Health Consultation

MODESTO DRY CLEANER INVESTIGATION:
"Service Cleaners" and "Sparkleen Laundry and Dry Cleaners"

MODESTO, CALIFORNIA

Prepared by:
California Department of Public Health

FEBRUARY 12, 2018

Prepared Under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
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. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
Or
Visit our Home Page at http://www.atsdr.cdc.gov

HEALTH CONSULTATION

Modesto Dry Cleaners Investigation:
"Service Cleaners" and "Sparkleen Laundry and Dry Cleaners"

MODESTO, CALIFORNIA

Prepared By:

California Department of Public Health
Environmental Health Investigations Branch
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Foreword

The Site Assessment Section (SAS) within the California Department of Public Health prepared this Health Consultation (HC) report under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to exposures to toxic substances. In order to prepare a HC, ATSDR and its cooperative agreement partners review available information about hazardous substances at sites and evaluate whether exposure to them might cause any harm to people. An HC is not the same as a medical exam or a community health study. SAS prepared this HC in accordance with ATSDR's approved methods, policies, and procedures existing at the date of publication. ATSDR has reviewed this document, and based on the information presented, concurs with its findings.

Table of Contents

List of Figures

List of Tables

Abbreviations and Acronyms

ATSDR - Agency for Toxic Substances and Disease Registry
Cal-EPA - California Environmental Protection Agency
CDPH - California Department of Public Health
CREG - cancer risk evaluation guide
DTSC - (California) Department of Toxic Substances Control
EPA - U.S. Environmental Protection Agency
HQ - hazard quotient
$\mu g/m^3$ - micrograms per cubic meter
LOAEL – Lowest Observed Adverse Effect Level
MRL - minimal risk level (ATSDR)
NOAEL – No Observed Adverse Effect Level
PCE - tetrachloroethylene, PERC
RfC - reference concentration
RSL - regional screening level
SL - screening level
SVE - soil vapor extraction (system)
TCE - trichloroethylene
VOC – volatile organic compound

Summary

INTRODUCTION

The California Department of Public Health (CDPH) is working with the federal Agency for Toxic Substances and Disease Registry (ATSDR) under a cooperative agreement to investigate releases of hazardous waste and evaluate if contamination could harm public health.

In April 2010, the California Environmental Protection Agency's (Cal-EPA) Department of Toxic Substances Control (DTSC) asked CDPH for help in responding to a community member in Modesto. The person had health concerns about potential exposures to volatile organic compound (VOC) releases from dry cleaning operations near their home. CDPH met with the person and responded to the concerns. In addition, CDPH reviewed the entire data set available for dry cleaner releases in Modesto. Twenty-three sites were identified and will be evaluated in health consultations. This health consultation provides more information about releases near two of these dry cleaners: former "Service Cleaners" (1425 La Loma Avenue, "Service") and former "Sparkleen Laundry and Dry Cleaners" (1511 Yosemite Boulevard, "Sparkleen").

It is very important to CDPH and the ATSDR that the Modesto community has all available information about potential exposures from former dry cleaners. We are committed to providing the best scientific information available and to promoting the health of the community.

The Service and Sparkleen dry cleaners operated from 1960-1985 and 1971-1979, respectively. Since 2001, the City of Modesto has investigated volatile chemicals released from dry cleaners into the local soil and groundwater, including releases at Service and/or Sparkleen. Sometimes volatile chemicals can enter buildings by way of soil gas, a process called "vapor intrusion." CDPH evaluated soil gas and indoor air data to determine if exposures from breathing indoor air might pose health risks for nearby residents or workers in these former dry cleaning buildings.

CDPH reached five conclusions about the former Service and Sparkleen dry cleaners.

CONCLUSION 1

CDPH concludes that breathing tetrachloroethylene (PCE) in indoor air at the former Service building is not expected to harm worker's health, but we do not have enough information to conclude whether

	or not PCE in the indoor air at the former Sparkleen building or in other commercial buildings could harm worker's health.
BASIS FOR CONCLUSION 1	Indoor air samples collected from 2014 to 2016 at the former Service building indicate that current indoor air does not contain levels of PCE that could cause non-cancer health effects or increase the risk for cancer. This is likely because the soil vapor extraction (SVE) system and an air handling system installed at the site have operated correctly. Shutting off these systems might affect the indoor air concentrations. The current PCE concentrations inside the former Sparkleen dry cleaner or in other commercial buildings nearby are unknown because indoor air measurements and related information are not available.
NEXT STEPS FOR CONCLUSION 1	CDPH recommends that 1. The City of Modesto continues to operate the SVE system near the Service and Sparkleen dry cleaners (resulting in the mitigation of vapor intrusion) and to monitor soil gas and outdoor air for volatile organic compounds (including rebound testing after SVE shut off). This will ensure that PCE is removed from soil gas and will show breakdown products of PCE in soil gas or outdoor air. 2. The City of Modesto conducts periodic indoor air sampling for VOCs for the dry cleaner buildings and other commercial buildings within 500 feet of the former dry cleaner buildings, where the greatest releases occurred. Indoor air samples are to be collected preferably during winter or summer. Monitoring during winter and summer are most likely to capture active vapor intrusion events. 3. DTSC continues the oversight of the City of Modesto's cleanup and monitoring of soil gas, outdoor and indoor air at the Service and Sparkleen dry cleaners, and buildings nearby. 4. Workers request indoor air testing at workplaces within 500 feet of the former dry cleaner buildings, to see if they are at risk. 5. Workers review the factsheets on vapor intrusion included in this health consultation and determine if they can take simple steps, such as increasing ventilation, to reduce potential exposures and improve indoor air quality. CDPH will work with DTSC and the City of Modesto to periodically review indoor air and soil gas data to ensure that the vapor intrusion remediation and mitigation measures are effective and indoor air concentrations for VOCs are safe for workers.

CONCLUSION 2	CDPH does not have enough information to conclude whether or not the current PCE concentrations in indoor air in homes near the former dry cleaners could harm people's health.
BASIS FOR CONCLUSION 2	Only soil gas data are available from 2014 to 2016. Soil gas sampling locations closest to Service had the highest PCE concentrations. At six of eight locations, the estimated indoor air concentrations, which were based on soil gas concentrations, exceeded the indoor air screening level. However, health conclusions cannot be drawn based on estimated indoor air concentrations alone.
NEXT STEPS FOR CONCLUSION 2	CDPH recommends that 1. The City of Modesto continues to operate the SVE system near the Service and Sparkleen dry cleaners (resulting in the mitigation of vapor intrusion) and to monitor soil gas and outdoor air for volatile organic compounds (including rebound testing after SVE shut off). This will ensure that PCE is removed from soil gas and will show breakdown products of PCE in soil gas or outdoor air. 2. The City of Modesto conducts periodic indoor air sampling for VOCs for homes within 500 feet of the former dry cleaner buildings, where the greatest releases occurred. Indoor air samples are to be collected preferably during winter or summer. Monitoring during winter and summer are most likely to capture active vapor intrusion events. 3. DTSC continues the oversight of the City of Modesto's cleanup and monitoring of soil gas, outdoor and indoor air in homes. 4. Residents request and allow the indoor air testing, to see if they are at risk. 5. Residents review the factsheets on vapor intrusion included in this health consultation and determine if they can take simple steps, such as increasing ventilation, to reduce potential exposures and improve indoor air quality. CDPH will work with DTSC and the City of Modesto to periodically review indoor air and soil gas data to ensure that the vapor intrusion remediation and mitigation measures are effective and indoor air concentrations for VOCs are safe for residents. CDPH will continue to reach out to the community near the dry cleaners under investigation to determine the community's outreach and information needs. CDPH can offer printed material, community meetings or educational workshops, depending on the community's preference.

