seasonality and of the heating, ventilation, and air conditioning (HVAC) systems on the levels of chemicals in indoor air. TDEC DoR conducted a warm weather indoor air sampling event in September 2013 (summarized in Table 2). The levels of chemicals detected in this event were all below the EPA's industrial RSLs with the exception of benzene (EPA 2014). All benzene measurements exceeded the industrial screening value of one excess cancer in one million people RSL of 1.6 µg/m^3. However, all benzene concentrations in indoor air were less than the EPA industrial RSL of 16 µg/m^3 for one excess cancer in 100,000 people (EPA 2014).

TDEC DoR conducted another indoor air sampling event in February 2014 (summarized in Table 2). TDEC DoR collected indoor air samples with both SUMMA canisters, consistent with the prior indoor air sampling events, and passive diffusion samplers as a comparison. None of the passive diffusion results exceeded applicable RSLs (Beacon 2014). Three of the five SUMMA canister indoor air samples collected exceeded the PCE industrial RSL (47 µg/m^3) and three of five exceeded the TCE industrial RSL (3 µg/m^3) (EPA 2014, Test America 2014). All PCE and TCE concentrations in indoor air were less than the industrial use 10^{-5} screening level, i.e. 470 µg/m^3 and 30 µg/m^3, respectively (EPA 2015). The combined hazard quotients (HQ) for PCE and TCE for the 8-hour sample SM03-0214IA collected in February 2014 were approximately equal to a non-carcinogenic HQ of 1.0 (TDEC 2014).

Table 2. Summarized ranges of benzene, tetrachloroethylene (PCE) and trichloroethylene (TCE) levels measured in indoor air of the 574 South Main Street Property building. Samples were collected in November 2012, September 2013, February 2014, October 2014, and March 2015. Indoor air was sampled using SUMMA canisters for an eight-hour time period during each sampling events. All results are reported in micrograms per cubic meter ($\mu g/m^3$).

Sample Date	November 2012			September 2013			February 2014			October 2014			March 2015		
Chemical	ben-zene	PCE	TCE	ben-zene	PCE	TCE	ben-zene	PCE	TCE	ben-zene	PCE	TCE	ben-zene	PCE	TCE
Results Range	**1.3 – 1.7**	**18 – 48**	**2.9 – 4.1**	**4.2 – 8.9**	**12 - 25**	<1.1 **– 1.5**	**0.93 – 1.4**	**35 – 90**	**2.3 – 5.2**	**0.51 – 1.3**	0.69 **– 3.9**	0.075 **– 0.62**	**0.99 – 1.4**	**2.5 – 6.2**	**0.093J – 0.45**
Screening Values															
EPA industrial RSL for 10^{-6} cancer risk	1.6	47	3	1.6	47	3	1.6	47	3	1.6	47	3	1.6	47	3
EPA industrial RSL for non-cancer health risk HI = 0.1	13	18	0.88	13	18	0.88	13	18	0.88	13	18	0.88	13	18	0.88
EPA residential RSL for 10^{-6} cancer risk	0.36	11	0.48	0.36	11	0.48	0.36	11	0.48	0.36	11	0.48	0.36	11	0.48
EPA non-cancer residential RSL HI = 0.1	3.1	4.2	0.21	3.1	4.2	0.21	3.1	4.2	0.21	3.1	4.2	0.21	3.1	4.2	0.21
ATSDR CREG	0.13	3.8	0.24	0.13	3.8	0.24	0.13	3.8	0.24	0.13	3.8	0.24	0.13	3.8	0.24
ATSDR EMEG	9.6	41	2.1	9.6	41	2.1	9.6	41	2.1	9.6	41	2.1	9.6	41	2.1

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.

PCE = tetrachloroethylene

TCE = trichloroethylene

Modifiers:

<1.1 = chemical not detected in the sample at or above the method detection limit for the analysis which is shown.

ngv = no guidance value for chemical

BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.

In the most recent March 2015 sampling (Figure 2) results showed detections of PCE in all 6 samples collected from inside the building (summarized in Table 2). In five of the six indoor air samples, TCE was found in low, estimated concentrations only, ranging from 0.093 to 0.19 µg/m^3. The sixth sample had an actual low measured TCE level of 0.45 µg/m^3. PCE measurements were similar and ranged from 2.5 to 6.2 µg/m^3. PCE and TCE were not detected in the outdoor air sample.

Tables A-1 through A-7 in Appendix A show the results of indoor air samples collected in the property building for each of the sampling events from November 2012 to March 2015. A discussion of the levels of chemicals found and comparison to previous events follows in the Discussion section of this Health Consultation.

Comparison Values

To evaluate exposure to a hazardous substance, health assessors often use health comparison values. If the chemical concentrations are below the comparison value, then health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the comparison values (ATSDR 2015c) for a particular chemical, then further evaluation is needed. The chemicals evaluated in this health consultation were benzene, PCE, and TCE. Carbon tetrachloride, chloroform, ethylbenzene, methylene chloride, and 1,1,1-TCA were not evaluated because the levels of these chemicals detected in the indoor air were below their non-cancer and cancer comparison values; or measured levels of these compounds in the indoor air were comparable to measured levels in the ambient air.

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 2015c) and are used for comparison to the indoor air data that was collected. Exposure durations are defined as acute (14 days or less), intermediate (15–364 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 78-year lifetime exposure. A reference concentration, or RfC, is an estimate of a daily inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of negative health effects during a lifetime of exposure. In January 2013, ATSDR adopted the EPA's RfC for TCE of 2 µg/m^3 as their chronic inhalation screening value.

It should be noted 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 2015c). ATSDR has cancer risk evaluation guides (CREGs) for cancer health effects evaluation.

Figure 2

Final March 2015 Air Sample Locations
John Little Drum Site and Neighboring Property
DoR# 79-781

Legend

Indoor/Ambient Air Samples

Name

- JL01-0315AA
- SM01-0315IA
- SM02-0315IA
- SM03-0315IA
- SM04-0315IA

Additional March 2015 Indoor Air Sample Locations

Name

- SM10-0315IA
- SM11-0315IA
- John Little Drum Site
- 574 South Main

The previous Station ID for the background ambient air sample was SM06. This station ID has been renamed as JL01, since it is located on the northern parcel of the John Little Drum site.

Map created by Merrie Embry, Project Manager
TDEC-Division of Remediation
April 15, 2015

This map contains the Mr. SID aerial imagery, courtesy of LizardTech.

175 Feet

Figure 2. 574 South Main Street Property (outlined in blue) showing general area of March 2015 indoor air sampling locations. Source: TDEC 2015.

EPA's RSLs for both residential and commercial/industrial air inhalation were used in evaluating the results of the indoor air testing (EPA 2014). These comparison values are shown in each table for the chemicals thought to be site-related and found in the indoor air. The TDH EEP uses these comparison values in addition to EPA residential indoor air comparison values and ATSDR non-cancer and cancer health affects comparison values. Residential values are used because the chemicals detected in indoor air are not used by the current occupant of the building, the occupants of the building are not informed about the chemicals, and the original source of the contamination is not thought to be the Property.

