Letter Health Consultation

FORMER MACON NAVAL ORDNANCE PLANT

ALLIED INDUSTRIAL PARK, UNIT 6

MACON, BIBB COUNTY, GEORGIA

EPA FACILITY ID: GAD003302676

Prepared by
Georgia Department of Public Health

SEPTEMBER 30, 2022

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Capacity Development and Applied Prevention Science
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Georgia Department of Public Health (GDPH) prepared this Letter Health Consultation for the Former Macon Naval Ordnance Plant (Allied Industrial Park, Unit 6), located in Macon, Bibb County, Georgia. This publication was made possible by a cooperative agreement (program #TS20-2001) with the federal Agency for Toxic Substances and Disease Registry (ATSDR). GDPH evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by the GDPH.

LETTER HEALTH CONSULTATION

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GEORGIA DEPARTMENT OF PUBLIC HEALTH

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September 30, 2022

Mr. Brian Ferrier and Peter Johnson
Remedial Project Manager, Superfund Division
U.S. Environmental Protection Agency, Region 4
61 Forsyth St. SW
Atlanta, GA 30303-8960

RE: Letter Health Consultation with Appendices
Unit 6 of Former Macon Naval Ordnance Plant NPL site, Allied Industrial Park
Macon, Bibb County, Georgia

Dear Mr. Ferrier and Johnson:

The Georgia Department of Public Health (DPH) developed this Letter Health Consultation (LHC) to evaluate indoor air and sub-slab soil gas sampling results for potential health effects from breathing indoor air within Unit 6 of the former Macon Naval Ordnance Plant (MNOP). Unit 6, currently operated by SD Polymers, is located at 121 Ennis Blvd. in Macon, Bibb County, Georgia. The former MNOP's National Priorities Listing prompted DPH, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), to develop this LHC. The main contaminant of concern at Unit 6 is the organic solvent trichloroethylene (TCE).

We reviewed indoor air and sub-slab soil gas sample data from 2015 and 2020 sampling events. Data indicate that inhalation exposure to TCE has occurred for workers within the facility. In summary, based on our assessment of sub-slab soil gas and indoor air data, some employees breathing TCE in Unit 6 via vapor intrusion may have been harmed in the past. In addition, past TCE exposure to laboratory employees would have placed pregnant women and women of childbearing age who become pregnant while employed there at slight risk for fetal heart development problems in their children. Some employees breathing TCE in Unit 6 that results from vapor intrusion have a slightly elevated estimated cancer risk from TCE exposure, assuming they have worked at SD Polymers for 20 years or more. Based on sub-slab soil gas data, a low-level risk from vapor intrusion will exist until contamination in sub-slab soil and groundwater is sufficiently reduced or removed (see Figure 3). Some limitations to our evaluations included the evaluation of indoor air data from samples that were collected during a small snapshot of time (8 hours), and thus may not have been reflective of temporal and seasonal changes that can occur over longer periods of time. Health-protective exposure assumptions were used in this LHC to evaluate and account for some of these limitations.

The most impactful way to reduce future exposures is to implement permanent measures to mitigate vapor intrusion into Unit 6. In addition, performing indoor air sampling at

Unit 6 after installation of mitigation system is necessary to determine if mitigation efforts are sufficient in decreasing vapor intrusion.

The remainder of the LHC provides a discussion of our Unit 6 data assessment and how we arrived at our conclusions along with recommendations to prompt action to prevent or reduce exposure by implementing measures to mitigate vapor intrusion into the facility.

The LHC and fact sheet summarizing the findings will be distributed to SD Polymer employees to ensure that health education on TCE exposure reaches those employees affected by vapor intrusion in Unit 6.

Historical and Current Use of the Property

The former Macon Naval Ordnance Plant (MNOP) property, currently the Allied Industrial Park (AIP), is located on 433 acres of an industrialized area in south Macon, Bibb County, Georgia [ERM 2019]. The U.S. Navy and the Reynolds Corporation produced ordnance materials at the site from 1941 until 1965. Ordnance manufactured at the MNOP included flares, small primers, detonators, and other triggering mechanisms. Allied Chemical Corporation, the subsequent owner of the property, manufactured automobile seat belts at the property and used nearly all the buildings, underground storage tanks (UST), aboveground storage tanks (AST), and utilities located at the former MNOP. A wastewater treatment plant (WWTP), located near the western boundary of the property, was constructed in the early 1940s, and operated until the early 1970s. The WWTP was designed to handle only sewage generated by the ordnance plant; however, chemicals used in the ordnance plant may have been disposed of in drains that connected to the WWTP [ERM 2019]. In 2013, the U.S. Environmental Protection Agency (EPA) placed the site on Superfund's National Priorities List (NPL) because waste disposal practices have impacted groundwater and nearby Rocky Creek [USEPA 2015a].

This letter health consultation focuses only on Unit 6. Unit 6 has multiple warehouses, an extruder line worker area, an office, a quality control lab, and an employee breakroom (see Figures 1 and 2). A metal plating facility at the former MNOP operated in Unit 6. The metal plating operation began in the 1940s and continued until 1980. The metal plating facility used cyanide, solvents, acid baths, caustic baths, and hydraulic oil in their operations. Records indicate that the plating operation generated chrome sludge during Allied Chemical's use of the facility. It is not known how this sludge was managed or disposed. Metal shavings were centrifuged to remove excess oils in the oil recovery process, and excess oil was drained onto the ground surface outside Unit 6 [RUST 1997]. Currently, SD Polymers conducts manufacturing in the building, with many areas of Unit 6 used as general warehouse space. SD Polymers has occupied Unit 6 since 1994. They specialize in producing fiberglass mats, materials for thermoplastic polyolefin (TPO) membrane roofing applications, plastic extrusion products, industrial rubber recycling and modifying rubber into rolls [SD Polymers 2020]. [USEPA 2015a].

Operations at Unit 6 are temporarily closed because of a fire that occurred on January 1, 2021 (see Figures 4 and 5). The fire destroyed the office and a small employee break room. The laboratory, which is adjacent to the fire-damaged area may be salvaged or relocated. Before the

fire, SD Polymers operated for 24-hour periods, with 10 to 12 employees per shift. There are 2 female adult lab workers under the age of 40 employed at SD Polymers. All employees work 8 hours shifts per day, 40 hours a week.

Environmental Contamination

Currently, the EPA, along with parties representing the potentially responsible parties (PRPs), are investigating the former MNOP. All the structures on the site are divided into 15 investigative units. EPA is overseeing vapor intrusion (VI) sampling throughout the MNOP because a known groundwater contamination plume containing trichloroethylene (TCE) and its breakdown products underlie many of the investigative units. Unit 6 VI sampling results showed TCE in indoor air above health-based comparison (screening) values, which required further evaluation to determine if workers were at risk of harmful effects. Three small, enclosed areas in Unit 6 with elevated TCE levels include: the office, the employee breakroom, and the laboratory [USEPA, 2020].

Elevated TCE levels were found in the laboratory area in 2015, then mitigated to acceptable levels by May 2016 [ERM 2019]. Indoor air sampling was not conducted again until January of 2020, when elevated TCE levels were once again detected. In March 2020, sampling results showed that elevated levels of TCE in indoor air were present in Unit 6. Steps have been taken to reduce TCE to acceptable levels in indoor air at these locations. These steps included increased air circulation, installation of additional air purification filters, and the sealing of cracks in the building foundation [USEPA 2020]. Of the three enclosed areas in Unit 6 with elevated TCE levels, two of those areas were destroyed in the fire in January 2021.

TCE is volatile, moderately water soluble, and readily migrates from contaminated surface soil into the subsurface soil. TCE is a dense non-aqueous phase liquid (DNAPL) that can move through the unsaturated zone into the saturated water zone where it displaces water and dissolves in it. TCE volatilizes rapidly from water and its volatility increases with increasing temperature [NCDEQ 2018]. Volatilization of TCE from soil is slower than from water but is more rapid than that of many other volatile organic compounds (VOCs). In the subsurface, the dominant fate of TCE is volatilization rather than degradation. Chemical degradation and biodegradation rates of TCE in the soil and groundwater are slow with a biodegradation half-life of months to years [ATSDR 2019]. Biodegradation products of TCE through anaerobic processes include dichloroethylene (DCE), vinyl chloride, and ethylene [NCDEQ 2018].

Sub-slab Soil Gas Assessment

A summary of sub-slab soil gas results collected at the former MNOP inside Unit 6 from 2015 and 2020 are presented in Table 1. A total of 114 sub-slab soil gas samples were collected by Environmental Resources Management (ERM). A vapor pin was installed to collect representative samples of soil gas immediately below the floor slab. Sub-slab soil gas was collected using 1-liter Summa canisters and were sent for laboratory analysis of volatile VOCs using USEPA Method-TO15 [ERM 2019]. ERM chose to perform the sampling event with windows/doors opened and/or closed to reflect normal working conditions in Unit 6 in accordance with Section 3.2 of the 2015 USEPA Vapor Intrusion Guidance [USEPA 2015b].