CONCLUSION 3	Breathing PCE in indoor air at the former Service building during 2011 could have harmed worker's health if similar exposures lasted for a long time (years). We do not have enough information to determine whether PCE in the indoor air at the former Sparkleen building or in other commercial buildings nearby could have harmed worker's health.
BASIS FOR CONCLUSION 3	Before the operation of an air handling system at Service (2011) and an SVE system (2013), breathing indoor air in the former Service building could have posed a public health hazard to workers if the exposure lasted for a long time (years). No indoor air data are available before 2011. Based on the highest indoor air concentration found (2011), the estimated cancer risk was 300 additional cancers in 1 million workers, if exposed for 25 years. This is an elevated cancer risk compared to a target risk of 1 additional cancer in 1 million people (the point of departure risk). The highest indoor air concentration also exceeded the screening level for non-cancer health effects for workers, based on the California Department of Toxic Substances Control Screening Level. The PCE concentrations inside the former Sparkleen dry cleaner or in other commercial buildings nearby are unknown because no indoor air measurements are available.
NEXT STEPS FOR CONCLUSION 3	Workers who might have been exposed in the past, and who have health or exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact CDPH and we can refer them to additional resources.
CONCLUSION 4	Breathing PCE in indoor air at some homes near the former Service and Sparkleen dry cleaners could have harmed people's health if exposures similar to those between 2010 and 2012 lasted for a long time (years).
BASIS FOR CONCLUSION 4	Of the 16 homes tested between 2010 and 2012, indoor air PCE concentrations in four homes were below levels of health concern for residents; six homes had indoor air concentrations associated with low cancer risks (1 to 10 in a million), and six homes had PCE concentrations associated with elevated cancer risks (greater than 10 in a million). In one home the ATSDR screening level for non-cancer health concerns was exceeded. That home also had the highest estimated cancer risk (410 additional cancers in 1 million residents, if exposed for 26 years). This is an elevated cancer risk, compared to the point of departure risk of 1 in 1 million. Before the operation of a sub-slab depressurization system under this and several other homes

	(2010) and an SVE system (2013), breathing indoor air in 12 of 16 homes tested could have posed a public health hazard if the exposure lasted for a long time (years). The PCE concentrations inside other homes near the former Service and Sparkleen dry cleaners are unknown because no indoor air measurements are available.
NEXT STEPS FOR CONCLUSION 4	CDPH recommends that 1. Residents who might have been exposed in the past, and who have health or exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact CDPH and we can refer them to additional resources. 2. The City of Modesto conducts follow-up sampling of indoor air in homes that have a subslab depressurization system installed, as some systems may require adjustments or upgrading.
CONCLUSION 5	CDPH does not have enough information to determine whether breathing PCE in indoor air at the former Service or Sparkleen buildings, in homes or other buildings nearby, in 2010 or before could have harmed people's health if the exposure lasted for a long time (years). However, based on the high concentration of PCE in soil gas at some locations (2001-2003), it is likely that concentrations of PCE in indoor air were elevated in some buildings.
BASIS FOR CONCLUSION 5	During 2001-2003, the only sampling data available are soil gas data. At 12 of 21 soil gas sampling locations, the estimated indoor air concentrations based on soil gas concentrations exceeded the indoor air screening level. The concentrations of PCE in indoor air in homes, the former Service and Sparkleen buildings, or in other buildings for this period are unknown and CDPH is unable to quantify the health risks based on soil gas concentrations. No data for soil gas or indoor air are available from 2004-2009.
NEXT STEPS FOR CONCLUSION 5	Residents and workers who might have been exposed in the past, and who have health or exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact CDPH and we can refer them to additional resources.
LIMITATIONS	Indoor air samples were available for 16 homes in a limited time frame (2010 – 2012), and most homes were sampled only once. Indoor air samples were available for the former Service building (2010 - 2016), but not for Sparkleen or other buildings. CDPH focused the investigation on the buildings near the dry cleaners (500

	ft. radius), where the greatest releases occurred. However, south of Yosemite Blvd, PCE concentrations in soil gas extend beyond the 500 ft. radius. This contamination may be due to releases from Service, Sparkleen, or from other releases.
FOR MORE INFORMATION	If you have questions about this health consultation, you may contact Dr. Gabriele Windgasse, CDPH, Gabriele.Windgasse@cdph.ca.gov or (510) 620-3610. You can also call ATSDR at 1-800-CDC-INFO and ask for information on the "Modesto Dry Cleaner Investigation: "Service Cleaners" and "Sparkleen Laundry and Dry Cleaners"" site.

Background and Statement of Issues for the Modesto Dry Cleaner Investigation: "Service Cleaners" and "Sparkleen Laundry and Dry Cleaners"

The California Department of Public Health (CDPH) is working with the federal Agency for Toxic Substances and Disease Registry (ATSDR) under a cooperative agreement to investigate releases of hazardous waste and evaluate if contamination could harm public health. CDPH and ATSDR want the Modesto community to have all available information about potential exposures to tetrachloroethylene (PCE) from 23 former dry cleaners. CDPH and ATSDR are committed to providing the best scientific information available and to promoting the health of the community.

Since 2001, the City of Modesto has investigated contaminants released from dry cleaners into the local soil and groundwater. Starting in 2002, the city and the California Department of Toxic Substances Control (DTSC) entered into oversight agreements to investigate and cleanup former dry cleaner sites. Under these agreements and DTSC oversight, the city has 1) conducted investigations to determine PCE concentrations in soil, soil gas, groundwater, and indoor air, and 2) built mitigation systems to remove PCE from the subsurface and potentially improve indoor air and groundwater conditions, at several former and current dry cleaners. The Voluntary Cleanup Agreement for the former Service was signed and amended in 2011.

In April 2010, DTSC requested assistance from CDPH to help in responding to a Modesto community member who had health concerns about potential exposure to volatile organic compound (VOC) releases from dry cleaning operations near their home. DTSC and the city provided CDPH with environmental data collected at or near various dry cleaners throughout Modesto. CDPH responded to the initial request and later reviewed the entire dataset. CDPH identified 23 dry cleaners where concentrations of PCE in soil gas exceeded the DTSC Screening Level (DTSC-SL) for soil gas (residential, current use) of 230 micrograms per cubic meter ($\mu g/m^3$) [1]. CDPH began public health assessment activities to investigate vapor intrusion concerns from releases near these 23 dry cleaners. Appendix A includes a map showing those dry cleaners (Figure A1). CDPH plans to write approximately 18 individual health consultations that focus on the evaluation of exposures in the neighborhoods near the 23 dry cleaners. The health consultations will evaluate the health impacts of exposures from vapor intrusion and identify actions needed to protect public health. Following the completion of the health consultations, CDPH initially proposed writing a public health assessment. However, ATSDR determined that a public health assessment will not provide additional information about exposures or actions to protect people's health.

This health consultation focuses on 2 of the 23 dry cleaners: former Service Cleaners at 1425 La Loma Avenue ("Service"), and former Sparkleen Laundry and Dry cleaners at 1511 Yosemite Boulevard ("Sparkleen") (Figure 1). It will serve as a template for the vapor intrusion approach of the remaining dry cleaner sites. Service operated from about 1960 to 1985. The building is now used as a check-cashing business [2]. Sparkleen operated from about 1971 to 1979. The building has since been used as a coin-operated laundry and as a used car sales lot. CDPH evaluated the available data for Service and Sparkleen together because they are located close to each other.

Throughout this process, the community can contact CDPH with questions and concerns. In addition, CDPH will determine the outreach and information needs of the community. CDPH can provide printed materials, community meetings or educational workshops, depending on the preference of the community.

