Health Consultation

Highway 18 Groundwater Superfund Site
Kermit, Winkler County, Texas

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry (ATSDR)
Office of Capacity Development and Applied Prevention Science
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure 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 report concludes the health consultation process for this site, unless additional information is obtained by ATSDR. If the new information, in the agency's opinion, indicates a need to revise or append the conclusions previously issued, the consultation may resume.

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Contents

List of Tables

List of Figures

Acronyms and Abbreviations

µg/m^3	Micrograms per cubic meter
ATSDR	Agency for Toxic Substances and Disease Registry
CTE	Central Tendency Exposure
CV	Comparison Values
DSHS	Department of State Health Services
EP	Entry Points
EP1	The Underwood Pumphouse
EP2	The Walton Pumphouse
EPA	Environmental Protection Agency
EPC	Exposure Point Concentrations
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
IUR	Inhalation Risk Factor
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
MOE	Margin of Exposure
MRL	Minimal Risk Level
NOAEL	No Observed Adverse Effects Level
ND	Not detected
NPL	National Priorities List
NTP	National Toxicity Program
PCE	Tetrachloroethylene or tetrachloroethene
PHAST	Public Health Assessment Site Tool
PVC	Polyvinyl chloride
PWS	Public Water System
RfC	Reference Concentration
RL	Reporting Limit
RV	Recreational vehicle
RME	Reasonable Maximum Exposure
SHOWER	Shower and Household Water-Use Exposure Model

TCE	Trichloroethylene or trichloroethene
TCEQ	Texas Commission on Environmental Quality
UCL	Upper Confidence Limit
VOCs	Volatile Organic Compounds

1. Summary

The Highway 18 Groundwater Plume site (the Site) is in Kermit, Winkler County, Texas. The Environmental Protection Agency (EPA) placed the Site on the National Priorities List (NPL) of hazardous substances on August 3, 2017, because of trichloroethylene (TCE) and tetrachloroethylene (PCE) groundwater contamination. The source of contamination was identified as a former dry cleaner. The dry cleaner was operational in the 1970s. Currently, Mekason Pharmacy-Kermit (pharmacy) occupies the building.

The contaminated groundwater spread beneath a residential area adjacent to the Site. According to the Texas Department of State Health Services (DSHS), approximately 121 occupied buildings and a recreational vehicle (RV) park are located above the contaminated groundwater.

The Agency for Toxic Substances and Disease Registry (ATSDR) was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. Since 1986, ATSDR is required by law to conduct a public health assessment at each site on the NPL. DSHS has a cooperative agreement with ATSDR to perform public health assessment activities for each NPL site in the state of Texas.

From 2019 to 2023, EPA collected groundwater from monitoring wells, soil, and indoor air samples to identify the source and the extent of contamination at the Site [EA 2020, Weston 2023]. This health consultation evaluates the sampling results. DSHS focused on health hazards from the NPL site, but also on chemicals not specifically related to the NPL site. The purpose of the health consultation is to determine whether past, present, and future exposure to contaminants in indoor air and groundwater could harm public health. DSHS will review and evaluate additional data as it becomes available.

1.1. Conclusions and Recommendations

DSHS reached seven conclusions in this health consultation.

Conclusion 1

Inhaling PCE and TCE in indoor air at the Mekason Pharmacy-Kermit is not likely to cause adverse noncancer or cancer health effects in workers and business patrons.

Basis for Conclusion

DSHS evaluated indoor air samples collected at the pharmacy in October 2022 and May 2023. PCE was detected in indoor air, but levels were below those expected to cause adverse noncancer and cancer health effects for full-time and part-time workers and for patrons. TCE was not detected above screening levels in indoor air.

PCE was detected in subslab soil gas samples collected along the perimeter of the pharmacy building. These observations suggest PCE in indoor air is likely from vapor intrusion from PCE in groundwater and soil near the pharmacy. Vapor intrusion occurs when chemicals evaporate from contaminated soil or groundwater and rise into the

	indoor air of buildings. Vapor intrusion can also occur when vapors from contaminated soil or groundwater enter a sewer line, travel through it, and then escape into a building through leaks or cracks.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at the pharmacy to confirm levels are not increasing and remain below EPA action levels.
Conclusion 2	PCE and TCE were not detected in indoor air at a nearby residence or at the Winkler Senior Recreation Center (recreation center). Because of the potential for seasonal variation, additional information is needed to determine the likelihood of future indoor inhalation exposure to PCE and TCE.
Basis for Conclusion	DSHS evaluated indoor air samples collected at a residence (1 sample in May 2023) and at a senior recreation center (a total of 4 samples collected in March 2020 and May 2023). The residence and senior recreation center are in the path of the groundwater contaminant plume. PCE and TCE were not detected in indoor air at the senior recreation center or the residence. However, PCE was detected in subslab soil gas samples collected along the perimeter of both properties. The PCE detection suggests the possibility of vapor intrusion into the buildings. DSHS cannot determine whether vapor intrusion occurs over time without additional vapor intrusion sampling (indoor air, subslab gas, and outdoor air). Additionally, sampling during cold weather would help account for seasonal variability.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at the residence and senior recreation center. Collecting indoor air samples in both cold and hot weather would help characterize seasonal variability in potential exposures to better inform health risks from vapor intrusion. Consider using tracers, surrogates, and indicator parameters during sampling to show whether vapor intrusion was likely active or dormant during the sampling event.[1]
Conclusion 3	Indoor air samples were not collected from other residential and commercial buildings located above the contaminated groundwater. DSHS cannot currently determine whether breathing indoor air at these locations may harm people's health.
Basis for Conclusion	DSHS estimates there are 111 residential homes, 2 apartment buildings, 8 businesses, and an RV park within 100 feet of the PCE

[1] https://clu-in.org/download/issues/vi/5-Tracers-Surrogates-Indicators_Fact-Sheet-Final_508.pdf

	groundwater plume. The plume was delineated to 5 micrograms per liter (μg/L) PCE in 2023. The depth of groundwater is as shallow as 6 feet below ground surface. Therefore, PCE can move from the groundwater and soil and enter the interior of these buildings. To date, indoor air samples have only been collected from 3 buildings (a pharmacy, a senior recreation center, and a residence). While PCE has been detected in indoor air above the screening level at the former dry cleaner, which is now a pharmacy, the levels are below those for a health concern. Based on groundwater sampling data from 2022 and 2023, the most contaminated portion of the plume appears to be about 400 feet southwest of the pharmacy near the intersection of Ash and Campbell streets (Figure 4). Elevated PCE concentrations were detected in monitor well-18, located about 600 feet from the pharmacy. Given this information, people living above the contaminated groundwater may be at increased risk of PCE exposure. However, the soil vapor intrusion assessment was limited in scope in the down gradient plume area from the Site. This conclusion may be revised with additional environmental sampling.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at residences and businesses located within 100 feet of the groundwater contamination greater than ATSDR vapor intrusion comparison values. The area for potentially contaminated indoor air at residences and businesses may be further refined by comparing the groundwater and soil gas data to vapor intrusion comparison values, which are based on empirical attenuation rates. Collecting indoor air samples in both cold and hot weather would help characterize seasonal variability in potential exposures to better inform health risks from vapor intrusion. Consider using tracers, surrogates, and indicator parameters during sampling to show whether vapor intrusion was likely active or dormant during the sampling event.[2] DSHS recommends EPA continue to monitor the path of the contaminated groundwater plume for changes in contaminant levels.
Conclusion 4	Based on available information, students and staff at the Kermit Junior High School and Kermit High School are not expected to be exposed to PCE in indoor air.
Basis for Conclusion	Inhaling PCE and TCE is not likely to have taken place at the junior high and high schools because the contaminated groundwater is not beneath or near the schools. The schools' boundaries are over 800

[2] https://clu-in.org/download/issues/vi/5-Tracers-Surrogates-Indicators_Fact-Sheet-Final_508.pdf

	feet from the boundary of the groundwater contamination. Additionally, the current direction of groundwater gradient flow is away from the school, suggesting future exposure is also not likely.
Next Steps	DSHS recommends EPA continue to monitor the path of the contaminated groundwater plume for changes in direction.
Conclusion 5	Exposure to PCE and other volatile chemicals in private drinking water wells servicing residential and business properties is not likely to occur. However, there is potential for future exposure if private water wells obtain water from contaminated groundwater zones.
Basis for Conclusion	Although the residential area is served by a public water system, 18 private water wells servicing residential and business properties within a 4-mile radius of the Site were sampled from 2013 to 2015. Among the private wells sampled, PCE in two water wells was detected, but levels were below the EPA maximum contaminant level (MCL) of 5 μg/L [EPA 2016b]. The depths of private water wells sampled were between 75 and 375 feet below ground surface. DSHS does not have any information for private water wells before 2013 or after 2015. Based on this information, exposure to PCE from private water wells is unlikely. In 2020 and 2023, a total of 89 groundwater samples were collected from 31 monitoring wells. The depth of monitoring wells ranged from 6 to 165 feet below ground surface. Several chemicals in groundwater were detected above ATSDR's drinking water comparison values for chronic exposures, including PCE and TCE. Chloroform and bromochloromethane, common drinking water disinfection byproducts, were also identified. If private water wells draw water from the same groundwater zones as these monitoring wells, exposure to contaminants from private water wells is possible.
Next Steps	DSHS recommends EPA continue to sample monitoring wells to check for potential PCE and TCE migration to nearby private wells.
Conclusion 6	Residential exposure to drinking water from the public water supply is not expected to harm people's health based on available information. However, there is a potential for future exposure.
Basis for Conclusion	Prior to distribution, the City of Kermit public water system blends water from multiple public water wells through two main entry points: the Underwood Pumphouse (EP1) and the Walton Pumphouse (EP2) [EPA 2024a]. Since 2006, PCE and TCE have been detected intermittently in the main entry points. Although PCE and TCE concentrations are below EPA MCLs, TCE has been detected above ATSDR's drinking water comparison value (0.44 μg/L) for

	chronic exposures [EPA 2024a]. In 2020, DSHS evaluated whether exposure to PCE and TCE in the public water supply could harm people's health and concluded that exposure was not a public health concern [DSHS 2020]. Samples collected after 2020 show PCE and TCE levels below those previously detected. Therefore, the results of DSHS's 2020 evaluation are still valid. The City of Kermit routinely samples water wells servicing the public water system and will take wells offline if there is an exceedance of the MCL. However, there is potential for future exposure should chemical concentrations increase above levels of concern.
Next Steps	DSHS recommends EPA continue to sample wells serving the public water supply to monitor levels of contaminants in the drinking water and to monitor for potential migration of PCE and TCE to other public water supply wells.
Conclusion 7	Chemicals not associated with the NPL site were detected in indoor air at Mekason Pharmacy-Kermit, at a residence, and at the Winkler Senior Recreation Center. The detected levels are unlikely to cause adverse non-cancer or cancer health effects in workers and residents.
Basis for Conclusion	Several chemicals not likely to be associated with the NPL site were detected in indoor air at the pharmacy, recreational center, and residence: • 1,3-Butadiene, allyl chloride, ethyl acetate, isopropyl alcohol, chloroform, benzene, and 1,2-dichloropropane were detected at the pharmacy. • Carbon tetrachloride, 1,2-dichloroethane, and benzene were detected at the senior recreation center. • Benzene was detected at the residence. The levels of the chemicals in indoor air were below those expected to cause noncancer and cancer health effects. The non-NPL site-related contaminants are likely from sources within the occupied buildings. Possible sources include cleaning solvents, paints, building materials, cigarette smoke, and gas stove emissions [EPA 2025].
Next Steps	Continue to sample indoor air or subslab soil gas at the Mekason Pharmacy-Kermit. Evaluate sewer gas as a potential exposure pathway in the vapor intrusion investigation.

1.2. Next Steps for DSHS

- DSHS will provide the final version of this health consultation to community members, city officials, the Texas Commission of Environmental Quality, EPA, and other interested parties.
- DSHS will continue to work with EPA and the Texas Commission on Environmental Quality (TCEQ) to evaluate additional data as they become available.
- DSHS will continue to engage with the community through community meetings and address any community concerns as they arise.

1.3. For More Information

For more information about this health consultation, contact the DSHS Health Assessment and Toxicology Program at 1-888-681-0927.

EPA posts available data on the site's Superfund webpage at https://cumulis.epa.gov/supercpad/Cursites/csitinfo.cfm?id=0606716.

2. Background

2.1. Statement of Issues and Purpose

This health consultation was prepared for the Highway 18 Groundwater Plume site (the Site) in accordance with a cooperative agreement between the Agency for Toxic Substances and Disease Registry (ATSDR) and the Texas Department of State Health Services (DSHS). Former dry cleaning operations contaminated soil and groundwater with chlorinated solvents, including trichloroethylene (TCE) and tetrachloroethylene (PCE) in Kermit, Winkler County, Texas. Based on the contamination, the Environmental Protection Agency (EPA) placed the Site on the National Priorities List (NPL) of hazardous waste sites on August 3, 2017 [EPA 2017].

In a March 2020 health consultation, DSHS concluded that exposure to PCE and TCE from private water wells and the Kermit public water supply (PWS) was not a public health concern [DSHS 2020]. However, DSHS suggested potential exposure to PCE and TCE in indoor air by vapor intrusion from contaminated groundwater into inhabited structures. DSHS recommended additional sampling to evaluate this exposure pathway.

EPA collected additional environmental samples from 2019 to 2023, which included indoor air, subslab soil gas, passive soil gas, and groundwater samples. This health consultation evaluates the additional sampling results collected from 2019 to 2023. The purpose of the health consultation is to determine whether exposure to contaminants in indoor air and groundwater (including private water wells and wells servicing the public water supply) could harm public health.

2.2. Site Description and Timeline

The Highway 18 Groundwater Plume site is in Kermit, Winkler County, Texas, at the intersection of Highway 18 and Jeffee Drive (Figure 1). Groundwater beneath the site is contaminated with PCE and TCE. The Kermit Public Water System (PWS) first detected TCE in its system in 1994. In 2000, PCE was detected at the PWS during routine sampling for federally regulated contaminants. The PCE and TCE levels have consistently been below EPA's maximum contaminant levels (MCL) for both chemicals [TCEQ 2025]. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act. The source of groundwater contamination was unknown until 2020. EPA identified the source as a former dry cleaner, located at the northeast corner of East Campbell St and South Avenue B [EA 2020] (Figure 1). The dry cleaner operated during the 1970s. In the 1980s and early 1990s, the building was used as a dental clinic. Since 2021, the property has been the site of Mekason Pharmacy-Kermit (pharmacy) [EPA 2024b].

The boundary of the groundwater contamination appears to be approximately 2,500 feet long and 1,000 feet wide. The direction of the contaminated groundwater plume is to the southwest. DSHS estimates about 121 occupied homes and an RV park sit atop the contaminated groundwater (Figures 1 and 3).

2.3. Site History

In 2020, DSHS evaluated data collected in 2013, 2014, and 2015 by the Texas Commission on Environmental Quality (TCEQ) [DSHS 2020]. DSHS determined that people who use private residential well water and water supplied by the Kermit PWS were not exposed to PCE or TCE at levels expected to harm people's health.