The main contaminant of concern, TCE, was detected in high concentrations in sub-slab soil gas. Along with TCE, other contaminants such as tetrachloroethylene, vinyl chloride, 1,1-dichloroethene (1,1-DCE), *trans*-1,2 dichloroethene *(trans*-1,2 DCE), and *cis*-1, 2 dichloroethene (*cis*-1, 2 DCE) were also detected in sub-slab soil gas samples in high concentrations.

Sub-slab soil gas data confirms significant TCE contamination below Unit 6 acting as a source for vapor intrusion into the interior of the facility. Multiple TCE degradation products were also confirmed exceeding comparison values in sub-slab soil gas data.

Table 1: Summary of Sub-slab Soil Gas Contaminants and Concentrations Exceeding Health-based Comparison Values (CVs) for Vapor Intrusion

Indoor Air Analyte	Sub-slab Soil Gas Investigation Areas	Concentration Range (µg/m^3)*	Samples Exceeding Comparison Value	Vapor Intrusion Comparison Value[1] (µg/m^3)	Type of Comparison Value
Trichloroethylene (TCE)	Unit 6 shipping office, QA/QC lab, breakroom, extruder line work area, line storage, restroom, and remaining areas of Unit 6	13,500 – 1,120,000	19 out of 19	7	CREG[2]
				70	cEMEG[3]
Tetrachloroethylene (PCE)		132 – 44,700	19 out of 19	130	CREG[2]
				1,400	cEMEG[3]
Vinyl Chloride		11.1 – 1,280	19 out of 19	3.7	CREG[2]
1,1 Dichloroethene		17.2 – 1,980	15 out of 19	80	cEMEG[3]
Trans-1,2-Dichloroethene		17.2 – 1,980	0 out of 19	26,000	iEMEG[4]
Cis-1,2-Dichloroethene		17.2 – 68,600	1 out of 19	26,000**	iEMEG

* µg/m^3: micrograms of analyte per cubic meter of air

** 26,000: Screening value for *Trans*-1,2- Dichloroethene used in absence of screening value for *Cis*-1,2- Dichloroethene.

[1]Comparison Value: Health-based screening value.

[2]CREG: ATSDR Cancer Risk Evaluation Guide (2021) based on an excess lifetime cancer risk of 1E-6 (a concentration expected to cause no more than 1 additional cancer case in 1,000,000 exposed people).

EMEG: An Environmental Media Evaluation Guide is an estimate of daily human exposure to a chemical (in µg/m^3) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

[3] cEMEG: ATSDR chronic (exposure for more than 365 days) Environmental Media Evaluation Guide for ambient air (2021).

[4] iEMEG: ATSDR intermediate (exposure for 15 to 365 days) Environmental Media Evaluation Guide for ambient air (2021).

Indoor Air Assessment

A summary of indoor air results collected in 2015 and 2020, inside Unit 6, is presented in Table 2. Samples were collected over an 8-hour period via summa cannister by ERM. ERM chose to perform the sampling event with windows/doors opened and/or closed to reflect normal working conditions in Unit 6 in accordance with Section 3.2 of the 2015 USEPA Vapor Intrusion Guidance [USEPA 2015b]. If the contaminant is a known or probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) were used as a health-based comparison value (CV) to screen for cancer risk from breathing indoor air at Unit 6 [ATSDR 2020b]. The main

contaminant of concern, TCE, was detected at elevated concentrations in indoor air samples at multiple locations within Unit 6. In addition, other contaminants such as: tetrachloroethylene, vinyl chloride, 1,1 dichloroethene, *trans*-1,2 DCE, and *cis*-1, 2 DCE were also detected. All TCE levels in indoor air samples exceeded ATSDR's CREG for cancer effects and approximately 67% of the samples exceeded the chronic environmental media evaluation guide (cEMEG) for noncancer health effects. TCE and vinyl chloride are the only contaminants that exceeded a CV.

Table 2: Summary of Indoor Air Contaminants and Concentrations Exceeding health-based Comparison Values (CVs)

Indoor Air Analyte	Indoor Air Investigation Area	Concentration Range (µg/m^3)	Samples Exceeding Comparison Value	Comparison Value (µg/m^3)	Type of Comparison Value
Trichloroethylene	Unit 6 shipping office, QA/QC lab, breakroom, extruder line work area, line storage, restroom, and remaining areas of Unit 6	0.339 - 123	60 of 60	0.21	CREG[2]
			40 of 60	2.1	cEMEG[3]
Tetrachloroethylene		0.136 – 0.339	0 of 53	3.8	CREG[2]
Vinyl Chloride		0.051 – 0.389	1	0.11	CREG[2]
1,1 Dichloroethene		0.079 – 0.091	0	2.4	cEMEG[3]
Trans-1,2-Dichloroethene		0.079 – 0.079	0	790	iEMEG[4]
Cis-1,2-Dichloroethene		0.079 – 2.1	0	790**	iEMEG

* µg/m^3: micrograms of analyte per cubic meter of air
** 790: Screening value for *Trans*-1,2- Dichloroethene used in absence of screening value for *Cis*-1,2- Dichloroethene.
[1]Comparison value: Health-based screening value used to select chemicals for further evaluation.
[2]CREG: ATSDR Cancer Risk Evaluation Guide (2021) based on an excess lifetime cancer risk of 1E-6 (a concentration expected to cause no more than 1 additional cancer case in 1,000,000 exposed people)
EMEG: An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.
[3]cEMEG: ATSDR chronic (exposure for more than 365 days) Environmental Media Evaluation Guide for ambient air (2021).
[4]iEMEG: ATSDR intermediate (exposure for 15 to 364 days) Environmental Media Evaluation Guide for ambient air (2021).

Evaluation Process

A two-stage evaluation process was used in the assessment of indoor air data. The first step was to review available sampling data and to select contaminants that warrant further evaluation, based on the potential for exposure to these contaminants to result in adverse health effects. DPH examines the types and concentrations of contaminants of concern, which are then screened with comparison values (CVs) established by ATSDR. If a chemical exceeds the recommended CV, we evaluate it further as explained in the next paragraph.

DPH then considers how people may come into contact with the contaminants. Because someone's exposure depends on the route, frequency, and duration of exposure and the concentration of the contaminants, this exposure information is essential to determine if a public health hazard exists. Therefore, the next step in the evaluation process involves an in-depth health-effects evaluation of the contaminants detected in the site media (in this case, indoor air). The primary focus of this effort is to evaluate the potential for the contaminant(s) to contribute to cancer and non-cancer health effects as a result of human exposure [ATSDR 2020a].

Contaminants of concern were determined by employing the previously described screening process. Comparison values used by DPH include ATSDR environmental media evaluation guides for air (EMEGs), and ATSDR cancer risk evaluation guides (CREGs) for air. CVs such as the EMEG and CREG offer a high degree of protection and assurance that people exposed to levels less than these CVs are unlikely to be harmed by contaminants in the environment. For chemicals that cause cancer, the CREGs represent levels that are calculated to increase the estimated risk of cancer by about one additional cancer in a million people exposed. From indoor air sampling results summarized in Table 2, TCE and vinyl chloride are the only contaminants that exceeded an indoor air CV. Therefore, they are evaluated further for public health implications. Other contaminants did not exceed indoor air CVs.

Main Contaminant of Concern

As discussed later, non-cancer health effects are not expected from exposure to detected vinyl chloride levels in the laboratory of Unit 6. The estimated cancer risk from 3 years of exposure was two orders of magnitude below 1 in a million. This supports our premise that the main contaminant of concern at Unit 6 is the organic solvent trichloroethylene (TCE).

Trichloroethylene (TCE)

Trichloroethylene or TCE is a clear, colorless, nonflammable liquid that has a sweet, fruity odor characteristic of chloroform. The odor threshold is approximately 100 parts per million (ppm). TCE does not occur naturally; therefore, its presence indicates manufacture, use, or storage. It is used mainly as a degreaser for metal parts. It is also used to make other chemicals. TCE can also be found in some household products, including typewriter correction fluid, paint removers, adhesives, and spot removers. The biggest source of TCE in the environment is evaporation from factories that use it. Once TCE is in the air, about half will be broken down within a week. If released to the soil, TCE generally does not break down in the soil but migrates into groundwater where it does break down, but at a very slow rate [ATSDR 2019].

People are usually exposed to TCE from breathing air or drinking water containing TCE. If a person breathes the chemical, about half the amount breathed will get into bloodstream and organs. The rest will be exhaled. If TCE comes into contact with skin, some of it can enter the body, although not as easily as when breathed or swallowed [ATSDR 2019]. Once in the blood, the liver changes much of the TCE into other chemicals. The majority of these breakdown products leave the body in the urine within a day. A person will also quickly breathe out much of the TCE in their bloodstream. Some of the TCE or its breakdown products can be stored in body fat for a brief period, and thus may build up in your body if exposure continues [ATSDR 2019].