Community Concerns and Outreach Activities

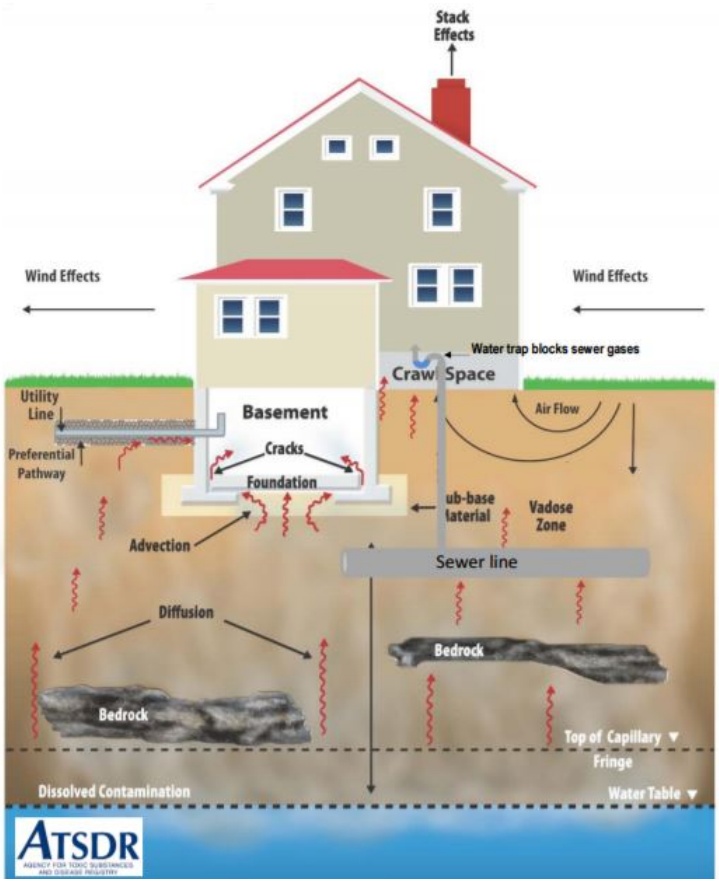
CDPH contacted communities near the dry cleaners through informal interviews during site visits and public availability meetings. CDPH also met with representatives of the City of Modesto, the Stanislaus County Department of Public Health and Environmental Resources, and Modesto physicians. During these outreach activities, CDPH received calls from community members concerned about the safety of their drinking water, soil, and air. CDPH responded to each community member, explained that this investigation is focused on the inhalation pathway from vapor intrusion, and provided them with a contact in the City of Modesto's Drinking Water Program. CDPH explained that community members are not likely to come into contact with soil contaminated by VOC releases from dry cleaners. That is because the sites do not have bare or unpaved soil, or the dry cleaners have perimeter area fencing that prevents access to the soil.

Figure 1. Locations of Service Cleaners and Sparkleen Laundry and Dry Cleaners

The Vapor Intrusion Pathway

For this investigation, CDPH looked at how soil contamination could affect the indoor air in nearby homes and the former dry cleaner buildings through a process called "vapor intrusion." Vapor intrusion occurs when solvents in soil release gases into air spaces. This "soil gas" can travel under buildings and enter buildings through cracks in the slab, foundation, or basement floor; through sewer lines, or through other openings. Solvents in groundwater can also contribute to soil gas. The City of Modesto and DTSC are investigating how soil, soil gas, and groundwater were affected by the releases in the past. Figure 2 shows how contamination from below ground can enter homes. Many factors determine whether soil gas can enter a building, including the following:

- the soil type and moisture content (how much water is in the soil)
- the air conditioning/heating settings in the building
- how long residents keep the windows open (ventilation rate)
- the type and condition of the floor (presence of a basement, crawl space or slab on grade, how many cracks in the concrete, holes for utilities)



How did the dry cleaners contaminate the soil?

All soils contain numerous tiny air pockets (soil gas), like the air spaces in a sponge. When dry cleaning solvents were released into the soil, these solvents evaporated and PCE vapor moved into the soil gas.

What happens to the PCE in soil gas?

The gas can move through the soil and through cracks and openings in foundation slabs, entering the indoor air of homes, a process called "vapor intrusion."

Figure 2. Vapor Intrusion Pathways [3]

To best evaluate vapor intrusion concerns, CDPH used many sources of information. These included the site history, indoor air and soil gas samples, soil type, sampling depth, and the type and condition of foundation. This is called a "multiple lines of evidence" approach.

The dry cleaning solvent detected at the highest concentrations is called tetrachloroethylene, perchloroethylene, perc or PCE. Over time, PCE can break down into other chemicals, such as trichloroethylene (TCE) and vinyl chloride. The City of Modesto and DTSC have collected data on PCE and its breakdown products in groundwater, soil, soil gas, and indoor air.

Tetrachloroethylene or PCE

Many household cleaning products, solvents, and paint thinners contain tetrachloroethylene (PCE). The U.S. Environmental Protection Agency (EPA) found an average concentration of 20.7 $\mu g/m^3$ of PCE in 2,195 measurements of indoor air in homes [4]. It is very hard to determine what part of PCE in a home or work place is from vapor intrusion and how much is from outdoor air or household products. PCE and its breakdown products are commonly found in outdoor air in areas where vapor intrusion is not a concern. In 2013, the median outdoor PCE concentration at 117 monitoring stations nationwide was 0.08 $\mu g/m^3$, with a range of 0.03 $\mu g/m^3$ to 0.26 $\mu g/m^3$ from the 10^{th} percentile to the 90^{th} percentile [5].

Investigation and Cleanup Activities at Service and Sparkleen

During 2001 – 2003, the City of Modesto collected soil gas and other environmental data to investigate dry cleaner releases [6]. Starting in 2002, the City of Modesto provided data to DTSC. In 2010, DTSC asked EPA to investigate the potential for vapor intrusion for homes near Service and Sparkleen. In 2010, EPA found concentrations of PCE that exceeded EPA and California indoor air screening levels in all nine homes tested. EPA installed a sub slab depressurization system under one multi-family building. A depressurization system removes the soil gas from under a building, thereby preventing PCE from entering the building.

In April 2013, a large soil vapor extraction (SVE) system was installed near Service and Sparkleen by the City of Modesto under DTSC oversight. Since 2013, the SVE system has been operating continuously (with temporary shut downs for repairs and maintenance). It continues to remove PCE from soil gas, thereby reducing the potential for PCE to enter nearby buildings. In the SVE system, PCE is absorbed by carbon pellets which are renewed regularly. The San Joaquin Valley Air Pollution Control District (SJVAPCD) reviewed the startup and compliance sampling data and issued a permit to DTSC and the City of Modesto to operate the SVE on July 30, 2013 and on March 12, 2014. SJVAPCD inspected the SVE system on April 22, 2014 and renewed the permit to operate on April 27, 2015. The permit expires April 22, 2018. During 3.5 years of operation, the SVE system has greatly reduced the concentrations of PCE in soil gas and has removed more than 2,965 pounds of PCE from soil gas [7].

Since 2010, the City of Modesto has sampled indoor air for VOCs in the former Service building (twice a year) and several homes. In indoor air samples, PCE was detected up to 640 $\mu g/m^3$ in

the Service main office in 2011 and up to 200 µg/m^3 in a nearby home in 2010. Since 2011, the city has been monitoring soil gas concentrations two- to four-times per year. One breakdown product of PCE, trichloroethylene (TCE) was detected in soil gas up to 780 µg/m^3 at 5 feet depth in 2013 at three locations near Service (Appendix B, Table B2; Appendix A, Figures A2, A3). In contrast, PCE was found in 2013 at 5 feet in every location sampled, up to 1,800,000 µg/m^3 (Appendix B, Table B7). TCE was not detected in any of the indoor air samples (detection limits ranged from 0.15 to 0.94 µg/m^3; and one analysis with a TCE detection limit of 1.8 µg/m^3). Another PCE breakdown product, vinyl chloride, was not detected in indoor air or soil gas (detection limits for indoor air: 0.035 to 0.22 µg/m^3, and one analysis with a detection limit of 0.44 µg/m^3; detection limits for soil gas varied widely: 2.5 to 55,000 µg/m^3).

Because PCE was the only dry-cleaning related compound detected in indoor air samples, CDPH identified PCE as the major chemical of concern for vapor intrusion, and evaluated only PCE for current and past exposures to residents and workers.

Available data

Outdoor air:

Outdoor air samples were collected around the dry cleaners and nearby homes between 2010 and 2016. The highest PCE concentration (5.9 µg/m^3) in the 12 outdoor air samples was detected in 2011 near Service. The remaining 11 PCE concentrations ranged from <0.17 µg/m3 – 1.1 µg/m^3 (see Appendix B, Table B2).