Because PCE and TCE are volatile chemicals and are present in the shallow groundwater table, they could potentially migrate through soil in the form of vapor. The vapor could enter the indoor air of homes and workplaces. Based on this information, DSHS recommended that EPA evaluate the vapor intrusion pathway at and around the site, especially for homes and other occupied buildings above the groundwater contamination plume. EPA conducted additional environmental investigations from 2019 to 2023. These sampling data were evaluated in the current health consultation:

- In December 2019, EPA collected 29 groundwater samples from 17 monitoring wells and 18 soil gas samples [EA 2020]. The boundary of PCE groundwater contamination was determined at 5 μg/L.
- In March 2020, EPA collected 32 groundwater samples from 17 monitoring wells and a total of 6 samples at a senior recreation center. The recreation center samples included 3 indoor air samples, 2 subslab soil gas samples, and 1 outdoor air sample [EA 2020].
- In September 2020, EPA collected 17 groundwater samples from 17 monitoring wells and 9 soil gas samples (Figure 4) [EA 2020]. PCE and TCE were detected in subslab soil gas samples.
- In October 2022, EPA collected 37 groundwater samples from 17 monitoring wells and 11 samples from 10 wells servicing the Kermit PWS (Figures 5 and 6). None of the constituents detected in samples collected from wells servicing the PWS exceeded MCLs or EPA's tap water regional screening levels (RSLs) [Weston 2023]. EPA collected 9 indoor air samples from the pharmacy [Weston 2023].
- In May 2023, EPA collected a total of 12 indoor air and subslab soil gas samples at three locations: the former dry-cleaning site (currently a pharmacy); one residence within the groundwater contamination plume area; and the senior recreation center (Figure 7) [Weston 2023]. EPA also collected passive soil gas samples at these locations (Appendix E). PCE and TCE were detected in indoor air and subslab soil gas samples. Other chemicals not associated with the Site were also detected in indoor air.

2.4. Land Use

DSHS estimates that 121 occupied buildings and an RV park are within 100 feet of the PCE groundwater contamination. The groundwater contaminant plume was defined as the volume of groundwater with PCE concentrations above the MCL of 5 μg/L (Figures 3 and 4). This includes 111 residential homes, 2 apartment buildings, and 8 businesses. The hydraulic gradient of the shallow groundwater, located at a depth of 6 to 250 feet below ground surface, is to the southwest of the Site (Figures 3 and 4).

2.5. Site Geology and Hydrogeology

The Santa Rosa Sandstone, the Santa Rosa aquifer, and the Cenozoic Pecos Alluvium aquifer are the primary sources of water for the Kermit PWS and private drinking water wells near the site [EPA 2017]. Surrounding the site, the Santa Rosa aquifer is approximately 250 to 500 feet below ground surface and consists of sandstone and clay. The Cenozoic Pecos Alluvium surrounding the Site is located from 2 to approximately 250 feet below ground surface and consists of sand and gravel.

In some areas, the Chinle Formations Equivalent, which consists of shale and gray sandstone, lies between the Cenozoic Pecos Alluvium and the Santa Rosa aquifer while in other areas it is speculated that the two aquifers are interconnected. PCE and TCE are suspected to have been released onto the ground at a former dry cleaner (now a pharmacy) and then migrated through the Cenozoic Pecos Alluvium to the Santa Rosa aquifer [EPA 2017].

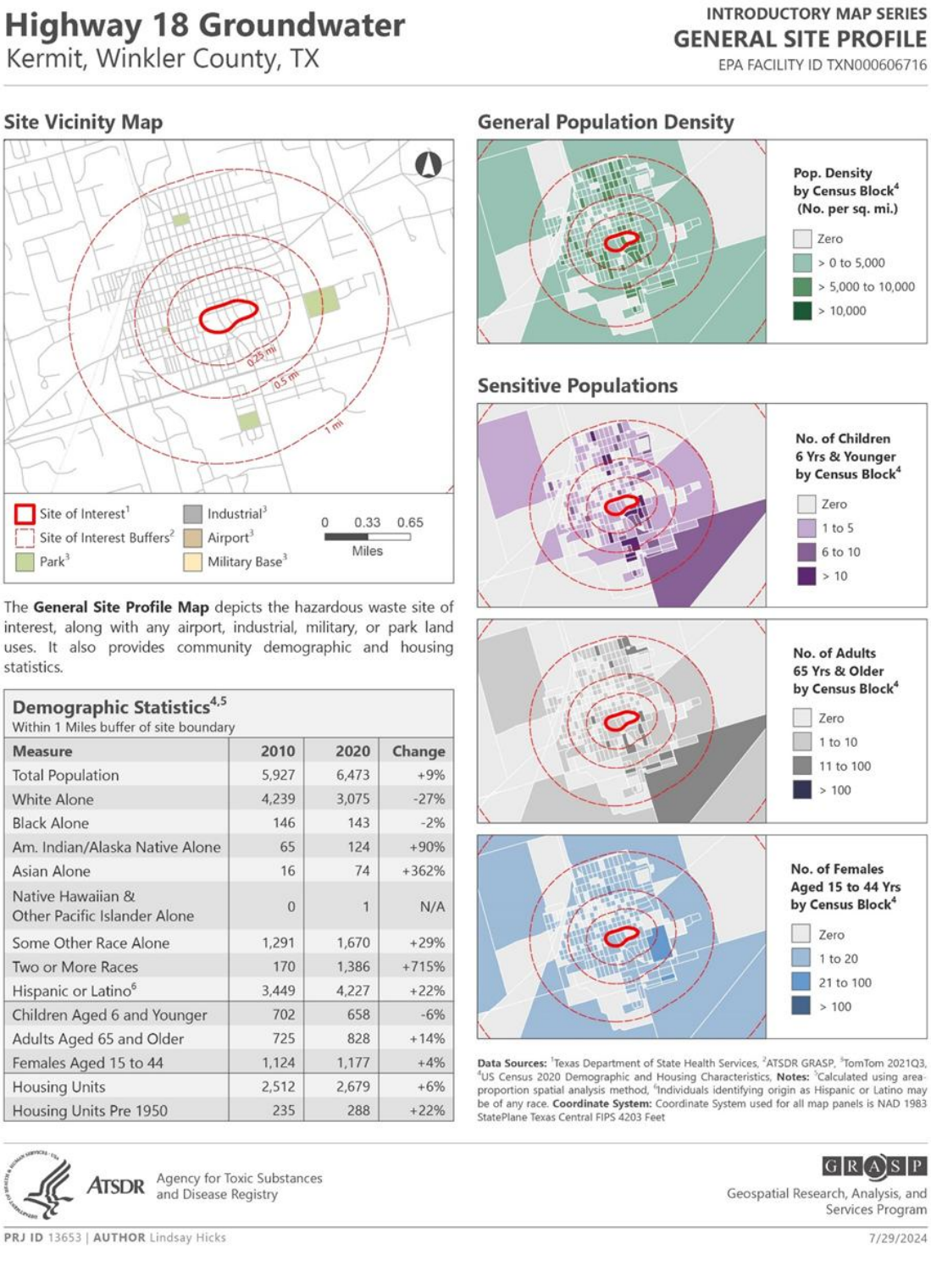
Figure 1. Highway 18 Groundwater Plume Superfund site [Weston 2023]

3. Community Description and Concerns

3.1. Community Demographics

There are approximately 6,473 people living within 1 mile of the Highway 18 site (Figure 2). According to the 2020 United States Census Bureau, 658 children under the age of seven years and 1,159 women of child-bearing age (15-44 years old) resided in this area and were served by the Kermit PWS. Within 1 mile of the Site, the largest demographic is Hispanic or Latino (approximately 4,227 people).

Figure 2. Demographic information for an area within 1 mile of the Highway 18 Groundwater Superfund site



3.2. Community Concerns

DSHS is not currently aware of any community concerns.

4. Sampling Data

DSHS evaluated results of indoor air, groundwater and soil gas samples collected by EPA. The samples were collected during remedial investigation activities and to evaluate the vapor intrusion pathway. The samples were collected and analyzed following EPA's standard protocols and quality assurance/quality control guidelines [EPA 2006; EA 2020]. DSHS assumed adequate quality assurance/quality control procedures were followed regarding data collection, chain of custody, laboratory procedures, and data reporting.

Other potential sources of indoor contamination were removed before indoor air samples were taken at the residential property. Because the pharmacy and recreation center were active businesses undergoing renovations, sampling teams could not isolate or remove potential VOC sources [Weston 2023]. Indoor air samples were collected in May and October at the pharmacy representing both hot and cold temperatures for this part of Texas. However, indoor air samples at the residence and senior recreation center were collected in March and May representing only warm to hot temperatures.

Samples were analyzed for VOCs. Some duplicate samples were collected for quality control purposes. DSHS used the higher concentration of the duplicate samples when determining the exposure point concentration.

4.1. Groundwater

DSHS evaluated groundwater sampling data collected from monitoring wells and public wells servicing the Kermit PWS. DSHS used the information to help determine the potential for vapor intrusion at the residential area and the onsite business (pharmacy).

A summary of the samples collected:

- In 2019, 29 groundwater samples from 21 monitoring wells (Figure 3) [EA 2020]
- In 2020, 49 groundwater samples from 21 monitoring wells (Figure 3) [EA 2020]
- In 2023, 37 groundwater samples from 21 monitoring wells (Figures 4 and 5) [Weston 2023]
- In 2023, 11 groundwater samples from 10 wells servicing the Kermit PWS (Figures 4 and 5) [Weston 2023].

In 2020, monitoring wells were installed at screening depths ranging from 6 to 40 feet below ground surface. In 2023, monitoring wells were installed at deeper depths (80 to 165 feet below ground surface) to establish the vertical extent of contamination [EA 2020, Weston 2023]. The screening depth of PWS wells ranged from 220 to 525 feet below ground surface [EA 2020].

4.2. Soil Gas and Indoor Air

DSHS evaluated passive gas, subslab gas, and indoor air samples collected from the pharmacy, a senior recreation center, and a residence. Sampling data included:

- 18 soil gas samples around the pharmacy and monitoring wells in December 2019 (Figure 3) [EA 2020];
- 3 indoor air samples (including 1 duplicate), 2 subslab soil gas samples, and 1 outdoor air sample at the senior recreation center in March 2020 (Figure 3) [EA 2020];
- 9 soil gas samples around the pharmacy and monitoring wells in September 2020 (Figure 3) [EA 2020];
- a total of 12 indoor air and subslab soil gas at three locations: the pharmacy; a residence; and the senior recreation center in October 2022 (Figure 6) [Weston 2023]; and
- a total of 12 indoor air samples from the pharmacy and senior recreation center [Weston 2023].

4.3. Vapor Intrusion

Vapor intrusion is the migration of volatile organic compounds (VOCs) from contaminated groundwater or subsurface soil into the indoor air of buildings (Figure 6). Chemical vapors may also migrate from contaminated subsurface sources through a sewer line. A sewer line can act as a preferential pathway into an overlying building's indoor air. However, the concentrations of contaminants entering the indoor air from the subsurface are dependent on site- and building-specific factors. These factors include building construction, soil type and moisture content, air conditioning/heating settings in the building, ventilation in buildings, and number and spacing of cracks and holes in the foundation. Additionally, estimating indoor air concentrations that people breathe from vapor intrusion has uncertainty because of the dynamic nature of the pathway in different conditions. Estimates must account for varying air exchange for a range of climatic conditions. Because of these uncertainties, collecting indoor air samples in both cold and hot weather would help characterize seasonal variability in potential exposures to better inform health risks from vapor intrusion.

The vapor intrusion pathway warrants consideration at this site because of the volatile nature of PCE and TCE. Both chemicals were detected in shallow groundwater (less than 100 feet below ground surface) beneath buildings. The groundwater contamination is horizontally within 100 feet of buildings. DSHS estimates that 121 occupied buildings and an RV park are located within 100 feet of the contaminated groundwater. This estimate is based on current groundwater data. These structures were identified for further potential investigation and may not be necessarily in known areas of exposure.

Figure 3. Tetrachloroethylene (PCE) concentrations in groundwater samples collected in March 2020

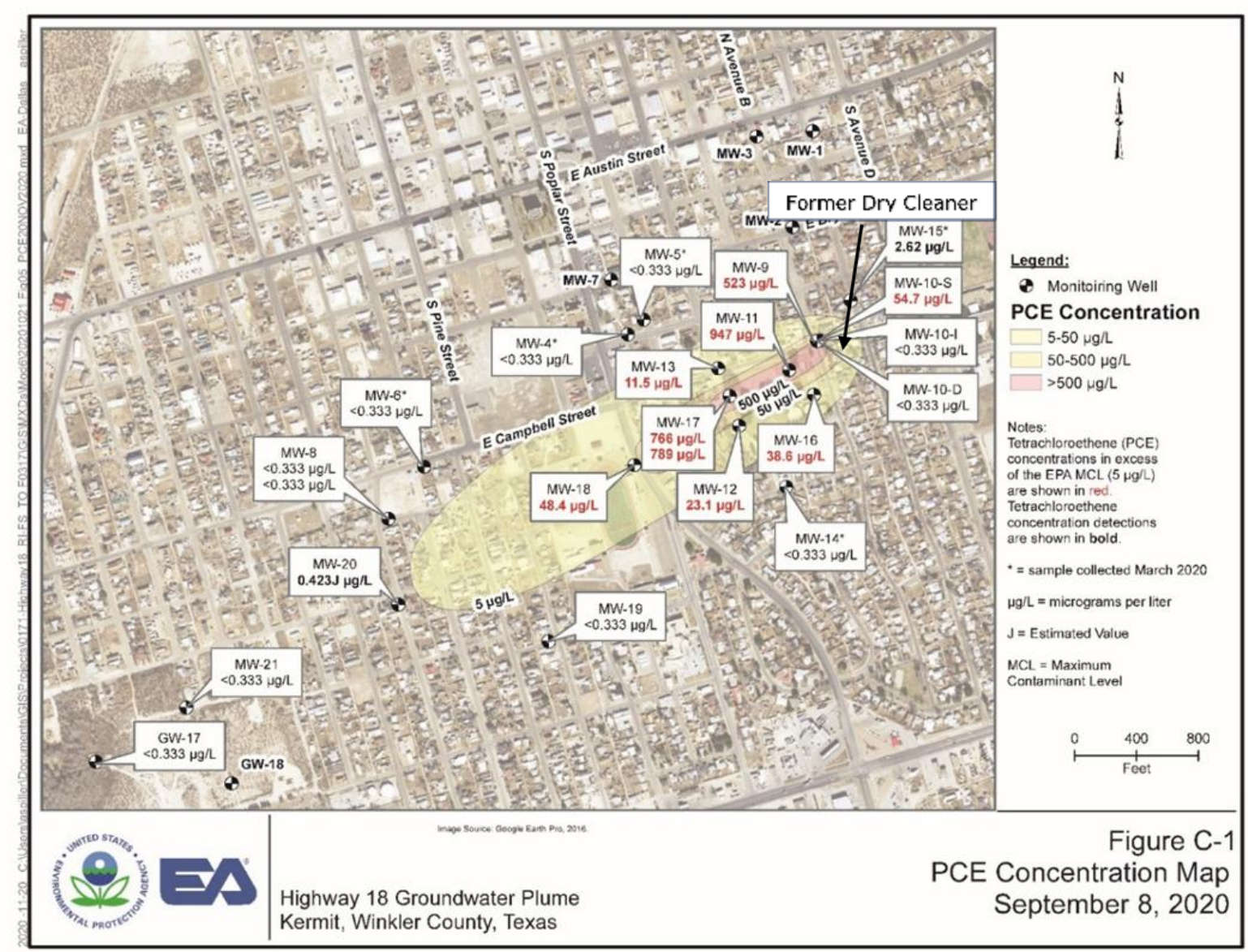


Figure 4: Tetrachloroethylene (PCE) groundwater plume and monitoring well locations for groundwater samples collected in 2022 and 2023 [Weston 2023]