PCE and its breakdown chemical TCE were of special interest at the site and were evaluated because they are thought to be *"reasonably anticipated to be human carcinogens"* (IARC 1995, NTP 2011). It has been determined by the International Agency for Research on Cancer (IARC) and EPA that benzene causes cancer in humans (IARC 1995, EPA 2012). PCE is readily absorbed following inhalation and oral exposure. We are concerned with the inhalation of PCE, TCE, and benzene from vapor intrusion into indoor air given the use of the site as a workout facility with young male and female clients. Compared to pulmonary and ingestion exposure, uptake of PCE and TCE vapors by the skin are minimal (ATSDR 2014a, 2014b). Breathing small amounts of TCE may cause fetal cardiac malformations in pregnant women, decreased immune system function, headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Regarding fetal heart malformations, animal studies have shown this health effect to be present in rats within a period of 1 to 22 gestation days (EPA 2014). Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage (ATSDR 2014a).

ATSDR's CREG for benzene (0.13 $\mu g/m^3$), PCE (3.9 $\mu g/m^3$), and TCE (0.24 $\mu g/m^3$) were exceeded in nearly all events in nearly all samples collected. EPA's reference concentration (RfC) for non-cancer health effects and the ATSDR EMEG for TCE (2 $\mu g/m^3$) were exceeded in several of the sampling events, especially those conducted in the colder months. The RfC for PCE (40 $\mu g/m^3$) was exceeded in the November 2012 and February 2014 sampling events.

The EPA recommends that 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 2012).

Exposure Assumptions

Gym employees and clients are being exposed to the chemicals found through the process of vapor intrusion. Vapors from beneath the building are migrating up into the indoor air of the building.

The exposure duration for the employees was assumed to be 9 hours per day for 5 days a week. To account for increased breathing rates for moderate exercising with their clients, and to be conservative in the evaluation process, the duration of exercising for the employees was doubled to 18 hours per day, for five days per week. It is however, unrealistic that a gym employee could

work 18 hours in one day and have a breathing rate associated with high intensity exercising for the entire period of time.

It is our understanding that exercising clients were adults, ranging in age from 20 to 65 years old, who attend work out sessions for 1.5 hours per day for 4 days per week. Because the gym is open for limited hours on Saturday and Sunday, we are estimating clients would work out 4 days per week (6 hours a week). To account for the increased breathing rate while a person is exercising at a high intensity and to be conservative in the evaluation process, the duration of exercising was doubled to three hours per day, four days per week and used in the exposure equation. Children can be affected by exposure the same ways as adults. It is not known if children are more susceptible to the health effects of benzene, PCE, or TCE than adults (ATSDR 2007, 2014a, and 2014b). It was estimated that children would spend 1.5 hours per day for 4 days per week in the gym. The time a child would spend in the gym with their parent was also doubled to account for the increased breathing rate of a child.

The results of doubling of the exposure time for non-cancer hazard quotient (HQ) calculations for PCE and TCE were checked by using an ATSDR-developed spreadsheet. The spreadsheet utilized high intensity exercise breathing rates published in EPA's Exposure Factors Handbook (2011) as well as age-dependent body weights. HQs were more conservative when calculated using a doubling of the exposure time.

Health Risk Evaluation

Based on previous investigations, residual contamination remains in soil-gas beneath the Property building. Calculated hazard quotients and excess lifetime cancer risk values for each sampling event are present in Appendix C, tables C-1 to C-5. For the following discussion of non-cancer and cancer health evaluations below, the highest levels of benzene, PCE, and TCE found in any of the five sampling events were used.

Non-cancer Health Evaluation – Gym Employees

The HQ for the maximum measured level of benzene, PCE, and TCE was calculated and presented in Table 3. The HQ is calculated by dividing the measured concentration by the chemical's reference concentration (RfC). The RfC for benzene is 30 $\mu g/m^3$ (EPA 2015); for PCE, it is 40 $\mu g/m^3$ (EPA, 2015); and for TCE it is 2 $\mu g/m^3$ (EPA 2015). An RfC is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful non-cancer effects during a lifetime. The calculated HQs below were adjusted to account for gym employees working 18 hours/day, 5 days/week, 50 weeks/year. The excessive working hours were used to take into account a moderate to high breathing rate that would be demonstrated by the employees as they were performing their jobs in the gym. Any HQ value less than 1 indicates that the air concentration is below the inhalation guideline and thus non-cancer health effects are unlikely. When the HQ exceeds 1, that indicates that the RfC was exceeded and further detailed analysis is needed to better characterize the risks. As a general rule, HQs between 1 and 2 should not result in any increased non-cancer health effects for healthy people. Calculations for exposure periods are presented in Appendix B.

There remain concerns regarding exposures to TCE above the RfC of 2 µg/m^3 in the gym. The breathing rate of workers would be increased, especially if they are participating in client workouts. Thus, there would be an increase in an exposure compared to a typical person that is resting or sedentary, but this increase would be moderate. There are possible exposures for pregnant women from TCE in the building, but again based on the amount of time workers would be in the building, the increase is slight. It appears the exposure concern is greater in the winter months when the building may not be ventilated as well as in the spring, summer, or fall. Chemical concentrations were highest in the September 2013 for benzene and in February 2014 for PCE and TCE possibly indicating less ventilation in the winter months and increased potential exposure to employees of the gym. Ventilation of the building should be increased in the winter months.

Table 3. Calculated hazard quotients (HQ) for gym employees using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building from five sampling events conducted from 2012 through 2015. HQs were calculated for by adjusting the maximum chemical levels for employees working 18 hours per day, 5 days per week, for 50 weeks per year, and then dividing the adjusted maximum measured level of the chemical by its RfC. HQs less than 1 indicate there should not be non-cancer health effects from breathing air with this level. All chemical levels were measured using Summa canisters. All results are reported in micrograms per cubic meter (µg/m^3).

Maximum benzene level (µg/m^3) September 2013	Adjusted Maximum benzene level (µg/m^3) September 2013	Non-cancer risk HQ	Maximum PCE level (µg/m^3) February 2014	Adjusted Maximum PCE level (µg/m^3) February 2014	Non-cancer risk HQ	Maximum TCE level (µg/m^3) February 2014	Adjusted Maximum TCE level (µg/m^3) February 2014	Non-cancer risk HQ
8.9	4.5	0.15	90	46	1.2	5.2	2.7	1.4

Notes:
µg/m^3 = micrograms per cubic meter
HQ = calculated hazard quotient
PCE = tetrachloroethylene
TCE = trichloroethylene

Non-cancer Health Evaluation – Gym Clients and Children

The HQ for the maximum measured level of each chemical for each sampling event for gym clients was calculated and presented in Table 4. The calculations were similar to those used and described above for gym employees. The calculated HQs below were adjusted to account for gym clients exercising in the building 3 hours/day, 4 days/week, 50 weeks/year. The normal amount of time clients and their children are usually in the building is 1 to 1.5 hours. EEP doubled the amount of time clients and their children would be in the building to account for clients' increased breathing rate resulting from high intensity exercising and to account for the increased breathing rate of children if they accompanied their parents to the gym. Calculations for exposure periods are presented in Appendix B.

The hazard quotients for clients and visitors to the gym are all less than 1. However, similar to the concerns for employees expressed above, there remain concerns regarding exposures to TCE above the RfC of 2 µg/m^3 in the gym facility. The breathing rate of clients would be elevated from their workouts. Like with gym employees, there would be a moderate increase in an exposure compared to a typical person that is resting or sedentary. There are possible exposures for pregnant women from TCE in the building, but again based on the amount of time clients would be in the building, the increase is slight. For children that accompany a parent to the gym facility, the increase in exposure would also be slight. As mentioned in the above section for gym employees, it appears the exposure concern is greater in the winter months when the building may not be ventilated as well as in the spring, summer, or fall. Chemical concentrations were highest in the November 2012 and February 2014 sampling events indicating less ventilation in the winter months and increased potential exposure to gym clients and client's children.