Indoor air:

Indoor air data were collected by the City of Modesto and EPA from 2010 to 2016 (Appendix B, Tables B3- B5). Air samples were collected in 24-hour summa canisters at 16 nearby homes (2010 – 2012) and inside the former Service dry cleaner (2011 – 2016). Access limitations prevented investigations in other homes. For privacy reasons, we do not identify the locations of the homes where samples were taken. For homes, indoor air concentrations ranged from <0.24 µg/m^3 to 200 µg/m^3, before the installation of a sub-slab depressurization system under one home (2010). For one home, PCE was measured in indoor air after the installation of the sub-slab depressurization system: 0.491 µg/m^3. For the former Service Cleaners, one indoor air measurement is available before the installation of an air handling system in 2011: 640 µg/m^3. After the installation of the air handling system, the PCE concentrations ranged from < 0.72 µg/m^3 to 6.6 µg/m^3.

Soil gas:

Soil gas samples can be collected directly under a house foundation (“sub slab”) or in soil near a home (under the sidewalk or street), by inserting a hollow probe into the soil and drawing the vapors out with a vacuum pump. Soil gas samples were collected by the City of Modesto from depths of 5 - 45 feet at many locations away from buildings from 2001 to 2003, and from 2011 onwards. Tables B6 - B8 in Appendix B soil gas samples taken at a depth of 5 feet. Figure A2 in Appendix A shows locations for soil gas samples taken between 2011 and 2015. Generally, the soil gas samples collected closest to the dry cleaners and from depths greater than 10 feet had the highest concentrations of PCE (up to 38,000,000 µg/m^3 at 45 feet in 2011 before the SVE system started, and up to 52,000,000 µg/m^3 at 15 feet in 2013, after the SVE system started operating). The highest concentration of PCE at 5 feet was 1,800,000 µg/m^3 in 2013, before the SVE system

started (see Appendix B, Table B7, sample IA3- VMP-2).

Use of soil gas data:
It is difficult to determine what indoor air concentrations can be expected based only on the soil gas concentrations. In evaluating vapor intrusion concerns, ATSDR recommends using a "multiple line of evidence" approach [8]. ATSDR prefers concurrently collected indoor air, outdoor air, and subsurface air (subslab or crawlspace) data obtained during multiple seasons. Mathematical models (such as the Johnson & Ettinger model [9]) estimate the indoor air concentrations based on external parameters (soil gas concentration, sampling depth, soil type, cracks in slab, etc.) and can be a useful line of evidence when supported by high-quality environmental measurements.

ATSDR does not use modeling alone to screen out sites from being considered vapor intrusion sites or to draw health hazard conclusions. Modeling can complement site-specific measurement, provide useful scoping information for vacant or undeveloped properties and can help prioritize buildings that warrant further investigation for vapor intrusion. The Johnson and Ettinger model has been found to under-predict vapor intrusion at some well-characterized sites [9]. The EPA version of the Johnson and Ettinger spreadsheets have been withdrawn because of concerns that users can inadvertently enter inconsistent and unreasonable sets of input values, that often lead to unreasonable outputs [10]. The Johnson and Ettinger model is also a 2-dimensional model designed to represent transport of vapors from directly beneath the footprint of a building. Exterior soil gas frequently underrepresents subslab gas for buildings [11]. Therefore, indoor air estimates based on Johnson and Ettinger modeling may be substantially less than the actual concentrations people are exposed to. Another consideration is that the remediation systems operating at the site may affect the normal spreading or fanning-out processes of soil gas that are the basis of the model and can invalidate the results. If soil gas is the only available data source, ATSDR and CDPH do not use the Johnson & Ettinger model with soil gas data to predict indoor air concentrations.

If only soil gas data were available, the data sets were evaluated in the following way:

1. Soil gas concentrations were compared with the HHRA Note 7 – DTSC Modified Screening Levels, published in October 2016 (DTSC-SLs) for PCE in soil gas, based on toxicity factors published by the California Office of Environmental Health Hazard Assessment (OEHHA): 230 $\mu g/m^3$ for current residential uses and 2,000 $\mu g/m^3$ for current commercial/industrial uses. [12]. The DTSC-SLs are advisory threshold levels for California below which Cal-EPA believes there is no health concern.

2. Soil gas concentrations were multiplied with EPA's "Recommended Vapor Attenuation Factor for Risk-based Screening of the Vapor Intrusion Pathway" for near source, exterior soil gas: 0.03 [11]. This attenuation factor is based on EPA's analysis of 913 buildings with vapor intrusion concerns. It estimates the 75^{th} percentile value of indoor air concentrations based on soil gas concentrations. The resulting indoor air concentration is used to screen sites for further evaluation. For this screening, CDPH used ATSDR's cancer risk evaluation guide (CREG). The CREG represents the concentration of a chemical in air that a person would need to be exposed to over a lifetime to have a one in a million risk (1.0E-06) for developing cancer from that chemical (point of departure risk). The CREG for PCE is 3.8 $\mu g/m^3$. At

concentrations above the CREG, ATSDR recommends that exposures are evaluated further for potential cancer health effects.

Soil gas data from 2001 - 2003

For 2001 - 2003, only soil gas data are available. No other information, such as indoor air, subslab or crawlspace data, can be used to help evaluate the potential for vapor intrusion and indoor air concentrations for PCE. The evaluation of the 2001 - 2003 soil gas data showed that further investigation of vapor intrusion near Service and Sparkleen was needed.

Soil gas data and indoor air data from 2010 - 2016

For 2010 - 2016, limited indoor and soil gas sampling data are available. When available, CDPH used indoor air data rather than soil gas data to evaluate health concerns for residents and workers. For homes, indoor air data were available for 2010 – 2012, and soil gas data were evaluated for 2014 - 2016. For workers at Service, indoor air data were available from 2011 - 2016.

Exposure Evaluation

Past exposures were evaluated using soil gas data collected from 2001 - 2003 and indoor air and soil gas data collected from 2010 - 2013. Current and future exposures were evaluated using the most current data collected from 2014 - 2016. Indoor air measurements were compared with screening levels that are considered safe for residents or for workers. ATSDR has developed screening concentrations called minimal risk levels (MRL) for non-cancer health effects that are considered safe for the general population, including children. The MRL for PCE is 40.7 µg/m^3. At concentrations above 40.7 µg/m^3, ATSDR recommends that exposures be evaluated further for non-cancer health effects. Potential cancer risks are evaluated separately, using ATSDR's CREG (3.8 µg/m^3). At concentrations above 3.8 µg/m^3, ATSDR recommends further evaluation of exposures for potential cancer health effects.

CDPH also used the California-specific screening level for PCE in indoor air (DTSC-SL)[1]. DTSC-SLs are based on EPA's regional screening levels (RSL) and toxicity factors developed by Cal-EPA's Office of Environmental Health Hazard Assessment [1] that are more health protective than those used by EPA (see Appendix C for health risk equations and toxicity factors). For PCE, the DTSC-SLs for potential cancer outcome are 0.46 µg/m^3 for residents and 2.0 µg/m^3 for workers. The DTSC-SLs for non-cancer outcomes are 37 µg/m^3 for residents and 150 µg/m^3 for workers.

Using the measured indoor air concentrations, CDPH evaluated the potential non-cancer and cancer health concerns for exposure to PCE using the DTSC-SLs for residents and workers. To evaluate non-cancer health concerns, CDPH calculated the ratio of contaminant concentration to the DTSC-SL, known as the "hazard quotient" (HQ) [1]. A hazard quotient above 1 indicates a potential for non-cancer health concerns from long-term exposures (years). However, a hazard

[1] Cal-EPA's DTSC: Human Health Risk Assessment Note 3:
"Ratios of the concentration of a particular chemical in a medium (e.g. soil, water, or air) to its risk-based concentration are calculated and the ratio is summed across all chemicals and media to estimate a total risk and hazard for the site." -https://www.dtsc.ca.gov/AssessingRisk/upload/HHRA-Note-3-2016-01.pdf

quotient above 1 does not necessarily mean that adverse health effects will occur. The potential cancer risk is calculated using the measured indoor air concentration and the California-specific toxicity factors in EPA's RSL calculator (Appendix C). The result is the estimated additional cancer risk per 1 million people exposed over a lifetime to this concentration. As a baseline or starting point toward further evaluation, the "point of departure" risk is one additional cancer case in 1 million people (1.0E-06).

