Health Consultation

UPDATED EVALUATION OF AIR SAMPLING RESULTS FOR THE

TOKHEIM SITE

JASPER, MARION COUNTY, TENNESSEE

JUNE 6, 2012

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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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Glossary of Terms and Acronyms

additive effect: A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together.

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 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 70 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.

Cancer Risk Evaluation Guide (CREG): CREGs are environmental media (water, soil, air) specific comparison values that are used to identify amounts of cancer-causing substances that are unlikely to result in an increase of cancer rates in people that have been exposed to the media.

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: Calculated concentration of a substance in air, water, food, or soil that is 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.

contaminant: A substance that is either 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.

Environmental Media Evaluation Guide (EMEG): EMEGs represent levels of substances in water, soil, and air, to which humans may be exposed during a specified amount of time (acute, intermediate, or chronic) without experiencing adverse 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.

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

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), noncancerous 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.

plume: A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction

they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

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. Environmental Protection Agency that are chemical-specific concentrations for individual contaminants in air, drinking water, and soil that may warrant further investigation or site cleanup.

remediation: 1. Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site; 2. for the Asbestos Hazard Emergency Response program, abatement methods including evaluation, repair, enclosure, encapsulation, or removal of greater than 3 linear feet or square feet of asbestos-containing materials from a building.

Remedial Investigation (RI): The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process of determining the type and extent of hazardous material contamination at a site.

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 (70 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).

source area: The location of or the zone of highest soil or groundwater concentrations, or both, of the chemical of concern. The source of contamination is the first part of an exposure pathway.

tetrachloroethylene: A chemical that is a nonflammable liquid at room temperature. It is also called perchloroethylene, Perc, or PCE. It is a manufactured chemical that is widely used for dry

cleaning of fabrics and for metal-degreasing. Tetrachloroethylene is also used to make other chemicals or is used in some consumer products. It evaporates easily into the air and has a sharp, sweet odor.

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.

vapor intrusion: 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, tetrachloroethylene, trichloroethylene, methylene chloride, methyl chloroform, and vinyl chloride.

Introduction

The Tennessee Department of Environment and Conservation's (TDEC), Division of Remediation's (DoR), State Remediation Program (SRP), requested that the Tennessee Department of Health's (TDH), Environmental Epidemiology Program (EEP), review the results of air samples collected at the former Tokheim Site. This review is based on samples collected and is not intended to be an in-depth comprehensive evaluation of the site. Data evaluated for this Health Consultation were collected as part of an updated indoor and outdoor investigation conducted in February 2012. The previous air testing was completed in October 2010.

Through previous environmental investigations, soil and groundwater beneath the former Tokheim Site were found to be contaminated by various chemicals. Many of the chemicals were volatile organic compounds (VOCs). Historical groundwater sampling north and northeast of the site found chlorinated solvents and other volatile organic compounds (VOCs). Chemicals found included: 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dichloroethylene (trans-1,2-DCE), tetrachloroethylene (PCE), trichloroethylene (TCE), vinyl chloride (VC), benzene, tert-butylbenzene, ethylbenzene, isopropylbenzene, n-propylbenzene, and xylenes (SM&A 2010a). Based on groundwater sampling and testing, the VOC groundwater plume was found to have migrated east and northeast from the former Tokheim property.

PCE has been the dominant site-related chemical found in groundwater both on-site and off-site. TDEC SRP was concerned about intrusion of vapors of PCE and its breakdown chemicals into the indoor air of homes near the site. TDEC SRP was also concerned about these vapors water migrating into the indoor air of the main site building.

TDH EEP published the Health Consultation: *Evaluation of the Vapor Intrusion Investigation for the Tokheim Site, Jasper, Marion County, Tennessee*, on May 27, 2011. The Health Consultation evaluated the potential for chemicals, in the groundwater plume migrating away from the former Tokheim Site, to affect the health of residents along Industrial Boulevard. The Health Consultation also evaluated the potential for chemicals in indoor air to affect the workers in the former Tokheim building. Low levels of PCE, TCE, and cis-1,2-DCE were previously reported in the indoor air of some homes east and northeast of the former Tokheim Site.

The initial Health Consultation concluded that based on the sampling results, the calculated theoretical excess cancer risk was in the range considered acceptable by EPA (1991) and would not likely create unhealthy indoor air. Another conclusion was that the minor amounts of PCE or PCE breakdown chemicals found in 3 homes tested would not harm the health of residents of those homes. Also, chemicals detected in the indoor air of the former Tokheim Site building were not expected to harm the health of the workers inside. Although no hazards were identified, recommendations were made.

Recommendations of the initial health consultation included advising TDEC to have the responsible party collect additional indoor air data in the 6 homes nearest to the Tokheim Site and to collect additional indoor air data from the Tokheim building. The additional sampling would provide more site-specific data and establish a trend over time. TDEC accepted EEP's recommendations and directed the responsible party to perform the recommended additional

indoor air testing. The responsible party's environmental consultant, St. John – Mittelhauser & Associates (SM&A), collected the additional indoor air samples in February 2012.

The homes located along and across Industrial Blvd. from the site and over the groundwater contamination were single family homes. Home construction varied; most were wood framed homes sided with aluminum, vinyl, or brick. Lot sizes also varied. Most lots appeared to be less than an acre; others appeared to be more (Google Earth 2012). None of the homes had basements or other subgrade living areas. All homes were typical of a rural residential setting.

Background

Background information for the former Tokheim Site can be found in the initial Health Consultation document: *Evaluation of the Vapor Intrusion Investigation for the Tokheim Site, Jasper, Marion County, Tennessee.* This report was published on May 27, 2011. The background discussion provides the location of the former Tokheim Site, the operational history of the site, the historic solvent use at the site, and details about area surrounding the site.

Figure 1 shows the location of the former Tokheim Site in Jasper, Tennessee. Figure 2 shows the details of the former Tokheim building. The site is now being used by Jasper Materials, Inc., but for the purpose of this Health Consultation, it will be referred to as the Tokheim Site.

Findings of Previous Investigations

TDEC SRP is managing the site and has designated it State Remediation Program Site SRS-0472. Many previous environmental investigations have been conducted at the site. Soil and groundwater investigations have been carried out on the site property and downgradient (mainly east and northeast) from the site. A summary of previous investigations carried out at the site can be found in the May 27, 2011, Health Consultation.

Additionally, interim remedial actions have been done at the site. Emulsified edible oil was injected into the groundwater beneath the site to increase the amount of degradation of PCE and its breakdown products. These injections were done shortly after the October 2010 indoor air sampling. These groundwater injections reportedly have played a part in an overall decrease in the amount of site-related VOCs in groundwater (SM&A 2012).

Introduction to Vapor Intrusion

Volatile and semi-volatile chemicals can evaporate from impacted subsurface soil and/or groundwater beneath a building and move toward areas of lower chemical levels such as the atmosphere, utility conduits, or basements. Subsurface vapors can enter a building due to two main factors: environmental effects and building effects. Some examples of these factors 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 amount of 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 factors. The rate 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.

