Health Consultation

TIGER CLEANERS

MEMPHIS, SHELBY COUNTY, TENNESSEE

Prepared by the
Tennessee Department of Health

May 5, 2011

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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 Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions 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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SUMMARY

INTRODUCTION

The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) wrote this health consultation at the request of the Tennessee Department of Environment and Conservation (TDEC), Drycleaner Environmental Response Program (DCERP). This health consultation was prepared to evaluate the results of indoor air sampling completed inside a former drycleaner space and other businesses in a strip mall. The strip mall is located at 970 East Brooks Road, Memphis, Shelby County, Tennessee.

The space formerly used by Tiger Cleaners is currently unoccupied. Adjacent to Tiger Cleaners is a restaurant. A fastener distributor business also shares the strip mall.

All data supplied for this health consultation were compared to residential health comparison values provided by the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency (EPA). Comparison values are chemical concentrations based on toxicology below which no adverse health effects are predicted to occur.

CONCLUSIONS

The EEP reached three conclusions in this health consultation:

Conclusion 1

EEP concludes that based on the data presented by the Indoor Air Sampling Reports dated November 23, 2009 and April 12, 2010, the concentrations of the drycleaner solvent tetrachloroethylene (PCE) and its breakdown products trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis- 1,2-DCE) in the indoor air of the former cleaner is not expected to harm the health of workers or customers.

Basis for Conclusion

Indoor air in the former cleaner space contained minor measured amounts of PCE, TCE, 1-2, cis-dichloroethylene. Drycleaning is no longer being done in the space. Workers and members of the general public who are customers of a business in the former cleaner space would have a limited exposure because they would spend only a short amount of time in the space.

Next Steps

No additional future actions are currently planned by TDEC DCERP at the Tiger Cleaners.

Conclusion 2

EEP concludes that based on the data presented by the Indoor Air

Sampling Reports dated November 23, 2009 and April 12, 2010, the concentrations of the drycleaner solvent tetrachloroethylene (PCE) and its breakdown products trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis- 1,2-DCE) in the indoor air of the restaurant is not expected to harm the health of workers or customers.

Basis for Conclusion

The average concentration of PCE in the indoor air samples collected in the restaurant was above the health guidance value for cancer effects assuming that those exposed would be inhaling the PCE continuously over a lifetime. However, the actual cancer risk from breathing the indoor air at the restaurant is expected to be much less because the exposure for a worker or customer of the restaurant would be much less than the cautious 24 hours per day, 7 day per week, lifetime exposure on which the acceptable risk values are based. In addition, PCE is no longer used or stored the site. The TCE concentration was within EPA's acceptable range for cancer risk of less than 1 excess cancer in 100,000 people.

Next Steps

No additional future actions are currently planned by TDEC DCERP at this leased space.

Conclusion 3

EEP concludes that based on the data presented by the Indoor Air Sampling Reports dated November 23, 2009, it is not likely that breathing the indoor air of the fastener business would harm people's health.

Basis for Conclusion

No concentrations of the drycleaner chemical PCE or its breakdown chemicals were identified above test detection limits. No exposure to these chemicals would occur and therefore workers or customers of the fastener business should not be harmed from breathing the indoor air.

Next Steps

No additional future actions are currently planned by TDEC DCERP at the fastener business leased space.

FOR MORE INFORMATION

If you have any questions or concerns about your health, you should contact your healthcare provider. For more information on this site, call TDEC DCERP at 615 532-0900. For questions on health-related topics concerning this site, call TDH EEP at 615-741-7247 or toll-free at 1-800-404-3006 during normal business hours, or e-mail at eep.health@tn.gov.

Introduction

TDEC's Drycleaner Environmental Response Program (DCERP) requested that the Tennessee Department of Health's (TDH), Environmental Epidemiology Program (EEP) review the results of indoor air samples collected for Tiger Cleaners. This health consultation was prepared to evaluate the results of indoor air sampling completed inside a former drycleaner space and other businesses in a strip mall.

Tiger Cleaners was located at 970 East Brooks Road, Memphis, Shelby County, Tennessee. The drycleaner owner participated in the DCERP and was assigned DCERP Facility No.: D-79-175. The former cleaner was located in a strip mall shopping center. Adjoining Tiger Cleaners leased space is a restaurant. A fastener distributor is also located in the strip mall.

Background

As noted, Tiger Cleaners was located in a strip mall shopping center that contains at least two other businesses (Figure 1). The former cleaner operation ceased approximately 10 years ago and the space has been vacant since that time (F. Thomas Moring, Moring Environmental Services, LLC, personal communication, July 7, 2010). Adjoining Tiger Cleaners leased space is a restaurant. A fastener distributor is also located in the strip mall.

Site History

According to City of Memphis records, the strip mall building was constructed between 1965 and 1975. Also during this time, a building permit was issued for improvements and a certificate of occupancy was issued. The use of the building is unknown until 1984 when the drycleaning operation reportedly began. The drycleaning operation was still functioning at the time of a Prioritization Investigation Report conducted by Eckland Consultants Inc. in 1999. Tetrachloroethylene (PCE or perc) was the chemical being used in the drycleaning operation. During a Phase I Environmental Site Assessment conducted in 1997, Eckland Consultants Inc. (Eckland) observed staining on the floor in the work area near a transfer type drycleaning machine and around a chemical storage area. No areas of surface stains outside the drycleaning facility were observed during the Phase I.