Evaluation of Current Exposures (2014 – 2016)

Indoor air measurements – workers at Service
Ten indoor air samples were collected from inside the main office and bathroom of the former Service building in 2014 (4/2/14 and 10/10/14), 2015 (5/5/15), and 2016 (5/4/2016 and 11/22/2016). No indoor air data are available for the former Sparkleen building, or other non-residential buildings. CDPH compared the indoor air concentrations to DTSC-SLs for workers. No sample concentrations taken from inside the former Service building exceeded the screening values (Appendix B, Table B3). All samples were collected in spring and autumn and are less likely to detect active vapor intrusion than samples collected in winter and summer. Several studies showed higher vapor intrusion in the summer in the southern Unites States, in homes with air conditioning, and in homes with crawl spaces [3].

Soil gas measurements – residents
No indoor air measurements or other lines of evidence (subslab or crawlspace samples) were available for homes during 2014-2016. Per ATSDR guidance, no specific conclusions about health hazards (cancer risk or non-cancer hazard) can be drawn from estimates modeled on soil gas alone. CDPH compared the soil gas concentrations with the DTSC-SL for soil gas (230 $\mu g/m^3$ for residential use) [1]. CDPH also multiplied the soil gas concentration with EPA's screening attenuation factor (0.03) to determine if the resulting estimated indoor air concentration exceeds the ATSDR CREG of 3.8 $\mu g/m^3$.

A total of 41 soil gas samples were collected during 2014 - 2016 at 5 feet depth from eight locations along La Loma Avenue and Covina Avenue and an alleyway behind Sparkleen (Appendix B, Table B6; locations shown in Appendix A, Figure A2). PCE concentrations in soil gas ranged from <8 $\mu g/m^3$ (about 180 feet north of Service) to 5,200 $\mu g/m^3$ (about 50 feet west of Service). During this period, the SVE system was operating and might have affected the normal diffusion into indoor air. The distance of the soil gas sampling location to the nearest home varied from less than 50 feet to about 150 feet. PCE concentrations at locations furthest from Service (IA3-VPM-7, -8 and -4) did not exceed the screening level for soil gas, with the exception of one measurement (390 $\mu g/m^3$ in November 2016 at IA3-VMP-4, about 180 feet from Service). Soil gas sampling locations closest to the Service (IA3-VPM-1, -2, -12) had the highest PCE concentrations. At six of eight locations, the screening level for soil gas was exceeded at least once. At seven of eight locations, the screening level for indoor air was exceeded at least once, resulting in a recommendation for further evaluation. The actual concentrations of PCE in indoor air are unknown, and CDPH is unable to quantify the health risks based on soil gas concentrations. Appendix B, Table B7 shows the soil gas concentrations of PCE at 5 feet depth from 2011 - 2016.

Outdoor air
Twelve outdoor samples were collected between 2010 and 2016 near Service (see Appendix B, Table B2). The highest PCE concentration in outdoor air was 5.9 $\mu g/m^3$ collected near Service. The next highest concentrations were 1.1 $\mu g/m^3$, 0.6 $\mu g/m^3$, 0.46 $\mu g/m^3$ and 0.26 $\mu g/m^3$. These samples were collected between 2010 and 2012 and are not associated with improper operation or venting of the SVE system that started operating in 2013. Four of 12 outdoor measurements, collected between 2010 and 2012, were equal to or exceeded the DTSC-SL for residential indoor air for cancer outcome (0.46 $\mu g/m^3$). The remaining eight outdoor samples were collected between 2013 and 2016. PCE concentrations in those samples were below the DTSC-SL of 0.46 $\mu g/m^3$. For 2010 - 2012, the outdoor air concentrations of PCE near Service and Sparkleen were higher than the 90^{th} percentile of outdoor PCE concentrations (0.26 $\mu g/m^3$) for 117 monitoring stations in the United States in 2013 [5]. All measurements for 2013 - 2015 are below the 90^{th} percentile. Outdoor air samples are influenced by location, weather and wind conditions. It is not clear how closely the 12 outdoor samples reflect conditions near Service and Sparkleen.

Evaluation of Past Exposures (2010 – 2013)

Indoor air: workers at Service
Indoor air data from 2011 - 2013 are available for workers at the former Service building (Appendix B, Table B4). Four of the six indoor air samples taken were above the DTSC-SL for work-related cancer outcomes. No indoor air data are available before 2011, and no indoor air data are available for workers at the former Sparkleen building. CDPH calculated the theoretical cancer risk and non-cancer hazard based on the DTSC-SL for workers (Appendix C). For long-term exposures (years), the potential cancer risk and non-cancer hazard are elevated based on the 2011 data: a theoretical cancer risk of 300 in 1 million and a non-cancer hazard quotient of 4.1. PCE concentrations were significantly reduced in 2013 (likely because of an air-handling system was installed at the former Service building later in 2011 and the SVE system was installed in 2013). The potential non-cancer hazards were not a concern and the potential cancer risk only slightly exceeded the point of departure risk in May 2013. In November 2013, no cancer or non-cancer concerns are evident. All samples were collected in spring and autumn and are less likely to detect active vapor intrusion than samples collected in winter and summer.

Indoor air: residents
Indoor air data from 2010 - 2012 are available for 16 homes (Appendix B, Table B5). No indoor air data for homes are available before 2010 or after 2012. Of the 16 homes, four had PCE concentrations that posed no health risk (homes J, M, N, and P); six homes had PCE concentrations that posed low estimated cancer risks (1 - 3 in a million; homes B, C, I, K, L, and O); and six homes had PCE concentrations that posed elevated estimated cancer risks (>10 in a million; A, D, E, F, G, and H). The non-cancer hazard was only of concern in one home (home F, hazard quotient of 5.4), which also has the highest estimated cancer risk (410 in 1 million). The subslab depressurization system was installed under this home in June 2010, but no additional indoor air samples were collected (access agreements could not be obtained). Overall, few residents signed access agreements to have indoor air samples collected. Only two homes were resampled at different dates (homes A and G). A slight increase in PCE concentration was found in home A, between 2010 and 2012, but a decrease was found in home G, where a subslab depressurization system was installed in 2010.

Evaluation of Past Exposures (2001 – 2003)

No indoor air measurements or other lines of evidence (subslab or crawlspace samples) were available for homes or former dry cleaner buildings for 2001 – 2003. Per ATSDR guidance, no specific conclusions about health hazards (cancer risk or non-cancer hazard) can be drawn from estimates modeled on soil gas alone. CDPH compared the soil gas concentrations with the DTSC-SL for PCE (230 µg/m^3 for residential use) and multiplied the soil gas concentration with EPA's screening attenuation factor (0.03) to determine if the resulting indoor air concentrations exceed ATSDR's CREG (3.8 µg/m^3).

Between 2001 and 2003, approximately 165 soil gas samples were collected at many locations and depths near Sparkleen and Service. Table B8 in Appendix B shows results of samples collected at 5 feet depth within a radius of about 500 feet from the center of Service. Appendix A, Figure A3, shows these sampling locations. The PCE concentrations in soil gas ranged from non-detect to 220,000 µg/m^3, with the highest concentrations found closest to the former dry cleaners. At nine locations, PCE was not detected in soil gas. At 12 locations, soil gas and estimated indoor air concentrations exceeded the screening levels for PCE in soil gas and for indoor air, respectively. For this period, the PCE concentrations inside homes and the former Service and Sparkleen dry cleaners are unknown and CDPH is unable to calculate the health risks. However, based on the high concentration of PCE in soil gas at some locations, it is likely that concentrations of PCE in indoor air were elevated in some buildings.

Health Effects Evaluation

Potential health effects of PCE
ATSDR published information on the toxicity of PCE in the *Toxicological Profile for Tetrachloroethylene* [4]. Whether or not health effects occur depends on many factors:

- how much PCE a person is exposed to (dose),
- how often and how long exposure occurs (duration),
- exposures to other chemicals,
- the age, sex, diet, genetic traits, lifestyle and health status of the person exposed.

In its review [4], ATSDR found that depending upon the concentration, exposure to PCE might harm the nervous system, liver, kidneys and reproductive system; be harmful to unborn children; and increase the risk for certain cancers.