TCE in the blood stream can cross the placenta and enter the developing baby. The TCE levels in the developing baby will be about the same level as that in the mother. The most vulnerable period for TCE to affect a fetus's heart development is between weeks 2 to 8 of pregnancy—which is very early in pregnancy. A pregnant woman's exposure to TCE during these weeks can increase the risk of having a baby born with a congenital heart defect. Not all babies exposed to TCE during pregnancy will be born with a birth defect of the heart. Even in studies of workers exposed to TCE, the chance that exposure during pregnancy might result in a baby with a birth defect of the heart was extremely low [ATSDR 2015].

Exposure Assumptions

ATSDR recommends assuming a full-time worker exposure scenario of 8.5 hours a day, 5 days a week, and 50 weeks per year for 20 years as a reasonable maximum exposure (RME), and 8.5 hours a day, 5 days a week for 50 weeks per year for 5 years as a reasonable central tendency exposure (CTE), unless site-specific conditions warrant an adjustment to these standard assumptions (ATSDR 2020a).

CTE refers to individuals who have an average or typical exposure to a contaminant in a work environment. RME refers to the high end of the exposure distribution (approximately the 95th percentile) for the exposed population. The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure. An exposure factor (EF) is an expression of how often and how long a person may be contacting a substance in the environment. In many instances, the EF will equal 1, representing a daily, continuous exposure to the contaminant. However, some exposures may occur on an intermittent or irregular basis (such as in a work environment); therefore, the EF can be less than one.

SD Polymers currently has 25 employees, including 2 female laboratory (lab) employees under the age of 40 years. One of the female lab employees, who has worked for SD Polymers for 3 years in Unit 6 had a child during that timeframe[1]. To date, only one employee has worked at the facility for 25 years[2]. Table 3 shows the exposure scenarios used in this health consultation and the EF of 0.2426 for full-time employees at Unit 6 for these scenarios.

Table 3: Exposure Factor (EF) and Scenarios for Employees Working at Unit 6

Scenarios	Reasonable Maximum Exposure (RME)[2](20 years)	Central Tendency Exposure (CTE)[3] (5 Years)	Maximum Exposure[4] (25 Years)	Laboratory Exposure[5] (3 Years)
EF[1]	0.2426 (for all above scenarios)			

[1]Exposure factor (EF): An expression of how often and how long a person may be contacting a substance in the environment. See Appendix B for example calculations.
[2]RME: Reasonable maximum exposure factor. RME refers to the high end of the exposure distribution (approximately the 95th percentile) for the exposed population. The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure.
[3]CTE: Central tendency exposure concentration. CTE refers to individuals who have average or typical exposure to a contaminant.
[4]Maximum Exposure: The maximum exposure scenario is intended to assess exposures of employees working at the facility for 25 years instead of 20 years.
[5]Laboratory Exposure: The exposure scenario is intended to assess exposure of employees working in the laboratory for just 3 years.

[1] Employee worked from 2018 to 2021 and had child around 2020. Personal communication with SD Polymer laboratory employee on March 23, 2021
[2] Personal communication with SD Polymer plant caretaker on March 23, 2021

Exposure Point Concentration Evaluation

Table 4 summarizes the adjusted Exposure Point Concentrations (EPC) based on exposure factor scenarios and compares exposure point concentrations with inhalation health guidelines. To find the adjusted EPC, we multiplied the maximum indoor air concentration with the exposure factor value from Table 3 [ATSDR 2020b]. Calculations are explained in Appendix B. The EPC was calculated for specific areas with high concentrations of TCE and some vinyl chloride in indoor air.

Table 4: Summary of Indoor Air Contaminants and the Adjusted Exposure Point Concentration in Specific Areas within Unit 6.

Indoor Air Analyte	Sample Location in Unit 6	Indoor Air Max Concentration (µg/m^3)	Adjusted Exposure Point Concentration (EPC)[1] for Health Effect (µg/m^3)		Health-Guideline (µg/m^3)
			RME[3] (20 yrs)	CTE[4] (5 yrs)	
TCE	Shipping Office IA-6-1	123	29.8	29.8	2.1 (MRL[2])
	Laboratory IA-6-4	26.4	6.4	6.4	
	IA-6-5	24.7	6	6	
	Line Storage IA-6-(35,42,46)	30.4	7.4	7.4	
Vinyl Chloride	Laboratory IA-6-4	0.389	0.1	0.1	77 (MRL[2])
Laboratory Exposure (3 Years)					
TCE	Laboratory IA-6-4	26.4	6.4		2.1 (MRL[2])

TCE: Trichloroethylene
µg/m^3: micrograms of analyte per cubic meter of air
[1]Exposure Point Concentration (EPC): The representative contaminant concentration within an exposure unit or area in an exposure pathway to which people are exposed for acute (1-14 days), intermediate (15-364 days), or chronic (365+ days) durations during the past, present, or future.
[2]MRL: ATSDR minimal risk level for TCE and vinyl chloride (ATSDR 2021; ATSDR 2019; ATSDR 2006). An MRL is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. MRLs are based on noncancer health effects only. MRLs can be derived for acute (1-14 days), intermediate (15-364 days), or chronic (365+ days) duration exposures by the inhalation and oral routes.
[3]RME: Reasonable maximum exposure. RME refers to the high end of the exposure distribution (approximately the 95th percentile) for the exposed population. The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure.
[4]CTE: Central tendency exposure concentration. CTE refers to individuals who have average or typical exposure to a contaminant.

After adjusting the vinyl chloride concentration in the laboratory to a continuous daily exposure, the concentration was compared to ATSDR's chronic inhalation Minimal Risk Level (MRL). Exposure scenarios of 8.5 hours per day, 5 days per week, for 20, 5, and 3 years were used to adjust the vinyl chloride concentration. Employees in the laboratory have worked there for 3 years. This duration was used to calculate an exposure factor for the laboratory employees. An adjusted EPC value for vinyl chloride did not exceed the health guideline. Therefore, non-cancer health effects are not expected from exposure to detected vinyl chloride levels in the laboratory area of Unit 6. The estimated cancer risk from 3 years of exposure was two orders of magnitude below 1 in a million. Thus, vinyl chloride was not evaluated further for public health implications because there is no concern for increased cancer risk.

In Table 4, TCE exceeded the health guideline (2.1 µg/m^3) in individual rooms throughout Unit 6. Adjusted EPC values were calculated for different areas inside Unit 6 using the maximum indoor air concentration of TCE in that specific area. In all areas of Unit 6, TCE exceeded the chronic inhalation MRL. The adjusted TCE in specific rooms within the building exceeded the health guideline and ranged from 6 µg/m^3 in the IA-6-5 area to 29.8 µg/m^3 in the shipping office.

Table 5 is similar to Table 4, except instead of summarizing the indoor air concentrations by individual areas within Unit 6, it summarizes the adjusted EPC for Unit 6 as a whole, which was then compared with the health guideline. Sample calculations are available in Appendix B. In Table 5, the 95 percent upper confidence limit (95% UCL) of the arithmetic mean of all indoor air concentrations of TCE measured in Unit 6 was used to determine an adjusted EPC of 3.6 µg/m^3. EPA's ProUCL software was used to calculate the 95% UCL [USEPA 2016] following ATSDR EPC Guidance for Discrete Sampling [ATSDR 2021]. It should be noted that workers worked in this facility for 3 to 25 years.

Table 5: Summary of TCE Concentrations and Adjusted Inhalation Exposure Point Concentration Exceeding Health Guidelines for the entire Unit 6

Indoor Air Analyte	Facility Location in Unit 6	Indoor air Concentration 95% UCL[5] (µg/m^3)	Adjusted Exposure Point Concentration (EPC)[1] for Health Effects (µg/m^3)		Health-Guideline (µg/m^3)
			RME[3] (20yrs)	CTE[4] (5yrs)	
TCE	Whole Unit 6	14.9	3.6	3.6	2.1 (MRL[2])
	Maximum Exposure (25 years)				
	Whole Unit 6	14.9	3.6	3.6	2.1 (MRL[2])

TCE: Trichloroethylene
µg/m^3: micrograms of analyte per cubic meter of air
[1]Exposure Point Concentration (EPC): The representative contaminant concentration within an exposure unit or area in an exposure pathway to which people are exposed for acute (1-14 days), intermediate (15-364 days), or chronic (365+ days) durations during the past, present, or future.
ATSDR: Agency for Toxic Substances and Disease Registry
[2]MRL: ATSDR minimal risk level (ATSDR 2021).
[3]RME: Reasonable maximum exposure. RME refers to the high end of the exposure distribution (approximately the 95th percentile) for the exposed population. The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure.
[4]CTE: Central tendency exposure concentration. CTE refers to individuals who have average or typical exposure to a

contaminant.