Eckland conducted a Limited Phase II Environmental Assessment in 1997, to evaluate the soil and groundwater conditions. It was determined that groundwater flowed to the northwest on this site (Moring 2008). The lateral and vertical extent of soil and ground water contamination could not be determined by the 1997 Limited Phase II Environmental Assessment. Additional subsurface exploration was recommended to include soil sampling and installation of groundwater monitoring wells. During a site visit around the time of the Prioritization Investigation in 1999, Eckland observed a new closed-loop drycleaning machine with secondary spill containment provisions (Eckland 1999). The facility was registered as active until January 2003. It was registered with the DCERP at that time as an abandoned facility (Alison Buford, DCERP personal communication, July 28, 2010).

Following the Limited Phase II Environmental Assessment, groundwater remediation and two years of additional groundwater monitoring were conducted. After the additional groundwater monitoring, DCERP requested additional site remediation. In 2006, permanganate injections were completed; permanganate injections may increase degradation rates of PCE through oxidation. Groundwater samples collected in May 2007, contained concentrations of chlorinated solvents that appeared to have changed little from concentrations present before the remediation. More results obtained during an October 2008, sampling event also showed concentrations changed little (Moring 2008).

Indoor air sampling was performed on two days in November 2009. The sampling was done in the former Tiger Cleaner space and an adjacent leased space occupied by a restaurant (Figure 2). Additional indoor air sampling was performed again in the restaurant on March 22, 2010 (Figure 3). A fastener distributing business located in the strip mall next to the restaurant was also sampled on this date (Moring 2010). Both indoor air testing events were performed to determine if the chemicals used in the cleaners were present in these other leased spaces.

TDEC DCERP requested TDH EEP review the indoor air data to determine if the employees and customers of the businesses in the strip mall could be affected by chemicals that remain in the indoor air from the former cleaner. TDEC DCERP wanted to protect the employees and customers of the businesses from involuntary exposure to drycleaner-related chemicals in indoor air.

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. 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.

Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will develop adverse health effects. A chemical's ability to affect public 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.

Potentially exposed populations at this site include future lessees of the former Tiger Cleaners space, employees and customers of the restaurant, and employees of the fastener distributing business, under a lease. Both adults and children are included in the population of the future lessees of Tiger Cleaners space and the restaurant.

Vapor Intrusion

Vapor intrusion is the movement of volatile chemicals from the subsurface into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that migrate through subsurface soils and into the indoor air of overlying buildings. 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, and 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.

Comparison Values

To evaluate exposure to a hazardous substance, health assessors often use comparison values. A comparison value is a chemical concentration below which 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 2010) for a particular chemical, then further evaluation is needed.

Non-Cancer Comparison Values

The Agency for Toxic Substances and Disease Registry (ATSDR) uses the no observed adverse effect level/uncertainty factor (NOAEL/UF) approach to derive non-cancer health effect environmental media evaluation guides (EMEGs) for hazardous substances. EMEGs are set below levels that, based on current information, might cause adverse health effects in the people most sensitive to such substance induced effects. Exposure to a level above the EMEG does not mean that adverse health effects will occur (ATSDR 2005).

EMEGs are based on conservative assumptions about chemical exposure. EMEGs consider non-cancer adverse health effects. Exposure durations are defined as acute (14 days or less), intermediate (15–365 days), and chronic (365 days or more) exposures.

Cancer Comparison Values

To evaluate whether exposure to concentrations of chemicals could potentially result in excess cancers, EEP compares the concentrations to ATSDR cancer risk evaluation guide (CREG) values. The CREG screening values were established for no more than one excess cancer in 1,000,000 people exposed during their lifetime (70 years). This can also be written as a $1x10^{-6}$ excess risk. CREGs are calculated from EPA cancer slope factors for oral exposures or unit risk

values for inhalation exposures. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

Environmental Sampling

Indoor air sampling was performed on November 3, 2009, in the former cleaner space. The next day, indoor air sampling was performed in an adjacent leased space occupied by a restaurant. Sampling was performed by Moring Environmental Services, LLC of Memphis, Tennessee, using Summa canisters that had flow controllers calibrated to collect a sample over a minimum eight-hour time period (Moring 2009). The November 2009 indoor air sampling was conducted at night at the request of the business owners (Moring 2009).

Additional vapor intrusion sampling was performed at the restaurant on March 22, 2010. The March 2010 indoor air sampling was conducted during normal business hours (Moring 2010). A fastener distributing business located next to the restaurant was also sampled. Again, samples were collected using Summa canisters over an eight-hour time period. It was thought that the cleaner space was used as a pick up store. In the past DCERP has found that indoor air samples collected from pick-up stores can contain vapors that have off-gassed from stored drycleaned clothes. The store, however, is not a pick-up store and has been vacant for some time (Moring personal communication, July 7, 2010).

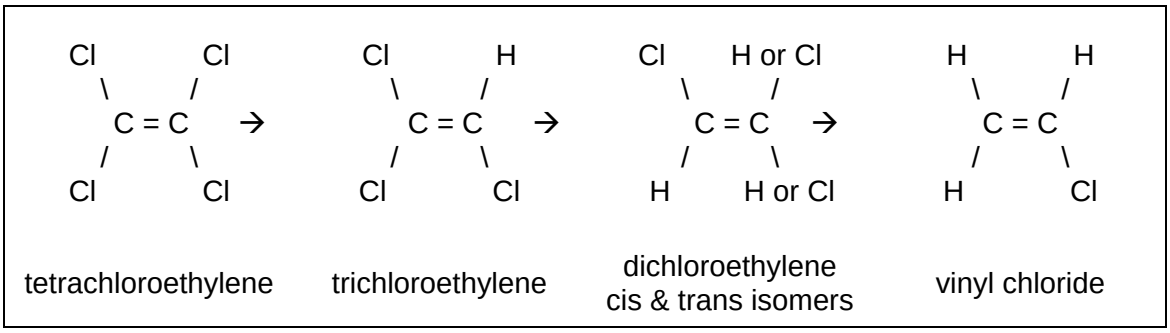
All Summa canisters were positioned at a height of 3 to 5 feet above the floor at their respective sampling locations. Indoor air samples from both sampling events were analyzed by H & P Mobile Geochemistry, Inc. of Carlsbad, CA, using EPA Method TO-15 (Moring 2009 and 2010).