Commonly found concentrations of chemicals in indoor and outdoor air are referred to as "background levels." These background levels are generally determined from the results of samples collected in homes, offices, and outdoor areas not thought to be affected by “outside” sources of volatile chemicals. For example, a home not known to be near a chemical spill, a hazardous waste site, a drycleaner, or a factory would still likely have background levels of some chemicals in the indoor air. Background levels of volatile chemicals are considered when conducting an investigation of the vapor intrusion pathway (NYSDOH 2006, EPA 2011b).

Indoor Air Investigation Work Plan

SM&A designed the February 2012 indoor air testing similar to that of the original testing performed in October 2010. The original work plan (SM&A 2010b) was very complete. For this investigation, samples of indoor air were collected at two locations inside the former Tokheim building and inside 6 homes above the ground-water contamination. Also, samples of outside air were collected near the site.

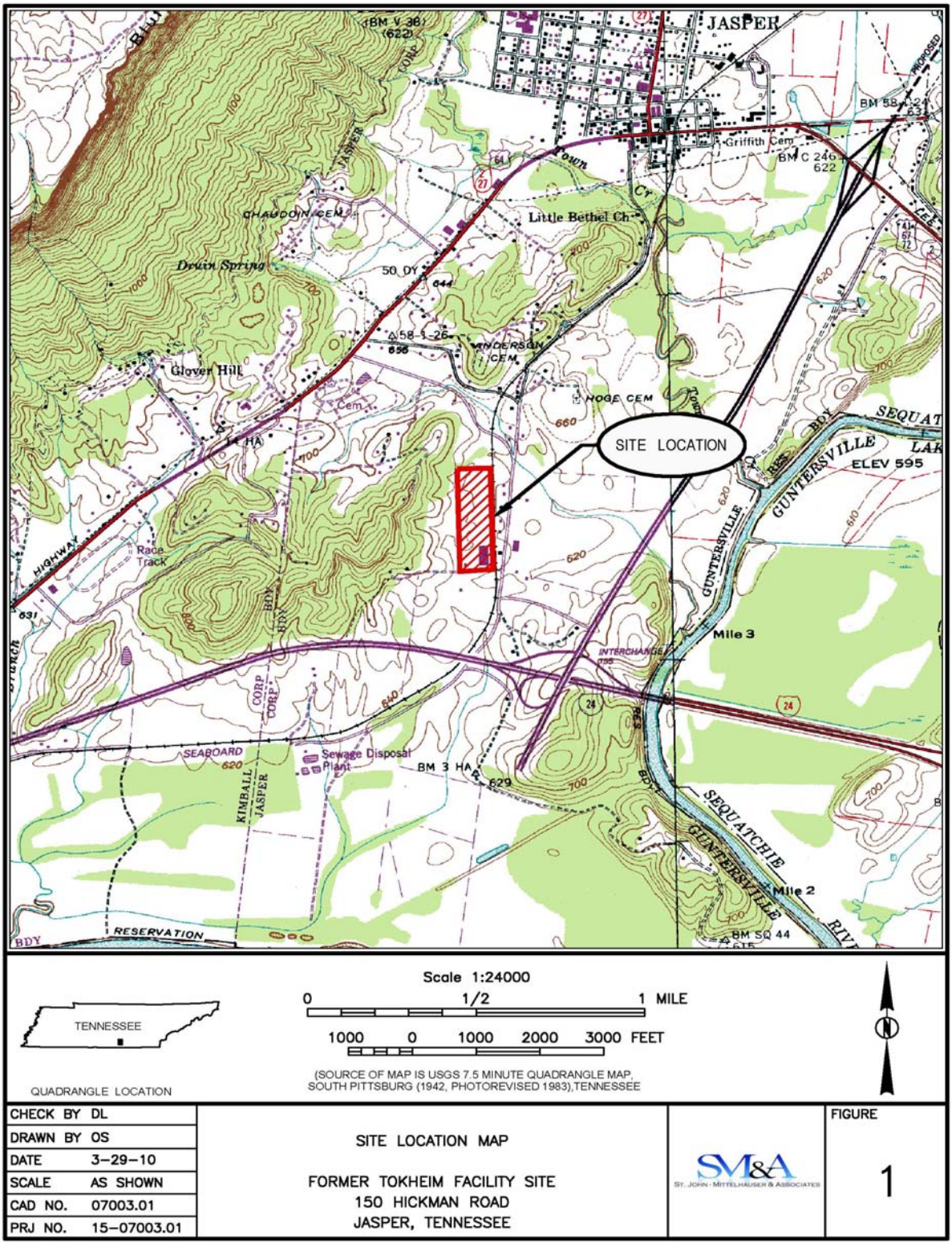


Figure 1. Tokheim Site location in Jasper, Marion County, Tennessee. There are homes east and northeast of the site. The site and homes are near Interstate 24. There is a small drainage east of the site that flows into the Sequatchie River (SM&A 2011a).