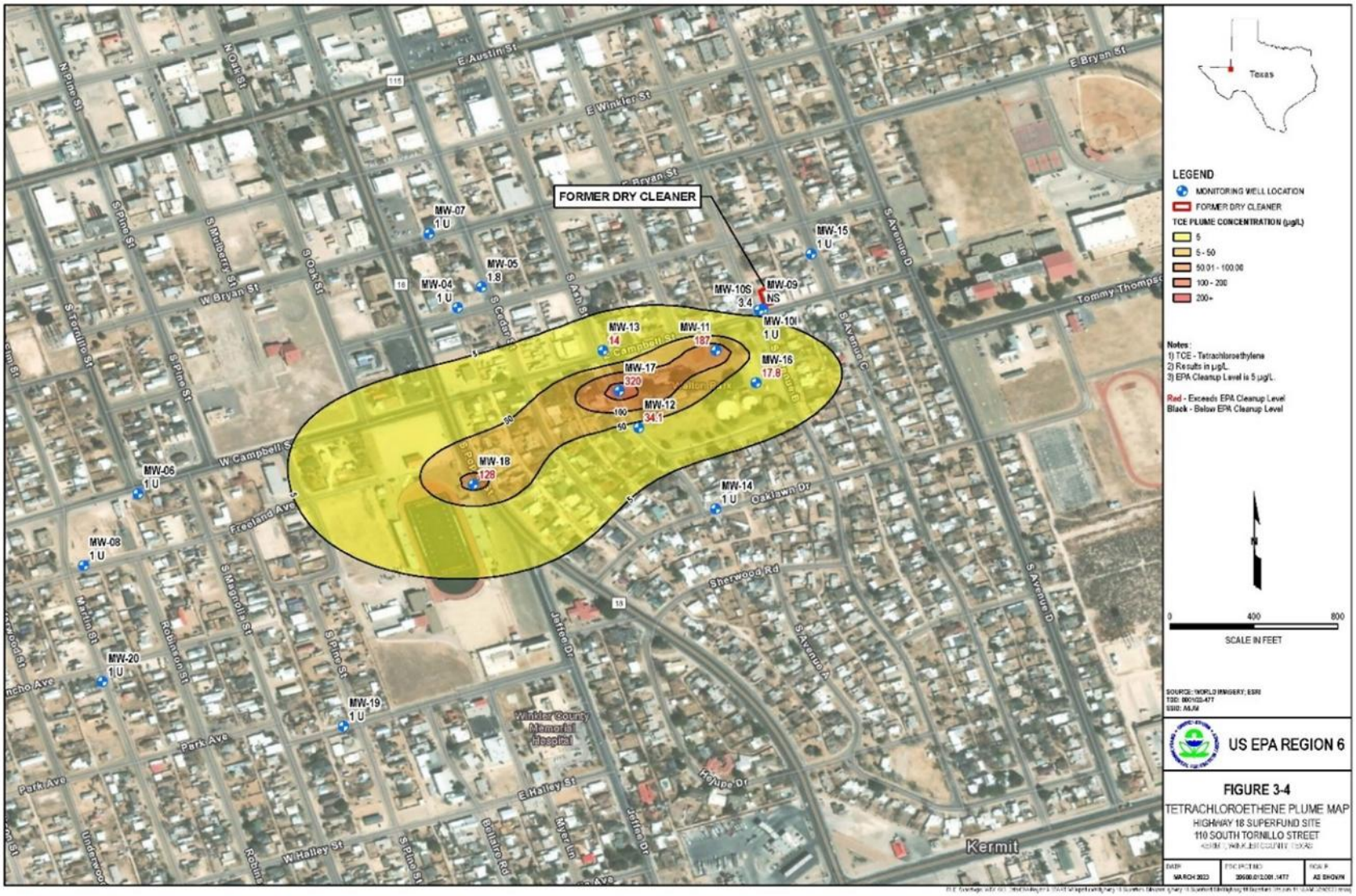
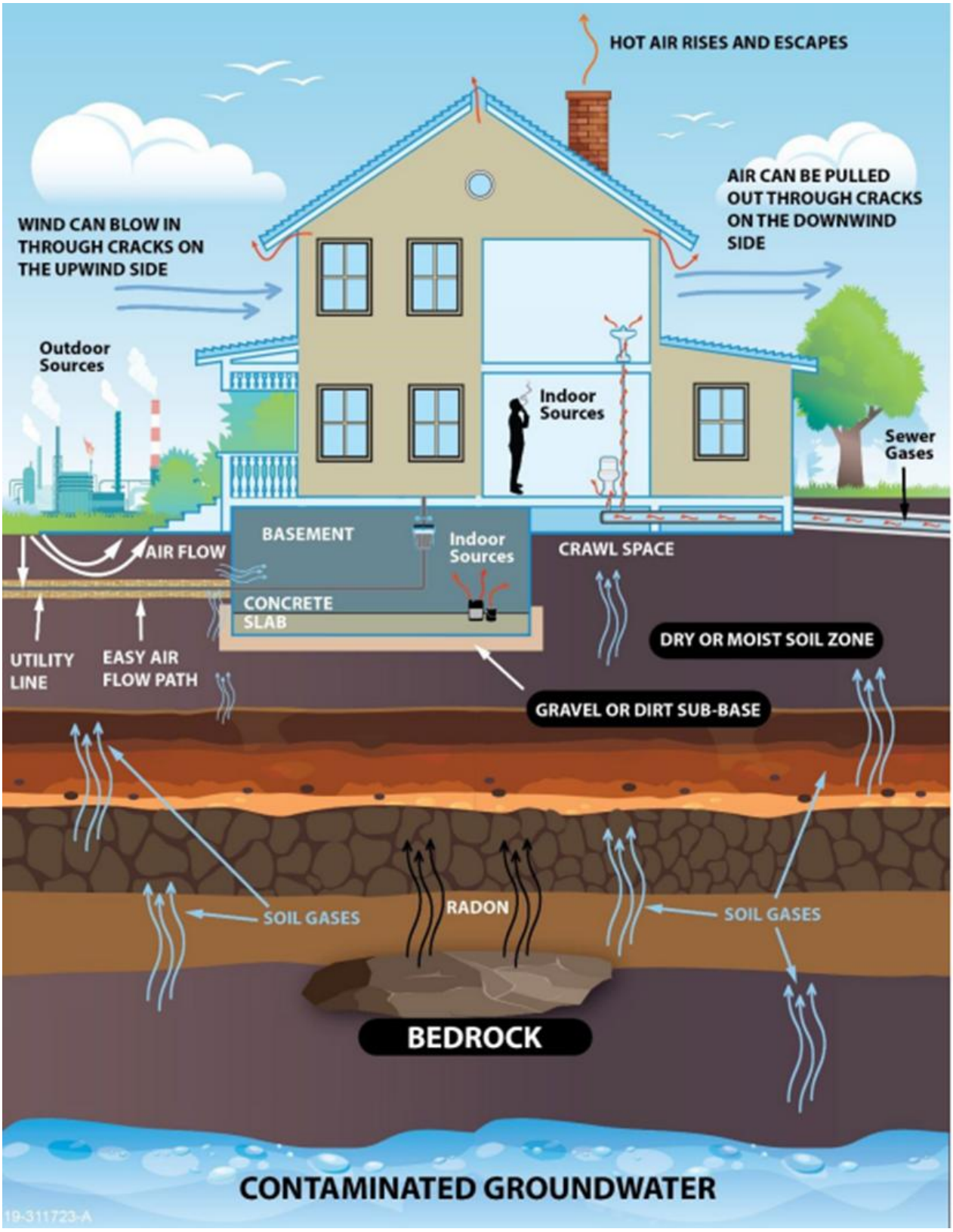


Figure 5: Locations of wells servicing the public water supply in Kermit, Texas. The screening depth of public water supply wells ranged from 300 to 700 feet below ground surface [Weston 2023]

Figure 6: Simplified schematic of vapor intrusion showing the pathway for contaminants moving from contaminated groundwater as soil gas and into buildings [ATSDR 2016]



5. Scientific Evaluations

DSHS used a three-step process to evaluate the public health implications from exposure to harmful chemicals. First, DSHS conducted an exposure pathway analysis to identify how people might be exposed. Second, DSHS compared sampling data to screening criteria to select contaminants for further evaluation. Screening criteria are media-specific levels below which no adverse health effects are expected to occur. Third, when screening criteria were exceeded, DSHS conducted a more detailed public health evaluation of contaminants of concern to determine whether harmful effects might be possible (Appendix A) [ATSDR 2022].

5.1. Exposure Pathway Analysis

An exposure pathway describes how a chemical moves from its source and comes into physical contact with people. Identifying exposure pathways is important in a health consultation because adverse health effects from contaminants or chemical substances can only happen if people are exposed to contaminants. The presence of a contaminant in the environment does not necessarily mean that people are coming into contact with it.

Five elements are considered in the evaluation of exposure pathways:

1. A source of contamination
2. An environmental media that could absorb or transport contamination
3. A point of exposure where people could contact the contaminated media
4. A route of exposure into the body, such as inhalation, ingestion, or dermal contact
5. An identifiable exposed population

DSHS divided exposure pathways into three categories: completed, potential, and eliminated.

- A completed exposure pathway occurs when all five elements are present, and exposure has occurred, is occurring, or will occur in the future.
- A potential exposure pathway occurs when one or more of the five elements cannot be identified but might have been present in the past or be present at some point in the future.
- Eliminated exposure pathways are missing one or more elements and exposure cannot occur.

An exposure pathway analysis identifies the different ways people could be or might have been exposed to the environmental contamination in the past, present, and future.

As part of the exposure pathway analysis for vapor intrusion, DSHS screened groundwater and subslab soil gas sampling results. Some indoor air sample results detected chemicals not related to the site activities. This was expected because there could be additional sources of contaminants within buildings, such as hobby materials and commercial cleaning products. All contaminants detected in the indoor air samples are included in the screening analysis.

5.2. Screening Analysis

After identifying the exposure pathways, DSHS conducted a screening analysis to identify potential contaminants of concern. The maximum concentration for each contaminant was compared to comparison values (CVs) published by ATSDR or other screening criteria when CVs were not available. CVs and other screening criteria are media-specific, which means they vary depending on whether the evaluation is for air, soil, or water. Adverse health effects are not expected to occur when contaminant levels are detected below CVs or other screening criteria. It is important to note that if a chemical concentration exceeds a CV or other screening criteria, it does not necessarily mean there is a health concern. Rather, it means the chemical- and site-specific exposure scenario warrants further public health evaluation. Chemicals without CVs or other screening criteria were further analyzed. Appendix B includes a summary of the screening analysis.

5.3. Completed Exposure Pathways

5.3.1. Inhalation of contaminants in occupational indoor air (past, present, and future)

For PCE at the pharmacy, the pathway for inhalation of contaminants in occupational indoor air is a completed exposure pathway. PCE was detected in 14 active indoor air and 2 subslab soil gas samples in October 2022 and May 2023 (Tables 1 and 2). The PCE levels were above CVs. This exposure pathway involves contaminant vapors moving from groundwater and soil and entering the interior of the pharmacy where workers are exposed through inhalation. Some non-site related contaminants were also detected in indoor air above screening values (Table 1): 1,3-butadiene, allyl chloride, ethyl acetate, isopropyl alcohol, chloroform, benzene and 1,2-dichloropropane. It is likely that the non-site related contaminants are from sources within the pharmacy. The sources may include cleaning solvents, paints, and building materials, [EPA 2025]. Except for chloroform, non-site related contaminants were not detected in subslab soil gas samples (Table 2) or groundwater (Tables 7 and 8).

Table 1. Indoor air sampling results collected from the pharmacy and screening values*

Contaminant	Reported Concentration ($\mu g/m^3$)	Media-Specific Screening Value ($\mu g/m^3$)	Type of Screening Level	Number of Detected Values Above Screening Value
Tetrachloroethylene (PCE)	0.6 - 110†	3.8	ATSDR CREG	14
1,3-Butadiene	ND - 10†	0.033	ATSDR CREG	7
Allyl Chloride	ND – 4.3†	1	ATSDR RMEG	1
Ethyl acetate	ND - 15†	73	EPA RSL Residential THQ 1‡	0
Isopropyl alcohol	ND – 3,600†	210	EPA RSL Residential THQ 1§	12
Chloroform	ND - 59†	0.043	ATSDR CREG	6

Benzene	ND - 1.8†	0.13	ATSDR CREG	12
1,2-Dichloropropane	ND - 9.4†	4	ATSDR RMEG	1

*A total of 18 indoor air samples were collected from the pharmacy in October 2022 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; EPA = Environmental Protection Agency; CREG = Cancer Risk Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide;
RSL = Regional Screening Level (noncarcinogenic value); THQ = Target Hazard Quotients; μg/m^3 = micrograms per cubic meter, ND = not detected; PCE = tetrachloroethylene or tetrachloroethene.
†indicates an exceedance of a screening value.
‡EPA's RSL for ethyl acetate is based on an inhalation rat study by Christoph [Christoph 2003]. Christoph et al. showed decreased body weights, body-weight gains, food efficiency, and startle response (both sexes) and decrease food consumption (males) in rats exposed to ethyl acetate for 13 weeks. A no adverse effects level adjusted human equivalent concentration (NOAEL$_{HEC}$) was determined to be 209 μg/m^3. EPA determined a provisional reference concentration (pRfC) of 0.07 μg/m^3 using an uncertainty factor of 3,000 [EPA 2013].
§EPA's RSL for isopropyl alcohol is based on inhalation studies in rats (104 weeks) and mice (78 weeks) [Burleigh-Flayer 1997]. The lowest adverse effect level adjusted human equivalent concentration (LOAEL$_{HEC}$) was determined to be 221 mg/m^3 and associated with decreased absolute and relative testes weights in male mice. EPA determined a pRfC concentration of 200 μg/m^3 using the LOAEL$_{HEC}$ and an uncertainty factor of 1,000 [EPA 2014].