[5]95% UCL: 95 Percentile Bootstrap UCL of arithmetic mean (Lognormal Regression on Order Statistics Using Imputed Non-Detects)[3].

Toxicological Evaluation

Trichloroethylene Noncancer Health Effects

The primary health concerns for employees working in Unit 6 are those associated with inhalation of TCE that has migrated into indoor air of Unit 6 via vapor intrusion. The immune system and the developing fetus are most sensitive to the toxic effects of TCE. Reductions in thymus weight [Kiel et al. 2009] and the development of fetal malformations during a three-week window of fetal heart development [Johnson et al. 2003] are health effects following low level exposures (ATSDR 2019). Although these studies were conducted in rats and mice exposed to TCE in drinking water, physiological-based pharmacokinetic (PBPK) modeling was used to extrapolate oral doses in animals to human equivalent concentrations (HECs) in air. The EPA Reference Concentration (RfC) of 2.1 µg/m^3 was derived from the Keil and Johnson studies. The RfC was adopted by ATSDR as both the intermediate and chronic inhalation MRLs for TCE exposure [ATSDR 2019]. Table 6 describes if the adjusted EPC in different sections/rooms inside Unit 6 exceeded MRL and HEC values associated with animal studies.

Table 6: Summary of Adjusted Exposure Point Concentrations Exceeding Health Guidelines and Human Equivalent Concentrations (HECs) Associated with Animal Studies

Area in Unit 6	Adjusted EPC[1] (µg/m^3)*	Duration (Years)	EPC Exceeded MRL[2] (2.1 µg/m^3)*	(190 µg/m^3)* HEC[3] Associated with Thymus Changes	(21 µg/m^3)* HEC Associated with Fetal Heart Malformations
Shipping Office	29.8	5 to 20	Yes	6 times lower	Exceeded
Laboratory	6.4	3 to 20	Yes	30 times lower	3 times lower
IA-6-5	6	5 to 20	Yes	32 times lower	4 times lower
Line Storage	7.4	5 to 20	Yes	26 times lower	3 times lower
Whole unit 6	3.6	3 to 25	Yes	53 times lower	6 times lower

[1]Exposure Point Concentration (EPC): The representative contaminant concentration within an exposure unit or area in an exposure pathway to which people are exposed for acute (1-14 days), intermediate (15-364 days), or chronic (365+ days) durations during the past, present, or future.
[2]MRL: ATSDR minimal risk level (ATSDR 2021).
[3]HEC: Human equivalent concentration.
* µg/m^3: micrograms of analyte per cubic meter of air

Unit 6 indoor air concentrations are above the MRL for TCE. The human equivalent concentration (HEC) for a 1 percent extra risk of fetal cardiac malformations is 21 µg/m^3, while the HEC for decreased thymus weight is 190 µg/m^3 [Kiel et al. 2009]. For fetal heart

[3] [ATSDR] Agency for Toxic Substances and Disease Registry. 2019. Exposure Point Concentration Guidance for Discrete Sampling. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, July 12.

malformations, EPA used an uncertainty factor of 10 to account for human variation and species differences. For decreased thymus weight, EPA used an uncertainty factor of 100 to account for the use of the lowest observed adverse effects level (LOAEL), as well as human variation and species differences. The midpoint between the candidate RfC for the two critical effects (rounding to one significant digit) was used to derive the TCE RfC of 2.1 µg/m^3 [USEPA 2011]. The highest indoor air concentration detected in the shipping office was 14 times above the RfC for chronic inhalation of TCE and above the HEC for fetal cardiac malformation.
In the past, employees utilized the shipping office for less than an hour for shipping purposes[4].

The second highest TCE concentration was detected in the laboratory, where two female employees of childbearing age work, and was 3 times above the RfC/MRL for chronic inhalation of TCE but not above the HEC for fetal cardiac malformation. Exposure of pregnant women to TCE levels above the MRL does not mean that fetal heart development will be impaired. However, breathing air approaching or exceeding 21 µg/m^3 of TCE begins to introduce a small risk to proper fetal development and should be avoided. Inside the entire building, the adjusted TCE exposure point concentration was approximately 2 times above the MRL for chronic inhalation of TCE but not above the HEC for fetal cardiac malformation. Some uncertainty exists in these calculations because of limited indoor air sampling. Therefore, there might have been periods where exposures were higher for brief periods.

Although the highest indoor air concentration detected is lower than the HEC of 190 µg/m^3 for decreased thymus weight observed in mice, a small amount of risk to impacts on the immune system may exist in immunosuppressed populations [ATSDR 2019]. It is also important to note that indoor air samples were collected during a small snapshot of time, and thus may not have been reflective of temporal changes that can occur over longer periods of time. Seasonal indoor air sampling with concurrent outdoor air and sub-slab gas sampling is recommended to assess exposure risks during different seasonal conditions. Using indicators, tracers, and surrogate technology[5] can increase confidence in the results from sampling events.

Cancer Risks

In addition to noncancer health risks associated with TCE exposure, long-term inhalation of TCE can also increase one's risk of developing certain cancers. The EPA released an extensive toxicological review of TCE, in which they reclassified TCE as "carcinogenic to humans by all routes of exposure" [USEPA 2011]. The National Toxicology Program has also determined that TCE is "reasonably anticipated to be a human carcinogen". The most consistent and convincing evidence of an association between TCE exposure in humans and cancer is for cancer of the kidney. However, there are also compelling links between TCE exposure and cancers of the lymphoid tissues (lymphoma) and liver [USEPA 2011].

In addition to the concentration in air that someone is exposed to, the duration of exposure is another important factor in estimating someone's risk of getting cancer from work

[4] Personal communication with SD Polymers plant manager on March 23, 2021.
[5] Temperature Measurement Fact Sheet (https://iavi.rti.org/assets/docs/Temp_Measurement_Fact_Sheet_int.pdf), Pressure Measurement Fact Sheet (https://iavi.rti.org/assets/docs/Pressure_Measurement_Fact_Sheet_Int.pdf), Radon Methods Fact Sheet (https://iavi.rti.org/assets/docs/Radon_methods_fact_sheet_int.pdf)

exposure. We therefore estimated cancer risk based on working at the facility for 3, 5, 20, and 25 years. We know that some workers worked at the facility for 3 years and at least one worker worked for 25 years. The average worker is at a job for 5 years while some workers are at a facility for 20 years or more.

Please refer to Appendix B for an explanation of the estimated excess cancer risk calculations associated with exposure to the average concentration of TCE detected in areas of Unit 6 during different exposure duration scenarios. Table 7 describes estimated cancer risks associated with location based on exposure scenarios used in the health consultation. Appendix C contains general cancer information.

Table 7: Estimated Cancer Risks from Long term Exposure to TCE at Unit 6.

Scenarios	Shipping Office	Laboratory	IA-6-5	Line storage area (IA-6-35, 42, 46)	Entire Unit 6
Reasonable Maximum Exposure (RME)[1] (20 years)	3×10^{-5}	7×10^{-6}	6×10^{-6}	8×10^{-6}	4×10^{-6}
Central Tendency Exposure (CTE)[2] (5 Years)	8×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}	1×10^{-6}
Maximum Exposure[3] (25 Years)	5×10^{-6}				
Laboratory Exposure[4] (3 Years)	1×10^{-6}				

[1]RME: Reasonable maximum exposure. RME refers to the high end of the exposure distribution (approximately the 95th percentile) for the exposed population. The RME scenario is intended to assess exposures that are higher than average but are still within a realistic range of exposure.
[2]CTE: Central tendency exposure. CTE refers to individuals who have average or typical exposure to a contaminant.
[3]Maximum Exposure: The maximum exposure scenario is intended to assess exposures of employees working at the facility for 25 years.
[4]Laboratory Exposure: The exposure scenario is intended to assess exposure of employees working in the laboratory for 3 years.

Cancer risks were calculated for adult employees only ranging from 21 to 65 years, working at Unit 6 from a minimum of 3 years to a maximum of 25 years. Typically, screening levels developed for carcinogens are based on one excess cancer case per 1,000,000 individuals and assumes that people are exposed to the same concentration over their lifetime. Because workers are not exposed their entire lifetime, we estimated cancer risk based on their working at the facility for different durations. DPH considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk (expressed exponentially as 1×10^{-6}).

Cancer risks from working at SD Polymers for 20 and 25 years

The estimated excess cancer risk shown in Table 7 assumes that workers are exposed to the same continuous concentration of TCE for 20 or 25 years (RME, long employment durations).

Personnel working in the shipping office all day, every day have the highest cancer risk with an estimated increased cancer risk of approximately 3 excess cancers in a population of 100,000 people exposed to the same TCE concentration for 20 years. However, the shipping office was only briefly occupied by personnel and was used as a mail room. If workers spent 1.5 hours day in the shipping office, cancer risk reduces to approximately 6 excess cancers in a population of 1,000,000 people. The shipping office was destroyed during a fire in January 2021 (Picture in Appendix A: Maps and Images, Figure 4), so exposure has ceased.