Table 4. Calculated hazard quotients (HQ) for gym clients and children using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building from five sampling events conducted from 2012 through 2015. HQs were calculated by adjusting the maximum chemical levels for employees exercising 3 hours per day, 4 days per week, for 50 weeks per year (to take into account an increased breathing rate), dividing the adjusted maximum measured level of the chemical by its RfC. HQs less than 1 indicate there should not be non-cancer health effects from breathing air with this level. All results are reported in micrograms per cubic meter (µg/m^3).

Maximum benzene level (µg/m^3) September 2013	Adjusted Maximum benzene level (µg/m^3) September 2013	Non-cancer risk HQ	Maximum PCE level (µg/m^3) February 2014	Adjusted Maximum PCE level (µg/m^3) February 2014	Non-cancer risk HQ	Maximum TCE level (µg/m^3) February 2014	Adjusted Maximum TCE level (µg/m^3) February 2014	Non-cancer risk HQ
8.9	0.61	0.02	90	6.1	0.16	5.2	0.36	0.18

Notes:
µg/m^3 = micrograms per cubic meter
HQ = calculated hazard quotient
PCE = tetrachloroethylene
TCE = trichloroethylene

Cancer Risk Evaluation

The Department of Health and Human Services, National Toxicology Program classifies PCE as reasonably anticipated to be a human carcinogen, and the IARC has determined that both PCE and TCE are probable human carcinogens. These determinations are based on limited human epidemiological studies suggesting elevated risks for PCE for esophageal cancer, non-Hodgkin's lymphoma, and cervical cancer and sufficient animal studies showing that PCE induced leukemia in rats and liver cancers in mice (NTP 2011, IARC 1995). For TCE it is determined that it is a probable human carcinogen based on epidemiological studies showing increased rates of liver cancer and non-Hodgkin lymphoma, 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 characterizes TCE as carcinogenic to humans by all routes of exposure (EPA 2014c).

The estimated risk of developing cancer resulting from exposure to the contaminants was calculated by multiplying the site-specific estimated exposure dose by an appropriate cancer slope factor or inhalation unit risk (EPA values can be found at http://www.epa.gov/iris). The result estimates the increase in risk of developing cancer after a lifetime of continuous exposure to the contaminant.

The actual increased risk of cancer may be lower than the calculated number, which gives an estimated risk of excess cancer. The methods used to calculate cancer slope factors assume that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The methods also assume that no safe level exists for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, most methods compute the upper 95th percent confidence limit for the risk but for this Health Consultation, the highest levels of the chemicals were used because of the limited number of sampling events conducted. The actual cancer risk may be lower, perhaps by orders of magnitude.

Because of uncertainties involved in estimating cancer risk, ATSDR employs a weight-of evidence approach in evaluating all relevant data. Therefore, the increased risk of cancer is described in words (qualitatively) rather than giving a numerical risk estimate only. Numerical risk estimates must be considered in the context of the variables and assumptions involved in their calculation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure. Since EPA has characterized both PCE and TCE as carcinogenic to humans, EEP calculated estimated excess lifetime carcinogenic risks for a three year exposure for site employees (Table 5) and for clients who use the gym (Table 6). EEP used a three year exposure because the facility has been operating for two years and EEP wanted to be more conservative in our estimation of cancer risk. The cancer risks presented are based on exposure that occurred between 2012 and 2015. As conditions change on the site, the amount of benzene, PCE, and TCE people are exposed to in specific areas of the site likely will change. This makes it difficult to predict what the cancer risk would be for people who use the site in the future.

Gym Employees

Estimated cancer risks for employees are shown in Table 5 for all sampling events using the highest measured level of each chemical for each event, adjusted for the number of hours the employee would be in the building (18) and number of years of employment (3).

The background lifetime risk of cancer in the United States is about one in two for men and one in three for women (ACS 2013). All cancer risk values used express the additional chance of developing cancer above this baseline. There does not appear to be estimated appreciable additional cancer risk to gym employees from breathing air with measureable levels of benzene, PCE, and TCE. Even though there are levels of these chemicals that have been detected in the

indoor air of the Property building, EEP concludes that these levels will likely not harm the gym employee's health because they have not been breathing the indoor air for a long period of time.

Table 5. Calculated cancer risk for gym employees using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building from five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for employees working 18 hours per day, 5 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by an exposure factor and a time factor to represent exposure for 3 years. All chemical levels were measured using Summa canisters. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Maximum benzene level ($\mu g/m^3$) September 2013	Adjusted maximum benzene level ($\mu g/m^3$) September 2013	Adjusted cancer risk	Maximum PCE level ($\mu g/m^3$) February 2014	Adjusted maximum PCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk	Maximum TCE level ($\mu g/m^3$) February 2014	Adjusted maximum TCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk
8.9	4.5	1.3E-6	90	46	4.6E-7	5.2	2.7	4.2E-7

Notes:
$\mu g/m^3$ = micrograms per cubic meter
PCE = tetrachloroethylene
TCE = trichloroethylene

Gym Clients

It is our understanding that exercising clients were adults, ranging in age from 20 to 65 years old who attended a work out session for 1 hour per day (EEP used a conservative estimate for being in the building for 3 hours per day) for 4 days per week (Appendix B). Because the facility is open for limited hours on Saturday and Sunday we are estimating clients would work out 4 days per week (6 hours a week). Estimated cancer risks for gym clients are shown in Table 7 and are similar to those calculated for gym employees, using the highest measured level of each chemical for each event.

There does not appear to be estimated appreciable additional cancer risk to gym clients from breathing air with measureable levels of benzene, PCE, and TCE. Based on the calculated theoretical excess cancer risk, the ranges calculated for gym clients fall into the range of *no increased risk*. Even though there are levels of these chemicals that have been detected in the indoor air of the Property building, EEP concludes that these levels will likely not harm the health of clients of the gym because they have not been breathing vapors for a long period of time.

Table 6. Calculated cancer risk for gym clients using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building from five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for clients exercising 3 hours per day, 4 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by an exposure factor and a time factor to represent exposure for 3 years. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Maximum benzene level ($\mu g/m^3$) September 2013	Adjusted maximum benzene level ($\mu g/m^3$) September 2013	Adjusted cancer risk	Maximum PCE level ($\mu g/m^3$) February 2014	Adjusted maximum PCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk	Maximum TCE level ($\mu g/m^3$) February 2014	Adjusted maximum TCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk
8.9	0.61	1.8E-7	90	6.1	6.0E-8	5.2	0.36	5.7E-8

Notes:

$\mu g/m^3$ = micrograms per cubic meter

PCE = tetrachloroethylene

TCE = trichloroethylene

BOLD indicates a calculated excess cancer risk above 1E-5. A calculated cancer risk above 1.0E-5 exceeds a commonly accepted cancer risk guideline, therefore a more detailed evaluation of the exposures needs to be conducted.

Child Health Considerations

Clients of the gym are generally younger adults working in the urban core of Memphis. It was indicated during an onsite meeting on March 31, 2015 that some clients bring their children to their workouts. It is not known if children would have more health effects than adults by breathing air with benzene, PCE, or TCE (ATSDR 2007, 2014a, and 2014b). Children, however, would not normally be part of the population that would normally be present inside the building. If they were present, it would be likely that they would not be in the building as many times as their parent.