Table 2. Subslab soil gas sampling results collected along the perimeter of the pharmacy building and screening values*

Contaminant	Reported Concentration (μg/m^3)	Media-Specific Screening Value (μg/m^3)	Type of Vapor Intrusion Screening Level	Number of Detected Values Above Screening Values
Tetrachloroethene (PCE)	18,000 – 20,000†	130	ATSDR CREG	2
Trichloroethene (TCE)	ND – 7.7†	7	ATSDR CREG	1

*A total of 2 subslab soil gas samples were collected in October 2022 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; μg/m^3 = micrograms per cubic meter; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
† indicates an exceedance of a screening value.

5.3.2. Inhalation of contaminants in residential indoor air (past, present, and future)

At the residence, the pathway for inhalation of contaminants in indoor air is a completed exposure pathway. In May 2023, EPA collected one indoor air sample from a residence located above the contaminated groundwater.

Although PCE and TCE were not detected in indoor air, PCE was detected above the screening value in one subslab soil gas sample collected from this residence. Subslab soil gas samples were collected along the perimeter of the home (Table 4).

Benzene was detected in the sample above the screening value in indoor air (Table 3). Benzene is not related to the NPL site and may be from other sources within the home. Sources may include cleaning solvents, paints, building materials, and cigarette smoke [EPA 2025].

Table 3. Indoor air sampling results collected from a residential structure and screening values*

Contaminant	Reported Concentration (µg/m³)	Media-Specific Screening Value (µg/m³)	Type of Screening Level	Number of Detected Values Above Screening Guideline
Benzene	0.4†	0.13	ATSDR CREG	1

*One indoor air sample was collected in May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; EPA = Environmental Protection Agency; CREG = Cancer Risk Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide; RSL = Regional Screening Level; THQ = Target Hazard Quotients; ug/m^3 = micrograms per cubic meter, ND = not detected.
†indicates an exceedance of a screening value.

Table 4. Subslab soil gas sample results collected along the perimeter of the residential structure and screening values*

Contaminant	Reported Concentration (µg/m³)	Media-Specific Screening Values (µg/m³)	Type of Vapor Intrusion Screening Level	Number of Detected Values Above Screening Values
Site-related				
Tetrachloroethene (PCE)	260†	130	ATSDR CREG	1

*One subslab soil gas sample was collected in May 2023.ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/m^3 = micrograms per cubic meter; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene.
†indicates an exceedance of a screening value.

5.3.3. Inhalation of contaminants in indoor air at a senior recreation center (past, present, future)

EPA collected a total of four indoor air samples from the recreation center in March 2020 and May 2023. Recreational and occupational exposure to contaminants in indoor air at the senior recreation center is a completed exposure pathway. The recreation center is used as a place for seniors to socialize and participate in activities. The center is not used as a residence.

PCE was not detected in any indoor air samples. Some non-site related contaminants were detected in indoor air above screening values (Table 5): 1,2-dichloroethane, carbon tetrachloride, and benzene. It is likely non-site related contaminants are from sources within

the senior recreation center. Sources could include cleaning solvents, paints, building materials, cigarette smoke, and gas stove emissions [EPA 2025].

PCE was detected above the screening value in two subslab soil gas samples in March 2020 but not in May 2023. Subslab soil gas samples were collected along the perimeter of the senior recreation center (Table 6).

Table 5. Senior recreation center indoor air sampling combined 2020 and 2023 results*

Contaminant (year sampled)	Reported Concentration (µg/m³)	Media-Specific Screening Value (µg/m³)	Type of Screening Level	Number of Detected Values Above Screening Value
1,2-Dichloroethane	ND – 0.6†	0.01	ATSDR CREG	2
Carbon tetrachloride	ND – 0.52†	0.17	ATSDR CREG	2
Benzene	2.4† – 2.8†	0.13	ATSDR CREG	4

*A total of 4 indoor air samples were collected in March 2020 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide; µg/m³ = micrograms per cubic meter; ND = not detected.
†indicates an exceedance of a screening value.

Table 6. Senior recreation center subslab soil gas sampling combined 2020 and 2023 results*

Contaminant	Reported Concentration(µg/m³)	Screening Value (µg/m³)	Type of Vapor Intrusion Screening Level	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	ND - 280†	19	ATSDR CREG	2
Benzene	ND - 4.6†	1.4	ATSDR CREG	2

*A total of 3 subslab samples were collected in March 2020 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/m³ = micrograms per cubic meter; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene.
†indicates an exceedance of a screening value.

5.4. Potential Exposure Pathways

5.4.1. Inhalation of contaminants in indoor air of homes and businesses not sampled (past, present, and future)

DSHS estimates there are 111 residential homes, 2 apartment buildings, 1 RV park, and 8 businesses that are located within 100 feet of the PCE groundwater contamination plume (Figure 4). Given the concentration of PCE in groundwater and groundwater being as shallow as 6 feet below ground surface, vapor intrusion into indoor air is a potential exposure pathway for homes and businesses not tested.

5.4.2. Ingestion, inhalation, and skin absorption of contaminants in water from private residential wells (past, present, and future)

Exposure to water from private wells is a potential exposure pathway. Although the residential area is connected to the public water system, between 2013 to 2015, 18 private residential water wells within a 4-mile radius of the site were sampled. The depth of private wells is between 75 and 375 feet below ground surface [EPA 2016B, EPA 2017].

PCE was detected in two wells but below the EPA maximum contaminant level (MCL) of 5 µg/L [EPA 2016B, EPA 2017]. DSHS does not have any sampling information for private water wells sampled before 2013 and after 2015. DSHS also does not have any information about the domestic use, if any, of the wells.

A total of 77 groundwater samples were collected from 31 monitoring wells in 2020 and 2023 (Tables 7 and 8). The depth of monitoring wells is between 6 and 165 feet below ground surface. Several chemicals in groundwater were detected above screening values for vapor intrusion, including PCE and TCE. Other non-site related chemicals were also detected, including chloroform and bromochloromethane. No private wells are known to draw water from the contaminated plume shown in Figures 3 and 4.

Based on groundwater sampling data from 2022 and 2023, the greatest concern for vapor intrusion for homes and businesses appears to be near MW-17 and MW-11 (Figure 4). PCE levels in this area range from 187 to 320 µg/L, which are above groundwater ingestion and vapor intrusion screening levels. Additionally, elevated concentrations were detected in MW-18, located about 800 feet from the pharmacy. Given this information, people living above the contaminated groundwater may be at increased risk of PCE exposure. However, because of the limited information available for private residential water wells, DSHS cannot fully evaluate this exposure pathway.

Table 7. Groundwater sampling results from monitoring wells and vapor intrusion screening values 2023*

Contaminant	Reported Concentration (µg/L)	Screening Value (µg/L)	Type of Vapor Intrusion Screening Level	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	ND – 320†	5.3	ATSDR CREG	10
Trichloroethene (TCE)	ND – 5†	0.52	ATSDR CREG	4
Chloroform	ND – 5†	0.29	ATSDR CREG	4

*A total of 37 groundwater samples were collected from monitoring wells in 2023. ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/L = micrograms per liter; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
†indicates an exceedance of a screening value.

Table 8. Groundwater sampling results from monitoring wells and vapor intrusion screening values 2020*

Contaminant	Reported Concentration (µg/L)	Screening Value (µg/L)	Type of Vapor Intrusion Screening Level	Number of Detected Values Above Screening Value / Total # of Samples
Tetrachloroethene (PCE)	ND – 947†	5.3	ATSDR CREG	17
Trichloroethene (TCE)	ND - 1.99†	0.52	ATSDR CREG	9
Chloroform	ND – 2.46†	0.29	ATSDR CREG	22

*A total of 49 groundwater samples were collected from monitoring wells in 2020. ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/L = micrograms per liter. NA = not available; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
†indicates an exceedance of a screening value.

5.4.3. Ingestion, inhalation, and skin absorption in water from the Kermit public water supply (past, present, and future)

Residential exposure to water from the public water supply is not expected to harm people's health based on available information. However, there is potential for future exposure should chemical levels increase.

Prior to distribution, Kermit PWS blends water from multiple water wells through two main entry points (EP): the Underwood Pumphouse (EP1) and the Walton Pumphouse (EP2). Since 2006, PCE and TCE have been detected intermittently in the main entry points at concentrations ranging from 0.56 to 2.9 µg/L and 0.5 to 1.2 µg/L, respectively (Appendix F). These levels are below MCLs [EPA 2024a]. However, in samples from EP1, TCE has been detected above the ATSDR drinking water comparison value (0.44 µg/L).

In 2020, DSHS evaluated whether exposure to PCE and TCE in the public water supply could harm people's health using ATSDR's Shower and Household Water-Use Exposure (SHOWER) Model (Version 1.0.1). DSHS concluded that exposure was not a health concern [DSHS 2020]. Based on the low PCE and TCE levels in samples collected after 2020, the results from the 2020 evaluation are still accurate.

5.5. Eliminated Exposure Pathway

5.5.1. Inhalation of contaminants in indoor air of the junior high school and high school (past, present, future)

Based on available information, students and staff at the Kermit Junior High School and Kermit High School are not expected to be exposed to PCE in indoor air. The schools are located about 800 feet up-gradient of the contaminated groundwater plume. Exposure to PCE is not likely to have taken place at the junior high school and high school because the contaminated groundwater is not beneath or close to the school. In addition, the groundwater flows away from the schools.

5.5.2. Incidental ingestion and dermal contact with soil at the source area (past, current, and future)

In 2014 and 2015, TCEQ collected soil samples from multiple commercial properties suspected of being contaminated with chemicals, including the former dry cleaner. VOCs, including PCE and TCE, were not detected in soil samples [EPA 2017].

Table 9. Exposure pathway chart

Source	Environmental Media	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time frame & Type of Exposure Pathway
Groundwater contamination	Groundwater, soil vapor	Indoor air from vapor intrusion	Inhalation	Workers at the pharmacy	Past – potential Present – completed Future – completed
Groundwater contamination	Groundwater, soil vapor	Indoor air from vapor intrusion	Inhalation	Residents at the home sampled for contaminants	Past – potential Present – completed Future – completed
Groundwater contamination	Groundwater, soil vapor	Indoor air from vapor intrusion	Inhalation	Visitors and employees at the senior recreation center	Past – potential Present – completed Future – potential
Groundwater contamination	Groundwater, soil vapor	Indoor air from vapor intrusion	Inhalation	Residents in homes where samples were not collected but located above the contaminated groundwater	Past – potential Present – potential Future – potential
Groundwater contamination	Groundwater, soil vapor	Indoor air from vapor intrusion	Inhalation	Students and staff at the junior high school and high school	Past – eliminated Present – eliminated Future – eliminated
Groundwater contamination	Groundwater	Private wells	Ingestion, inhalation, dermal	Residents	Past – completed Present – potential Future – potential
Public water system	Residential drinking water	Residential tap	Ingestion, inhalation, dermal	Residents	Past – eliminated Present – eliminated Future – potential
Former Dry Cleaner Site	Soil	Soil	Ingestion, dermal	Workers, nearby residents	Past – eliminated Present – eliminated Future - eliminated

5.6. Evaluation of Indoor Air

5.6.1. Exposure Point Concentrations and Exposure Calculations

The potential contaminants of concern that exceeded screening values were further evaluated by calculating exposure point concentrations (EPCs) [ASTDR 2023]. The EPC is the specific location where people may come in contact with site contaminants.

DSHS used the 95% Upper Confidence Limit (UCL) of the arithmetic mean as the EPC if:

- eight or more samples were collected
- the contaminant was detected in at least four samples, and
- the contaminant was detected at least 20% of the time.

This is because the UCL provides a more health-protective estimate of the true mean concentration. The 95% UCL was calculated using R Statistical Software and the EnvStats and NADA packages [R Core Team 2024, Millard and Kowarik 2024, Lee 2020].
The maximum concentration was used as the EPC if less than four samples were detected (Table 10).

Table 10. Exposure point concentrations for contaminants exceeding comparison values in indoor air at the pharmacy

Contaminant	Number of Detections / Number of Samples	Range (μg/m^3)	EPC (μg/m^3)	EPC Type
Tetrachloroethene (PCE)	17/17	0.6 - 110	110	95% UCL
1,3-Butadiene	4/17	ND - 10	4.0	95% UCL
Allyl chloride	1/17	ND – 4.3	4.3	Maximum
Chloroform	6/17	ND - 59	40	95% UCL
Benzene*	12/14	ND – 1.8	1.1	95% UCL
1,2-Dichloropropane	1/17	ND - 9.4	9.4	Maximum

95% UCL = 95th percentile of the upper confidence limit of the mean; EPC = exposure point concentration; ND = not detected; PCE = tetrachloroethene or tetrachloroethylene; μg/m^3 =micrograms per meter cubed
* DSHS excluded 3 samples not detected from analyses because the detections limits were higher than the maximum detected concentration. The UCL was calculated using the results of the other 14 samples only.

DSHS estimated noncancer and cancer risks using the EPC. No site-specific exposure information was available, so DSHS calculated the health effects using health protective exposure assumptions for two exposure scenarios. These included a typical or central tendency exposure (CTE) and the high or reasonable maximum exposure (RME). Both are recommended by ATSDR (Appendix C). The RME refers to people who are at the upper end of the exposure distribution (about the 95th percentile). The CTE refers to people who have an average or typical exposure.

5.6.2. Noncancer Health Effects

To evaluate noncancer health effects, DSHS compared EPCs to appropriate health guidelines, such as ATSDR'S chronic inhalation minimal risk level (MRL) and EPA's reference concentration (RfC). A health guideline is an estimate of daily exposure to a substance over a specified

duration that is unlikely to cause harmful, noncancer health effects in humans. If an estimated exposure is lower than the health guideline, adverse noncancer health effects are not expected to occur. If an estimated exposure is higher than the health guideline, it does not necessarily mean it will harm people's health. It does, however, mean that DSHS must conduct an in-depth evaluation to determine if adverse health effects are possible and if the exposure poses a health hazard. This is done by comparing the exposure to known noncancer health effect levels reported in the scientific literature.

DSHS calculated hazard quotients (HQs) to compare estimated exposure to health guidelines. The HQs were calculated by dividing the estimated exposure doses or concentration by the health guideline. If the HQ is less than 1, then adverse health effects are not likely because the estimated dose or concentration in people is below the health guideline. If the HQ is greater than 1, DSHS further evaluates the margin of exposure (MOE). The MOE is a measure of how close the estimated dose or concentration is to harmful levels. The smaller the MOE, the closer the exposure is to effect levels. When the MOE is less than 1, then exposures exceed effect levels.

5.6.3. Cancer Health Effects

To estimate cancer risk for cancer-causing contaminants, the EPC was multiplied by the inhalation unit risk factor (IUR). The cancer risk is an excess lifetime cancer risk, which estimates the proportion of a population that might be affected by a carcinogen during their lifetime (365 days/year for 78 years) (Appendix C). An excess lifetime cancer risk represents the additional risk above the existing background cancer risk. For example, an estimated cancer risk of two per million (or 2E-6) potentially represents two extra cancer cases in a population of 1 million over their lifetime. In the United States, the background cancer risk (or the probability of developing cancer at some point during a person's lifetime) is about two in five (or 40%) for men and women [ACS 2020]. Note, the cancer risk estimates in this document are not a measure of the actual cancer cases in the neighborhood northeast of the site; rather, they are a tool used by DSHS for making public health recommendations in this document.