Indoor air samples collected in November 2009 and March 2010 were tested for the following drycleaner constituents: PCE, TCE, 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dichloroethylene (trans-1,2-DCE), 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), and vinyl chloride (VC).

Drycleaner Solvent Explanation

The process of drycleaning is not truly dry, but it uses so little water that it has come to be known as drycleaning. Instead of water, chemical solvents are used in the cleaning process. The most commonly used solvent for drycleaning is PCE. It is a colorless liquid and has sweet smell (ATSDR 1997). PCE is a volatile organic compound. It will quickly evaporate into a gas at room temperature.

As its name implies, tetrachloroethylene has four chlorine anions on a two-carbon molecule. As these chlorine anions react, the molecule breaks down into other chlorinated volatile organics. Each of these breakdown products has slightly different chemical properties and toxicities. The following diagram is an example of how one chemical can breakdown to form another.



For example, PCE can breakdown to TCE, then to DCE, and then to VC. The only way to truly know the ratio of these breakdown products is to collect environmental samples. The drycleaner solvent, PCE, and all of its breakdown products plus their isomers were carefully considered in developing this report.

Results

This review will specifically evaluate the indoor air concentrations of the chemical PCE used in drycleaning. It will also evaluate the indoor air concentrations of TCE, which is one of the chemicals which break down from PCE. Additionally, this evaluation will provide discussion on other chemicals that were identified in indoor air at concentrations above their health comparison values in the two indoor air sampling events conducted. The review of all the data collected is to protect the health of those who work in and visit the businesses of the strip mall.

The results of the November 2009 and March 2010 indoor air sampling are summarized in Table 1. Laboratory reporting limits that were greater than one or more screening values are noted in Table 1 with italicized text.

Indoor air in Tiger Cleaners was tested in November 2009. The drycleaner chemical PCE and its breakdown chemicals TCE, and cis-1,2-DCE were found in the indoor air sample. PCE was measured at a concentration of 20.64 parts per billion (ppb). TCE was reported at 1.86 ppb. Cis-1,2-DCE was found at a concentration of 4.04 ppb. No other PCE breakdown chemicals were detected.

The restaurant next door to the former cleaner was also sampled in November 2009 and again in March 2010. The November 2009 testing measured indoor air concentrations of PCE in the restaurant to be 11.79 ppb. TCE was measured to be 1.43 ppb. Cis-1,2-DCE was reported to be 2.77 ppb. Again no other drycleaner solvent breakdown chemicals were detected. For the testing done in March 2010, PCE was measured at a concentration of 3.98 ppb. No other PCE breakdown chemicals were detected.

Indoor air in the fastener distributor was sampled only in March 2010. Neither the drycleaner chemical PCE nor its breakdown products were measured above detection limits during this testing.

TABLE 1. Indoor air sampling results for Tiger Cleaners, Memphis, Shelby County, TN, leased space and adjacent leased spaces. Event samples were collected on November 3 - 4, 2009, and March 22, 2010, over 8 hours with Summa canisters (Moring 2009, 2010). Values reported in parts per billion (ppb). Health comparison values are the ATSDR CREG for cancer risk (ATSDR 2010), EPA Regional Screening Levels for cancer risk (EPA 2010), and/or the ATSDR EMEG for chronic non-cancer exposure duration greater than 365 days (ATSDR 2010).

Chemical / Sampling Data and Location	Acronym	Reporting Limit	11/3/09 - 11/4/09		3/22/10		ATSDR CREG (10^{-6} excess cancer risk)	EPA RSL (10^{-6} excess cancer risk)	ATSDR EMEG (HI=1 non-cancer hazard)
			Tiger Cleaners	Restaurant	Restaurant	Fastener Distributor			
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
tetrachloroethylene	PCE	*0.74*	**20.64**	**11.79**	**3.98**	ND	ngv	0.06	40
trichloroethylene	TCE	*0.93*	**1.86**	**1.43**	ND	ND	ngv	0.22	7.4[EPA]
1,1-dichloroethylene	1,1-DCE	1.26	ND	ND	ND	ND	nc	nc	20i
cis-1,2-dichloroethylene	cis-1,2-DCE	1.26	4.04	2.77	ND	ND	nc	nc	ngv
trans-1,2-dichloroethylene	trans-1,2-DCE	1.26	ND	ND	ND	ND	nc	nc	200i
1,1-dichloroethane	1,1-DCA	*1.24*	ND	ND	ND	ND	ngv	0.38	ngv
1,2-dichloroethane	1,2-DCA	*1.24*	ND	ND	ND	ND	0.01	0.02	600
vinyl chloride	VC	*1.96*	ND	ND	ND	ND	0.04	0.06	30i

Notes:

Reporting Limit = Limits that can be greater than or equal to the method detection limit for the laboratory analysis.

ND = Not detected in the air sample above the analytical reporting limit

ATSDR EMEG = Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide (ATSDR 2010). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide (ATSDR 2010). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people used to determine if chemical concentrations warrant further health-based screening.

EPA RSL = Environmental Protection Agency's Regional Screening Level (EPA 2010). The screening levels were developed using risk assessment guidance from the EPA Superfund Program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. RSLs are considered by EPA to be protective for humans (including sensitive groups) over a lifetime.

bold text = Indoor air concentration exceeded 1 in 1,000,000 excess cancer health comparison value but not the non-cancer health comparison value

Italicized text = Reporting limit was greater than one or more screening values.