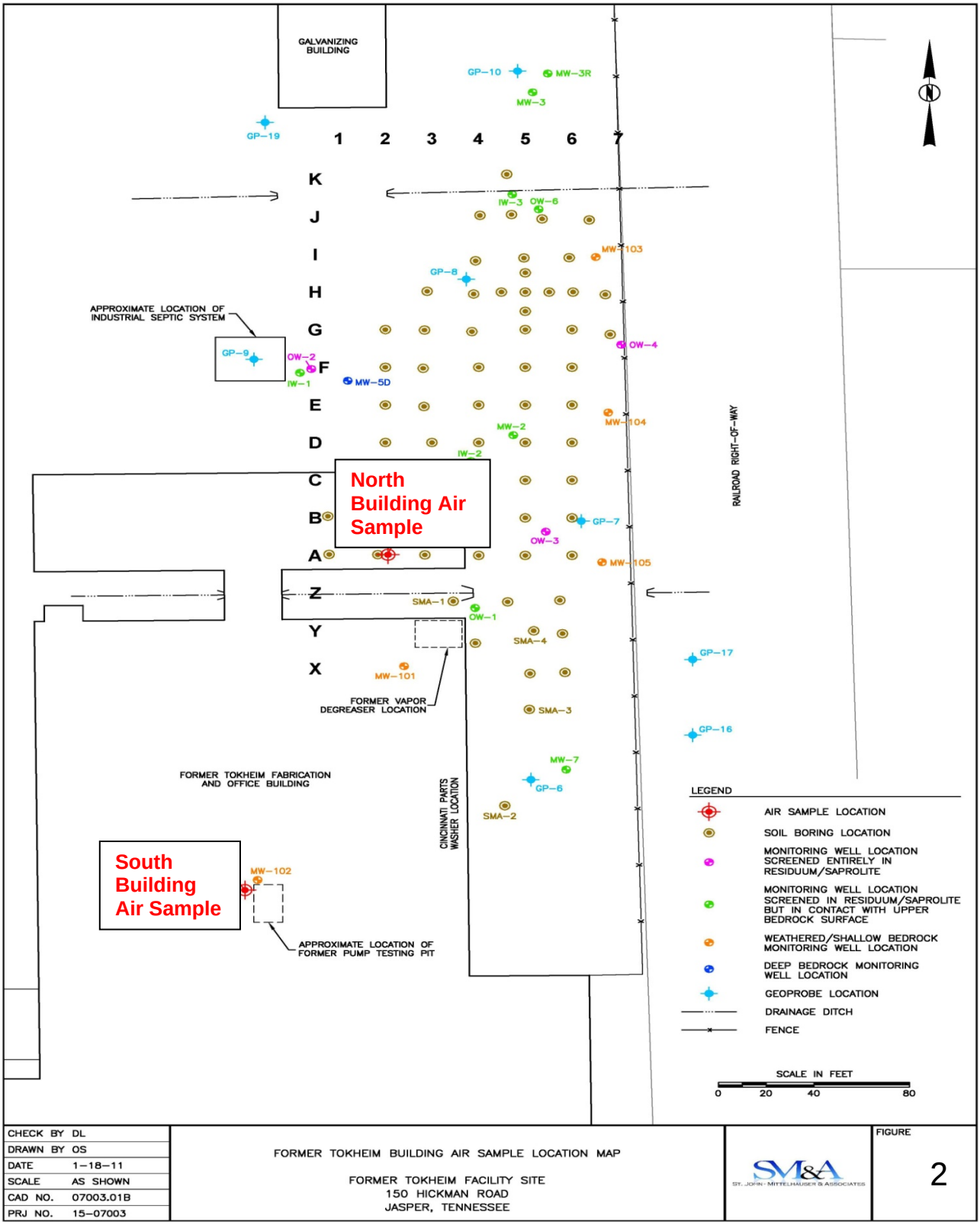


Figure 2. Location of the 2 air sampling locations inside the former Tokheim building. Colored dots show the many soil boring, groundwater monitoring well, and air sampling locations (SM&A 2011).

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 no one comes into contact with a contaminant, then no exposure occurs, and thus, no health effects could occur. An exposure pathway contains five parts:

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

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

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

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 health is controlled by a number of other factors, including:

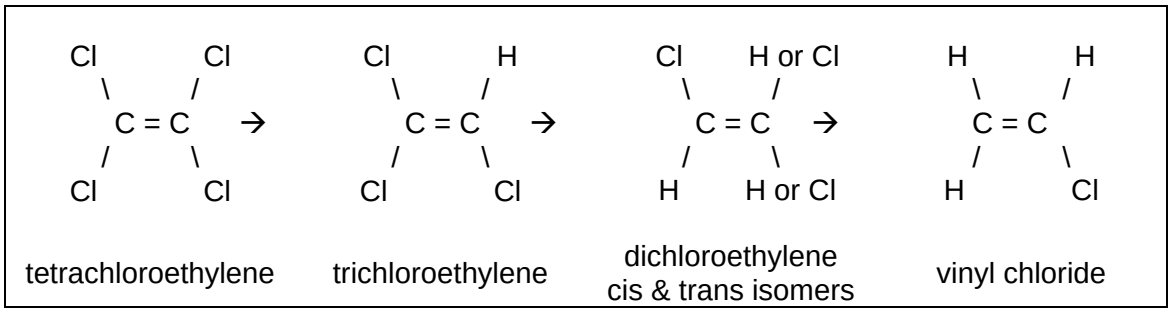
- the amount of the chemical that a person is exposed to (dose),
- the length of time that a person is exposed to the chemical (duration),
- the number of times a person is exposed to the chemical (frequency),
- the person's age and health status, and
- the person's diet and nutritional habits.

For this project, there are two potentially exposed receptor populations. People who live in homes nearby and above the groundwater plume are one receptor population. Workers in the former Tokheim Site building are a second receptor population.

Solvent Explanation

Past activities included the use of PCE for degreasing in the Tokheim building. PCE was used as the main solvent to remove grease and other contaminants from the metal parts manufactured at the site. This evaluation will focus on PCE and its chemical breakdown products.

PCE is a volatile organic compound. It can quickly evaporate into a gas at room temperature. As its name implies, tetrachloroethylene (PCE) has four chlorine anions on a two-carbon molecule. PCE can breakdown into other chlorinated volatile organics, especially in environmental conditions that lack oxygen, or anaerobic conditions. 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 this example, PCE can break down to TCE, and then to DCE, and then to VC. The only way to truly know the ratio of these breakdown chemicals is to collect environmental samples. The degradation products cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC have been noted in groundwater samples collected at the site, showing that there are anaerobic conditions in the soils and groundwater beneath the site. PCE appears to be the dominant chemical present in the groundwater. Though all chemicals, PCE, TCE, cis-1,2-DCE, and VC, were carefully considered in developing this report.

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 2012) for a particular chemical, then further evaluation is needed.

The Agency for Toxic Substances and Disease Registry's (ATSDR) develops Minimal Risk Levels (MRLs) using conservative assumptions. ATSDR uses the term 'conservative' to refer to values that are protective of public health in essentially all situations. Environmental Media Evaluation Guidelines (EMEGs) are calculated by ATSDR from their MRLs. EMEGs consider non-cancer adverse health effects. Exposure durations are defined as acute (14 days or less), intermediate (15–365 days), and chronic (365 days or more) exposures. ATSDR does not use serious health effects, such as irreparable damage to the liver or kidneys, or birth defects, as a basis for establishing EMEGs. Chronic EMEGs assume exposure for 24 hours per day, 7 days per week, 52 weeks, 365 days per year, over a 70-year lifetime exposure. Exposure to a level

above the EMEG does not necessarily mean that adverse health effects will occur (ATSDR 2007).

To understand if concentrations of the solvents PCE, or PCE's breakdown chemicals TCE, cis-1,2-DCE, or VC could lead to excess cancers, measured concentrations of these chemicals were also compared to ATSDR cancer risk evaluation guides (CREGs). Thus, environmental media concentrations are compared to CREGs to understand the potential cancer health effects of exposure to the chemical. Lifetime exposure to a chemical at a concentration equal to its CREG comparison value could theoretically result in a one in a million risk of developing cancer in addition to the background risk of developing cancer. The background cancer risk is the risk that all people have of developing cancer which is currently 1 in 2 for men and 1 in 3 for women. Both ATSDR and EPA prefer to have residential risk values less than 1 excess cancer in 1 million people; another way to write that is less than a $1x10^{-6}$ risk. An excess cancer risk between 1 in 10,000 and 1 in a million is considered acceptable (EPA 1991).

EPA's Regional Screening Levels (RSLs) for residential air inhalation were also used in evaluating the results of the indoor air testing. Exposure to workers and residents would be involuntary. Since Tokheim no longer occupies the site and it is being reused, current site workers may not know that there are potential exposure issues in the site building. Solvents are no longer used to clean manufactured parts at the site. Federal Occupational Safety and Health Administration (OSHA) work place standards were not used. This is because employees of Jasper Materials Inc., which is using the former Tokheim Site building, no longer use PCE and are not covered under a workplace safety plan outlining the hazards associated with the chemical. Industrial health comparison values were not used for comparison of the indoor air values measured in the Tokheim building because of the involuntary exposure that would be experienced by those workers.