The toxicological studies of PCE try to identify the concentration in air at which no adverse effects are observed (No Observed Adverse Effect Level - NOAEL), or the concentration at which for the first time an adverse effect is observed (Lowest Observed Adverse Effect Level - LOAEL). These concentrations are determined for acute (short term), intermediate, and chronic (long term) exposures, for humans and animal species. ATSDR's evaluation of human chronic inhalation exposures to PCE is based on a study of changes in color vision in workers (dry cleaners and ironers) [4]. The LOAEL in this study was determined to be 7.3 ppm (volume), which is equivalent to 49,500 µg/m^3. The highest concentration found inside Service, was 640 µg/m^3, which is significantly lower than the occupational LOAEL. ATSDR converted the occupational LOAEL to continuous exposure for a LOAEL of 1.7 ppm or 11,500 µg/m^3. The highest concentration found inside a home was 200 µg/m^3, also significantly lower than the LOAEL for chronic, continuous exposures, for an outcome affecting color vision.

PCE and its breakdown products can be measured in blood and urine. However, the detection of PCE or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because PCE and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure. For exposures related to the dry cleaner releases, CDPH is concerned about long-term exposures that exceed the screening levels for indoor air. Exposures to PCE below the screening levels are considered safe. The ATSDR *Toxicological Profile for Tetrachloroethylene* [4] states the following, with regards to exposures exceeding the screening levels:

"*People who are exposed for longer periods of time to lower levels of tetrachloroethylene in air may have changes in mood, memory, attention, reaction time, or vision. Studies in animals exposed to tetrachloroethylene have shown liver and kidney effects, and changes in brain chemistry, but we do not know what these findings mean for humans. Tetrachloroethylene may have effects on pregnancy and unborn children. Studies in people are not clear on this subject, but studies in animals show problems with pregnancy (such as miscarriage, birth defects, and slowed growth of the baby) after oral and inhalation exposure*.

Exposure to tetrachloroethylene for a long time may lead to a higher risk of getting cancer, but the type of cancer that may occur is not well-understood. Studies in humans suggest that exposure to tetrachloroethylene might lead to a higher risk of getting bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma, but the evidence is not very strong. In animals, tetrachloroethylene has been shown to cause cancers of the liver, kidney, and blood system. It is not clear whether these effects might also occur in humans, because humans and animals differ in how their bodies handle tetrachloroethylene." [4].

From the few studies available, we do not know if children are more susceptible than adults to the effects of PCE.

Can the toxicological evaluation predict who will develop cancer or other health effects?

No. The estimated exposures from the toxicological evaluation are based on mathematical models that rely on available information such as types of contaminants and concentrations, the characteristics of the population (children or residents or workers), and research studies that are often based on animal studies with very high exposures.

In contrast to non-cancer outcomes, no safe dose is associated with carcinogens. We each experience many exposures throughout our lifetime. The evaluations of potential non-cancer and cancer outcomes in a health consultation like this cannot predict if any one person will develop health effects. These health assessment and lifetime cancer risk calculations enable us to assess the level of concern related to the exposure, based on the concentration and toxicity of a substance. CDPH uses these calculations to make recommendations that reduce exposures and protect public health.

Cancer

Cancer is a common disease. The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program states that the lifetime risk for men and woman of being diagnosed with cancer is about 40 cases in 100 people, or 40% (for all cancer sites, diagnosis at some point

in life, based on 2009–2011 data). This corresponds to 400,000 cases in 1 million people [14]. The calculated cancer risk is the theoretical chance of developing cancer from a lifetime of exposure. As a baseline, the "point of departure" risk is one additional cancer case in 1 million people. For this site, the highest cancer risk for residents based on indoor air measurements was 410 in 1 million, based on one indoor air sampling event in 2010 (200 $\mu g/m^3$). For workers at the former Service building the highest risk was 300 in 1 million people, based on one indoor air sampling event in 2011 (640 $\mu g/m^3$). A sub slab-depressurization system was installed under the home in 2010, and an air handling system was installed at Service in 2011 to reduce soil gas and indoor air concentrations. An SVE system installed in 2013 has removed PCE from soil gas and reduced vapor intrusion. The indoor air concentrations before 2010 are unknown, and no health conclusions can be made based on soil gas concentrations alone.

Conclusions

CDPH reached the following five conclusions in this health consultation:

1. **CDPH concludes that breathing tetrachloethylene (PCE) in indoor air at the former Service building is not expected to harm worker's health, but we do not have enough information to conclude whether or not PCE in the indoor air at the former Sparkleen building or in other commercial buildings could harm worker's health.**

   Indoor air samples collected from 2014 to 2016 at the former Service building indicate that current indoor air does not contain levels of PCE that could cause non-cancer health effects or increase the risk for cancer. This is likely because the soil vapor extraction (SVE) system and an air handling system installed at the site have operated correctly. Shutting off these systems might affect the indoor air concentrations. The current PCE concentrations inside the former Sparkleen dry cleaner or in other commercial buildings nearby are unknown because indoor air measurements and related information are not available.

2. **CDPH does not have enough information to conclude whether or not the current PCE concentrations in indoor air in homes near the former dry cleaners could harm people's health.**

   Only soil gas data are available from 2014 to 2016. Soil gas sampling locations closest to Service had the highest PCE concentrations. At six of eight locations, the estimated indoor air concentrations, which were based on soil gas concentrations, exceeded the indoor air screening level. However, health conclusions cannot be drawn based on estimated indoor air concentrations alone.

3. **Breathing PCE in indoor air at the former Service building during 2011 could have harmed worker's health if similar exposures lasted for a long time (years). We do not have enough information to determine whether PCE in the indoor air at the former Sparkleen building or in other commercial buildings nearby could have harmed worker's health.**

   Before the operation of an air handling system at Service (2011) and an SVE system (2013), breathing indoor air in the former Service building could have posed a public health hazard

to workers if the exposure lasted for a long time (years). No indoor air data are available before 2011. Based on the highest indoor air concentration found (2011), the estimated cancer risk was 300 additional cancers in 1 million workers, if exposed for 25 years. This is an elevated cancer risk compared to a target risk of 1 additional cancer in 1 million people (the point of departure risk). The highest indoor air concentration also exceeded the screening level for non-cancer health effects for workers, based on the California Department of Toxic Substances Control Screening Level. The PCE concentrations inside the former Sparkleen dry cleaner or in other commercial buildings nearby are unknown because no indoor air measurements are available.

4. **Breathing PCE in indoor air at some homes near the former Service and Sparkleen dry cleaners could have harmed people's health if exposures similar to those between 2010 and 2012 lasted for a long time (years).**

   Of the 16 homes tested between 2010 and 2012, indoor air PCE concentrations in four homes were below levels of health concern for residents; six homes had indoor air concentrations associated with low cancer risks (1 to 10 in a million), and six homes had PCE concentrations associated with elevated cancer risks (greater than 10 in a million). In one home the ATSDR screening level for non-cancer health concerns was exceeded. That home also had the highest estimated cancer risk (410 additional cancers in 1 million residents, if exposed for 26 years). This is an elevated cancer risk, compared to the point of departure risk of 1 in 1 million. Before the operation of a sub-slab depressurization system under this and several other homes (2010) and an SVE system (2013), breathing indoor air in 12 of 16 homes tested could have posed a public health hazard if the exposure lasted for a long time (years). The PCE concentrations inside other homes near the former Service and Sparkleen dry cleaners are unknown because no indoor air measurements are available.

5. **CDPH does not have enough information to determine whether breathing PCE in indoor air at the former Service or Sparkleen buildings, in homes or other buildings nearby, in 2010 or before could have harmed people's health if the exposure lasted for a long time (years). However, based on the high concentration of PCE in soil gas at some locations (2001-2003), it is likely that concentrations of PCE in indoor air were elevated in some buildings.**

   Only soil gas data are available for 2001-2003. At 12 of 21 soil gas sampling locations, the estimated indoor air concentrations based on soil gas concentrations exceeded the indoor air screening level. The concentrations of PCE in indoor air in homes, the former Service and Sparkleen buildings, or in other buildings for this period are unknown and CDPH is unable to quantify the health risks based on soil gas concentrations. No data for soil gas or indoor air are available from 2004-2009.