EPA = There is not a published EMEG for TCE. The results were compared to the EPA's most current evaluation of the potential health risks from exposure to TCE at 7.4 ppb (EPA 2008).

i = ATSDR comparison value for intermediate exposures (15-365 days); typically higher than a chronic value

nc = Not classified as a carcinogen

ngv = No guidance value available

Indoor air results were evaluated in relation to comparison values published by the ATSDR (ATSDR 2010). For chemicals for which ATSDR did not have comparison values, results were compared to EPA Regional Screening Levels (RSLs) for residential indoor air (EPA 2010). Residential values were used because of the involuntary exposure that would be experienced by people working in or visiting the leased space of the former cleaner and other leased spaces in the shopping center. People working in or visiting the leased space of the former cleaner and other leased spaces in the shopping center make up a potentially exposed population at this site. The individuals are not like workers who work in an environment with chemicals and are told about the hazards of them (OSHA Right-To-Know laws). Workers that work with or in areas near chemicals willingly accept the risks by continuing to work with them or be in the same area as the chemicals. Workers who work in an environment with chemicals and are told about the hazards of them have access to, and training on, the use of personal protective equipment (PPE).

To evaluate if there could be non-cancer health effects from breathing indoor air in any of the strip mall spaces tested, indoor air results were compared to the PCE EMEG of 40 ppb. This chronic EMEG value represents an exposure over a long period of time. In the case of trichloroethene (TCE), there is not a published EMEG. Therefore, the results were compared to the EPA RSL for TCE of 7.4 ppb.

PCE is classified as reasonably anticipated to be a carcinogen. The cancer risk posed by PCE has been under evaluation for some time within EPA and the health community. Because of this lack of agreement, ATSDR does not have a published CREG for PCE. However, EPA has a residential PCE inhalation RSL for one excess cancer in 1,000,000 people of 0.06 ppb. For EPA's policy of considering 10^{-6} to 10^{-4} range of risk acceptable (EPA 1991), the range is 0.06 to 6 ppb PCE. EPA considers a theoretical risk of excess concentration in a million (1x10-6) to 1 in 10,000 (1x10-4) acceptable.

The PCE breakdown product TCE is also classified as reasonably anticipated to be a carcinogen. Similar to PCE, the cancer risk posed by TCE has also been under evaluation and ATSDR does not have a published CREG for TCE. For EPA's policy of considering 10^{-6} to 10^{-4} range of risk acceptable (EPA 1991), the range is 0.22 to 22 ppb TCE.

Indoor Air Evaluation –Tiger Cleaners Space

Cancer Evaluation

The indoor air sample collected at Tiger Cleaners space in November 2009 had a concentration of 20.64 ppb (140 µg/m^3) PCE. When compared to the PCE RSL for residential indoor air of 0.06 to 6 ppb, the cancer risk for this concentration exceeded the acceptable limit of 1 excess cancer in 10,000 people.

RSLs were developed for a chronic, 24 hours per day, 7 days a week, 365 days per year, 70-year lifetime exposure. A theoretical risk for this chronic exposure scenario that workers would be subjected to can be calculated using the concentration of PCE in the former cleaner space multiplied by the inhalation unit risk (IUR) derived for PCE.

The theoretical risk for a chronic exposure scenario was calculated as follows:

$$140\ \mu g/m^3 \times 5.9x10^{-6}\ (\mu g/m3)^{-1} = 8.26x10^{-4}$$

The concentration in the cleaner was 20.64 ppb (140 $\mu g/m^3$) multiplied by the PCE inhalation unit risk of $5.9x10^{-6}$ $(\mu g/m^3)^{-1}$. The theoretical risk would $8.26x10^{-4}$ or about 8 extra cancers in 10,000 people. This risk exceeded the acceptable limit of 1 excess cancer in 10,000 people.

The inhalation unit risk factor was based on assumptions that exposure would be continuous and extend over a lifetime (EPA 2010b). These exposure assumptions are greater than the actual exposure that is expected at Tiger Cleaners. Therefore, the actual cancer risk from breathing the indoor air would be much less than the theoretical risk. The actual risk would be in EPA's acceptable range (EPA 1991).

In an attempt to calculate a site-specific risk, the risk was modified for a worker working 8-hours per day, 6 days per week, 50 weeks per year, for 10 years. The calculated exposure risk of $8.26x10^{-4}$ was multiplied by an exposure duration modifier of 0.039 to adjust the exposure duration. Therefore, the adjusted calculated exposure risk was $3.2x10^{-5}$ or approximately 3 excess cancers in 100,000 people. EEP believes this site-specific calculated cancer risk is closer to the actual risk, and it is within the 10^{-6} to 10^{-4} excess cancer risk considered acceptable by EPA.

The exposure duration modifier was calculated as follows:

$$\frac{8\ hours\ per\ day}{24\ hours\ per\ day}\ x\ \frac{6\ days\ per\ week}{7\ days\ per\ week}\ x\ \frac{50\ weeks\ per\ year}{52\ weeks\ per\ year}\ x\ \frac{10\ years\ exposure}{70\ years\ exposure} = 0.039$$

The measured concentration of TCE was 1.86 ppb in the indoor air at Tiger Cleaners. This measurement was within the range of 2 to .2 ppb that corresponds to an acceptable range for cancer risk of 1 excess cancer in 10,000 people to 1 excess cancer in 100,000 people (EPA 1991).