5.7. Occupational Indoor Air at the Pharmacy

DSHS used indoor air samples collected in the pharmacy in 2020 and 2023 to estimate noncancer and cancer health risks for:

- PCE,
- benzene,
- 1,3-butadiene,
- allyl chloride, and
- chloroform.

The indoor air EPCs were adjusted for full-time and part-time workers. The adjusted EPC is a concentration that represents 24 hours of continuous exposure. It accounts for exposure factors, including the time workers spend in the building, and can be compared to chronic inhalation MRL or RfC. To calculate the adjusted EPC, DSHS used default RME exposure factors for full-time workers and default CTE exposure factors for part-time workers. The full-time

worker exposure was 8.5 hours per day, 5 days per week, 50 weeks per year, for 20 years. The part-time worker exposure was 5.1 hours per day, 5 days per week, 50 weeks per year, for 3.1 years.

5.7.1. Tetrachloroethylene (PCE)

PCE is widely used for dry cleaning fabrics and metal degreasing. It is also used as a building block for making other chemicals and is used in some consumer products [ASTDR 2019]. PCE enters the environment by evaporating into the air during use. It can also get into the water supply and soil during disposal of sewage sludge and factory waste and when leaking from underground storage tanks [ASTDR 2019]. It can stay in air for several months before it is broken down into other chemicals or is brought back down to soil and water from rain [ASTDR 2019]. Consumer products that might contain PCE include water repellants, fabric softeners, spot removers, adhesives, and wood cleaners [ASTDR 2019].

5.7.1.1. Noncancer Effects

DSHS used the chronic inhalation MRL of 41 $\mu g/m^3$. The MRL is based on an occupational epidemiology study that reported decreased color vision among workers in dry cleaners exposed to PCE. Based on these results, a lowest observed adverse effect level (LOAEL) of 11,544 $\mu g/m^3$ was estimated after adjusting to a continuous exposure [ASTDR 2019, Gobba 1998].

The adjusted EPCs were below the chronic inhalation MRL (HQs less than 1) for full-time and part-time workers at the pharmacy. Therefore, workers are not likely to experience adverse noncancer health effects from inhaling PCE in indoor air (Table 11).

5.7.1.2. Cancer Effects

EPA considers PCE likely to be carcinogenic to humans by all routes of exposure [EPA 2012]. The National Toxicity Program (NTP) classifies PCE as reasonably anticipated to be a human carcinogen based on sufficient evidence in experimental animals [NTP 2021]. Human studies suggest that exposure to PCE might increase the risks for developing bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma [EPA 2012]. Additionally, animal studies have shown that PCE can cause liver, kidney, and blood system cancers.

DSHS used the IUR of 2.6E-7 $(\mu g/m^3)^{-1}$ to estimate cancer risk. The IUR is based on an animal study that showed hepatocellular adenomas or carcinomas development in mice exposed to PCE [EPA 2012, Chiu and Ginsberg 2011].

DSHS calculated excess cancer risk for inhalation of PCE at the pharmacy for full-time and part-time workers. DSHS estimated cancer risk for full-time workers to be 2 cases in 1,000,000 people (2E-6) and for part-time workers to be 2 cases in 10,000,000 people (2E-7). These cancer risks are not a health concern.

Table 11. Noncancer and cancer risk estimates for chronic occupational exposure to PCE at the pharmacy*

Exposure Group	Adjusted EPC (µg/m^3)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	31	<1	2E-6	20
Part-time worker (CTE)	18	<1	2E-7	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m^3 = micrograms per meter cubed; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); yrs = years; PCE = tetrachloroethene or tetrachloroethylene.

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 41 µg/m^3 and the cancer risks were calculated using the inhalation unit risk of 2.6E-7 (µg/m^3)$^{-1}$.

5.7.2. 1,3-Butadiene

1,3-Butadiene is a chemical made from processing petroleum [ATSDR 2012]. It is a volatile gas used in the production of synthetic rubber for automobile tires. It is also used in the production of some plastics. 1,3-Butadiene is released into the environment from industrial sources during manufacturing, use, transport, and storage. It can be found at oil refineries, chemical manufacturing plants, and plastic or rubber factories. It is also released in low levels from automobile exhaust, cigarette smoke, wood burning stoves and fireplaces, and the burning of rubbers and plastics [ATSDR 2012].

5.7.2.1. Noncancer Effects

DSHS used the RfC of 2 µg/m^3. The RfC is based on a 2-year inhalation study on mice inhaling 1,3-butadiene for 6 hours a day, 5 days a week at concentrations up to 625,000 µg/m^3 [EPA 2002]. The most sensitive health outcome was ovarian atrophy, which was found in all test groups. Benchmark dose modeling[3] was used to calculate the RfC and resulted in a benchmark concentration lower bound[4] (BMCL10) of 1,980 µg/m^3.

The adjusted EPCs for 1,3-butadiene were below the RfC (HQs less than 1). Therefore, workers are not likely to experience adverse noncancer health effects from inhaling 1,3-butadiene in indoor air at the pharmacy (Table 12).

5.7.2.2. Cancer Effects

EPA considers 1,3-butadiene to be carcinogenic to humans by inhalation [EPA 2004]. The NTP classifies 1,3-butadiene as known to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in humans, including epidemiological and mechanistic studies [NTP 2021]. Several epidemiological studies have shown an association between occupational

[3] Benchmark dose modeling is a mathematical approach used to determine human health guidelines (reference dose). It involves fitting the model to experimental data to determine the dose at which a small, predefined increase in response is observed.

[4] A benchmark concentration lower bound ($BMCL_{10}$) is a human equivalent concentration based on the lower confidence limit for benchmark where a 10% response might be expected.

exposure to 1,3-butadiene and excess mortality from cancer of the lymphatic and hematopoietic systems [NTP 2021].

DSHS used the IUR of 3.0E-5 $(\mu g/m^3)^{-1}$ to estimate cancer risk [EPA 2002]. It is based on an epidemiological study of leukemia occurrence in over 15,000 male rubber production workers exposed to 1,3-butadiene [Delzell 1995, EPA 2002].

DSHS estimated excess cancer risk for long term inhalation of 1,3-butadiene at the pharmacy for full-time and part-time workers. DSHS estimated cancer risk from 1,3-butadiene to be 8 cases in 1,000,000 (8E-6) for full-time workers and 7 cases in 10,000,000 (7E-7) for part-time workers (Table 12). These cancer risk estimates are not a health concern.

Table 12. Noncancer and cancer risk estimates for chronic occupational exposure to 1,3-butadiene at the pharmacy*

Exposure Group	Adjusted EPC ($\mu g/m^3$)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	0.97	<1	8E-6	20
Part-time worker (CTE)	0.58	<1	7E-7	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; $\mu g/m^3$ = micrograms per cubic meter; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher)

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 2 $\mu g/m^3$ and the cancer risks were calculated using the inhalation unit risk of 3.0E-5 $(\mu g/m^3)^{-1}$.

5.7.3. Allyl Chloride

Allyl chloride is a human made volatile and flammable liquid chemical [EPA 1991b]. It is primarily used in the production of the chemical epichlorohydrin, which is used in the production of plastics. It is also used as an alkylating agent in the production of pharmaceuticals and pesticides [EPA 1991b].

5.7.3.1. Noncancer

DSHS used the inhalation RfC of 1 $\mu g/m^3$. The critical study for developing the RfC included neurological effects (such as functional and histological peripheral neurotoxicity) of allyl chloride exposure in rabbits, cats, and rats over 3 months, 6 hours per day, 6 days per week [Boqin 1982]. A no observed adverse effects level human equivalent concentration ($NOAEL_{HEC}$) of 3,600 $\mu g/m^3$ was used as the point of departure. EPA calculated the RfC using the $NOAEL_{HEC}$ and an uncertainty factor of 3,000. EPA determined a LOAEL human equivalent concentration ($LOAEL_{HEC}$) of 44,000 $\mu g/m^3$ [EPA 1991b].

The adjusted EPC for full-time workers was equal to the RfC for allyl chloride (HQ = 1). However, the adjusted EPC was well-below the effect level for neurological effects (MOE of 44,000) (Table 13). The adjusted EPC for part-time workers is below the RfC for allyl chloride. Therefore, adverse health effects are unlikely for full-time or part-time workers exposed to allyl chloride at the pharmacy (Table 13).

5.7.3.2. Cancer

EPA considers allyl chloride to be a possible human carcinogen due to the lack of human evidence and limited animal studies [EPA 1991b]. EPA has not yet developed cancer toxicity values for allyl chloride. Therefore, cancer risk was not determined.

Table 13. Noncancer and cancer risk estimates for chronic occupational exposure to allyl chloride at the pharmacy*

Exposure Group	Adjusted EPC (μg/m³)	Hazard Quotient	Margin of Exposure	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	1.0	1†	44,000	NA	20
Part-time worker (CTE)	0.63	<1	NA	NA	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; μg/m³ = micrograms per cubic meter; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); NA = not analyzed.
†indicates value HQ equal or greater than 1.
* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 2 μg/m³.

5.7.4. Chloroform

Chloroform is a colorless volatile liquid. It occurs naturally in the environment and is released in volcanic eruptions or by burning organic matter [ASTDR 2024a]. Chloroform is also a human made chemical that was used as an inhaled anesthetic in the past. Chloroform is currently used as a solvent and to make other chemicals. Chloroform exposure can happen at low levels when drinking water sources are treated with chlorine and at higher levels for people who work in industries that produce or use chloroform [ASTDR 2024a].

5.7.4.1. Noncancer Effects

DSHS used the chronic inhalation MRL of 2 μg/m³ [ASTDR 2024a]. The MRL is based on an animal study that exposed female rats by inhalation to chloroform for 104 weeks, 5 days a week, 6 hours a day [Yamamoto et al. 2002]. The most sensitive endpoint was nasal lesions. ATSDR adjusted the concentration to a continuous exposure and calculated a LOAEL human equivalent concentration ($LOAEL_{HEC}$) of 550 μg/m³. An uncertainty factor of 300 was used to calculate the MRL.

The adjusted EPCs from PHAST exceeded the MRL (HQs greater than 1) for both full-time and part-time workers. However, the difference between the EPC and the effect level is high (MOEs above 50) (Table 14), which means the exposures are well below harmful levels. Therefore, adverse health effects are not likely to occur in full-time and part-time workers exposed to chloroform at the pharmacy (Table 14).

5.7.4.2. Cancer Effects

EPA considers chloroform likely to be carcinogenic to humans by all routes of exposure at high levels that result in cell damage. However, it is not likely to be carcinogenic by any exposure route at lower levels that do not cause cell damage [EPA 2001]. NTP determined chloroform to

be reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity in experimental animals [NTP 2021]. The International Agency for Research on Cancer (IARC) determined that chloroform is possibly carcinogenic to humans based on inadequate evidence in humans and sufficient evidence in experimental animals [IARC 1999].

DSHS used the IUR of 2.3E-5 $(\mu g/m^3)^{-1}$ to estimate cancer risk [EPA 2001]. The IUR is based on occurrence of liver and kidney tumors in mice. Occurrence of tumors only occurred at concentrations causing cell damage (cytotoxicity) in test mice [EPA 2001].

DSHS calculated excess cancer risk for inhalation of chloroform at the pharmacy for full-time and part-time workers. DSHS estimated cancer risk to be 6 cases in 100,000 full-time workers (6E-5) and 5 cases in 1,000,000 part-time workers (5E-6). These cancer risk estimates are not a health concern.

Table 14. Noncancer and cancer risk estimates for chronic occupational exposure to chloroform at the pharmacy*

Exposure Group	Adjusted EPC ($\mu g/m^3$)	Hazard Quotient	Margin of Exposure	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	9.7	>1	57	6E-5	20
Part-time worker (CTE)	5.8	>1	189	5E-6	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; $\mu g/m^3$ = micrograms per cubic meter; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher).

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 2 $\mu g/m^3$ and the cancer risks were calculated using the inhalation unit risk of 2.3E-5 $(\mu g/m^3)^{-1}$.

5.7.5. Benzene

Benzene is a colorless, sweet-smelling liquid that evaporates quickly and dissolves slightly into water [ASTDR 2024b]. It is highly flammable and can be formed naturally and by human industry. Industry is the main source of benzene in the environment. Benzene is produced from petroleum and is used in a variety of industries, such as chemical manufacturing, and in manufacturing rubbers, lubricants, dyes, detergents, drugs, and pesticides [ASTDR 2024b]. Benzene usually breaks down within a few days in the air but breaks down much more slowly when in the water or soil. Benzene can enter a human body through the lungs, gastrointestinal track, or across the skin.

5.7.5.1. Noncancer Effects

DSHS used the chronic inhalation MRL of 6.4 $\mu g/m^3$. The chronic MRL for benzene is based on a study of workers exposed to benzene in two shoe manufacturing facilities in China [Lan 2004]. The most sensitive health outcome in developing the MRL was a decrease in peripheral lymphocytes (B cell lymphocytes) in the blood of these workers. The workers had been employed for an average of 6.1 years. Using benchmark dose modeling and adjusting the

worker exposure to a continuous exposure, ATSDR estimated that the lowest level for blood-related effects to be 96 µg/m^3 [ASTDR 2024b].

The adjusted EPCs from PHAST for benzene are below the MRL (HQs less than 1) for full-time and part-time workers. Therefore, exposure to benzene for workers at the pharmacy is not a noncancer health concern (Table 15).

5.7.5.2. Cancer Effects

Long-term exposure to benzene in air at high concentrations can cause acute myelogenous leukemia (a type of cancer that affects the blood-forming organs) [ASTDR 2024b]. EPA and NTP have classified benzene as a known human carcinogen based on evidence from human and animal studies [ASTDR 2024b, NTP 2021, EPA 2007].

DSHS used the IUR of 7.8E-6 (µg/m^3)$^{-1}$ to estimate cancer risk [EPA 2007]. The IUR is based on the incidence of leukemia in several human studies.

DSHS calculated excess cancer risk for inhalation of benzene at the pharmacy for full-time and part-time workers. DSHS estimated cancer risk from benzene exposure to be 5 cases in 10,000,000 (5E-7) full-time workers and 5 cases in 100,000,000 (5E-8) part-time workers. These estimated cancer risks are not a health concern.

Table 15. Noncancer and cancer risk estimates for chronic occupational exposure to benzene at the pharmacy*

Exposure Group	Adjusted EPC (µg/m^3)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	0.27	<1	5E-7	20
Part-time worker (CTE)	0.16	<1	5E-8	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m^3 = micrograms per cubic meter; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 6.4 µg/m^3 and the cancer risks were calculated using the inhalation unit risk of 7.8E-6 (µg/m^3)$^{-1}$.

5.7.6. 1,2-Dichloropropane

1,2-Dichloropropane is a human made volatile and flammable liquid. It is mainly used to produce other chemicals such as chlorinated and industrial solvents [ATSDR 2021]. It is also included in household stain removers and waxes or in sealants for natural stone and other surfaces [ATSDR 2021].