Residential comparison values were used for evaluation of exposure for those living in homes above the groundwater contamination that has migrated downgradient from the site. The specific comparison values used were ATSDR's EMEGs and CREGs and EPA's residential indoor air RSLs. For further evaluation of TCE levels found, EPA's inhalation unit risk (IUR) values were used to calculate a theoretical potential cancer risk for TCE.

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 2001) and because they were identified in the initial indoor air sampling. PCE is readily absorbed following inhalation and oral exposure as well as from direct exposure to the skin. For this site, we are concerned with the inhalation of PCE and TCE from vapor intrusion into indoor air. Compared to pulmonary and ingestion exposure, uptake of either PCE or TCE vapors by the skin is minimal (ATSDR 1997a, 1997b).

ATSDR has generated CREGs for both PCE and TCE (ATSDR 2012). The PCE CREG is 0.57 parts per billion (ppb), while the TCE CREG is 0.045 ppb. EPA has residential setting PCE inhalation regional screening levels (RSL) of 0.6 ppb for one excess cancer in 1 million people (IRIS 2012). EPA also has a residential setting TCE inhalation RSL of 0.08 ppb for one excess cancer in 1 million people, respectively. The IUR for TCE is $4.1x10^{-6}$ $(\mu g/m^3)^{-1}$.

Cis-1,2-DCE is not classified regarding its carcinogenicity. VC has been determined to be a *"known human carcinogen"* (NTP 2005); ATSDR has a published CREG of 0.04 ppb. ATSDR does not have a chronic EMEG for VC, but has an intermediate EMEG of 30 ppb. EPA has both a non-cancer and cancer RSL for VC. EPA's non-cancer RSL is 39 ppb. EPA's RSL for VC is 0.06 ppb for one excess cancer in 1 million people.

Environmental Sampling

For this second air testing investigation, 1 outdoor and 7 indoor air samples were collected by SM&A personnel on February 1-2, 2012. Indoor air samples were taken at two locations inside the former Tokheim Site building (Figure 2) similar to the October 2010 sampling. Indoor air was tested in 6 homes along and across Industrial Blvd. from the site (Figure 3). One Summa regulator malfunctioned inside one of the homes. SM&A returned to the site and sampled indoor air in the home on February 21-22, 2012 (SM&A 2012). Another outdoor air sample was collected over the same time period as the retest. Both outdoor ambient air samples were collected south of the main building in an upwind location.

The indoor air testing inside the Tokheim Site building was carried out over an 8-hour period during work hours (SM&A 2012). One sample location in the building was centered in the fabrication area. The second sample location was in the northern portion of the building.

The air samples collected from inside the homes and the outdoor ambient air sample were collected over a 24-hour period (SM&A 2012). All indoor air samples were collected from the first floor of homes along and across Industrial Blvd., above the groundwater plume migrating from the site (Figure 3).

All investigation samples were shipped in their appropriate containers under chain-of-custody procedures to Environmental Sciences Corporation in Mount Juliet, Tennessee (SM&A 2012). The samples collected were tested for the entire TO-15 list of chemicals using the selective ion mode (SIM) methodology. The SIM method allows lower detection levels to be met.

Results

The outdoor air testing results showed that PCE was measured in very low amounts. Neither TCE, cis-1,2-DCE, nor VC were found in the outdoor air sample. PCE and TCE were measured in low amounts in the indoor air samples from many of the homes tested. VC was not measured in indoor air of any of the homes. No other site-related chemicals were measured in the homes. Small amounts of PCE were measured inside the Tokheim Site building (SM&A 2012).

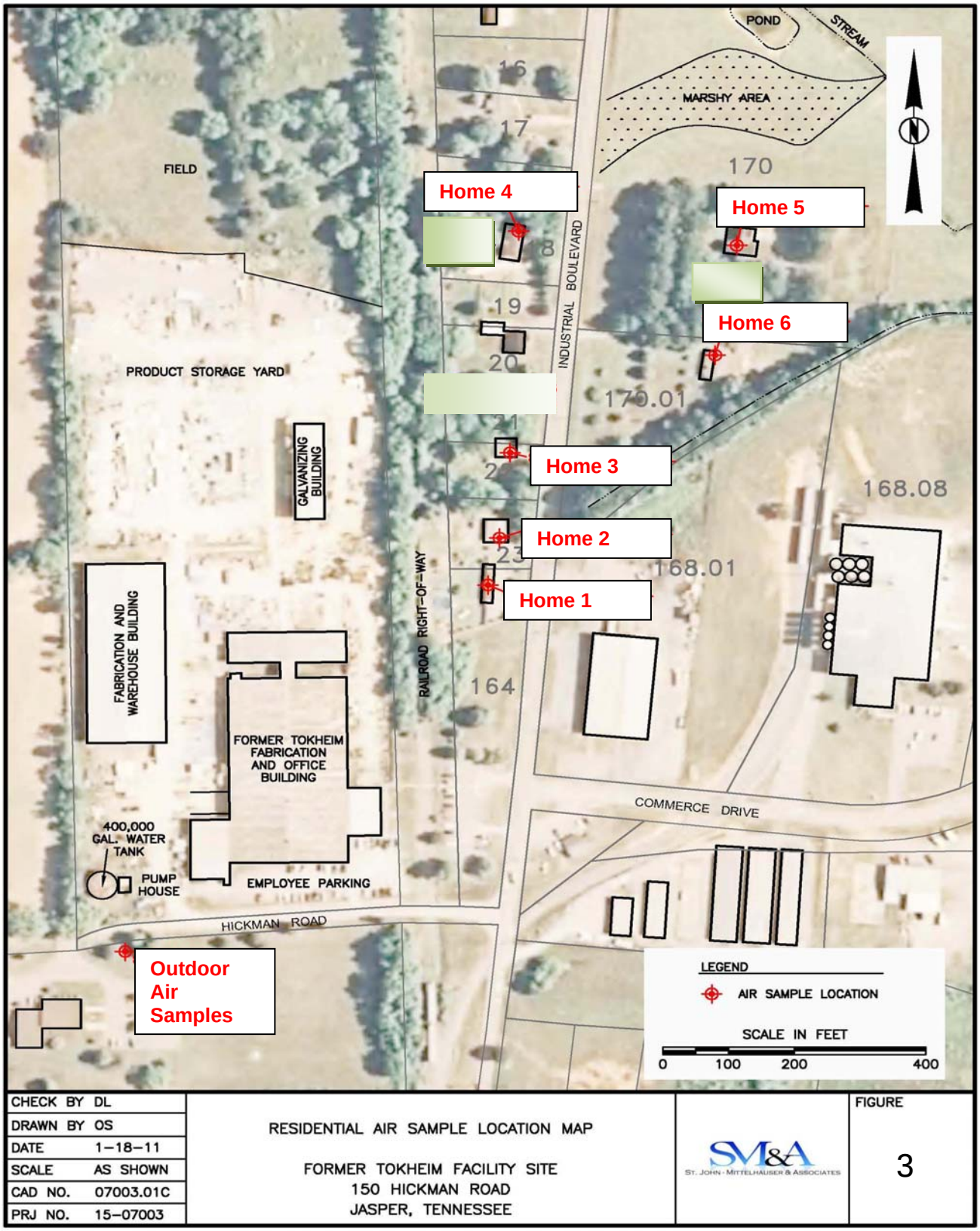


Figure 3. Locations of indoor air samples collected in homes and outdoor air samples collected on February 1-2, and 21-22, 2012 (SM&A 2011a)

Outdoor Air

See Table 1 below for results of the outdoor air sampling. Six VOCs were detected: benzene, carbon tetrachloride, chloroform, cis-1,2-dichloroethylene, ethylbenzene, and PCE. Three of these VOCs, carbon tetrachloride, chloroform, and ethylbenzene have not ever been found in the groundwater contamination coming from the site and thus not pertinent to this project. The results from the outdoor air samples were not compared to any regulatory concentrations or comparison values but were compared to measured background concentrations in the United States. They were used as reference information for ambient conditions and for comparison to indoor air results.