Based on employees working at the facility for either 20 or 25 years, the estimated cancer risk for the other rooms in Unit 6 range from 4 to 8 in a million and employees would have low increased cancer risk.

Cancer risks from working at SD Polymer for 3 or 5 years

The estimated excess cancer risk shown in Table 6 assumes that workers are exposed to the same concentration of TCE for 3 or 5 years (CTE, average employment duration).

When looking at estimated cancer risks for the typical employee who works either 3 or 5 years at the facility, estimated cancer risks are less than long-time workers. The cancer risk of short-time (CTE) workers ranges from approximately 1 to 2 in a million. Cancer risk is estimated to be 8 in a million if personnel spent a typical 8.5-hour day in the shipping office for 5 years. However, based on personnel occupying the shipping office for 1.5 hours a day for 5 years, their estimated cancer risk is about 1 in a million. Cancer risk decreases as employment duration and hours decrease. For personnel working at SD Polymers for approximately 5 years or less, estimated increased cancer risks are low. Personnel working in the laboratory for 3 years had an estimated increased cancer risk of approximately 1 in a million, considered an insignificant estimated excess cancer risk.

Personnel working in different areas of Unit 6 have about a 2 in a million estimated cancer risk from their exposures assuming 3 to 5 years of exposure. This risk decreases when employees move around all areas of Unit 6.

Conclusions

DPH evaluated past and current exposure to TCE from breathing indoor air at Unit 6 at the former Macon Naval Ordnance Plant (MNOP). Although, employees were exposed to TCE levels above the MRL, it does not mean employees will experience adverse health outcomes. This evaluation includes an assessment of exposure doses and estimated increased cancer risk from inhalation of contaminants present in indoor air.

DPH reached the following conclusions:

1. Some employees may have experienced adverse non-cancerous health effects from their exposure to TCE in indoor air. Exposure varies depending upon where people worked within Unit 6 and how long they worked there. Potential non-cancerous health effects from TCE exposure at various locations within Unit 6 are specified below:

    a. Shipping Office (IA-6-1): Past exposure to TCE in the shipping office via vapor intrusion for 5 to 20 years or more could have harmed an employee's health or the fetus of an employee who became pregnant during their employment.

    The levels of TCE were six times lower than the human equivalent concentration (HEC) associated with thymus changes in animal studies so employees have a slight risk for immune system impacts. Past TCE exposure to pregnant women could have resulted in fetal heart malformations as the levels were above the HEC associated with animal studies. However, this assumes employees were exposed to TCE in the shipping office for 8.5 hours per day, 5 days per week. The shipping office was used as a mailroom, occupied by employees less than an hour at a time when being used. This significantly reduces the exposure duration in the shipping office and any actual exposures to TCE levels. Furthermore, the shipping office was destroyed by fire in January 2020 and employees are no longer exposed to TCE from that area.

    b. Laboratory (IA-6-4): Employee exposure to TCE in the laboratory via vapor intrusion for 3 to 20 years or more could harm an employee's health or the fetus of an employee who becomes pregnant during their employment.

    Women who become pregnant while working in the laboratory have a slight risk for fetal heart development problems in their developing fetus since, the levels were approaching the HEC associated with animal studies. Exposure of pregnant women to TCE at this level does not mean that fetal heart development will be impaired but breathing air contaminated with TCE introduces a small risk to proper fetal development and should be avoided. Employees exposed to the levels of TCE found in the lab are unlikely to be harmed by immune system impacts as the levels of TCE were 30 times lower than the HEC associated with decreased thymus weight in animal studies. Currently, SD Polymers has plans to move the laboratory from Unit 6 to another building across the street from current operations. Indoor air sampled in the proposed new laboratory location tested negative for vapor intrusion contaminants that were found in Unit 6.

    c. IA-6-5 & Line Storage IA-6-(35,42,46): Exposure to TCE in these areas via vapor intrusion for 5 to 20 years or more could harm an employee's health or the fetus of an employee who becomes pregnant during their employment.

    Pregnant women exposed to these areas have a slight risk for fetal heart development problems in their developing fetus since, the levels were approaching the HEC

associated with animal studies. Exposed employees are unlikely to experience health effects, such as immune system impacts since the levels of TCE were 26 to 32 times lower than the HEC that has been associated with decreased thymus weight in animal studies.

d. Whole Unit 6: Employees exposed to TCE in indoor air via vapor intrusion for 3 to 25 years while working in various locations throughout Unit 6 are not expected to be harmed.

Employees who are continually working in various locations of Unit 6 are represented by Whole Unit 6 exposures: the levels of TCE were estimated at 53 times lower than the HEC associated with decreased thymus weight in animal studies and 6 times lower than the HEC for fetal heart malformations that has been associated with animal studies. However, at Unit 6, the elderly, immune compromised, and employees with pre-existing disease may experience health effects that have been associated with animal studies.

2. Cancer risk varies depending upon where people worked within Unit 6 and how long they worked there. The following cancer risks are based on assuming workers worked for short periods (3 to 5 years) or long periods (20 to 25 years) in Unit 6 and were exposed to TCE in indoor air.

Cancer risk based on 3 to 5 years of exposure

a. When looking at estimated cancer risks for the typical employee who works either 3 or 5 years at the facility, estimated cancer risks are less than for long-time workers. The increased cancer risk of short-term (CTE) workers ranges from approximately 1 to 8 in a million. Personnel working in the laboratory for 3 years had an estimated increased cancer risk of approximately 1 in a million. For personnel working at SD Polymers for approximately 5 years or less, estimated increased cancer risks are not a concern.

Cancer risk based on 20 to 25 years of exposure

b. Unit 6: Employees breathing TCE that results from vapor intrusion in parts of Unit 6 have a slightly elevated estimated cancer risk ranging from 4 to 8 in a million from TCE exposure based on available data.

Shipping Office: If employees worked full-time in the shipping office in the past, they would have a small elevated estimated cancer risk from their exposures (approximately 3 excess cancers in a population of 100,000 people over a 20-year period). Their actual risk is lower because the shipping office was used as a mailroom that was only briefly occupied by workers. Most personnel working in Unit 6 are estimated to have a slightly increased cancer risk from their exposures to TCE. Breathing TCE for long periods may increase the risk of kidney cancer, liver cancer, and non-Hodgkin's lymphoma.

3. Based on sub-slab soil gas data, a low-level risk from vapor intrusion will exist until contamination in sub-slab soil and groundwater is sufficiently reduced or removed. Sub-slab soil gas data confirms significant TCE contamination below Unit 6 acting as a source for vapor intrusion into the interior of the facility.

Recommendations

To protect the current and future health of individuals working in Unit 6, DPH recommends the following actions:

1. EPA should inform employees of past elevated TCE concentrations in Unit 6, the potential health risks associated with TCE inhalation, and steps taken and planned to mitigate TCE exposure in Unit 6.

2. EPA/potentially responsible party (PRP) should implement permanent measures to mitigate vapor intrusion in Unit 6. In addition, EPA/PRP should ensure proper maintenance and effectiveness of any VI mitigation system.

3. The EPA/PRP should perform indoor air sampling at Unit 6 after installation of mitigation system to determine if mitigation efforts are sufficient in decreasing vapor intrusion into Unit 6. It is important to note that indoor air samples were collected during a small snapshot of time, and thus may not have been reflective of temporal changes that can occur over longer periods of time. In addition, seasonal indoor air sampling with concurrent outdoor air and sub-slab gas sampling is recommended to assess exposure risks during different seasonal conditions. Using indicators, tracers, and surrogate technology can increase confidence in the results from sampling events and provide more accurate data from which to assess exposure risks. Vapor intrusion rates can fluctuate with changes in season and the use of heating and cooling systems. Temperature and humidity can affect monitors so these parameters would also have to be monitored. The PRP should implement indoor air filtration as necessary, ventilate Unit 6 and seal all cracks and openings on the floors (slab) in Unit 6.

4. SD Polymers should move laboratory and laboratory employees to another location with no VI occurrences. In addition, SD Polymers should consider implementing temporary measures to prevent TCE exposure to female workers of childbearing age until permanent mitigation solutions are in place.

Public Health Action Plan

DPH will:

1. Distribute a fact sheet summarizing our findings to SD Polymer employees and ensure that health education on TCE exposure reaches those employees affected by vapor intrusion in the Unit 6.

2. Continue to review sampling data and take appropriate actions as additional data become available.

3. Continue to respond to all requests for information and health concerns regarding the safety of breathing contaminated indoor air.

DPH and ATSDR are available to review additional data and assist with communicating health risks to the facility owner and employees. If you have any questions regarding the findings presented in this letter, please contact me at (404) 657- 6534 or by email at anita.saha@dph.ga.gov.