Table 7 shows the calculated theoretical cancer risk for children spending the same amount of time as their parent in the gym. If a substance causes cancer by a mutagenic mode of action, there is a greater cancer risk for exposures that occur in early life. A current list of substances EPA considers mutagenic can be found at http://www.epa.gov/oswer/riskassessment/sghandbook/chemicals.htm. For these substances, age-dependent adjustment factors (ADAFs) are applied to the risks estimated as follows: An ADAF of 10 is applied for exposures taking place from birth up to two years old, and an ADAF of 3 is applied for children's exposures taking place from age 2 up to age 16. No adjustment is applied for ages 16 or above.

There does not appear to be estimated appreciable additional cancer risk to children of gym clients from breathing air with measureable levels of benzene, PCE, and TCE. Based on the calculated theoretical excess cancer risk, the ranges calculated for both children 0 to 2 years old and 2 to 16 years old fall into the range of *no increased risk*. Just as for an adult, this estimated

increased risk would be in addition to the average risk for cancer for men and women in the United States, which is one in two for men and one in three for women.

Table 7. Calculated cancer risk for children of gym clients using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building from five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for client's children being in the gym building 3 hours per day, 4 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by a time factor to represent exposure for 3 years. An additional factor was applied depending on the age of the child to calculate the cancer risk. For children age 16 and above, the cancer risk is estimated to be the same as an adult. All chemical levels were measured using Summa canisters. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Child Age Grouping / ADAF	Adjusted maximum benzene level ($\mu g/m^3$) September 2013	Adjusted cancer risk	Adjusted maximum PCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk	Adjusted maximum TCE level ($\mu g/m^3$) February 2014	Adjusted cancer risk
	0.61	1.8E-7	6.1	6.0E-8	0.36	5.7E-8
Child (age 0–2 years)	ADAF = 10	1.8E-6		6.0E-7		5.7E-7
Child (age 2-16 years)	ADAF=3	5.4E-7		1.8E-7		1.7E-7

Notes:

ADAF = Age-Dependent Adjustment Factor

$\mu g/m^3$ = micrograms per cubic meter

PCE = tetrachloroethylene

TCE = trichloroethylene

BOLD indicates a calculated excess cancer risk above 1E-5. A calculated cancer risk above 1.0E-5 exceeds a commonly accepted cancer risk guideline, therefore a more detailed evaluation of the exposures needs to be conducted.

Limitations and Uncertainties in Vapor Intrusion

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 unavailability of an "as built" drawing for this building. The number of breaks in floor slabs or utility perforations entering the building were also variables that could influence test results. For example, the exact amount of contamination under the building is an unknown. The amount and frequency of vapor off-gassing is likely not constant. Even though a thorough building inventory of chemicals and possible sources was performed, it is unknown if there were background amounts of the chemicals in the indoor air. There could be a limitation from event to event on whether containers with off-gassing chemicals were or were not in the building at the time of the indoor air tests. The use of cleaning products

in the building that sometimes contain many of the same chemicals that are tested for could influence the results of the testing.

TDEC indicated that during the warmer months of the year the gym opens windows and an overhead door to provide ventilation throughout the building. Large fans are also used to circulate the air. During the cooler months the windows and overhead door are kept closed, decreasing the ventilation. Based on the indoor air tests conducted, the levels of chemicals in the indoor air appear to be less in the warmer months and higher in the cooler months.

All conclusions and recommendations presented in this Health Consultation were based on the results of the indoor air testing prior to and including March 31, 2015. Levels of chemicals in the indoor air of the site building could vary depending on vapor flux from the soil gas to the indoor air of the building, precipitation events, building ventilation, and seasonal effects. If additional tests were performed, there is a possibility of different results, as previous testing has shown.

What happened in the past at the site or other nearby sites is another uncertainty. The amounts and locations of any or all spills from the former JLD Site were undocumented. Basic handling practices of chemicals were much different during the time period that the JLD Site was used as a laundry and then for chemical storage. Remaining drums of stored chemicals that were found housed in the JLD building were properly disposed of in August 1987. Historic commercial businesses and industries were located on nearby properties. It is unknown if there are legacy environmental concerns remaining at those properties.

Conclusions

TDEC began their initial indoor air investigations at the site in November 2012. Prior to and during 2012 it was confirmed that soil-gas beneath the 574 South Main Street Property building contained elevated levels of ethylbenzene, PCE, and TCE. Levels of benzene, PCE, and TCE have been detected in indoor air since November 2012. Levels of benzene, PCE, TCE, and other chemicals detected are shown to change in each of the indoor air monitoring events and are dependent on a number of factors, including ventilation. Measured levels in the indoor air appear to be higher in cooler months. The amounts of chemicals measured in the indoor air will likely continue to change. The conclusions presented are based on the 3-years of data reviewed.

Main Conclusion:

Chemicals have been measured in soil-gas beneath the 574 South Main Street Property building. Indoor air testing has revealed the same chemicals are present in the indoor air. Vapor intrusion of PCE and TCE appears to be occurring.

Conclusion 1: *TDH EEP concluded that gym employees and clients of the gym, and client's children who may accompany them have been exposed to levels of TCE in indoor air. EEP concludes the levels of TCE in indoor air are not expected to harm people's health.*

Measured TCE levels over the past three years are, at times, more than twice the health comparison value for the chemical. Measured levels were adjusted for the amount of time gym employees or clients would be in the building. The levels are thought not to be elevated enough to harm the health of gym employees or gym clients and their children. There are increased exposures due to the higher breathing rates of the clients exercising that sedentary people would not be exposed to, but based on the levels measured, the extra exposure would not pose a health threat to those exercising because of the short time they would be in the building.

Conclusion 2: *TDH EEP concluded that gym employees and clients of the gym, and client's children who may accompany them have been exposed to levels of PCE in indoor air. EEP concludes that levels of PCE in indoor air are not expected to harm people's health.*

Measured PCE levels over the past three years are, at times, more than twice the health comparison value for the chemical. Measured levels were adjusted for the amount of time gym employees or clients would be in the building. The levels are thought not to be elevated enough to harm the health of gym employees or gym clients and their children. There are increased exposures due to the higher breathing rates of the clients exercising that sedentary people would not be exposed to, but based on the levels measured, the extra exposure would not pose a health threat to those exercising because of the short time they would be in the building.

Conclusion 3: *EEP concluded that gym employees and clients of the gym, and client's children who may accompany them have been exposed to levels of benzene in indoor air. EEP concludes the levels of benzene in indoor air are not expected to harm people's health.*

Measured levels of benzene were above both non-cancer and cancer comparison levels. Employees and clients are exposed to elevated levels of benzene. The source of the benzene is not specifically known at this time. There are increased exposures due to the higher breathing rates of the clients exercising that sedentary people would not be exposed to, but based on the levels measured, the extra exposure would not pose a health threat to those exercising because of the short time they would be in the building.