1,1-DCE, trans-1,2-DCE, 1,1-DCA, 1,2-DCA and VC are drycleaner solvent breakdown products that were not detected in any samples at concentrations above their respective laboratory reporting limit. The concentrations for these chemicals were noted in Table 1 as "ND". 1,2-DCA and VC are two of the drycleaner solvent breakdown products and have very low comparison values. The reporting limit for VC at Tiger Cleaners was 1.96 ppb. The reporting limit for 1,2-DCA at Tiger Cleaners was 1.24 ppb. The representative health screening levels for cancer endpoints for these two chemicals were less than the reporting limit. Based on their toxicology and the analytical results, it is unlikely that there would be any long-term health concerns from breathing indoor air containing these two chemicals at their detection limit concentrations.

The CREGs listed in Table 1 are for chronic, lifelong exposure. A worker or customer of this site would have a shorter exposure. Because VC and 1,2-DCA have CREG values, further evaluation of the potential exposure was considered. The toxicology of the carcinogen VC is well understood. EPA's adult inhalation unit risk for VC is $4.4x10^{-6}$ $(\mu g/m^3)^{-1}$ (ATSDR 2007).

For a conservative evaluation of the potential exposure using the reporting limit of 1.96 ppb for the chemical concentration, one would expect about 1 additional excess cancer in 100,000 people, or $2.2x10^{-5}$, which is a very low risk, from a lifetime exposure to vinyl chloride for Tiger Cleaners.

The toxicology of 1,2-DCA is less well understood (ATSDR 2001). It is anticipated to be a human carcinogen, but the data are less certain. The lifetime inhalation unit risk for 1,2-DCA is $2.6x10^{-5}$ $(\mu g/m^3)^{-1}$. For a conservative evaluation of the potential exposure suing the reporting limit of 1.24 ppb for the chemical concentration, one would expect slightly more than 1 additional excess cancer in 10,000 people, or $1.31x10^{-4}$ cancer risk for Tiger Cleaners due to the presence of 1,2-DCA. The inhalation unit risk factor was based on assumptions that exposure would be continuous and extend over a lifetime (EPA 2010b). These exposure assumptions are greater than the actual exposure that is expected at Tiger Cleaners. The risk would be less than the calculated theoretical risk using the IUR and the detection limit as a theoretical concentration. Therefore, the actual cancer risk from breathing the indoor air would be much less than the theoretical risk. The actual risk would be in EPA's acceptable range (EPA 1991).

Non-Cancer Evaluation

The PCE concentration at Tiger Cleaners in November 2009 of 20.64 ppb was below ATSDR's non-cancer effects EMEG comparison value of 40 ppb for chronic, greater than 365 days, exposure. The TCE concentration in November 2009 was below the EPA comparison value of 7.4 ppb for non-cancer health effects. Therefore, there should not be any non-cancer health effects related to breathing indoor air containing this level of PCE.

Cis-1,2-DCE was detected at Tiger Cleaners space in November 2009 at a concentration of 4.04 ppb. No ATSDR or EPA comparison values are available for cis-1,2-DCE; therefore, the intermediate EMEG of 200 ppb for the isomer trans-1,2-DCE was used. The detected concentration was well below the intermediate EMEG. No non-cancer health effects would be expected from presence of cis-1,2-DCE.

No other PCE breakdown chemicals were detected in the indoor air at the restaurant above their respective reporting limit.

Indoor Air Evaluation – Restaurant

Cancer Evaluation

The restaurant adjoins Tiger Cleaners space in the strip mall. Indoor air samples were collected in November 2009 and March 2010. The average concentration of PCE in the two indoor air samples was 8 ppb. This was above EPA's comparison value of 6 ppb for cancer risk of 1 excess cancer in 10,000 people (EPA 1991). The indoor air sample collected at the restaurant in November 2009 contained the higher concentration of the two with a concentration of 11.79 ppb PCE compared to 3.98 ppb in the March 2010 sample. For a conservative evaluation of the cancer risk, the November 2009 concentration was used in calculations assuming that those exposed would be inhaling the PCE continuously over a lifetime (EPA 2010b). The calculated theoretical risk for indoor air PCE concentration based on this exposure duration, the measured concentration of 11.79 ppb, or 80.0 $\mu g/m^3$ and an inhalation unit risk of $5.9x10^{-6}$ $(\mu g/m^3)^{-1}$ would

be $4.7x10^{-4}$ or 4.7 excess cancers in 10,000 people. This risk exceeded the acceptable limit of 1 excess cancer in 10,000 people (EPA 1991). A worker or customer of the restaurant would not be breathe the indoor air of this lease space for that time interval.

The theoretical risk for a chronic exposure scenario was calculated as follows:

$$80\ \mu g/m^3 \times 5.9x10^{-6}\ (\mu g/m3)^{-1} = 5.9x10^{-6}$$

As with the risk calculated for the former Tiger Cleaner space, in an attempt to calculate a site-specific risk, the risk was modified for a worker working 8-hours per day, 6 days per week, 50 weeks per year, for 10 years. The calculated exposure risk of $8.26x10^{-4}$ was multiplied by an exposure duration modifier of 0.039 to adjust the exposure duration. Therefore, the adjusted calculated exposure risk was $1.8x10^{-5}$ or approximately 2 excess cancers in 100,000 people. EEP believes this site-specific calculated cancer risk is closer to the actual risk, and it is within the 10^{-6} to 10^{-4} excess cancer risk considered acceptable by EPA.