Sincerely,

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References

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006 Toxicological Profile for Vinyl Chloride. Atlanta, Georgia: U.S. Department of Health and Human Services; July 2006.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015. Who is most sensitive to TCE? – Developing Baby. December 29, 2015. https://www.atsdr.cdc.gov/tox-tool/trichloroethylene/05/tce_5a.html

[ATSDR]. Agency for Toxic Substances and Disease Registry. 2019. Toxicological Profile for Trichloroethylene (Update). Atlanta, Georgia: U.S. Department of Health and Human Services; June 2019.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2020a. Guidance for inhalation exposure, v1- Sept 30, 2020 (in ATSDR's PHAST).

[ATSDR] Agency for Toxic Substances and Disease Registry. 2020b. Public Health Assessment Guidance Manual (update). Atlanta, Georgia: U.S. Department of Health and Human Services; December 2020.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2021. Minimal Risk Levels (MRLs). March 2021. https://wwwn.cdc.gov/TSP/MRLS/mrlsListing.aspx

[ATSDR] Agency for Toxic Substances and Disease Registry. 2021. EPC Guidance for Discrete Sampling. August 2021.

[ERM] Environmental Resources Management. Remedial Investigation/ Feasibility Study Work Plan. 2019. Facility ID# GAD003302676, Former Macon Naval Ordinance Site. Submitted to EPA September 3, 2019.

Johnson P, Goldberg S, Mays M and Dawson B. 2003. Threshold of trichloroethylene contamination in maternal drinking waters affecting fetal heart development in the rat. Environmental Health Perspectives 111(3):289-292.

Keil DE, Peden-Adams MM, Wallace S, Ruiz P and Gilkeson GS, 2009. Assessment of trichloroethylene (TCE) exposure in murine strains genetically prone to develop autoimmune disease. Journal of Environmental Science and Health 44(5):443-453.

[NCDEQ] North Carolina Department of Environmental Quality. 2018. Trichloroethylene (TCE) Inhalation Immediate Action Levels and Response Guidance for Indoor Air Protective of Cardiac Developmental Defects. October 15.

[RUST] RUST Environment and Infrastructure Inc. 1997. Final Site Investigation Report, Allied Industrial Park Site, Macon, Georgia. Submitted to U.S Army Corps of Engineers (USACE). May.

[USEPA] U.S. Environmental Protection Agency. 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March.

[USEPA] U.S. Environmental Protection Agency. 2011. Toxicological Review of Trichloroethylene in Support of Summary Information on the Integrated Risk Information System (IRIS). September. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0199_summary.pdf.

[USEPA] U.S. Environmental Protection Agency.2015a. Region 4 EPA, Science and Ecosystem Support Division, Quality Assurance Project Plan, Macon Naval Ordnance Plant Vapor Intrusion Study. February.

[USEPA] U.S. Environmental Protection Agency. 2015b. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. June.

[USEPA] U.S. Environmental Protection Agency. 2016. ProUCL: Statistical Support Software for Site Investigation and Evaluation. March.

[USEPA] U.S. Environmental Protection Agency. 2020. Question and Answers for Workers at 121 Ennis Blvd. March.

Appendix A: Maps and Images

Figure 1: Former Macon Naval Ordinance Plant property at 600 Guy Paine Rd, Macon, GA 31206. Unit 6 [highlighted in yellow] is located at the northern side of the site with an address of 121 Ennis Blvd, Macon, GA 31206. Currently, SD Polymers is operating at Unit 6. [Photo credit: Brian Ferrier, EPA Region 4]

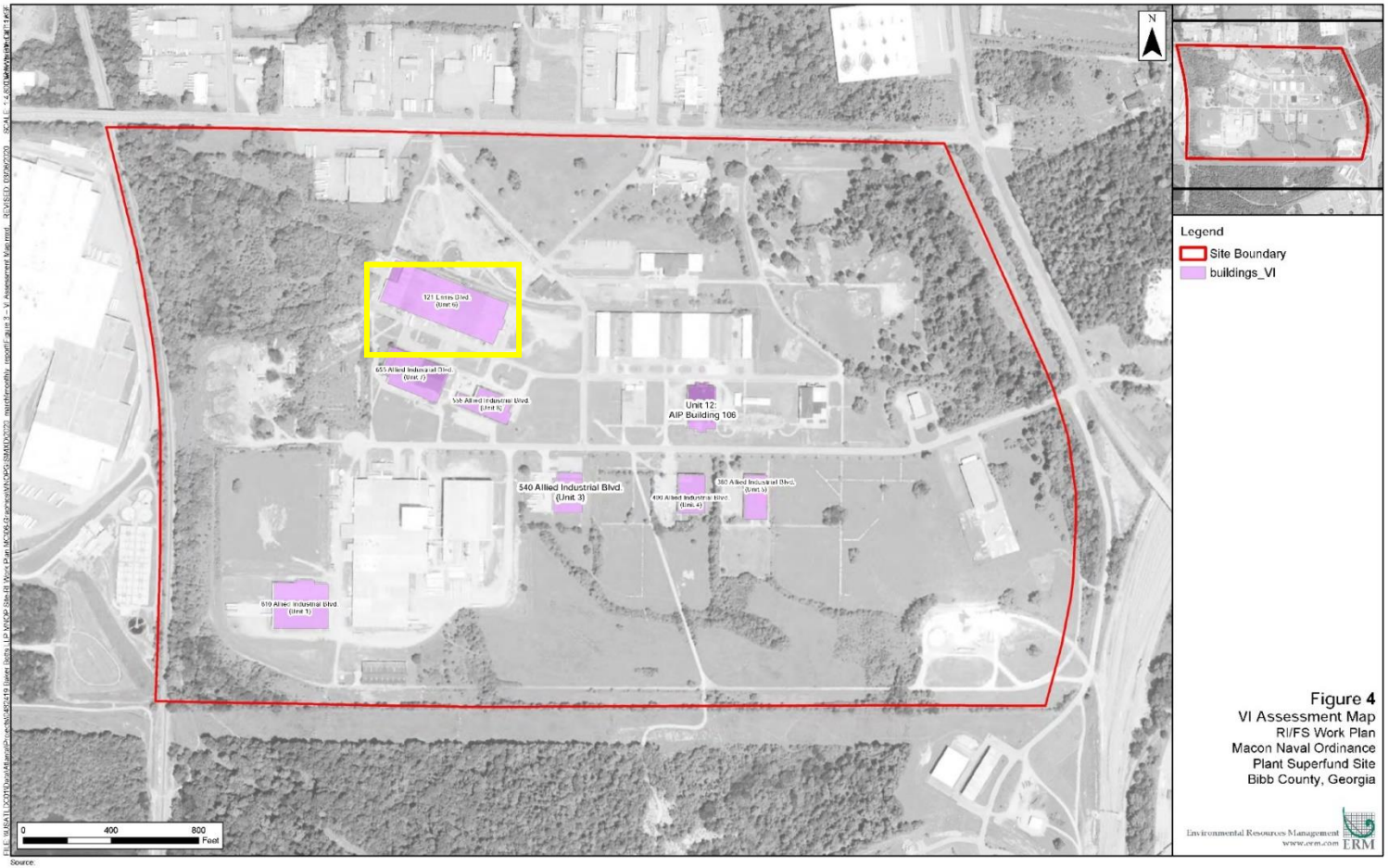

Figure 2: Unit 6 layout. Buildings #2 and #3 [highlighted in orange] were burned down during the fire on January 1, 2021. Buildings #2 and #3 in Unit 6 included: the shipping office, employee breakroom, and storage areas. [Photo credit: Brian Ferrier, EPA Region 4]