5.7.6.1. Noncancer Effects

DSHS used the chronic RfC of 4 µg/m^3. The chronic RfC for 1,2-dichloropropane is based on a 13-week inhalation toxicity study with rats, mice, and rabbits exposed to 1,2-dichloropropane [EPA 1991a]. The most sensitive endpoint was respiratory effects based on nasal epithelial hyperplasia (increased cell growth within the nose) in female rats. The study observed respiratory effects at a $LOAEL_{HEC}$ of 1,300 µg/m^3. An uncertainty factor of 300 was applied to the $LOAEL_{HEC}$ to calculate the RfC.

The adjusted EPCs from PHAST for 1,2-dichloropropane were below the RfC (HQs less than 1). Therefore, exposure to 1,2-dichloropropane is not a noncancer health concern for full-time or part-time workers at the pharmacy (Table 16).

5.7.6.2. Cancer Effects

IARC has classified 1,2-dichloropropane as carcinogenic to humans [EPA 1991a]. However, EPA has not classified the carcinogenicity of 1,2-dichloropropane due to the limited available information and has not yet developed cancer toxicity values. Therefore, cancer risk was not determined.

Table 16. Noncancer and cancer risk estimates for chronic exposure to 1,2-dichloropropane at the pharmacy*

Exposure Group	Adjusted EPC ($\mu g/m^3$)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	2.3	<1	NA	20
Part-time worker (CTE)	1.4	<1	NA	3.1

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; $\mu g/m^3$ = micrograms per meter cubed; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); NA = not analyzed.

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) EPA reference concentration (RfC) of 4 $\mu g/m^3$.

5.8. Evaluation of Indoor Air at Residence

DSHS estimated noncancer and cancer health risks for benzene using indoor air samples taken at a residence located above the PCE groundwater plume. Benzene is not site-related but has potential sources in the home including cleaning solvents, paints, building materials, and cigarette smoke.

DSHS used ATSDR default residential exposure factors where children and adults are exposed 24 hours per day, 7 days per week, 52.14 weeks per year, for 21 years (children) or 33 years (adults).

5.8.1. Benzene

5.8.1.1. Noncancer

The EPCs for benzene are below the MRL (HQ less than 1) for children and adults. Noncancer health effects from benzene are not a concern for children and adults at the residence (Table 17).

5.8.1.2. Cancer

DSHS calculated excess cancer risk as 8 cases in 10,000,000 children (8E-7) and 1 case in 1,000,000 adults (1E-6). These cancer risks are not a health concern.

Table 17. Noncancer and cancer risk estimates for benzene exposure at the residence*

Exposure Group	EPC (µg/m^3)	Noncancer Hazard Quotient	Cancer Risk	Exposure Duration (years)
Children (birth to <21 years)	0.4	<1	8E-7	21
Adult	0.4	<1	1E-6	33

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m^3 = micrograms per meter cubed

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 6.4 µg/m^3 and the cancer risks were calculated using the inhalation unit risk of 7.8E-6 (µg/m^3)$^{-1}$.

5.8.1.3. Occupational and Recreational Exposure at the Senior Recreation Center

DSHS estimated noncancer and cancer health risks for 1,2-dichloroethane, carbon tetrachloride, and benzene using indoor air samples collected from the senior recreation center in 2020 and 2023. The indoor air EPCs were adjusted for full-time workers, part-time workers, and senior visitors using different exposure factors. DSHS used default RME exposure factors for full-time workers and default CTE exposure factors for part-time workers. The full-time worker exposure was 8.5 hours per day, 5 days per week, 50 weeks per year for 20 years. The part-time worker exposure was 5.1 hours per day, 5 days per week, 50 weeks per year for 3.1 years. DSHS used conservative site-specific recreational exposure factors for senior visitors to estimate potential exposure. The exposure factors for senior visitors were an exposure for 4 hours per day, 3 days per week, 50 weeks a year for 10 years.

5.8.2. 1,2-Dichloroethane

1,2-Dichloroethane is a human made volatile liquid. It is mainly used in the production of vinyl products, such as polyvinyl chloride (PVC) pipes [ASTDR 2024a]. It is also used as an industrial solvent or degreaser. In the past, it was also used in some household cleaning products, such as carpet and textile cleaners [2024].

5.8.2.1. Noncancer

ATSDR and EPA have not derived health guidelines (MRL or RfC) for chronic inhalation to 1,2-dichloroethane because only a few chronic studies are available. Therefore, DSHS used the intermediate MRL of 400 µg/m^3. The MRL is based on a study where male mice were exposed to 1,2-dichloroethane for 6 hours per day for 28 days [ASTDR 2024a, Zhong 2022]. The study identified neurological effects as the most sensitive health outcome. These included decreased physical activity and increased vacuolization (the process of forming or filling with vacuoles) in the cerebral cortex. ATSDR used a Bayesian benchmark dose model to calculate a Bayesian benchmark response of 1 standard deviation ($BBMCL_{1sd}$) as the point of departure to calculate the MRL.

The adjusted EPCs from PHAST are below the MRL (HQ less than 1) for all exposure groups (Table 18). Therefore, intermediate (more than 14 days but less than one year) noncancer

adverse health effects are not a health concern for full-time workers, part-time workers, or senior visitors at the senior recreation center.

5.8.2.2. Cancer

EPA considers 1,2-dichloroethane as a probable human carcinogen [EPA 1987]. The IARC has determined that 1,2-dichloroethane is possibly carcinogenic to humans [IARC 1979], and HHS has determined that 1,2-dichloroethane may reasonably be anticipated to be a human carcinogen [NTP 2021]. Studies in rats and mice exposed to 1,2-dichloroethane have observed increased incidence of stomach, liver, and circulatory system cancers in males and mammary and uterus cancers in females. Both male and female mice had increased incidence of lung cancer [EPA 1987].

DSHS used the IUR of 2.6E-5 $(\mu g/m^3)^{-1}$ to estimate excess cancer risks. DSHS calculated cancer risks to be

- 1 case in 1,000,000 (1E-6) for full-time workers,
- 9 cases in 100,000,000 (1E-8) for part-time workers, and
- 1 case in 10,000,000 (1E-7) for senior visitors.

These excess cancer risks are not a health concern.

Table 18. Noncancer and cancer risk estimates for 1,2-dichloroethane exposure at the senior recreation center*

Exposure Group	Adjusted EPC ($\mu g/m^3$)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	0.15	<1	1E-6	20
Part-time worker (CTE)	0.087	<1	9E-8	3.1
Senior Visitor	0.041	<1	1E-7	10

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; $\mu g/m^3$ = micrograms per meter cubed; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The cancer risks were calculated using the inhalation unit risk of 2.6E-5 $(\mu g/m^3)^{-1}$. The noncancer hazard quotients were calculated using the acute or intermediate (less than 1 year) minimal risk level of 400 $\mu g/m^3$.

5.8.3. Carbon Tetrachloride

Carbon tetrachloride is a clear liquid that can quickly vaporize into the air. It is a manufactured chemical that was used to make refrigeration fluid and propellants for aerosol cans. It was also used as a pesticide, cleaning fluid, degreaser, fire extinguishing chemical, and spot remover. Carbon tetrachloride was banned in the 1970s for most applications because of its harmful effects [ATSDR 2005].

5.8.3.1. Noncancer

DSHS used an RfC of 100 $\mu g/m^3$. The RfC is based on a study in which rats were exposed to carbon tetrachloride vapor for 6 hours a day, 5 days a week, for 14 weeks [Nagano 2007, JBRC 1998]. The study identified fatty changes in the liver, an indicator for cellular damage of the

liver, as the most sensitive endpoint. EPA calculated a benchmark concentration (using the 95% lower confidence limit at the 10% response level) of 14,300 µg/m^3 as the point of departure. EPA also applied an uncertainty factor of 100 to calculate the RfC [EPA 2010].

Adjusted EPCs from PHAST were below the RfC for full-time workers, part-time workers, and senior visitors (HQ less than 1) (Table 19). Therefore, adverse noncancer health effects are not a health concern.

5.8.3.2. Cancer

EPA has classified carbon tetrachloride as likely to be carcinogenic to humans [EPA 2010A]. The NTP has classified carbon tetrachloride to be reasonably anticipated to be a human carcinogen [NTP 2021].

DSHS used the IUR of 6.0E-6 (µg/m^3)$^{-1}$ to estimate cancer risk The IUR is based on a study [Nangano 1998] in which male and female rats were exposed to carbon tetrachloride vapors for 104 weeks. EPA evaluated concentration response relationships between carbon tetrachloride and frequency of liver tumors and pheochromocytomas (a hormone-secreting tumor that can occur in the glands on top of the kidneys) to calculate the human equivalent concentration and to calculate the IUR [EPA 2010A].

DSHS calculated the excess cancer risk as:

- 2 cases in 10,000,000 (2E-7) for full-time workers
- 2 cases in 100,000,000 (2E-8) for part-time workers, and
- 3 cases in 100,000,000 (3E-8) for senior visitors.

These excess cancer risks are not a health concern.

Table 19. Noncancer and cancer risk estimates for exposure to carbon tetrachloride at the senior recreation center*

Exposure Group	Adjusted EPC (µg/m^3)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	0.13	<1	2E-7	20
Part-time worker (CTE)	0.076	<1	2E-8	3.1
Senior Visitor	0.036	<1	3E-8	10

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m^3 = micrograms per meter cubed; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 100 µg/m^3 and the cancer risks were calculated using the inhalation unit risk of 6.0E-6 (µg/m^3)$^{-1}$.

5.8.4. Benzene

5.8.4.1. Noncancer

Adjusted EPCs from PHAST for benzene are below the MRL (HQ less than 1) (Table 20). Adverse noncancer health effects from benzene for full-time workers, part-time workers, and senior visitors are not a health concern.

5.8.4.2. Cancer

DSHS calculated excess cancer risks as:

- 2 cases in 1,000,000 (2E-6) for full-time workers,
- 1 case in 10,000,000 (1E-7) for part-time workers, and
- 2 cases in 10,000,000 (2E-7) for senior visitors.

These cancer risks are not a health concern.

Table 20. Noncancer and cancer risk estimates for exposure to benzene at the senior recreation center*

Exposure Group	Adjusted EPC (µg/m^3)	Hazard Quotient	Cancer Risk	Exposure Duration (years)
Full-time worker (RME)	0.68	<1	2E-6	20
Part-time worker (CTE)	0.41	<1	1E-7	3.1
Senior Visitor	0.19	<1	2E-7	10

Adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m^3 = micrograms per meter cubed; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 6.4 µg/m^3 and the cancer risks were calculated using the inhalation unit risk of 7.8E-6 (µg/m^3)$^{-1}$.

5.9. Comparing VOCs detected in indoor air at the Site to VOCs measured in North American residences form 1990-2005

Indoor air typically contains VOCs from a variety of sources, including consumer products, building materials, and outdoor air. Indoor air concentrations resulting from these sources are referred to as background or background concentrations. Any indoor air sample collected for site-specific assessment of soil gas vapor intrusion is likely to detect chemicals from these other sources. Table 21 compares indoor air concentrations detected in the pharmacy, the senior recreation center, and a residential home to background levels (50th and the 95th percentile) measured in North American residences between 1990 and 2005 [EPA 2011]. PCE and chloroform detected in indoor air at the pharmacy were above the 50th and 95th percentile background concentrations. This means that vapor intrusion is possible from soil gas beneath

the pharmacy. Carbon tetrachloride and benzene levels were below the 50th and 95th percentile background concentrations measured in the North American residences. All indoor air levels in the senior recreation center and the residence were below background levels (50th and the 95th percentile) measured in North American residences.

Table 21. Comparison of VOCs detected in indoor air at the Site to VOCs measured in indoor air in North American residences during 1990-2005

Chemical*	Indoor air levels in the pharmacy (µg/m^3)	Indoor air levels in the senior recreation center (µg/m^3)	Indoor air levels in the residence (µg/m^3)	Indoor air levels in North American residences – 50th percentile (µg/m^3)	Indoor air levels in North American residences – 95th percentile (µg/m^3)
Tetrachloroethene (PCE)	0.6 - 110†	ND	ND	<RL*- 2.2	4.1 - 9.5
Carbon tetrachloride	0.44 – 0.52	ND	<RL*- 0.68	0.89	<RL - 1.1
Chloroform	2.1 – 59†	ND	ND	<RL*- 2.4	4.1 - 7.5
Benzene	0.3 - 1.8	2.4 - 2.8	0.4 - 1.8	<RL*- 4.7	9.9 - 29

µg/m^3 = micrograms per cubic meter; ND = not detected; VOCs = volatile organic compounds; RL = reporting limit; PCE = tetrachloroethene or tetrachloroethylene.
*Reporting limits represent the lowest concentration that the laboratory will report for a compound without data qualifiers. In this report, the term "reporting limits" is used synonymously with the term "detection limits" because the different studies compiled used varying conventions for these two terms.
†indicates an exceedance of 95th percentile air levels in North American residences.

5.10. Addressing Community Concerns

DSHS is not currently aware of any community concerns.

5.11. Summary of Limitations and Uncertainties

Indoor air and subslab soil gas samples were only collected from three properties, including one residence. There are 111 residential homes, 2 apartment buildings, 8 businesses and an RV park within 100 feet of the PCE groundwater plume that may warrant further investigation.

There was only one indoor air sample taken from the residence and four indoor air samples taken at the senior recreation center. The limited number of samples may not accurately represent long-term chronic exposures. In these situations, the maximum detected values were used as the EPC.

Many indoor-air samples were flagged for blank contamination. This means the sample may have been contaminated during collection, storage, shipment, or handling. This can result in some of the sample concentrations being overestimated in the analysis.

Indoor air concentrations from vapor intrusion can vary substantially on a daily and seasonal basis. Vapor intrusion during warm and cold seasons can result in higher indoor concentrations.

Limited single-day samples may not represent worst case or time-averaged indoor air concentrations and may overpredict or underpredict exposure.

6. Conclusions

Conclusion 1	Inhaling PCE and TCE in indoor air at the Mekason Pharmacy-Kermit is not likely to cause adverse noncancer or cancer health effects in workers and business patrons.
Basis for Conclusion	DSHS evaluated indoor air samples collected at the pharmacy in October 2022 and May 2023. PCE was detected in indoor air, but levels were below those expected to cause adverse noncancer and cancer health effects for full-time and part-time workers and for patrons. TCE was not detected above screening levels in indoor air. PCE was detected in subslab soil gas samples collected along the perimeter of the pharmacy building. These observations suggest PCE in indoor air is likely from vapor intrusion from PCE in groundwater and soil near the pharmacy. Vapor intrusion occurs when chemicals evaporate from the contaminated soil or groundwater and rise into the indoor air of buildings. Vapor intrusion can also occur when vapors from contaminated soil or groundwater enter a sewer line, travel through it, and then escape into a building through leaks or cracks.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at the pharmacy to confirm levels are not increasing and remain below EPA action levels.
Conclusion 2	PCE and TCE were not detected in indoor air at a nearby residence or at the Winkler Senior Recreation Center (recreation center). Because of the potential for seasonal variation, additional information is needed to determine the likelihood of future indoor inhalation exposure to PCE and TCE.
Basis for Conclusion	DSHS evaluated indoor air samples collected in May 2023 at a residence (1 sample) and in March 2020 and May 2023 at a senior recreation center (a total of 4 samples). The residence and senior recreation center are in the path of the groundwater contaminant plume. PCE and TCE were not detected in indoor air at the senior recreation center or the residence. However, PCE was detected in subslab soil gas samples collected along the perimeter of both properties. The PCE detection suggests the possibility of vapor intrusion into the buildings.