The exposure duration modifier was calculated as follows:

$$\frac{8\ hours\ per\ day}{24\ hours\ per\ day}\ x\ \frac{6\ days\ per\ week}{7\ days\ per\ week}\ x\ \frac{50\ weeks\ per\ year}{52\ weeks\ per\ year}\ x\ \frac{10\ years\ exposure}{70\ years\ exposure} = 0.039$$

The measured concentration of TCE in the indoor air at the restaurant in November 2009 was 1.43 ppb. TCE was not detected in the indoor air at the restaurant in March 2010. The November 2009 TCE measurement was within EPA's acceptable range for cancer risk of less than 1 excess cancer in 100,000 people (EPA 1991).

Vinyl Chloride and 1,2-DCA were not detected in the indoor air at the restaurant in November 2009 at concentrations above their respective laboratory reporting limit. 1,2-DCA and VC have very low comparison values that are below the laboratory reporting limit. Using the reporting limit for the chemical concentration, one would expect about 1 additional excess cancer in 100,000 people, or $2.2x10^{-5}$, from a lifetime exposure to vinyl chloride for the restaurant. Likewise, the lifetime inhalation unit risk for 1,2-DCA is $2.6x10^{-5}$ $(\mu g/m^3)^{-1}$ which yields a slightly more than 1 additional excess cancer in 10,000 people, or $1.31x10^{-4}$ cancer risk for the former restaurant when using the laboratory reporting limit as the reference concentration. Again, it is unlikely that there would be any long-term health concerns for workers or customers of the restaurant because the inhalation unit risk factor was based on assumptions that exposure would be continuous and extend over a lifetime (EPA 2010).

Non-Cancer Evaluation

Indoor air samples were collected in November 2009 and March 2010 from the restaurant in the leased space next to the cleaner. The averaged results of these concentrations for PCE and TCE were evaluated for non-cancer outcome concerns.

The average PCE concentration of 7.9 ppb was below ATSDR's non-cancer effects EMEG comparison value of 40 ppb for chronic (greater than 365 days) exposure. Likewise, the average

TCE concentration (1.2 ppb) using the measured concentration of 1.43 ppb and the reporting limit of 0.93 ppb was below the comparison value of 7.4 ppb.

Cis-1,2-DCE was detected at the restaurant in November 2009 at a concentration of 2.77 ppb. No ATSDR or EPA comparison values are available for cis-1,2-DCE. No other PCE breakdown chemicals were detected in the indoor air at the restaurant above their respective reporting limit.

Based on the non-cancer evaluation of chemicals present in the indoor air of the restaurant, there should not be any non-cancer health effects related to breathing indoor air at the restaurant.

Indoor Air Evaluation – Fastener Distribution Business

The fastener distributor was located in the strip mall next to the restaurant to the east. No drycleaner-related constituents were detected above reporting limits in the indoor air sample collected at the fastener distributor in March 2010. Based on the data presented by Moring's *Indoor Air Sampling Report* dated April 12, 2010, and the evaluations outlined above, there is no concern to workers or customers of the fastener distributor from the drycleaner chemical PCE or its breakdown chemicals.

As no chemicals related to the drycleaner were detected in the fastener distributor, there is not a completed exposure pathway.

PCE and TCE Mixture

PCE and TCE were both present in Tiger Cleaners space and the restaurant during the November 2009 sampling. There are possible additive health effects from these chemicals to an exposed population (ATSDR 2004). There is no evidence to indicate that greater-than-additive interactions among TCE or PCE health effects might occur. This includes interactions for the most common liver and kidney or nervous system effects observed from PCE or TCE exposure.

Adding together the risks of PCE and TCE, the total excess cancer risk was still about one in 100,000. It is unlikely that the presence of both PCE and TCE in indoor air would create any appreciable increased health effects to those visiting or working in Tiger Cleaners space or the restaurant.

Concentration(s) of Other Compounds in Site Indoor Air

The indoor air samples collected in Tiger Cleaners leased space and other leased spaces in the strip mall contained other compounds not related to drycleaning, including acetone, benzene, 2-butanone, n-hexane, chloroform, n-heptane, toluene, ethylbenzene, m,p-xylene, o-xylene, and 1,2,4-trimethylbenzene. Many of these compounds are associated with petroleum products, paint, or alcohols. The source(s) of these chemicals were not identified. Many of the compounds could be related to previous activities in the leased spaces or building. The source of the benzene is unknown. It was not a chemical used in the type of drycleaning process operated at Tiger Cleaners. Benzene is found in urban and suburban areas as a component of indoor air and can be present due to automobile or truck emissions. Concentrations of all of the compounds, except benzene, were either below their respective screening values or within EPA's

acceptable range for cancer risk or less than 1 excess cancer in 1 million people to 1 excess cancer in 10,000 people (EPA 1991).

Other Considerations

A second strip mall building of similar construction is located west of Tiger Cleaners (Figure 4). No information was provided concerning occupancy of the second building. A groundwater monitoring report dated December 13, 2008, stated that the groundwater flow was to the northwest. The underground chemical plume also migrates along the groundwater flow path to the northwest. Due to the proximity to the source of contamination and the direction of groundwater flow, testing of indoor air in the leased space should be considered if currently or potentially occupied.

Future Considerations

Because of concentration of PCE detected in the indoor air and the estimated concentration of 1,2-DCA at Tiger Cleaners, DCERP should consider additional sampling of the indoor air of the former cleaner space to determine potential exposure based on space usage should the space become reoccupied.

Child Health Considerations

The many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances (ATSDR 1997, 1998). Children have lower body weights than adults. Although children's lungs are usually smaller than adults, children breathe a greater relative volume of air compared to adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage.

In preparation of this health document, the health of children was thoughtfully considered. The workers and visitors to the spaces in the strip mall are primarily adults. Children are unlikely to spend more than a very limited time in these spaces now and in the future. Spending a short time in these leased spaces would not lead to any appreciable exposure to the drycleaner chemical PCE or its breakdown chemicals.