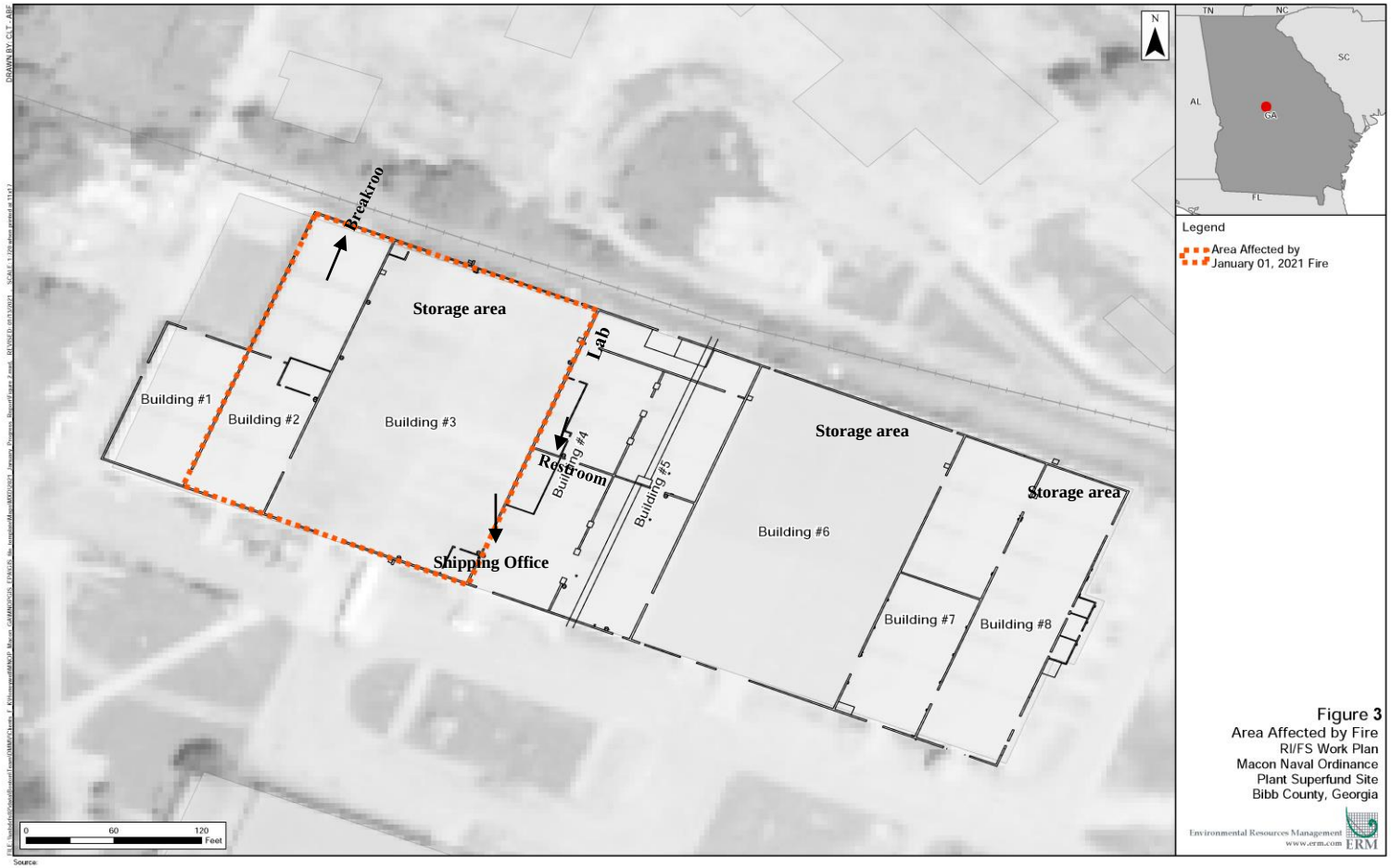

Figure 3: Concentration of TCE (in ppb) in groundwater at Former Macon Naval Ordinance Plant at 600 Guy Paine Rd, Macon, GA 31206. Unit 6 [highlighted in yellow] has TCE in groundwater beneath buildings in the unit. [Photo credit: Brian Ferrier, EPA Region 4]

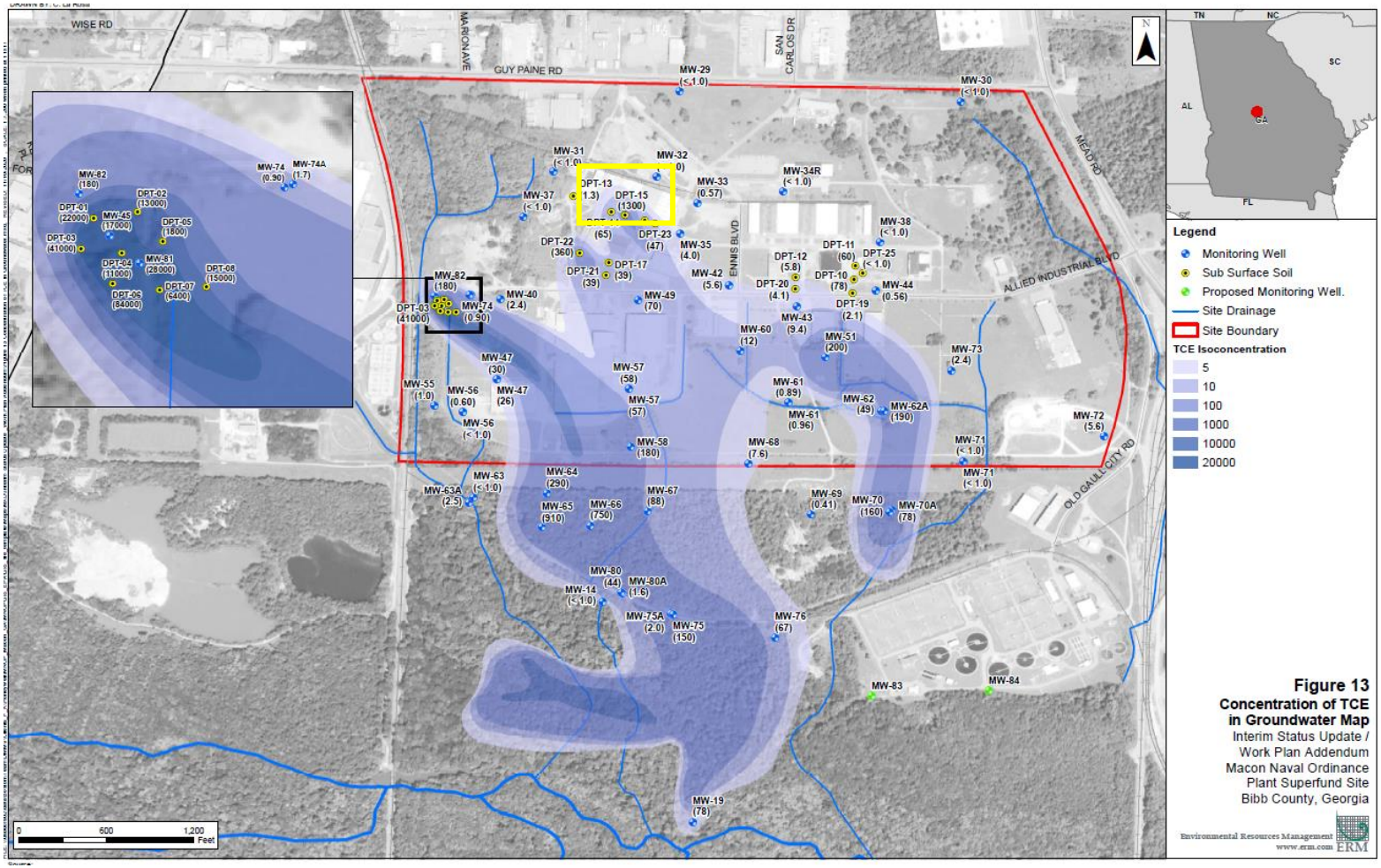

Figure 4: Shipping office was located on the front corner of building 3 in Unit 6. Building 3 in Unit 6 including the shipping office was destroyed during the fire on January 1, 2021. [Photo credit: Anita Saha, and Franklin Sanchez DPH, 3/23/2021]

Figure 5: Burnt Area at Unit 6. Building 3 in Unit 6 including the shipping office was destroyed during the fire on January 1, 2021. The outside ledge on the right side of this photo is where TCE storage tanks were once placed. Their leakage led to the underlying groundwater contamination plume at the MNOP. [Photo credit: Anita Saha, DPH, 3/23/2021]

Appendix B: Explanation of Evaluation Process

Step 1--The Screening Process

In order to evaluate the available data, DPH used comparison values (CVs) to determine which chemicals to examine more closely. CVs are contaminant concentrations found in a specific environmental media (air, soil, water, sediment, and food) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard quantity of environmental media that someone may inhale or ingest each day. CVs are generated to be conservative and non-site specific. The CV is used as a screening level during the public health assessment or health consultation process. CVs are not intended to be environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based CVs are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factors for ingestion exposure, or inhalation risk units for inhalation exposure. Non-cancer CVs are calculated from ATSDR's minimal risk levels, EPA's reference doses, or EPA's reference concentrations for ingestion and inhalation exposure. When a cancer and non-cancer CV exist for the same chemical, the lower of these values is used as a conservative measure.

Step 2--Evaluation of Public Health Implications

The next step in the evaluation process is to take those contaminants that are above their respective CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Adult exposure doses (or the amount of a contaminant that gets into a person's body) are calculated for site-specific scenarios, using assumptions regarding an individual's likelihood of exposure to contaminants in indoor air. A brief explanation of the calculation of estimated exposure doses used in this health consultation is presented below.