Conclusion 4: *TDH EEP suggests a prudent public health action would be to install a mitigation system to lower or remove chemical vapors from the soil-gas beneath the 574 South Main Street Property building. If a mitigation system is not installed, adjustment to the building's ventilation system or portable air purifiers should also be considered as short-term options to mitigate the chemical vapors present. At least annual indoor air sampling should be performed by TDEC as long as there are occupants in the building if a mitigation system is not installed. And if a mitigation system were installed, confirmation indoor air sampling should be performed by TDEC to identify if the system is operating properly.*

The source at the 574 South Main Street Property building is likely vapor intrusion from the soil-gas beneath the building. Testing of soil-gas beneath the building showed elevated levels of both PCE and TCE. The source of the elevated chemical levels in soil-gas will remain. Action should be taken to lower the levels of chemicals in soil-gas. Otherwise, indoor air testing should be continued at least annually to monitor the levels in indoor air. The building should be

ventilated as much as possible, especially during the winter months when elevated levels of chemicals have been measured.

Recommendations

The focus of this health consultation was to make sure the indoor air breathed by employees and clients of the gym will not lead to harmful health effects. Based on the results of this indoor air sampling investigation, TDH EEP has the following recommendations:

1. Steps should be taken by TDEC or the building owner to reduce the amount of benzene, PCE, and TCE in the indoor air of the building. The levels should be reduced to those protective of public health.

2. TDEC should conduct additional indoor air sampling to monitor levels of chemicals in indoor air, especially if mitigation measures are not taken.

3. EEP recommends that TDEC take necessary steps to avoid establishing residences, a child care facility, or a clinic on the property unless the appropriate mitigation measures were taken to make the building safe for this type of occupancy.

Public Health Action Plan

The public health action plan for the 574 South Main Street Property building 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 three years of indoor air data from the building.

- Conferred with TDEC MFO personnel regarding the elevated levels of chemicals identified in the indoor air.

- Participated in a meeting with the building owner and owner of the gym to explain the Health Consultation process and what screening levels the results would be compared to.

- Prepared this Health Consultation.

Public health actions that will be taken include:

- TDH EEP will provide a copy of this health consultation to the 574 South Main Street Property building owner and the owner of the gym business.

- TDH EEP will provide copies of this health consultation to state and federal government agencies interested in the site.

- 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.

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[TDEC] Tennessee Department of Environment and Conservation, Division of Superfund. Preliminary Assessment, John Little Drum Site. April 28, 1995. Memphis, TN.

[TDEC] Tennessee Department of Environment and Conservation, Division of Remediation. 2014a. February 2014 Building Survey and Screening Forms for 574 South Main Street. Forms obtained from State of California Vapor Intrusion Guidance Document – Final, Appendices L and M. February 2014. Available at: https://dtsc.ca.gov/AssessingRisk/upload/FInal_VIG_Oct_2011.pdf.

[TDEC] Tennessee Department of Environment and Conservation, Division of Remediation. 2014b. John Little Drum Site. September 17, 2014 Field Notes. Memphis, TN.

[TDEC] Tennessee Department of Environment and Conservation, Division of Remediation. 2015. John Little Drum Site. March 31, 2015 Field Notes. Memphis, TN.

[Test America] Test America Laboratories, Inc. 2014. Analytical report – John Little Drum Site, October 21, 2014. Knoxville, TN. October 2014.

Appendix A. – Sampling Event Results Tables

Table A-1. November 2012 indoor air sampling results. Indoor air was sampled using SUMMA canisters for an eight-hour time period. All results are reported in micrograms per cubic meter ($\mu g/m^3$).

Chemical	ben-zene	chloro-form	ethyl-benzene	1,1,1-TCA	PCE	TCE
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	ngv	47	3
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	2,200	18	0.88
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	ngv	11	0.48
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	520	4.2	0.21
ATSDR CREG	0.13	0.043	ngv	ngv	3.8	0.24
ATSDR EMEG	9.6	98	260	3,800	41	2.1
Sample ID						
IA-01 (garage, later the gym)	***1.7***	**0.38**	**1.2**	3.6	**18**	***4***
IA-02 (warehouse, later the gym)	***1.6***	**0.35**	**1.2**	3.3	***48***	***4.1***
IA-03 (duplicate IA-02)	**1.3**	**0.31**	**1.1**	2.3	**35**	***2.9***
IA-04 (SW corner office)	**1.3**	**0.36**	**1.1**	2.1	**25**	***3***
IA-05 (SW conference room)	***1.6***	**0.35**	**1.2**	3.0	**36**	***4***
OA-01 (ambient air sample, JLD)	**1.2**	**0.22**	0.52	<0.11	0.36	<0.11

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.

PCE = tetrachloroethylene

TCE = trichloroethylene

1,1,1-TCA = 1,1,1-trichloroethane

JLD = John Little Drum property

Modifiers:

<0.11 = chemical not detected in the sample at or above the method detection limit for the analysis which is shown.

ngv = no guidance value for chemical

BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.

ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Table A-2. September 2013 indoor air sampling results. Indoor air was sampled using SUMMA canisters for an 8-hour time period. All results are reported in micrograms per cubic meter (µg/m^3).

Chemical	ben-zene	chloro-form	ethyl-benzene	1,1,1-TCA	PCE	TCE
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	ngv	47	3
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	2,200	18	0.88
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	ngv	11	0.48
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	520	4.2	0.21
ATSDR CREG	0.13	0.043	ngv	ngv	3.8	0.24
ATSDR EMEG	9.6	98	260	3,800	41	2.1
Sample ID						
SM01-0913IA (gym area)	***4.2***	<0.97	<0.87	<1.1	**12**	<1.1
SM02-0913IA (gym locker/weight lifting area)	***4.5***	<0.97	<0.87	<1.1	**16**	<1.1
SM03-0913IA (duplicate of SM02)	***7***	<0.97	<0.87	<1.1	**25**	***1.2***
SM04-0913IA (SW corner office)	***8.9***	<0.97	<0.87	<1.1	**16**	<1.1
SM05-0913IA (NW corner office)	***6.4***	<0.97	<0.87	<1.1	**23**	***1.5***
SM06-0913AA (ambient air sample, JLD)	<0.64	<0.97	<0.87	<1.1	<1.4	<1.1

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.

PCE = tetrachloroethylene

TCE = trichloroethylene

1,1,1-TCA = 1,1,1-trichloroethane

JLD = John Little Drum property

Modifiers:

<0.64 = chemical not detected in the sample at or above the method detection limit for the analysis which is shown.

ngv = no guidance value for chemical

BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.

ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Table A-3. February 2014 indoor air sampling results. Indoor air was sampled using SUMMA canisters for an 8-hour time period. All results are reported in micrograms per cubic meter (µg/m^3).

Chemical	ben-zene	chloro-form	ethyl-benzene	methylene chloride	1,1,1-TCA	PCE	TCE
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	1,200	ngv	47	3
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	260	2,200	18	0.88
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	100	ngv	11	0.48
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	63	520	4.2	0.21
ATSDR CREG	0.13	0.043	ngv	100	ngv	3.8	0.24
ATSDR EMEG	9.6	98	260	1,000	3,800	41	2.1
Sample ID							
SM01-0214IA (gym area)	**1**	**0.16 J**	0.33	1.6	3.0	***52***	***3.4***
SM02-0214IA (gym locker/weight lifting area)	**1**	**0.11 J**	0.28	0.75	3.2	***60***	***3.5***
SM03-0214IA (duplicate of SM02)	**1.4**	**0.12 J**	0.32	0.91	3.9	***90***	***5.2***
SM04-0214IA (SW corner office)	**1**	**0.15 J**	0.4	1.5	2.0	***42***	***2.9***
SM05-0214IA (NW corner office)	**0.93**	**0.11 J**	0.37	1.2	1.6	**35**	***2.3***
SM06-0214AA (ambient air sample, JLD)	**0.77**	**0.095 J**	0.17	1.0	<0.065	<0.11	<0.075

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.