	DSHS cannot determine whether vapor intrusion is occurring over time without additional vapor intrusion sampling (indoor air, subslab gas, and outdoor air). Additionally, sampling during cold weather would help account for seasonal variability.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at the residence and senior recreation center. Collecting indoor air samples in both cold and hot weather would help characterize seasonal variability in potential exposures to better inform health risks from vapor intrusion. Consider using tracers, surrogates, and indicator parameters during sampling to show whether vapor intrusion was likely active or dormant during the sampling event.[5]
Conclusion 3	Indoor air samples were not collected from other residential and commercial buildings located above the contaminated groundwater. DSHS cannot currently determine whether breathing indoor air at these locations may harm people's health.
Basis for Conclusion	DSHS estimates there are 111 residential homes, 2 apartment buildings, 8 businesses, and an RV park within 100 feet of the PCE groundwater plume. The plume was delineated at 5 micrograms per liter (μg/L) PCE in 2023. The depth of groundwater is as shallow as 6 feet below ground surface. Therefore, PCE can move from the groundwater and soil and enter the interior of these buildings. To date, indoor air samples have only been collected from 3 buildings (a pharmacy, a senior recreation center, and a residence). While PCE has been detected in indoor air above the screening level at the former dry cleaner, which is now a pharmacy, the levels are below those for a health concern. Based on groundwater sampling data from 2022 and 2023, the most contaminated portion of the plume appears to be about 400 feet southwest of the pharmacy near the intersection of Ash and Campbell streets (Figure 4). Elevated PCE concentrations were detected in monitor well-18, located about 600 feet from the pharmacy. Given this information, people living above the contaminated groundwater may be at increased risk of PCE exposure. However, the soil vapor intrusion assessment was limited in scope in the down gradient plume area from the Site.

[5] https://clu-in.org/download/issues/vi/5-Tracers-Surrogates-Indicators_Fact-Sheet-Final_508.pdf

	This conclusion may be revised with additional environmental sampling.
Next Steps	DSHS recommends EPA continue to sample indoor air or subslab soil gas at residences and businesses located within 100 feet of the groundwater contamination greater than ATSDR vapor intrusion comparison values. The area for potentially contaminated indoor air at residences and businesses may be further refined by comparing the groundwater and soil gas data to vapor intrusion comparison values, which are based on empirical attenuation rates. Collecting indoor air samples in both cold and hot weather would help characterize seasonal variability in potential exposures to better inform health risks from vapor intrusion. Consider using tracers, surrogates, and indicator parameters during sampling to show whether vapor intrusion was likely active or dormant during the sampling event.[6] DSHS recommends EPA to monitor the path of the contaminated groundwater plume for changes in contaminant levels.
Conclusion 4	Based on available information, students and staff at the Kermit Junior High School and Kermit High School are not expected to be exposed to PCE in indoor air.
Basis for Conclusion	Inhaling PCE and TCE is not likely to have taken place at the junior high and high schools because the contaminated groundwater is not beneath or near the schools. The schools' boundaries are over 800 feet from the boundary of the groundwater contamination. Additionally, the current direction of groundwater gradient flow is away from the school, suggesting future exposure is also not likely.
Next Steps	DSHS recommends EPA continue to monitor the path of the contaminated groundwater plume for changes in direction.
Conclusion 5	Exposure to PCE and other volatile chemicals in private drinking water wells servicing residential and business properties is not likely to occur. However, there is potential for future exposure, if private water wells obtain water from the contaminated groundwater zones.
Basis for Conclusion	Although the residential area is served by a public water system, 18 private water wells servicing residential and business properties within a 4-mile radius of the Site were sampled from 2013 to 2015. Among the private wells sampled, PCE in two water wells was detected, but levels were below the EPA maximum

[6] https://clu-in.org/download/issues/vi/5-Tracers-Surrogates-Indicators_Fact-Sheet-Final_508.pdf

	contaminant level (MCL) of 5 μg/L [EPA 2016b]. The depths of private water wells sampled were between 75 and 375 feet below ground surface. DSHS does not have any information for private water wells before 2013 or after 2015. Based on this information, exposure to PCE from private water wells is unlikely. In 2020 and 2023, a total of 89 groundwater samples were collected from 31 monitoring wells. The depth of monitoring wells ranged from 6 to 165 feet below ground surface. Several chemicals in groundwater were detected above ATSDR's drinking water comparison values for chronic exposures, including PCE and TCE. Chloroform and bromochloromethane, common drinking water disinfection byproducts, were also identified. If private water wells draw water from the same groundwater zones as these monitoring wells, exposure to contaminants from private water wells is possible.
Next Steps	DSHS recommends EPA continue to sample monitoring wells to check for potential PCE and TCE migration to nearby private wells.
Conclusion 6	Residential exposure to drinking water from the public water supply is not expected to harm people's health based on available information. However, there is potential for future exposure.
Basis for Conclusion	Prior to distribution, the City of Kermit public water system blends water from multiple public water wells through two main entry points: the Underwood Pumphouse (EP1) and the Walton Pumphouse (EP2) [EPA 2024a]. Since 2006, PCE and TCE have been detected intermittently in the main entry points. Although PCE and TCE concentrations are below EPA MCLs, TCE has been detected above ATSDR's drinking water comparison value (0.44 μg/L) for chronic exposures [EPA 2024a]. In 2020, DSHS evaluated whether exposure to PCE and TCE in the public water supply could harm people's health and concluded that exposure was not a public health concern [DSHS 2020]. Samples collected after 2020 show PCE and TCE levels below those previously detected. Therefore, the results of DSHS's 2020 evaluation are still valid. The City of Kermit routinely samples water wells servicing the public water system and will take wells offline if there is an exceedance of the MCL. However, there is potential for future exposure should chemical concentrations increase above levels of concern.
Next Steps	DSHS recommends EPA continue to sample wells serving the public water supply to monitor levels of contaminants in the

	drinking water and to monitor for potential migration of PCE and TCE to other public water supply wells.
Conclusion 7	Chemicals not associated with the NPL site were detected in indoor air at Mekason Pharmacy-Kermit, at a residence, and at the Winkler Senior Recreation Center. The levels detected are unlikely to cause adverse noncancer or cancer health effects in workers and residents.
Basis for Conclusion	Several chemicals not likely to be associated with the NPL site were detected in indoor air at the pharmacy, recreational center, and residence: • 1,3-Butadiene, allyl chloride, ethyl acetate, isopropyl alcohol, chloroform, benzene, and 1,2-dichloropropane were detected at the pharmacy. • Carbon tetrachloride, 1,2-dichloroethane, and benzene were detected at the senior recreation center. • Benzene was detected at the residence. The levels of the chemicals in indoor air were below those expected to cause noncancer and cancer health effects. These non-NPL site-related contaminants are likely from sources within occupied buildings. Possible sources include cleaning solvents, paints, building materials, cigarette smoke, and gas stove emissions [EPA 2025].
Next Steps	Continue to sample indoor air or subslab soil gas at the Mekason Pharmacy-Kermit. Evaluate sewer gas as a potential exposure pathway in the vapor intrusion investigation.

7. Recommendations and Public Health Action Plan

This document will be made available to community members, city officials, TCEQ, EPA, and other interested parties.

DSHS will continue to work with EPA, TCEQ, and other interested parties to ensure the safety of the public.

DSHS will continue participating in community meetings and addressing community concerns as they arise.

8. Authors, Site Team, and Contributors

The Texas Department of State Health Services (DSHS) prepared this health consultation for the Highway 18 Superfund Site, Kermit, Dallas County, Texas, under a cooperative agreement [program # CDC-RFA-TS-23-0001] with ATSDR. DSHS evaluated data of verified quality using

approved methods, policies, and procedures in effect at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by DSHS.

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Appendices

Appendix A: Brief Summary of ATSDR's Public Health Assessment (PHA) Process

ATSDR follows the PHA process to find out:

- Whether people living near a hazardous waste site are being exposed to toxic substances.
- Whether that exposure is harmful.
- What must be done to stop or reduce exposure.

The PHA process is a step-by-step consistent approach during which ATSDR:

- Establishes communication mechanisms, including engaging communities at the beginning of site activities and involving them throughout the process to respond to their health concerns.
- Collects many different kinds of site information.
- Obtains, compiles, and evaluates the usability and quality of environmental and biological sampling data (and sometimes modeling data) to examine environmental contamination at a site.
- Conducts four main, sequential scientific evaluations.
    - Exposure pathways evaluation to identify past, present, and future site-specific exposure situations, and categorize those exposures as completed, potential, or eliminated.
    - Screening analysis to compare the available sampling data to media-specific environmental screening levels (ATSDR comparison values [CVs] and non-ATSDR screening levels). This process identifies potential contaminants of concern that require further evaluation for completed and potential exposure pathways.
    - Exposure Point Concentrations (EPCs) and exposure calculations for contaminants flagged as requiring further evaluation in completed and potential exposure pathways. It involves calculating EPCs, using EPCs to perform calculations that characterize exposure, and determining which site-specific exposure scenarios requires an in-depth toxicological effects analysis.
    - In-depth toxicological effects evaluation, if necessary, based on the three previous scientific evaluations. This step looks more closely at contaminant-specific toxicity information in the context of site exposures. This evaluation can also help determine if there is a potential for non-cancer or cancer health effects and what those effects might be.
- Summarizes findings and next steps, while acknowledging uncertainties and limitations.
- Provides recommendations to site-related entities, partner agencies, and communities to prevent and minimize harmful exposures.

The sequence of steps can differ based on site-specific factors. For instance, health assessors might define an exposure unit before or after the screening analysis or refine EPC calculations as they go through their site-specific analysis.

For more detail on the PHA process, visit Explanation of ATSDR's PHA Process Evaluation. Readers can also refer to ATSDR's Public Health Assessment Guidance Manual for all information related to the step-wise PHA process.

Appendix B: Screening Analysis

Indoor Air

Table 22. Indoor air sampling results collected from the pharmacy and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (µg /m³)	Screening Value (µg /m³)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	17	0.6 - 110†	3.8	ATSDR CREG	14
1,3-Butadiene	7	ND - 10†	0.033	ATSDR CREG	7
Allyl Chloride	1	ND – 4.3†	1	ATSDR RMEG	1
Ethyl acetate	12	ND - 15†	73	EPA RSL Residential THQ 1‡	6
n-Heptane	7	ND – 4.8	420	EPA RSL Residential THQ 1§	0
Isopropyl alcohol	14	ND – 3,600†	210	EPA RSL Residential THQ 1¶	12
Chloroform	6	ND - 59†	0.043	ATSDR CREG	6
Benzene	10	ND - 1.8†	0.13	ATSDR CREG	10
Propane &/ or Propene	8	ND – 13	NA	NA	NA
Dichlorodifluoromethane	3	ND – 2.8	100	EPA RSL Residential THQ 1#	0
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1	ND – 4.6	NA	NA	NA
1,2-Dichloropropane	1	ND - 9.4†	4	ATSDR RMEG	1

*A total of 18 indoor air samples were collected from the pharmacy in October 2022 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; EPA = Environmental Protection Agency; CREG = Cancer Risk Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide; EPA = Environmental Protection Agency; RSL = Regional Screening Level; THQ = Target Hazard Quotients; μg/m^3 = micrograms per cubic meter; ND = not detected; NA = not available PCE = tetrachloroethene or tetrachloroethylene.
†indicates an exceedance of a screening value.
§EPA's RSL for n-heptane is based on an inhalation rat study (28 days) [Simonsen and Lund 1995]. The benchmark confidence limit 1 standard deviation (BMCL1SD) human equivalent concentration (HEC) of 1,170 mg/m^3 identified for loss of hearing sensitivity in rats, and an uncertainty factor of 3,000 was used in the derivation of the chronic p-RfC [EPA 2016C].
¶EPA's RSL for isopropyl alcohol is based on inhalation studies in rats (104 weeks) and mice (78 weeks) [Burleigh-Flayer 1997]. The lowest adverse effect level adjusted for dosimetric difference across species to human equivalent concentration ($LOAEL_{HEC}$) was determined to be 221 mg/m^3 and associated with decreased absolute and relative testes weights in male mice. EPA determined a chronic provisional reference concentration (of 0.2 mg/m^3 using the $LOAEL_{HEC}$ and an uncertainty factor of 1,000 [EPA 2014].
#EPA's RSL for dichlorodifluoromethane is based on an intermittent exposure study in guinea pigs, rabbits, dogs, and monkeys [Prendergast 1967]. A $LOAEL_{HEC}$ of 985 mg/m^3 associated with reduced body weight was determined. EPA derived a subchronic provisional reference concentration of 1 mg/m^3 using the $LOAEL_{HEC}$ and an uncertainty factor of 1,000 [EPA 2010].

Table 23. Indoor air sampling results collected from the residence and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (μg /m^3)	Screening Value (μg /m^3)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	1	0.9	3.8	ATSDR CREG	0
Ethyl acetate	1	2.5	73	EPA RSL Residential THQ 1‡	0
1-Ethyl-4-methylbenzene	1	3.5	NA	NA	NA
Acetone	1	56	NA	NA	NA
Benzene	1	1.2†	0.13	ATSDR CREG	1

*Indoor air samples were collected from the residence in May 2023.

ATSDR = Agency for Toxic Substances and Disease Registry; EPA = Environmental Protection Agency; CREG = Cancer Risk Evaluation Guide; RSL = Regional Screening Level; μg/m^3 = micrograms per cubic meter, NA = not available; PCE = tetrachloroethene or tetrachloroethylene.
†indicates an exceedance of a screening value.
‡EPA's RSL for ethyl acetate is based on an inhalation rat study (13 weeks) by Christoph [Christoph 2003]. Christoph et al. showed decreased body weights, body-weight gains, food efficiency, and startle response (both sexes) and decreased food consumption (males) in rats exposed to ethyl acetate for 13 weeks. A no adverse effects level adjusted for dosimetric differences across species to human equivalent concentration ($NOAEL_{HEC}$) was determined to be 209 μg/m^3. EPA determined a provisional RfC (pRFC) of 0.7 μg/m^3 using an uncertainty factor of 3,000 [EPA 2013].