Not shown in Table 1, a small amount of benzene was measured at 0.26 ppb. This was below EPA Region 4's measured background benzene concentration for the southeast of 0.32 ppb (EPA 2008). The benzene found in the outdoor air at the site was likely a normal background amount.

TABLE 1. Outdoor air sampling results for the Tokheim Site, Jasper, Marion County, TN. Site-related chemicals are shown. Samples were collected on October 25, 2010, February 1-2, 2012, and February 21-22, 2012, over 24 hours with Summa canisters (SM&A 2011, 2012). Location of outdoor air samples are shown on Figure 3. All values are reported in parts per billion (ppb). All detections were below or approximately the same as their respective background levels.

Chemical / Sampling Data and Location Name	Acronym	October 25, 2010 Outdoor Air Measurements	February 1-2, 2012 Outdoor Air Measurements	February 21-22, 2012 Outdoor Air Measurements	Measured United States Background Levels
tetrachloroethylene	PCE	*0.024*	*0.029*	<0.02	0.12[1]
trichloroethylene	TCE	<0.02	<0.02	<0.02	0.15[2]
1,1-dichloroethylene	1,1-DCE	<0.02	<0.02	<0.02	4.6[3]
cis-1,2-dichloroethylene	cis-1,2-DCE	<0.02	*0.51*	<0.02	0.67[2]
trans-1,2-dichloroethylene	trans-1,2-DCE	<0.02	<0.02	<0.02	0.93[2]
vinyl chloride	VC	<0.02	<0.02	<0.02	<0.008[4]

Notes:

<0.02 = Not detected in the air sample. Concentration represents the analytical reporting limit.

0.024 = Detection of chemical in outdoor air.

[1] = EPA Region 9 ambient air background values, EPA 2004.

[2] = Some emission and exposure data for trichloroethylene and related chemicals, EPA National Center for Environmental Assessment, Office of Research and Development, Washington, D.C. March 2001.

[3] = Toxicological profile for 1,1-Dichloroethylene, ATSDR, Atlanta, GA, May 1994.

[4] = Background concentrations of 18 air toxics for North America, Journal of Air and Waste Mgmt. Assoc. 2006, 56: 3-11.

Tokheim Building Indoor Air

See Table 2 for results of the indoor air sampling in the Tokheim building. PCE was identified in the indoor air samples collected. One sample was collected from the south building and one from the north building. The 2 indoor air samples had measurements of PCE at 0.022 and 0.027

TABLE 2. Tokheim building, Jasper, Marion County, TN indoor air sampling results. Two samples were collected both on October 25, 2010, and on February 2, 2012, over 8 hours with Summa canisters (S&ME 2011a, 2012). Locations of samples are shown on Figure 3. Values reported in parts per billion (ppb). Where the chemical was not detected, the result is reported as being less than (<) the reporting limit. Health comparison values used are non-cancer chronic environmental media evaluation guides (ATSDR 2012), ATSDR cancer risk evaluation guides (ATSDR 2012), and EPA residential indoor air Regional Screening Levels (EPA 2012).

Chemical / Sampling Data and Location Name	Acronym	North Building 10/25/10	North Building 02/02/12	South Building 10/25/10	South Building 02/02/12	ATSDR EMEG (non-cancer) (ppb)	ATSDR CREG (10^{-6} excess cancer risk) (ppb)	EPA RSL	
								(10^{-6} excess cancer risk) (ppb)	(10^{-4} excess cancer risk) (ppb)
tetrachloroethylene	PCE	*0.27**	*0.022*	*0.22**	*0.027*	40	0.57	0.6*	60
trichloroethylene	TCE	<0.20	<0.02	<0.02	<0.02	0.37	0.045	0.08	8
1,1-dichloroethylene	1,1-DCE	<0.20	<0.02	<0.02	<0.02	20i	nc	ngv	ngv
cis-1,2-dichloroethylene	cis-1,2-DCE	<0.20	<0.02	*0.08*	<0.02	ngv	nc	nc	nc
trans-1,2-dichloroethylene	trans-1,2-DCE	<0.20	<0.02	<0.02	<0.02	200i	nc	nc	nc
vinyl chloride	VC	<0.20*	<0.02	<0.02	<0.02	30i	0.04	0.06	6

Notes:

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

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

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

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

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

Modifiers:

<0.20 = Not detected in the air sample. Numerical values represent the analytical reporting limit.

* = Reporting limit was greater than one or more comparison values.

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

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

nc = Not classified as to carcinogenicity and no guidance value is available.

ngv = No guidance value available. EPA has not found suggestive evidence of carcinogenic potential and has not developed a guidance value.

ppb. PCE is no longer used in the former Tokheim building and has not been used for some time. The levels of PCE found were approximately the background air PCE levels. TCE, cis-1,2-DCE, and VC were not detected in these two air samples. Five other VOCs were measured in the indoor air along with PCE. These 5 VOCs included benzene, carbon tetrachloride, chloroform, chloromethane, and ethylbenzene. Benzene, carbon tetrachloride, and chloromethane were measured in concentrations above the US background outdoor air sample concentrations listed in Table 1 and above their respective ATSDR or EPA health comparison values for indoor air concentrations. These chemicals are not considered related to the site groundwater contamination. They are discussed for the benefit of the current homeowners. The chemical's origin is unknown. These chemicals may be related to the nearby interstate or other nearby industries.

Home Indoor Air

See Table 3 for results of the indoor air sampling of the homes downgradient from the Tokheim Site building. Organic vapor readings using a photoionization detector were not collected during this sampling event. Indoor air PCE measurements in 6 homes downgradient from the Tokheim building ranged from non-detect at 0.02 ppb to 0.38 ppb. TCE measurements in indoor air in these homes ranged from non-detect at 0.02 ppb to 0.061 ppb. VC was not measured in any of the homes. Overall, the results for PCE were the same or lower for the February 2012 indoor air sampling when compared to the previous October 2010 indoor air sampling. TCE results were lower overall in the February 2012 sampling when compared to those of the October 2010 sampling.

Results

The highest PCE measurement found in February was 0.38 ppb. The measurement was in a home located along a small intermittent drainage, northeast of and across Industrial Blvd. from the Tokheim Site. The residents of the home reported that they periodically have drycleaned clothing in the home, a known source of PCE in indoor air (SM&A 2012). A neighboring home did not have measureable PCE in the indoor air. The next highest PCE measurement in a home was 0.075 ppb. The remaining PCE measurements in indoor air were 0.058 ppb, 0.034 ppb, and 0.028 ppb, which was similar to the measured background level. PCE was detected in the February 2012, outdoor sample at 0.029 ppb.