PCE = tetrachloroethylene

TCE = trichloroethylene

1,1,1-TCA = 1,1,1-trichloroethane

JLD = John Little Drum property

Modifiers:

<0.11= chemical not detected in the sample at or above the method detection limit for the analysis.

ngv = no guidance value for chemical

J = result is an approximate value less than the reporting limit but greater than or equal to the method detection limit.

BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.

ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Table A-4. February 2014 Passive Diffusion indoor air sampling results. Indoor air was sampled using Passive Diffusion sorbent tube samplers as a complementary sampling method to the SUMMA canisters used. Passive Diffusion Samples were exposed to the indoor air of the building for 16 days. All results are reported in micrograms per cubic meter (µg/m^3).

Chemical	ben-zene	chloro-form	ethyl-benzene	methylene chloride	1,1,1-TCA	PCE	TCE
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	1,200	ngv	47	3
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	260	2,200	18	0.88
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	100	ngv	11	0.48
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	63	520	4.2	0.21
ATSDR CREG	0.13	0.043	ngv	100	ngv	3.8	0.24
ATSDR EMEG	9.6	98	260	1,000	3,800	41	2.1
Sample ID							
SM01-0214IAP (gym area)	ND	ND	ND	ND	1.5	**24**	***3***
SM02-0214IAP (gym locker/weight lifting area)	ND	ND	**1.2**	ND	1.5	**29**	***2.4***
SM02-0214IAP (duplicate of SM02)	ND	ND	**1.1**	ND	1.4	**31**	***2.6***
SM04-0214IAP (SW corner office)	ND	ND	ND	ND	ND	**18**	***1.7***
SM05-0214IAP (NW corner office)	ND	ND	ND	ND	ND	**17**	***1.6***
SM06-0214AAP (ambient air sample, JLD)	ND	ND	ND	ND	ND	ND	ND

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.

ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.

PCE = tetrachloroethylene
TCE = trichloroethylene
1,1,1-TCA = 1,1,1-trichloroethane
JLD = John Little Drum property

Modifiers:

ND = chemical not detected in the sample at or above the method detection limit for the analysis.
ngv = no guidance value for chemical

BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.

ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Table A-5. October 2014 indoor air sampling results. Indoor air was sampled using SUMMA canisters for an 8-hour time period. All results are reported in micrograms per cubic meter (µg/m^3).

Chemical	ben-zene	chloro-form	ethyl-benzene	methylene chloride	1,1,1-TCA	PCE	TCE	vinyl chloride
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	1,200	ngv	47	3	2.8
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	260	2,200	18	0.88	44
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	100	ngv	11	0.48	0.17
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	63	520	4.2	0.21	10
ATSDR CREG	0.13	0.043	ngv	100	ngv	3.8	0.24	0.11
ATSDR EMEG	9.6	98	260	1,000	3,800	41	2.1	77
Sample ID								
SM01-1014IA (gym area)	**0.51**	**0.10 J**	0.15 J	0.86	<0.065	0.69	<0.075	<0.074
SM02-1014IA (gym locker/weight lifting area)	**1.3**	**0.10 J**	0.26 J	1.9	<0.065	3.1	0.16 J	<0.074
SM03-1014IA (duplicate of SM02)	**0.99**	0.092J	0.24 J	1.0	<0.065	2.4	0.088 J	<0.074
SM04-1014IA (SW corner office)	**1.3**	**0.50**	0.42	0.84	0.18 J	**3.9**	**0.62**	<0.074
SM05-0913IA (NW corner office)	**1.2**	**0.44**	0.45	0.80	0.16 J	**3.8**	**0.53**	<0.074
JL01-1014AA (ambient air sample, North JLD)	**0.31**	**0.078J**	0.14 J	0.76	<0.065	<0.11	<0.075	***4.1***
JL11-1014AA (ambient air sample, south JLD)	**0.31**	**0.090J**	0.13 J	0.74	<0.065	0.48 J	<0.075	<0.074

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime).
ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.
ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.
PCE = tetrachloroethylene
TCE = trichloroethylene
1,1,1-TCA = 1,1,1-trichloroethane
JLD = John Little Drum property

Modifiers:

ND = chemical not detected in the sample at or above the method detection limit for the analysis.
J = result is an approximate value less than the reporting limit but greater than or equal to the method detection limit.
ngv = no guidance value for chemical
BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.
ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Table A-6. March 2015 indoor air sampling results. Indoor air was sampled using SUMMA canisters for an 8-hour time period. All results are reported in micrograms per cubic meter ($\mu g/m^3$).

Chemical	ben-zene	chloro-form	ethyl-benzene	methylene chloride	1,1,1-TCA	PCE	TCE
EPA industrial air RSL for cancer risk of 10^{-6}	1.6	0.53	4.9	1,200	ngv	47	3
EPA industrial air RSL for non-cancer health risk for HI of 0.1	13	43	440	260	2,200	18	0.88
EPA residential air RSL for cancer risk of 10^{-6}	0.36	0.12	1.1	100	ngv	11	0.48
EPA non-cancer residential air RSL for HI of 0.1	3.1	10	100	63	520	4.2	0.21
ATSDR CREG	0.13	0.043	ngv	100	ngv	3.8	0.24
ATSDR EMEG	9.6	98	260	1,000	3,800	41	2.1
Sample ID							
SM01-0315IA (gym area)	**0.99**	0.098 J	0.36	0.92	<0.012	2.5	0.093J
SM02-0315IA (gym locker/weight lifting area)	**1.0**	0.10 J	0.42	1.0	0.085J	**5.2**	0.12 J
SM03-0315IA (Duplicate location of SM02-0315IA)	**1.1**	0.094 J	0.42	1.2	0.081J	**6.0**	0.13 J
SM04-0315IA (SW office)	**1.3**	0.14 J	0.90	0.83	0.22 J	**6.2**	**0.45**
SM10-0315IA (gym area - highest TCE soil-gas)	**1.1**	0.096 J	0.46	0.99	0.084J	**3.5**	0.14 J
SM11-0315IA (gym office area)	**1.4**	0.12 J	0.73	0.96	0.12J	**4.6**	0.19 J
JL01-0315AA (ambient/background air sample, JLD)	**0.62**	0.083 J	0.20 J	0.80	<0.012	<0.11	<0.075

Notes:

EPA RSLs = Environmental Protection Agency Regional Screening Level (EPA 2015). These non-cancer and cancer health effects residential screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are levels of that chemical considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.
ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2015c). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10^{-6} risk) over a 70-year lifetime. A CREG is an environmental media-specific comparison value used to identify levels of cancer-causing chemicals that are unlikely to result in an increase of cancer rates to those people that have been exposed to the chemical.
ATSDR EMEG = Agency for Toxic Substance and Disease Registry Environmental Media Evaluation Guide (ATSDR 2015c). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical levels require further health-based screening. They are levels of the chemical to which humans may be exposed to without experiencing adverse health effects. Chronic EMEGs are listed.
PCE = tetrachloroethylene
TCE = trichloroethylene
1,1,1-TCA = 1,1,1-trichloroethane
JLD = John Little Drum property

Modifiers:

ND = chemical not detected in the sample at or above the method detection limit for the analysis.
J = result is an approximate value less than the reporting limit but greater than or equal to the method detection limit.
ngv = no guidance value for chemical
BOLD RESULT = measured level of chemical exceeds EPA or ATSDR cancer effects screening value for one additional cancer in one million people.
ITALICIZED and BOLD RESULT = measured indoor air level of chemical exceeds both EPA and ATSDR non-cancer and cancer effects screening values for one additional cancer in one million people.