Recommendations

CDPH recommends that

1. The City of Modesto continues to operate the SVE system near the Service and Sparkleen dry cleaners (resulting in the mitigation of vapor intrusion) and to monitor soil gas and

outdoor air for volatile organic compounds (including rebound testing after SVE shut off). This will ensure that PCE is removed from soil gas and will show breakdown products of PCE in soil gas or outdoor air.

2. The City of Modesto conducts periodic indoor air sampling for VOCs for the dry cleaner buildings, homes and other buildings within 500 feet of the former dry cleaner buildings, where the greatest releases occurred. Indoor air samples are to be collected preferably during winter or summer. Monitoring during winter and summer are most likely to capture active vapor intrusion events.

3. The City of Modesto conducts follow-up sampling of indoor air in homes that have a subslab depressurization system installed, as some systems may require adjustments or upgrading.

4. DTSC continues the oversight of the City of Modesto's cleanup and monitoring of soil gas, outdoor and indoor air at the Service and Sparkleen dry cleaners, homes and buildings nearby.

5. Workers request indoor air testing at workplaces within 500 feet of the former dry cleaner buildings, to see if they are at risk.

6. Residents request and allow the indoor air testing within 500 feet of the former dry cleaner buildings, to see if they are at risk.

7. Workers and residents review the factsheets on vapor intrusion included in this health consultation and determine if they can take simple steps, such as increasing ventilation, to reduce potential exposures and improve indoor air quality.

8. Workers or residents who might have been exposed in the past, and who have health or exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact CDPH and we can refer them to additional resources.

Public Health Action Plan

1. CDPH will work with DTSC and the City of Modesto to periodically review indoor air and soil gas data to ensure that the vapor intrusion remediation and mitigation measures are effective and indoor air concentrations for VOCs are safe for workers and residents.
2. CDPH will continue to reach out to the community near the dry cleaners under investigation to determine the community's outreach and information needs. CDPH can offer printed material, community meetings or educational workshops, depending on the community's preference.
3. CDPH will write health consultations for the remaining 21 dry cleaners that were identified by CDPH and will send these health consultations to the community near the dry cleaners, the City of Modesto, and DTSC.

Report Preparation

This health consultation for the Modesto Dry Cleaner Investigation:
"Service Cleaners" and "Sparkleen Laundry and Dry Cleaners" Site was prepared by the California Department of Public Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

California Department of Public Health

Gabriele Windgasse, DrPH
Chief, Site Assessment Section
Environmental Health Investigations Branch

Contributing Authors

Danny Kwon, MPH
Health Assessor, Site Assessment Section
Environmental Health Investigations Branch

Nancy Villaseñor, MS
Health Educator, Site Assessment Section
Environmental Health Investigations Branch

Agency for Toxic Substances and Disease Registry

Audra Henry, MS
Technical Project Officer
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

References

1. California Department of Toxic Substances Control. Human and Ecological Risk Office (HERO). Human Health Risk Assessment (HHRA). Note Number 7: Updated OEHHA Inhalation Cancer Toxicity Criteria for Tetrachloroethylene (PCE) and DTSC Recommended Ambient Air and Soil Gas Screening Levels (DTSCSLs). October 2016. Available online at: http://www.dtsc.ca.gov/upload/HHRA-Note-7-OEHHA-PCE-Toxicity-Criteria-DTSC-SL-Air-and-Soil-Gas-ver2016-10-17.pdf.
2. TetraTech. Remedial Investigation of the Former Service Cleaners. March 2012.
3. Agency for Toxic Substances and Disease Registry. Evaluating Vapor Instrusion Pathways. Guidance for ATSDR's Division of Community Health Investigations. October 2016. Available online at: https://www.atsdr.cdc.gov/docs/svi_guidance_508.pdf.
4. Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Tetrachloroethylene. October 2014. Available online at: http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=265&tid=48.
5. United States Environmental Protection Agency. EPA's Report on the Environment. Technical Documentation. 2014. Available online at: https://cfpub.epa.gov/roe/technical-documentation.cfm?i=90#six.
6. California Department of Toxic Substances Control. Database of Soil Gas Samples Collected in the City of Modesto between 2001 and 2003. 2010.
7. TetraTech. Twenty-Four Month Update, Long-Term Soil Vapor Extraction Pilot Test, Former Service Cleaners, 1425 La Loma Avenue, Modesto, California. July 2015.
8. Agency for Toxic Substances and Disease Registry. Memorandum: Use of Modeling in Evaluating Vapor Intrusion Pathways. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. August 2013.
9. Hers I Z-GR, Johnson PC, Li L. Evaluation of the Johnson and Ettinger Model for Prediction of Indoor Air Quality. Ground Water Monitoring & Remediation. 23(2): 119-133, 2003.
10. Johnson PC. Identification of Application-Specific Critical Inputs for the 1991 Johnson and Ettinger Vapor Intrusion Algorithm. Ground Water Monitoring & Remediation. 25(1): 63-78, 2005.
11. United States Environmental Protection Agency. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. July 2015. Available online at: https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor
12. California Environmental Protection Agency, Office of Environmental Health and Hazard Assessment. Soil and Soil-Gas Screening Numbers (California Human Health Screening Levels or CHHSLs). 2010. Available online at: http://oehha.ca.gov/chhsltable#Table3.
13. California Environmental Protection Agency, Office of Environmental Health and Hazard Assessment. Notice of Adoption of Inhalation Cancer Unit Risk Factor for Perchloroethylene. September 2016. Available online at: http://oehha.ca.gov/air/crnr/notice-adoption-inhalation-cancer-unit-risk-factor-perchloroethylene

14. National Cancer Institute. Surveillance. Epidemiology, and End Results (SEER) Program. Cancer Statistics Fact Sheets. All Cancer Sites. Available online at: http://seer.cancer.gov/statfacts/html/all.html
15. TetraTech. Forty-Two Month Update, Long-Term Soil Vapor Extraction Pilot Test, Former Service Cleaners, 1425 La Loma Avenue, Modesto, California. January 2017.
16. United States Environmental Protection Agency. On-Scene Coordinator (OSC) Website for Sparkleen Cleaners Vapor Intrusion, and additional information provided by the California Department of Toxic Substances Control, 2011.

Appendix A. Figures

Figure A1. Extent of Dry Cleaner Investigation in Modesto (23 dry cleaners)