Exposure Factor (EF) Calculation:

Reasonable Maximum Exposure: 8.5 hours exposures per day for 20 years

$$\mathrm{EF} = \frac{8.5\frac{hr}{d}\times 5\frac{d}{wk}\times 50\frac{wk}{yr}\times 20yr}{24\frac{hr}{d}\times 7\frac{d}{wk}\times 52.14\frac{wk}{yr}\times 20yr} = 0.242593$$

Exposure Point Concentration (EPC) Concentration:

Exposure Point Concentration = Exposure Factor x Max Concentration x $\frac{20\ year}{20\ year}$

Example: Shipping Office = 0.2426 x 123 µg/m^3 x $\frac{20}{20}$ = 29.8 µg/m^3

Step 3--Cancer Risk Evaluation

Exposure to a cancer-causing chemical, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated risk for developing cancer from exposure to contaminants associated with breathing indoor air in Unit 6 was calculated by multiplying the adjusted air concentrations by EPA's chemical-specific inhalation unit risks (IURs) available at *www.epa.gov/iris*. The adjusted air concentration was determined based on the following factors:

- How many hours per day someone worked in a room (typically 8.5 hr/day),
- How many days a week someone worked (typically 5 days/week), and
- How many years someone worked (ranged from 3 to 25 years).

This calculation estimates an excess cancer risk expressed as a proportion of the population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated risk of 1 x 10^{-6} predicts the probability of one additional cancer over background in a population of 1 million exposed persons. An increased lifetime cancer risk is not an estimate of expected cancers in the workforce or community. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime in his or her lifetime following exposure to a particular contaminant under specific exposure scenarios.

When there is sufficient weight of evidence to conclude that a carcinogen operates through a mutagenic mode of action, and in the absence of chemical-specific data on age-specific susceptibility, EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* [USEPA 2005] advises that increased early-life susceptibility be assumed and recommends that default age-dependent adjustment factors (ADAFs) be applied to adjust for this potential increased susceptibility from early-life exposure. The current ADAFs and their age groupings are 10 for <2 years, 3 for 2 to <16 years, and 1 for ≥16 years. For risk assessments based on specific exposure assessments, the 10- and 3-fold adjustments to the slope factor or unit risk estimates are to be combined with age-specific exposure estimates when estimating cancer risks from early-life (<16-years-of-age) exposure. Currently, due to lack of appropriate data, no ADAFs are used for other life stages, such as the elderly.

In the case of TCE, the inhalation unit risk and oral slope factor estimates reflect lifetime risk for cancer at multiple sites, and a mutagenic mode of action has been established for one of these sites, the kidney. EPA provides three organ-specific cancer potency factors for TCE (kidney, liver, and non-Hodgkin's lymphoma) for calculating cancer risk. Because TCE is mutagenic for kidney cancers, ADAFs are applied to only the kidney portion of the cancer risk.

The equations used in Examples B.1 and B.2 (specific exposure scenarios) are described below. It is assumed that an individual is exposed to the ATSDR MRL/cEMEG of 2.1 $\mu g/m^3$ of TCE in air from birth through age 78 years. A summary of the estimated cancer risks associated with specific areas in Unit 6 and based on different exposure scenarios is provided in Table 7 of this health consultation.

Equations used in Examples B.1 and B.2:

CR = Adjusted EPC x IUR x (ED ÷ LY)

ADAF-adjusted CR = (Adjusted EPC x IUR) x (ED ÷ LY) x ADAF

Total CR = Sum of the CR for all exposure groups

Where,

CR = cancer risk (unitless),

EPC = exposure point concentration ($\mu g/m^3$ or ppb),

IUR = inhalation unit risk (($\mu g/m^3$ or ppb)$^{-1}$),

ED = exposure duration (years),

LY = lifetime years (78 years),

ADAF = age-dependent adjustment factor (unitless)

Example B.1: Calculation for total cancer risk for adult employees at <u>Whole Unit 6</u> based on the kidney unit risk estimate, potential risk for NHL and liver cancer, and potential increased early-life susceptibility, assuming constant exposure to 3.6 µg/m^3 for 8.5 hrs/day at 5 days/week for 5 years.	
TCE Cancer Risk = Adjusted EPC x IUR x ADAF x $\frac{5}{78}$ = 3.6 x (1x10^{-06} + 1x10^{-06} + 2.1x10^{-06}) x 1 x $\frac{5}{78}$ = 9.5x10^{-07} or 1x10^{-06*}	Adjusted EPC: Adjusted Exposure Point Concentration = 3.6 µg/m^3 IUR: Inhalation Unit Risk = (1x10^{-06}[Liver] + 1x10^{-06}[kidney] + 2.1x10^{-06}[NHL[1]]) = 4.1x10^{-06} ADAF: Age Dependent Adjustment Factor = 1

[1]NHL: non-Hodgkin's lymphoma

* Rounded to 10E-07 which is equivalent to 1E-06

** The calculations in this example were generated using ATSDR's PHAST v2.1.1.0.

Example B.2: Calculation for total cancer risk for adult employees at <u>Laboratory</u> based on the kidney unit risk estimate, potential risk for NHL and liver cancer, and potential increased early-life susceptibility, assuming constant exposure to 6.4 µg/m^3 for 8.5 hrs/day at 5 days/week for 3 years.	
TCE Cancer Risk = Adjusted EPC x IUR x ADAF x $\frac{3}{78}$ = 6.4 x (1x10^{-06} + 1x10^{-06} + 2.1x10^{-06}) x 1 x $\frac{3}{78}$ = 1.0x10^{-06}	Adjusted EPC: Adjusted Exposure Point Concentration = 6.4 µg/m^3 IUR: Inhalation Unit Risk = (1x10^{-06}[Liver] + 1x10^{-06}[kidney] + 2.1x10^{-06}[NHL[1]]) = 4.1x10^{-06} ADAF: Age Dependent Adjustment Factor = 1

[1]NHL: non-Hodgkin's lymphoma

** The calculations in this example were generated using ATSDR's PHAST v2.1.1.0.

Appendix C: General Cancer Information

Cancer will affect one in 2 men and one in 3 women in the United States, according to statistics collected by the Surveillance Epidemiology and End Results program at the National Cancer Institute [*www.seer.cancer.gov*]. Cancer is a group of more than 100 diseases characterized by uncontrolled growth and spread of abnormal cells. Different types of cancers have differing rates of occurrence, different causes, and chances for survival. Therefore, we cannot assume that all the different types of cancers in a community or workplace share a common cause or can be prevented by a single intervention.

Cancers may be caused by a variety of factors acting alone or together, usually over a period of many years. Scientists estimate that most cancers are due to factors related to how we live, or lifestyle factors which increase the risk for cancer including: smoking cigarettes, drinking heavily, and diet (for example, excess calories, high fat, and low fiber). Other important cancer risk factors include reproductive patterns, sexual behavior, and sunlight exposure. A family history of cancer may also increase a person's chances of developing cancer.

Smoking is by far the leading risk factor for lung cancer. Smokers are about 20 times more likely to develop lung cancer than nonsmokers. People who don't smoke but who breathe the smoke of others also have a higher risk of lung cancer. A non-smoker who lives with a smoker has about a 20% to 30% greater risk of developing lung cancer. Workers exposed to tobacco smoke in the workplace are also more likely to get lung cancer. Exposure to radon, asbestos, arsenic, chromium, nickel, soot, tar, and other substances can also cause lung cancer. An increased risk for lung cancer has also been associated with personal or family history of lung cancer. Most people are older than 65 years when diagnosed with lung cancer.

Smoking tobacco is also an important risk factor for kidney cancer. Obesity and high blood pressure have also been linked to the disease. People with a family member who had kidney cancer have a slightly increased risk of kidney cancer. Also, certain hereditary conditions can increase the risk. Kidney cancer is about twice as common in men as in women and is slightly more common among blacks than other races. Workplace exposure to asbestos, cadmium, some herbicides, benzene, and organic solvents, particularly trichloroethylene, has also been associated with an increased risk for kidney cancer.

While cancer occurs in people of all ages, new cases of most types of cancer rise sharply among people over 45 years of age. When a community, neighborhood, or workplace consists primarily of people over the age of 45 (and even more so over the age of 60), we would expect more cancers than in a neighborhood or workplace with people of younger ages. However, cancer is also the second leading cause of death in children.

Many people believe that cancer is usually caused by toxic substances in the home, community, or workplace. Although we do not know the exact impact now of environmental pollutants on cancer development, less than 10% of cancers are estimated to be related to toxic exposures – only 2 percent are attributed to environmental causes.

Since the 1970s when state cancer registries were first being organized, many public health scientists and residents hoped that anecdotal observations of clusters of cancer in the community might lead to prevention of new cases via discovery of specific causes of these cancers. Since then, thousands of investigations have taken place throughout the country, mainly conducted by

state, local, or federal agencies. With one or two possible exceptions involving childhood cancers, none of these investigations have led to the identification of the causes of any of these possible clusters, even when a statistically elevated number of cancers in a geographic area could be documented. The Georgia Department of Public Health has developed strategies for active cancer surveillance. This systematic approach to monitoring cancer trends in our state will lead to more opportunities for prevention and control of cancer in Georgia.