TCE measurements were very low, ranging from non-detect at 0.02 ppb to 0.061 ppb. The highest TCE measurements were in both Homes 1 and 2, immediately northeast of the Tokheim Site. These TCE measurements were still below the US background value of 0.15 ppb for TCE. Homes 3, 5, and 6 did not have TCE measurements above detection limits. TCE was not measured in outdoor air.

Limitations and Uncertainties

Several possible sources for the indoor air contaminants were identified and documented on the pre-sampling indoor air building survey forms prepared by SM&A (2012). The following possible sources were identified at one or more of the residences:

- kerosene or fuel oil
- car exhaust emissions
- gas-powered equipment stored near the home
- paints/thinners/strippers
- cleaning solvents
- moth balls
- other house cleaning products
- polishes/waxes
- air freshener(s)
- nail polish/remover
- hairspray

The exact activities of the residents in the homes were not known. Household products that contain site-related chemicals may have contributed to some of the concentrations found in the homes. All of these sources can create an indoor air background level of a contaminant inside a home. This background level exists whether or not vapor intrusion is occurring. It is not possible to separate background sources from vapor intrusion. Therefore, risk assessors look for evidence of contaminants at much higher levels than background to conclude that vapor intrusion is occurring.

Health Risk Evaluation

As with the previous Health Consultation, the evaluation of the health risk at the site and in homes along Industrial Blvd. near the site will only consider the chemicals that have been confirmed to be present in groundwater. These chemicals include PCE, and the PCE breakdown chemicals TCE, cis-1,2-DCE, and VC. The evaluation is organized by locations of samples: outdoor and indoor air samples collected in the former Tokheim Site building and samples collected in homes near the site.

Outdoor Air

Outdoor air results are shown in Table 1. One site-related chemical, PCE, was found in the outdoor air sample collected upwind and immediately south of the Tokheim Site. All other site-related chemicals were below their analytical reporting limits. The source of the PCE in the outdoor air is unknown. Chemicals found in the outdoor air were compared to background measurements collected by EPA and ATSDR as a reference (Table 1). This comparison was done to understand if the background levels near the Tokheim Site were similar to measurements found in other areas of the United States. The concentration of PCE is less than the background PCE level measured by EPA Region 9.

Tokheim Building Indoor Evaluation

To understand if vapor intrusion was occurring in the Tokheim Site building, indoor air was evaluated. Indoor air results showed detections of 1 site-related chemical – PCE (Table 2). Other site-related chemicals were not detected. The PCE measurements were compared to the outdoor air PCE measurement and their respective non-cancer indoor air health comparison values published by the ATSDR (2012) and EPA (2012). The concentrations measured for PCE

TABLE 3. Indoor air sampling results of samples collected in 6 downgradient homes. Samples were collected in October 2010 and in February 2012 over 24 hours with Summa canisters (S&ME 2011, 2012). Locations of samples are shown on Figure 3. Values reported in parts per billion (ppb). Health comparison values shown were non-cancer chronic exposure duration greater than 365 days (ATSDR 2012), ATSDR cancer risk evaluation guides (ATSDR 2012), and EPA residential indoor air Regional Screening Levels (EPA 2012). Photoionization detector (PID) results measured after sampling was completed. PID results are also reported in ppb.

Chemical / Sampling Data and Location Name	Acronym	**Home 1**		**Home 2**		**Home 3**		Ambient Outdoor Samples			ATSDR EMEG (non-cancer) (ppb)	ATSDR CREG (10^{-6} excess cancer risk) (ppb)	EPA RSL	
		Oct 25, 2010	Feb 2, 2012	Oct 25, 2010	Feb 2, 2012	Oct 25, 2010	Feb 22, 2012	Oct 25, 2010	Feb 2, 2012	Feb 22 2012			(10^{-6} excess cancer risk) (ppb)	(10^{-4} excess cancer risk) (ppb)
tetra-chloroethylene	PCE	*0.98*	*0.057*	*0.14*	*0.075*	*0.31*	<0.02	*0.024*	*0.029*	<0.02	40	0.57	0.6*	60
tri-chloroethylene	TCE	*0.078*	*0.061*	*0.026*	*0.061*	*0.04*	<0.02	<0.02	<0.02	<0.02	0.37	0.045	0.08	8
1,1-dichloroethylene	1,1-DCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	20i	nc	ngv	ngv
cis-1,2-dichloroethylene	cis-1,2-DCE	*0.63*	*0.17*	*0.80*	*0.40*	<0.02	<0.02	<0.02	*0.50*	<0.02	ngv	nc	nc	nc
trans-1,2-dichloroethylene	trans-1,2-DCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	200i	nc	nc	nc
vinyl chloride	VC	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	30i	0.04	0.06	6
In-home PID reading (ppb)		0	NR	2,389	NR	15	NR	NA	NA	NA	NA	NA	NA	NA

Notes:

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

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

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

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

Modifiers:

0.98 = Measured amount of the chemical in the indoor air sample tested.

<0.02 = Not detected in the air sample. Value represents the detection limit of the test.

* = Reporting limit was greater than one or more comparison values.

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

nc = Not classified as to carcinogenicity and no guidance value is available

ngv = No guidance value available. EPA has not found suggestive evidence of carcinogenic potential and has not developed a guidance value.

NR = Not Reported

NA = Not Applicable

TABLE 3. Indoor air sampling results of samples collected in 6 downgradient homes. Samples were collected in October 2010 and in February 2012 over 24 hours with Summa canisters (S&ME 2011, 2012). Locations of samples are shown on Figure 3. Values reported in parts per billion (ppb). Health comparison values shown were non-cancer chronic exposure duration greater than 365 days (ATSDR 2012), ATSDR cancer risk evaluation guides (ATSDR 2012), and EPA residential indoor air Regional Screening Levels (EPA 2012). Photoionization detector (PID) results measured after sampling was completed. PID results are reported in ppb.

Chemical / Sampling Data and Location Name	Acronym	**Home 4**		**Home 5**		**Home 6**		Ambient Outdoor Samples		ATSDR EMEG (non-cancer) (ppb)	ATSDR CREG (10^{-6} excess cancer risk) (ppb)	EPA RSL	
		Oct 25, 2010	Feb 2, 2012	Oct 25, 2010	Feb 2, 2012	Oct 25, 2010	Feb 2, 2012	Oct 25, 2010	Feb 2, 2012			(10^{-6} excess cancer risk) (ppb)	(10^{-4} excess cancer risk) (ppb)
tetra-chloroethylene	PCE	*0.035*	*0.028*	*0.03*	*0.034*	*0.83*	*0.38*	*0.024*	*0.029*	40	0.57	0.6*	60
tri-chloroethylene	TCE	*0.32*	*0.058*	<0.02	<0.02	*0.044*	<0.02	<0.02	<0.02	0.37	0.045	0.08	8
1,1-dichloroethylene	1,1-DCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	20i	nc	ngv	ngv
cis-1,2-dichloroethylene	cis-1,2-DCE	*0.20*	*0.16*	*0.08*	*0.12*	*0.09*	*0.16*	<0.02	*0.50*	ngv	nc	nc	nc
trans-1,2-dichloroethylene	trans-1,2-DCE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	200i	nc	nc	nc
vinyl chloride	VC	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	30i	0.04	0.06	6
In-home PID reading (ppb)		462	NR	103	NR	114	NR	NA	NA	NA	NA	NA	NA

Notes:

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

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

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

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

Modifiers:

0.035 = Measured amount of the chemical in the indoor air sample tested.