Conclusions

EEP reached three conclusions in this health consultation:

EEP concludes that based on the data presented by the Indoor Air Sampling Reports dated November 23, 2009 and April 12, 2010, the concentrations of the drycleaner solvent tetrachloroethylene (PCE) and its breakdown products trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis- 1,2-DCE) in the indoor air of the former cleaner is not expected to harm the health of workers or customers. Indoor air in the former cleaner space contained minor measured amounts of PCE, TCE, 1-2, cis-dichloroethylene. Drycleaning is no longer being done in the space. Workers and members of the general public who are customers of a business in the

former cleaner space would have a limited exposure because they would spend only a short amount of time in the space.

EEP concludes that based on the data presented by the Indoor Air Sampling Reports dated November 23, 2009 and April 12, 2010, the concentrations of the drycleaner solvent tetrachloroethylene (PCE) and its breakdown products trichloroethylene (TCE) and cis-1,2-dichloroethylene (cis- 1,2-DCE) in the indoor air of the restaurant is not expected to harm the health of workers or customers. The average concentration of PCE in the indoor air samples collected in the restaurant was above the health guidance value for cancer effects assuming that those exposed would be inhaling the PCE continuously over a lifetime. However, the actual cancer risk from breathing the indoor air at the restaurant is expected to be much less because the exposure for a worker or customer of the restaurant would be much less than the cautious 24 hours per day, 7 day per week, lifetime exposure on which the acceptable risk values are based. In addition, PCE is no longer used or stored the site. The TCE concentration was within EPA's acceptable range for cancer risk of less than 1 excess cancer in 100,000 people.

EEP concludes that based on the data presented by the Indoor Air Sampling Reports dated November 23, 2009, it is not likely that breathing the indoor air of the fastener business would harm people's health. No concentrations of the drycleaner chemical PCE or its breakdown chemicals were identified above test detection limits. No exposure to these chemicals would occur and therefore workers or customers of the fastener business should not be harmed from breathing the indoor air.

Recommendations

This health consultation was prepared to evaluate the results of indoor air sampling completed inside a former drycleaner space and other businesses in a strip mall. With that in mind and based on EEP's review of the sampling data, EEP has no recommendations at this time.

Public Health Action Plan

1. This report and any needed explanation will be provided to the TDEC DCERP. This report will also be provided to the property owner, or a future lessee should the former cleaner space be redeveloped.

2. TDH EEP will continue to work with TDEC DCERP as the site continues through the DCERP regulatory process.

3. TDH EEP will be available to review additional data should the need arise.

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[TDEC] Personal communication with Alison Buford, Environmental Specialist, Tennessee Department of Environment and Conservation, Drycleaner Environmental Response Program, July 28, 2010.

FIGURE 1 - Photo of the strip mall housing Tiger Cleaners leased space, a restaurant and a fastener distribution business.

Memphis, Shelby County, TN
Photo credit: Google Maps, May 18, 2010

FIGURE 2 - Site map of the strip mall showing two November 2009 indoor air sample locations in Tiger Cleaners and the restaurant.

Drawing Credit: Moring Environmental Service, LLC.