Table 24. Indoor air sampling results collected from the senior recreation center and screening values for all chemicals detected*

Contaminant of Concern	Number of Detected Values	Concentration Range (μg /m^3)	Screening Value (μg /m^3)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	0	ND	3.8	ATSDR CREG	0
1,1,1-Trichloroethane	2	ND – 1.7	700	ATSDR Intermediate EMEG/MRL	0
1,2-Dichloroethane	2	ND – 0.6†	0.01	ATSDR CREG	2
Acetone	2	ND – 20	NA	NA	NA
Benzene	4	2.3† – 2.8†	0.13	ATSDR CREG	4
Carbon Tetrachloride	2	ND – 0.52†	0.03	ATSDR CREG	2
Ethyl acetate	2	ND – 5.1	73	EPA RSL Residential THQ 1‡	0
Ethylbenzene	2	ND – 0.64	60	ATSDR Chronic EMEG/MRL	0
Toluene	2	ND – 4.4	1,000	ATSDR Chronic EMEG/MRL	0
m,p-Xylene	2	ND – 2	23	ATSDR RMEG	0
o-Xylene	2	ND – 0.83	50	ATSDR Chronic EMEG/MRL	0

*A total of 4 indoor air samples were collected from the pharmacy in March 2020 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; EPA = Environmental Protection Agency; CREG = Cancer Risk Evaluation Guide; RMEG = Reference Dose Media Evaluation Guide; EPA = Environmental Protection Agency; RSL = Regional Screening Level; THQ = Target

Hazard Quotients; μg/m^3 = micrograms per cubic meter; ND = not detected; NA = not available; PCE = tetrachloroethene or tetrachloroethylene.
† indicates an exceedance of a screening value.
‡EPA's RSL for ethyl acetate is based on an inhalation rat study (13 weeks) by Christoph [Christoph 2003]. Christoph et al. showed decreased body weights, body-weight gains, food efficiency, and startle response (both sexes) and decreased food consumption (males) in rats exposed to ethyl acetate for 13 weeks. A no adverse effects level adjusted for dosimetric differences across species to human equivalent concentration ($NOAEL_{HEC}$) was determined to be 209 mg/m^3. EPA determined a provisional RfC (pRFC) of 0.7 mg/m^3 using an uncertainty factor of 3,000 [EPA 2013].

Table 25. Subslab soil gas sampling results collected from the pharmacy and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (μg /m^3)	Screening Value (μg /m^3)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	2	18,000† – 20,000†	130	ATSDR CREG	2
Trichloroethene (TCE)	2	3.1 – 7.7†	7	ATSDR CREG	1
Acetone	2	8.5 – 12	NA	NA	NA

*A total of 2 indoor air samples were collected from the pharmacy in October 2022 and May 2023. ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; mg/m^3 = micrograms per cubic meter, NA = not available; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
†indicates an exceedance of a screening value.

Table 26. Subslab soil gas sampling results collected from the residence and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (μg /m^3)	Screening Value (μg /m^3)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	1	260†	130	ATSDR CREG	1
Acetone	1	26	NA	NA	NA

*One sample was collected from the pharmacy in May 2023.

ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/m^3 = micrograms per cubic meter, NA = not available; PCE = tetrachloroethene or tetrachloroethylene.
† indicates an exceedance of a screening value.

Table 27. Subslab soil gas sampling results collected from the senior recreation center and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (µg /m^3)	Screening Value (µg /m^3)	Source of Screening Value	Number of Detected Values Above Screening Value
Tetrachloroethene (PCE)	2	44 – 280†	130	ATSDR CREG	3
Acetone	1	ND - 15	NA	NA	NA
Benzene	2	ND – 4.6†	4.3	ATSDR CREG	2

*A total of 3 subslab samples were collected from the senior recreation center in October 2022 and May 2023.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/m^3 = micrograms per cubic meter; ND = not detected; NA = not available; PCE = tetrachloroethene or tetrachloroethylene.
† indicates an exceedance of a screening value.

Groundwater

Table 28. Groundwater sampling 2023 results from monitoring wells and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (µg/L)	Screening Value (µg/L)	Source of Screening Value	# of Detected Values Above Screening Value
Tetrachloroethene (PCE)	17/37	ND – 320†	5.3	ATSDR CREG	10
Trichloroethene (TCE)	6/37	ND – 5†	0.52	ATSDR CREG	4
Acetone	2/37	ND – 10	NA	NA	NA
Chloroform	6/37	ND – 5†	0.29	ATSDR CREG	4
Bromodichloromethane	1/37	ND – 5	80	EPA MCL	0

*A total of 37 groundwater samples were collected in 2023. DSHS excluded 20 samples taken outside of the area of the Site. The samples excluded were collected at wells GW-01, GW-12, GW-13, GW-17, GW-18, GW-19, GW-20, GW-22, GW-30, and GW-31.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; µg/L = micrograms per liter. ND = not detected; NA = not available; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
† indicates an exceedance of a screening value.

Table 29. Groundwater sampling 2019-2020 results from monitoring wells and screening values for all detected chemicals*

Contaminant of Concern	Number of Detected Values	Concentration Range (µg/L)	Screening Value (µg/L)	Source of Screening Value	# of Detected Values Above Screening Value / Total # of Samples
Tetrachloroethene (PCE)	22/78	ND – 947†	5.3	ATSDR CREG	10
Trichloroethene (TCE)	11/78	ND – 2.0†	0.52	ATSDR CREG	4
Acetone	6/78	ND – 15	NA	NA	NA
Chloroform	25/78	ND – 2.5†	0.29	ATSDR CREG	4
Benzene	2/78	ND - 1.0†	0.57	ATSDR CREG	0
Bromodichloromethane	8/78	ND – 2.0	80	EPA MCL	0

* A total of 78 groundwater samples were collected in 2019 -2020.
ATSDR = Agency for Toxic Substances and Disease Registry; CREG = Cancer Risk Evaluation Guide; EPA = Environmental Protection Agency = EPA; MCL = maximum contaminant Level; µg/L = micrograms per liter; ND = not detected; NA = not available; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.
† indicates an exceedance of a screening value.

Appendix C: Input parameters and equations used to calculate exposure point concentration in PHAST

Air Inhalation

Equations

Air Inhalation Exposure Equation

Adjusted EPC = EPC x $EF_{noncancer}$ **Equation 1**

EPC = exposure point concentration, $EF_{noncancer}$ = exposure factor (unitless)

Hazard Quotient

HQ = Adjusted EPC ÷ HG **Equation 2**

HQ = hazard quotient, EPC = exposure point concentration (µg/m³ or ppb), HG = health guideline (e.g., oral MRL, RfD)

Cancer Risk Equations

CR = Adjusted EPC x IUR x (ED ÷ LY) **Equation 3**

ADAF-adjusted CR = (Adjusted EPC x IUR) x (ED ÷ LY) x ADAF **Equation 4**

Total CR = Sum of the CR for all exposure groups **Equation 5**

CR = cancer risk (unitless), EPC = exposure point concentration (µg/m³ or ppb), IUR = inhalation unit risk ((µg/m³ or ppb)$^{-1}$),
ED = exposure duration (years), LY = lifetime years (78 years), ADAF = age-dependent adjustment factor (unitless),
EF (cancer) = exposure factor (cancer) calculated as follows: EF (non-cancer; unitless) x exposure group specific exposure duration (years) ÷ lifetime of 78 years

Appendix D: Trichloroethylene (TCE)[7] Cancer Risk Calculations

Cancer risk (CR) calculations for TCE incorporate three types of cancer: non-Hodgkin's lymphoma (NHL), kidney cancer, and liver cancer. Because TCE is only considered to be mutagenic for kidney cancer, age-dependent adjustment factors (ADAFs) are only applied to the kidney cancer portion of the cancer slope factor (CSF) and inhalation unit risk (IUR).

Therefore, TCE cancer risk = (non-Hodgkin's lymphoma risk + liver cancer risk) + (kidney cancer risk with ADAFs applied)

For inhalation:

Total TCE CR = (NHL and liver CR) + (ADAF-adjusted kidney CR)

NHL & liver CR = (C × (IUR for NHL + IUR for liver cancer)) × (ED/LY)

ADAF-adjusted kidney CR = (C × IUR for kidney cancer) × ED/LY) × ADAF

Where,

CR = cancer risk,

C = air concentration ($\mu g/m^3$),

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

ED = age-specific exposure duration (years),

LY = lifetime in years (78 years),

ADAF = age-dependent adjustment factor (unitless),

NHL = non-Hodgkin's lymphoma

The following ADAFs are applied for the evaluation of kidney cancer:

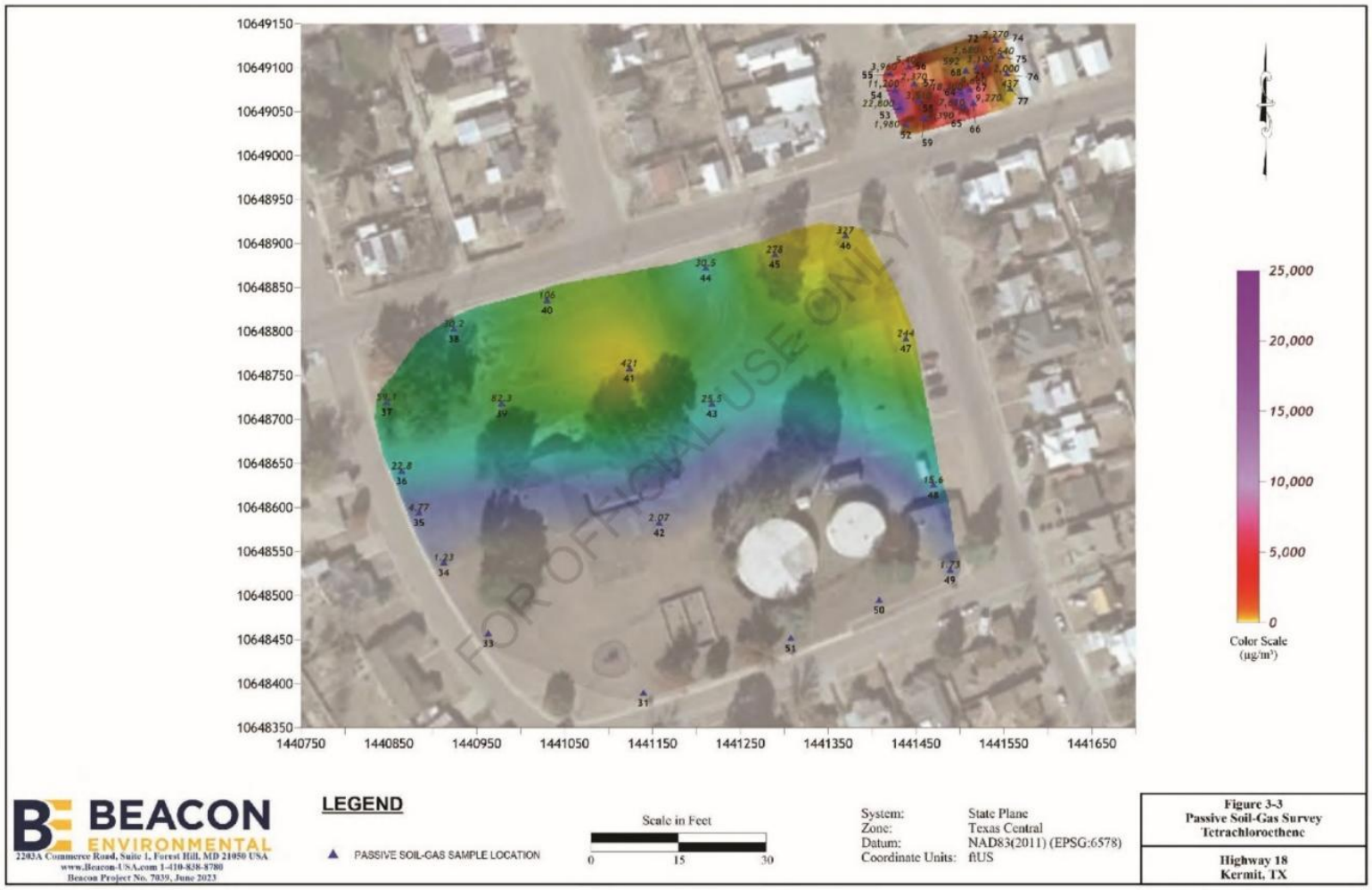
ADAF of 10 for exposures occurring from birth to <2 years

ADAF of 3 for exposures occurring from 2 to <16 years

[7] TCE = trichloroethene or trichloroethylene

Appendix E: Passive Soil Gas Sample 2023

Figure 7. Tetrachloroethylene (PCE)[8] passive soil gas map [Weston 2023]. Colors reflect relative qualitative soil gas levels of the PCE in subsurface soils. The highest levels (red colors) were detected at the pharmacy.



[8] PCE = tetrachloroethylene or tetrachloroethene

Figure 8. Trichloroethylene (TCE)[9] passive soil gas map [Weston 2023]. Colors reflect relative qualitative soil gas levels of the TCE subsurface soils. The highest levels (blue color) were detected at the pharmacy.

[9] TCE = trichloroethylene or trichloroethene

Appendix F: City of Kermit Water System Results

Table 30. Results from the City of Kermit Public Water System 2004-2024 [TCEQ 2025]

Date	Entry Points (EP)*	Tetrachloroethylene (PCE) (µg/L)	Trichloroethylene (TCE) (µg/L)
5/1/2024	EP1	--	--
5/1/2024	EP2	1.37	--
5/22/2023	EP1	--	0.5
5/22/2023	EP2	1.25	--
5/10/2022	EP1	--	0.56†
5/10/2022	EP2	0.97	--
5/4/2021	EP1	--	0.75†
5/4/2021	EP2	0.75	--
7/21/2020	EP1	--	--
7/21/2020	EP2	0.91	--
5/6/2019	EP1	--	0.57†
5/6/2019	EP2	0.56	--
6/11/2018	EP1	--	0.76†
6/11/2018	EP2	--	--
5/25/2017	EP1	--	0.7†
5/25/2017	EP2	--	--
6/30/2016	EP1	--	0.9†
6/30/2016	EP2	2.58	--
6/15/2015	EP1	--	0.92†
6/15/2015	EP2	--	--
5/27/2014	EP1	--	0.95†
5/27/2014	EP2	--	--
12/9/2013	EP1	--	0.81†
12/9/2013	EP2	--	--
9/19/2012	EP1	--	1.2†
9/19/2012	EP2	--	--
9/26/2011	EP1	--	0.5
9/26/2011	EP2	--	--
9/27/2010	EP1	--	0.8†
9/27/2010	EP2	2.5	--
9/21/2009	EP1	--	0.6†
9/21/2009	EP2	2.9	--
6/24/2008	EP1	--	1.12†
6/24/2008	EP2	1.79	--
5/1/2007	EP1	--	1.1†
5/1/2007	EP2	0.95	--
7/11/2006	EP1	--	1.18†
7/11/2006	EP2	1.48	--
8/12/2004	EP1	––	1.1†
8/12/2004	EP2	––	--

*The Kermit public water system blends water from multiple public water wells before distribution through two entry points, the Underwood Pumphouse (EP1) and the Walton Pumphouse (EP2). "- -" = not detected; μg/L = microgram per liter; PCE = tetrachloroethene or tetrachloroethylene; TCE = trichloroethene or trichloroethylene.

† indicates concentration above ATSDR drinking water comparison values: 5.3 μg/L PCE and 0.43 μg/L for TCE.