<0.02 = Not detected in the air sample. Value represents the detection limit of the test.

* = Reporting limit was greater than one or more comparison values.

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

nc = Not classified as to carcinogenicity and no guidance value is available

ngv = No guidance value available. EPA has not found suggestive evidence of carcinogenic potential and has not developed a guidance value.

NR = Not Reported

NA = Not Applicable

were well below its respective non-cancer chronic (greater than 365 days) EMEG of 40 ppb.

There were no detections of TCE, cis- or trans-1,2-DCE, 1,1-DCE, or VC. Their detection limit concentrations were compared to their respective non-cancer indoor air health comparison values published by the ATSDR (2012) and EPA (2012). All detection limit levels were below their respective non-cancer health comparison values.

The workers should not experience non-cancer health effects from breathing the indoor air having these very low levels of PCE in the Tokheim Site building.

As discussed above, PCE was the site-related chemical measured in the indoor air of the Tokheim Site building. The PCE measurements were compared to the outdoor air PCE measurement and the cancer indoor air health comparison values published by the ATSDR (2012) and EPA's Integrated Risk Information System (IRIS). PCE concentrations measured in the north and south portions of the site building were similar at 0.022 ppb in the north and 0.027 ppb in the south. PCE was measured in the outdoor air at 0.029 ppb. The indoor air results were basically the same as the outdoor air result. It is unknown if the PCE came from inside the building or from exchange with outside air. Given that the indoor air and outdoor air concentrations are about the same, it is unlikely that the indoor air is being affected by vapor intrusion. The PCE measurements were also compared to the PCE ATSDR CREG of 0.57 ppb and an EPA IRIS risk comparison value of 0.6 ppb for one excess cancer in 1 million people, or a 10^{-6} risk. There is not a cancer health concern because of these minor levels of PCE in the indoor air of the building.

There were no detections of TCE, trans-1,2-DCE, 1,1-DCE, and VC in indoor air (Table 3). As a worst case scenario, the detection limit values of these chemicals were compared to their respective health comparison values published by the ATSDR (ATSDR 2012) or EPA (2012). The test detection limits were low; all were 0.02 ppb. A comparison was done for TCE as a worst case scenario evaluation. The highest detection limit value of 0.027 ppb for TCE was much less than the ATSDR CREG comparison value of 0.045 ppb (ATSDR 2012) and the EPA RSL for residential air of 0.08 ppb (EPA 2012). Therefore, there should not be any health concerns from breathing indoor air. The detection limits for 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride, were below their respective health comparison values.

Downgradient Homes Indoor Air Evaluation

Indoor air was evaluated to better understand potential health effects that site-related chemicals may have on residents living in homes located downgradient and over the groundwater contamination migrating from the Tokheim Site. Indoor air samples were collected from 6 downgradient homes.

Indoor air results showed detections of 3 site-related chemicals (Table 3). PCE, TCE, and cis-1,2-DCE were measured in indoor air in 3 of the 6 homes. In 2 of the 6 homes only PCE and cis-1,2-DCE were detected. One home did not have any measurements of any site-related chemicals.

The PCE measured in indoor air of the homes downgradient of the site ranged from 0.028 ppb to 0.38 ppb. These measured amounts were well below ATSDR's non-cancer effects EMEG comparison value of 40 ppb for chronic (greater than 365 days) exposure for PCE.

TCE measured in the indoor air of the homes ranged from 0.044 to 0.061 ppb. These amounts were below the ATSDR EMEG of 0.37 ppb for non-cancer health effects (EPA 2001). TCE was not measured in either of the ambient outdoor air samples collected.

Cis-1,2-DCE measured in the indoor air of the homes ranged from non-detect at 0.02 ppb to 0.40 ppb. There are no non-cancer health comparison values for cis-1,2-DCE in air. These levels are very low, less than background levels of cis-1,2-DCE measured by EPA Region 9.

Trans-1,2-DCE, 1,1-DCE, and VC were not measured in the indoor air of any home tested. The reporting limit concentrations of these chemicals were all below their respective non-cancer health comparison values.

As mentioned above, PCE, TCE, and cis-1,2-DCE were measured in the indoor air of the 3 of 6 homes tested. PCE and cis-1,2-DCE were measured in 2 other homes. One home did not have any measurements of site-related chemicals. The measured indoor air concentrations were compared to their respective cancer indoor air health comparison values published by ATSDR (ATSDR 2012) and EPA (2012).

Three homes had PCE concentrations measured in a range between 0.05 ppb and 0.4 ppb. The PCE indoor air concentrations were compared to ATSDR's CREG for one excess cancer in one million people health risk comparison value of 0.57 (ATSDR 2012) and EPA's RSL for an excess cancer risk of one in a million of 0.6 ppb (IRIS 2012). Outdoor air had a PCE measurement of 0.029 ppb. The 3 highest indoor air PCE measurements of 0.38 ppb, 0.075 ppb, and 0.057 ppb were below the ATSDR CREG health comparison value and the EPA RSL.

The ATSDR CREG for 1 additional cancer in 1 million people for TCE is 0.045 ppb (ATSDR 2012), and EPA's TCE cancer effects comparison value is 0.08 ppb (EPA 2012). The TCE concentrations in Home 1 at 0.061 ppb, Home 2 at 0.061 ppb, and Home 4 at 0.058 ppb, slightly exceed the ATSDR CREG. These measurements did not exceed the EPA RSL for cancer effects. No TCE was detected in outdoor air. TCE was not measured in the remaining 3 homes. EPA's RSL is based on the latest information on how TCE causes cancer, while the ATSDR CREG has not been updated as of May 2012. All TCE measurements were below the EPA RSL of 0.08 ppb.

To gain a better understanding of the risk produced by the highest TCE concentration in indoor air, a theoretical risk was calculated using this measured TCE concentration and EPA's inhalation unit risk (IUR). Using the 0.061 ppb TCE concentration (0.33 $\mu g/m^3$) and multiplying it by the IUR for TCE of $4.1x10^{-6}$ $(\mu g/m^3)^{-1}$, a theoretical risk of $1.4x10^{-6}$ was calculated. Therefore, the theoretical extra cancer risk would be about 1 extra cancer in addition to the background cancer risk in 1 million people. The background cancer risk is 1 in 2 for men and 1 in 3 for women. This extra cancer risk is negligible and is considered acceptable by EPA (EPA 1991).