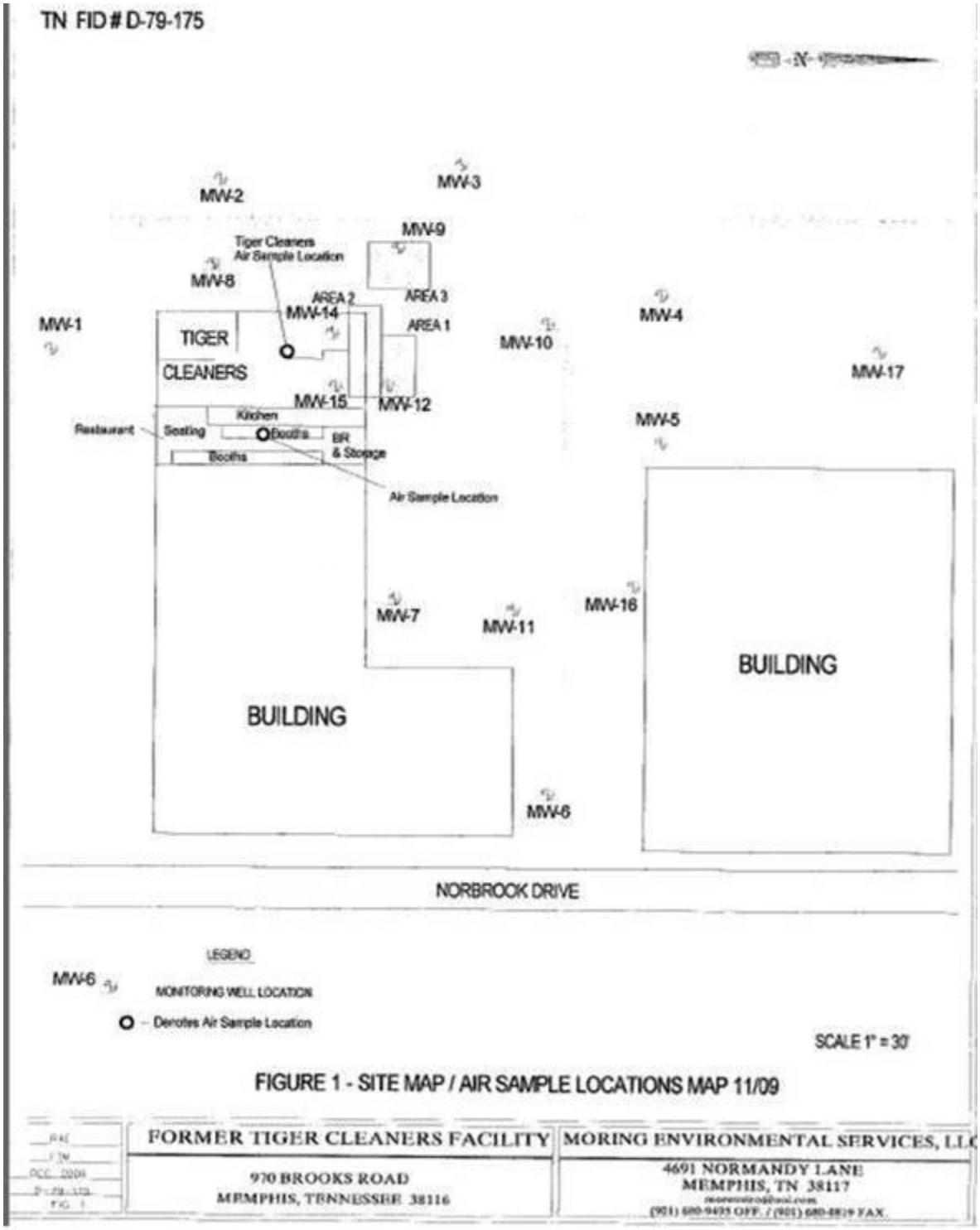

FIGURE 3 - Site map of the strip mall showing two March 2010 indoor air sample locations in the restaurant and the fastener distributor.

Drawing Credit: Moring Environmental Service, LLC

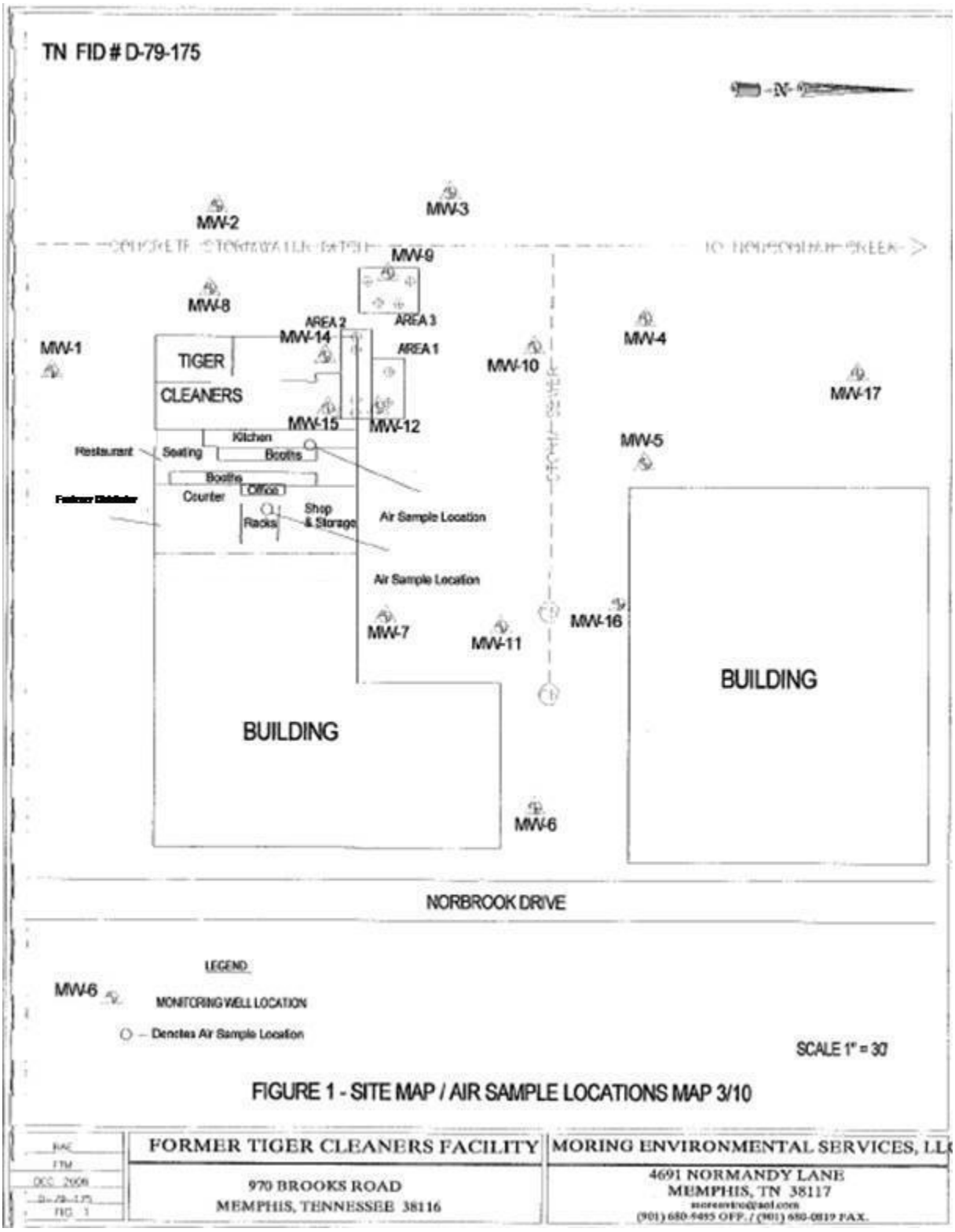

FIGURE 4 - Overhead view of Tiger Cleaners Leased Space.

Photo credit: Google Earth, May 26, 2010.

Certification

This Public Health Consultation: *Tiger Cleaners, 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 begun.

Director of EEP, CEDS, TDH