Appendix B – Calculations

Exposure Calculations

EC = $(CA \ x \ ET \ x \ EF \ x \ ED) \div AT$

Where:
EC = exposure concentration in micrograms per cubic meter (µg/m^3)
CA = contaminant concentration in air (µg/m^3)
ET = exposure time in hours per day (hrs/day)
EF = exposure frequency in days per year (days/year)
ED = exposure duration in years, and
AT = averaging time (ED in years x 365days/year x 24 hours/day)

Adjusted Exposure Factor for Gym workers and clients:

Gym Employees – 18 hours of exposure per day: 18 hours x 5 days x 50 weeks x 3 years / 3 years x 24 hours/day x 7 days/week x 52 weeks/year = 0.52
Gym Clients – 3.0 hours of exposure per day: 3 hours x 4 days x 50 weeks x 3 years / 3 years x 24 hours/day x 7 days/week x 52 weeks/year = 0.068
Gym Client's Children – 3.0 hours of exposure per day: 3.0 hours x 4 days x 50 weeks / 24 hours x 7 days x 52 weeks = 0.068

Adjusted Exposure Concentrations (µg/m^3)

Adjusted exposure concentration = Adjusted Exposure Factor x Concentration

Example: PCE measured level for February 2014 of 90 µg/m^3:

Gym employees - For 18 hours/day for 5 days: 0.51 x 90 µg/m^3 = 45.9 µg/m^3
Gym clients - For 3 hours/day for 4 days: 0.068 x 90 µg/m^3 = 6.1 µg/m^3
Children of Gym clients - For 3 hours/day for 4 days: 0.068 x 90 µg/m^3 = 6.1 µg/m^3

For Cancer Risk Calculations

Risk = Inhalation unit Risk (IUR) x EC x (3 years / 78 years) for 3 years of exposure

Where:
IUR (Inhalation Unit Risk) – for benzene: 7.8E-6
for PCE: 2.6E-7
for TCE: 4.1E-6

EC = exposure concentration (µg/m^3)

e.g. for PCE level of 6.1 µg/m^3 = 2.6E-7 x 6.1 (maximum adjusted PCE concentration) x 3 years / 78 year lifetime = 6.0E-8

Appendix C – Calculated hazard quotients and excess lifetime cancer risk tables for each sampling event

Table C-1. Calculated hazard quotients (HQ) for gym employees using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building during five sampling events conducted from 2012 through 2015. HQs were calculated by adjusting the maximum chemical levels for employees working 18 hours per day, 5 days per week, for 50 weeks per year, and then dividing the adjusted maximum measured level of the chemical by its RfC. HQs less than 1 indicate there should not be non-cancer health effects from breathing air with this level. All chemical levels were measured using Summa canisters. All results are reported in micrograms per cubic meter ($\mu g/m^3$).

Sampling Event	Adjusted Maximum benzene level ($\mu g/m^3$)	Non-cancer risk HQ	Adjusted Maximum PCE level ($\mu g/m^3$)	Non-cancer risk HQ	Adjusted Maximum TCE level ($\mu g/m^3$)	Non-cancer risk HQ
November 2012	0.87	0.03	24.5	0.6	2.1	1.0
September 2013	4.5	0.15	12.8	0.3	0.77	0.4
February 2014	0.71	0.02	46	1.2	2.7	1.4
October 2014	0.66	0.02	2.0	0.05	0.32	0.16
March 2015	0.71	0.02	3.2	0.08	0.23	0.11

Notes:

$\mu g/m^3$ = micrograms per cubic meter

HQ = calculated hazard quotient

PCE = tetrachloroethylene

TCE = trichloroethylene

Table C-2. Calculated hazard quotients (HQ) for gym clients and children using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building during five sampling events conducted from 2012 through 2015. HQs were calculated by adjusting the maximum chemical levels for employees exercising 3 hours per day, 4 days per week, for 50 weeks per year (to take into account an increased breathing rate), dividing the adjusted maximum measured level of the chemical by its RfC. HQs less than 1 indicate there should not be non-cancer health effects from breathing air with this level. All chemical levels were measured using Summa canisters. All results are reported in micrograms per cubic meter ($\mu g/m^3$).

Sampling Event	Adjusted Maximum benzene level ($\mu g/m^3$)	Non-cancer risk HQ	Adjusted Maximum PCE level ($\mu g/m^3$)	Non-cancer risk HQ	Adjusted Maximum TCE level ($\mu g/m^3$)	Non-cancer risk HQ
November 2012	0.12	0.004	3.3	0.08	0.28	0.14
September 2013	0.61	0.02	1.7	0.04	0.1	0.05
February 2014	0.1	0.003	6.2	0.16	0.36	0.18
October 2014	0.09	0.003	0.27	0.007	0.04	0.02
March 2015	0.1	0.003	0.43	0.01	0.03	0.02

Notes:
$\mu g/m^3$ = micrograms per cubic meter
HQ = calculated hazard quotient
PCE = tetrachloroethylene
TCE = trichloroethylene

Table C-3. Calculated cancer risk for gym employees using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building during five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for employees working 9 hours per day, 5 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by an exposure factor and a time factor to represent exposure for 3 years. All chemical levels were measured using Summa canisters. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Sampling Event	Adjusted maximum benzene level ($\mu g/m^3$)	Adjusted cancer risk	Adjusted maximum PCE level ($\mu g/m^3$)	Adjusted cancer risk	Adjusted maximum TCE level ($\mu g/m^3$)	Adjusted cancer risk
November 2012	0.87	2.6E-7	24.5	2.4E-7	2.1	3.3E-7
September 2013	4.5	1.3E-6	12.8	1.3E-7	0.77	1.2E-7
February 2014	0.71	2.1E-7	46	4.6E-7	2.7	4.2E-7
October 2014	0.66	1.9E-7	2.0	2E-8	0.32	4.9E-8
March 2015	0.71	2.1E-7	3.2	3.1E-8	0.23	3.6E-8

Notes:
$\mu g/m^3$ = micrograms per cubic meter
PCE = tetrachloroethylene
TCE = trichloroethylene

Table C-4. Calculated cancer risk for gym clients using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building during five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for clients exercising 3 hours per day, 4 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by an exposure factor and a time factor to represent exposure for 3 years. All chemical levels were measured using Summa canisters. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Sampling Event	Maximum benzene level ($\mu g/m^3$)	Adjusted cancer risk	Maximum PCE level ($\mu g/m^3$)	Adjusted cancer risk	Maximum TCE level ($\mu g/m^3$)	Adjusted cancer risk
November 2012	0.12	3.6E-8	3.3	3.3E-8	0.28	4.2E-8
September 2013	0.61	1.8E-7	1.7	1.7E-8	0.1	1.6E-8
February 2014	0.1	3E-8	6.1	6.0E-8	0.36	5.7E-8
October 2014	0.09	2.7E-8	0.27	2.7E-9	0.62	9.7E-8
March 2015	0.1	3E-8	0.43	4.2E-9	0.03	4.6E-9

Notes:
$\mu g/m^3$ = micrograms per cubic meter
PCE = tetrachloroethylene
TCE = trichloroethylene

Table C-5. Calculated cancer risk for children of gym clients using the maximum measured indoor air level of site-related chemicals detected in the 574 South Main Street Property building during five sampling events conducted from 2012 through 2015. Cancer risk was calculated by adjusting the maximum chemical levels for client's children being in the gym building 3 hours per day, 4 days per week, for 50 weeks per year, multiplying the adjusted maximum measured level of the chemical by a time factor to represent exposure for 3 years. An additional factor was applied depending on the age of the child to calculate the cancer risk. For children age 16 and above, the exposure is the same as an adult. All chemical levels were measured using Summa canisters. All chemical results are reported in micrograms per cubic meter ($\mu g/m^3$). Calculated cancer risk values are unitless.