Cis-1,2-DCE is not classified with regard to carcinogenicity by EPA. Therefore, there are no cancer comparison values published by EPA for the chemical. The ambient outdoor air sample had levels of cis-1,2-DCE present. The outdoor air near the site appears to have higher levels than the indoor air of the homes tested.

Based on the results of this second sampling, migration of vapors into the indoor air of the homes along Industrial Blvd. does not appear to be taking place. The lack of moderate to high levels of site-related chemicals in the indoor air of the homes provides the support for this conclusion.

Chemical Mixture

When you have more than one chemical found at a sampling location, there are potential additive health effects from a mixture of chemicals to an exposed population (ATSDR 2004). There is no evidence to indicate that greater-than-additive interactions among PCE or TCE health effects happen. PCE, TCE, and cis-1,2-DCE were measured in indoor air samples collected from the Tokheim Site building and in most samples from residences east and northeast from the site along Industrial Blvd.

Adding together the approximate site-specific theoretical, worst-case risks of PCE of $1.0x10^{-6}$ and approximately $1.3x10^{-6}$ for TCE, the total excess cancer risk above background was still about 2 in 1 million. The contribution from cis-1,2-DCE would be 0 because it has not been found not to cause cancer. Therefore, there is no increased risk because there is a mixture of both PCE and TCE in very small amounts in the indoor air in Homes 1, 2, and 4.

Child Health Considerations

The health of children was considered as part of this health consultation. The many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances (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.

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

PCE was measured in the indoor air of the 2 homes closest to the site and in a home along the path of the groundwater contamination. It was reported that at least 2 children under the age of 13 were living in home closest to the site (SM&A 2012). As part of a very cautious approach, an evaluation was done of PCE using the indoor air test results. None of the results were above the ATSDR EMEG or CREG values for this chemical.

EPA developed the RSL for TCE using the latest toxicology information, including the increased risk from childhood exposure. The concentrations of TCE found in indoor air are less than the EPA RSL for TCE.

The Jasper Materials workers at the Tokheim Site building are adults. Children should not have any exposure to the indoor air in the building.

Other Considerations

SM&A performed a remedial injection of emulsified edible oil at the site in November 2010. This injection seems to have brought down PCE levels in groundwater and reduced the potential for vapor intrusion of PCE and TCE (SM&A 2012). Continued monitoring of the groundwater plume would be prudent.

Limitations and Uncertainties in Vapor Intrusion Studies

Having and following an accepted protocol for conducting indoor air investigations is important. A general protocol was developed for this investigation and approved by TDEC DoR and was reviewed by TDH EEP. Even a good protocol cannot remove all limitations or uncertainties. Limitations and uncertainties can sometimes influence the results of the investigation.

There were several characteristics of the homes and businesses that may have influenced the indoor air testing. Some examples of limitations and uncertainties include the detail of the design of each of the homes and businesses not being readily available. The number of breaks in floor slabs or utility perforations entering the buildings were also variables. Also, the exact amount of the chemicals in the groundwater beneath the buildings is unknown and the amount and frequency of vapor off-gassing from the groundwater is likely not constant.

The presence of background chemicals in the indoor air of the homes and businesses tested could also be an uncertainty. The use of cleaning products that sometimes contain many chemicals could influence the results of the testing as not all sources may be found when performing a building inventory. This could be the case especially if cleaning products were recently used in the home or business. The routines of the individuals living in the homes and working in the businesses were another uncertainty.

What has happened in the past at the sampling locations is another uncertainty. Any or all spills that may have occurred are likely to remain undocumented, especially at a residence.

Future Considerations

According to SM&A, groundwater at the site has benefitted from the injection of the emulsified edible oil. Reportedly, chemical concentrations in groundwater have decreased since the injection that was done shortly after the October 2010 air sampling event (SM&A 2012). It is hopeful that the reduction in chemicals in groundwater will lead to a decreased likelihood for vapor intrusion to occur. Comparing the pre-injection air test results from October 2010 with the post-injection air test results from February 2012, PCE measurements in air have decreased in 5

of the homes. PCE levels in 1 home were nearly the same in both air tests. Comparing the TCE measurements of the two tests, TCE measurements in air decreased in 5 homes and increased in 1 home between October 2010 and February 2012.

If at any point in the future groundwater contamination is found further east from the site to other areas with residential homes, then sampling indoor air or soil-gas in those areas would also be prudent. If the site-specific depth-to-groundwater trend continues, groundwater would likely be shallower farther from the site. If impacted groundwater is found further from the site, groundwater plume contaminant vapors could be even closer to the ground surface. Shallow groundwater can provide a greater potential for vapor intrusion into residences. It is not known if the shallow groundwater comes to the surface in the nearby downgradient stream.

Conclusions

Conclusion 1: *EEP concludes that the minor amounts of tetrachloroethylene (PCE) or any of PCE's breakdown chemicals found in the homes tested will not harm anyone breathing the air in the homes.*

Levels of chemicals in the indoor air of homes do not suggest that migration of vapors from the underlying groundwater would be a health problem. Site-related chemicals were measured in the indoor air of 5 of 6 homes. The levels were very low. Some household items contain these same chemicals. At very low levels it is impossible to know if the chemicals present in the air were from sources already within the home or from another source such as vapor intrusion. Levels for chemicals such as PCE or TCE were below health guidance values. Breathing indoor air with these very low chemical levels would not result in adverse health effects.

Conclusion 2: *EEP concludes that the chemicals detected in the indoor air of the former Tokheim building are not expected to harm the health of the workers.*

Air inside the former Tokheim building was basically the same as the outdoor air near the building. Nothing potentially harmful was identified by the air testing. The amount of PCE measured in the building was very low. The amount of PCE was below its non-cancer and cancer health comparison values. The levels will not harm those breathing the indoor air in the building. There was no evidence discovered that vapor intrusion was occurring.

Recommendations

The focus of this health consultation was to make sure vapor intrusion was not occurring in the homes near the former Tokheim Site along Industrial Blvd. or in the former Tokheim building. The indoor air breathed by residents east and northeast of the site and site workers will not lead to harmful health effects. There was no evidence that vapor intrusion was occurring. Based on the results of both the October 2010 and February 2012 indoor air sampling investigations, TDH EEP identified no health concerns and has no further recommendations at this time. As recommended in our first Health Consultation, if contamination is found further from the site

near other homes, then TDH EEP recommends additional sampling.

Public Health Action Plan

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

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

- Reviewing 2 separate sets of indoor air data from both the former Tokheim building and the residential properties east and northeast of the former Tokheim building.

- Preparing this Health Consultation update.

Public health actions that will be taken include:

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

- TDH EEP will provide copies of this health consultation to SM&A to distribute to residents.

- TDH EEP will maintain dialogue with ATSDR, TDEC, EPA, and other interested stakeholders to safeguard public health.

- TDH EEP staff are available to answer questions regarding the interpretation of the indoor air results should homeowners be interested in speaking with us.

- TDH EEP will be available to review newly collected and additional environmental data, and provide interpretation of the data, as requested by TDEC.

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Certification

This Public Health Consultation: *Updated Evaluation of the Vapor Intrusion Investigation for the Tokheim Site, Jasper, Marion 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.

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