Sampling Event	Maximum benzene level ($\mu g/m^3$)	Adjusted cancer risk	Maximum PCE level ($\mu g/m^3$)	Adjusted cancer risk	Maximum TCE level ($\mu g/m^3$)	Adjusted cancer risk
November 2012	0.12	3.6E-8	3.3	3.3E-8	0.28	4.2E-8
Child (age 0–2 years)	ADAF = 10	3.6E-7		3.3E-7		4.2E-7
Child (age 2 to 16 years)	ADAF=3	1.1E-7		9.9E-8		1.3E-7
September 2013	0.61	1.8E-7	1.7	1.7E-8	0.1	1.6E-8
Child (age 0–2 years)	ADAF = 10	1.8E-6		1.7E-7		1.6E-7
Child (age 2 to 16 years)	ADAF=3	5.4E-7		5.1E-8		4.8E-8
February 2014	0.1	3E-8	6.1	6.0E-8	0.36	5.7E-8
Child (age 0–2 years)	ADAF = 10	3E-7		6.0E-7		5.7E-7
Child (age 2 to 16 years)	ADAF=3	9E-8		1.8E-7		1.7E-7
October 2014	0.09	2.7E-8	0.27	2.7E-9	0.62	9.7E-8
Child (age 0–2 years)	ADAF = 10	2.7E-7		2.7E-8		9.7E-7
Child (age 2 to 16 years)	ADAF=3	8.1E-8		8.1E-9		2.9E-7
March 2015	0.1	3E-8	0.43	4.2E-9	0.03	4.6E-9
Child (age 0–2 years)	ADAF = 10	3E-7		4.2E-8		4.6E-8
Child (age 2 to 16 years)	ADAF=3	9E-8		1.3E-8		1.4E-8

Notes:
$\mu g/m^3$ = micrograms per cubic meter
PCE = tetrachloroethylene
TCE = trichloroethylene

Appendix D – Glossary of Terms and Acronyms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

adverse health effect: A change in body function or cell structure that might lead to disease or health problems.

ambient: Surrounding (for example, ambient air).

ATSDR: Agency for Toxic Substances and Disease Registry.

background level: An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

cancer: Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

cancer risk: The theoretical excess risk for getting cancer if exposed to a substance every day for 78 years (a lifetime exposure). The true risk might be lower. The excess cancer risk is often expressed as $1x10^{-6}$ for one excess cancer in 1 million people.

carcinogen: A substance that may cause cancer.

chronic exposure: Contact with a substance that occurs over a long time (more than 1 year).

Comparison Value (CV): Calculated concentration of a substance in air, water, food, or soil unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

concentration: The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Cancer Risk Evaluation Guide (CREG): soil, water, or air comparison values prepared by ATSDR used to identify concentrations of cancer-causing substances unlikely to result in an increase of cancer rates in an exposed population.
contaminant: A substance that is present in an environment where it does not belong.

detection limit: The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Excess Lifetime Cancer Risk (ECLR): The additional risk that someone may have of getting cancer if that person is exposed to cancer-causing chemicals.

EEP: Environmental Epidemiology Program of the Tennessee Department of Health.

Environmental Media Evaluation Guide (EMEG): Concentrations of substances in water, soil, or air developed by ATSDR to which humans may be exposed during a specified period of time (acute, intermediate, chronic) without experiencing adverse non-cancer health effects.

EPA: United States Environmental Protection Agency.

epidemiology: The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

exposure: Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).

exposure pathway: The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: 1. a source of contamination (such as an abandoned business), 2. an environmental media and transport mechanism (such as movement through groundwater), 3. a point of exposure (such as a private well), 4. a route of exposure (eating, drinking, breathing, or touching), and 5. a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

groundwater: Water beneath the Earth's surface in the spaces between soil particles and between rock surfaces.

hazard: A source of potential harm from past, current, or future exposures.

health consultation: A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

inhalation: The act of breathing. A hazardous substance can enter the body this way.

Inhalation Unit Risk (IUR): The excess lifetime cancer risk estimated to result from continuous (24-hour per day, 7 days per week, 365 days per year) exposure to a chemical at a concentration of 1 microgram per cubic meter ($\mu g/m^3$) in air.

intermediate duration exposure: Contact with a substance that occurs for more than 14 days and less than a year.

$\mu g/m^3$: Microgram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

migration: Chemical movement from one location to another.

Minimal Risk Level (MRL): An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), non-cancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects.

ppb: parts per billion.

reference dose: An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Regional Screening Level (RSL): comparison levels prepared by the U.S. EPA that are chemical-specific concentrations for individual contaminants in air, drinking water, and soil that may warrant further investigation or site cleanup.

remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.

Reference Concentration (RfC): An estimate of a continuous inhalation exposure for a given duration, to a group of people that is not expected to cause adverse health effects over a lifetime.

risk: The probability that something will cause injury or harm. For non-carcinogen health effects, it is evaluated by comparing an exposure level over a period to a reference dose derived from experiments on animals. For carcinogenic health effects, risk is estimated as the incremental probability of an individual developing cancer over a lifetime (78 years) as a result of exposure to a potential carcinogen.

route of exposure: The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

sample: A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population. An environmental sample, such as a small amount of soil or water, might be collected to measure contamination in the environment at a specific location.

soil-gas: Gaseous elements and compounds in the small spaces between particles of earth and soil. Such gases can be moved or driven out under pressure.

solvent: A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

TDEC: Tennessee Department of Environment and Conservation

tetrachloroethylene (PCE or Perc): A chemical this is a nonflammable liquid at room temperature. It is a colorless liquid and has a sweet smell. It is widely used as a solvent and is the most common chemical used in drycleaning garments.

toxicological profile: An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

toxicology: The study of the harmful effects of substances on humans or animals.

trichloroethylene (TCE): A chemical this is a nonflammable liquid at room temperature. It is also called TCE. It is a manufactured chemical that is widely used to remove grease from metal parts. Trichloroethylene is also an ingredient in other consumer products. It evaporates easily into the air from surface water and has a somewhat sweet odor.

vapor intrusion (VI): The process by which volatile chemicals migrate from an underground source into the indoor air of buildings.

Volatile Organic Compounds (VOCs): Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, dichloroethylene, toluene, trichloroethylene, methylene chloride, methyl chloroform, and vinyl chloride.

Other glossaries and dictionaries:

Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

Certification

This Public Health Consultation: *Review and Evaluation of Indoor Air Data from 2012 through 2015, at the 574 South Main Street Property, Memphis, Shelby 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 prepared.

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Tennessee Department of Health