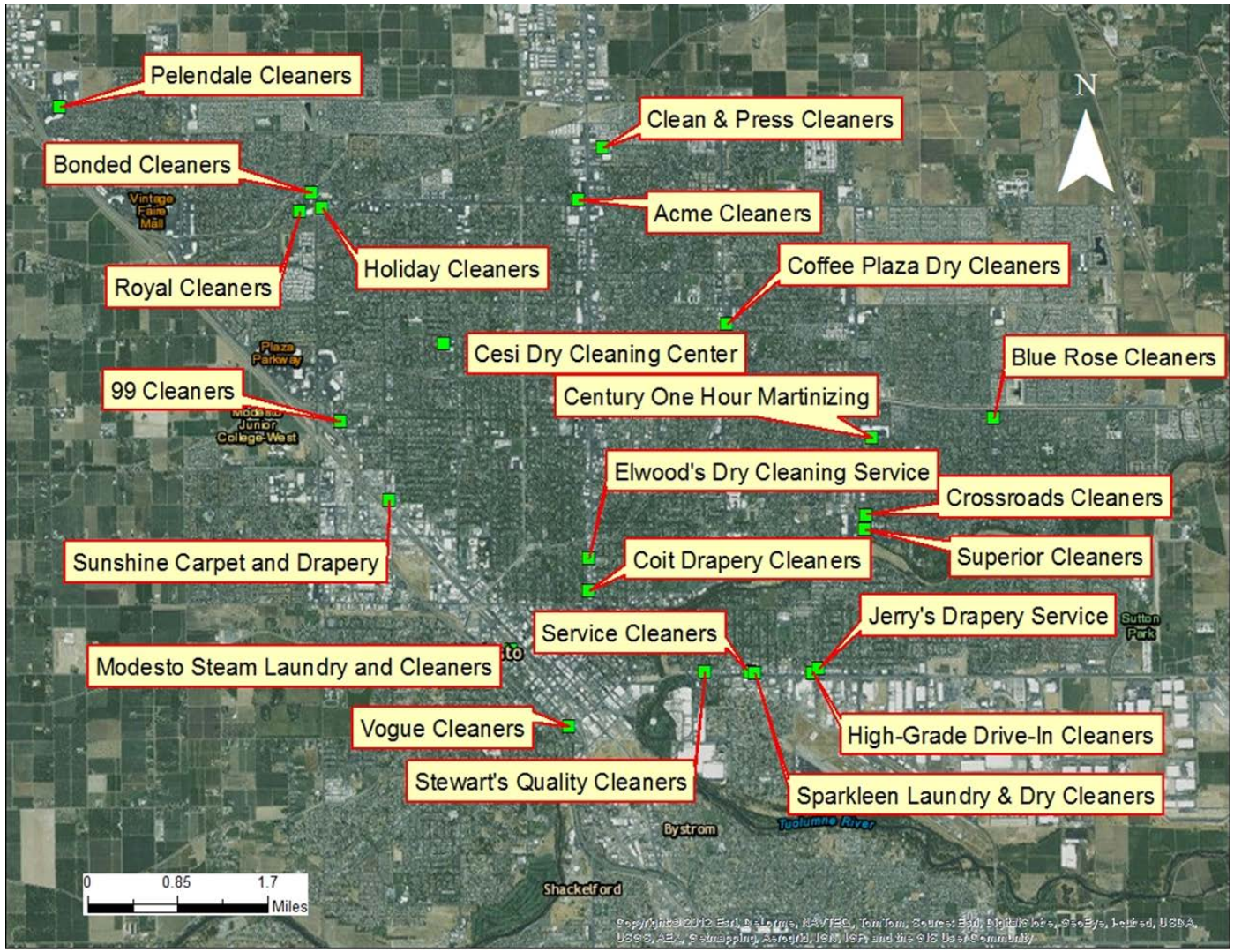


Figure A2: Soil Gas Sampling Locations 2010 – 2015

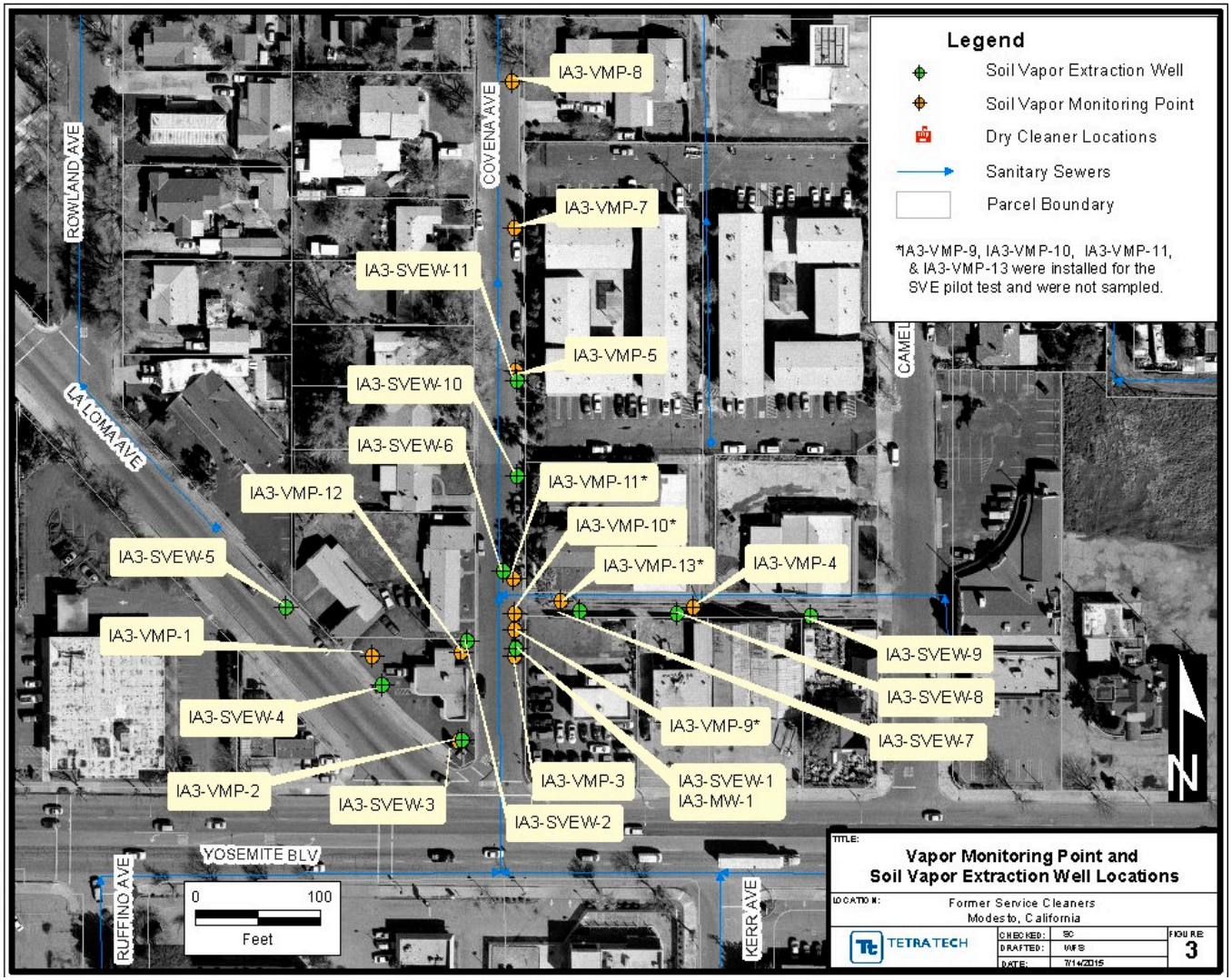


Figure A3: PCE Concentrations in soil gas at 5 feet depth within a 500 feet radius of Service and Sparkleen (2001-2003)

Source: [6]

Appendix B. Tables

Table B1. Highest trichloroethylene (TCE) concentrations in soil gas samples taken at 5 feet depth, Modesto, California		
Sampling location	**Sampling Date***	**TCE Concentration ($\mu g/m^3$)**
IA3-17	11/5/2001	660
IA3-VMP-1	2/21/2013	730
IA3- VMP-3	2/20/2013	780
IA3-VMP-12	7/25/2013	15

Source: [7]
Abbreviation: µg/m3: micrograms per cubic meter
* Soil Vapor Extraction (SVE) system was installed April 2013.

Table B2. Tetrachloroethylene (PCE) concentrations in outdoor air, Modesto, California		
Sampling location	**Sampling Date**	**PCE Concentration ($\mu g/m^3$)**
Near Service	4/22/2010	1.1
	10/26/2011	5.9
	11/28/2012	0.6
	5/22/2013	< 0.23
	11/15/2013	< 0.22
	4/2/2014	< 0.17
	10/10/2014	< 0.18
	5/5/2015	<0.23
	5/4/2016	<0.22
	11/22/2016	<0.22
Near Home H	4/22/2010	< 0.22
	11/28/2012	0.24
Near Home D	4/22/2010	0.46
Moran Park (background)	4/22/2010	< 0.21

Source:[7,15]
Abbreviation: µg/m3: micrograms per cubic meter

Table B3. Current exposures for workers: indoor air measurements from the former Service Cleaners, Modesto, California, 2014 - 2016

Sampling Date	Location	PCE in Indoor Air (µg/m^3)	Comparison to Indoor Air Screening Values for Workers (µg/m^3)	
			DTSC-SL (non-cancer) 150	DTSC-SL (cancer) 2.0
			Hazard Quotient	Cancer risk
4/2/2014	Bathroom	1.4	<1	< 1E-06
10/10/2014		0.94	<1	< 1E-06
5/5/2015		0.88	<1	< 1E-06
5/4/2016		1.4	<1	< 1E-06
11/22/2016		<0.72	<1	< 1E-06
4/2/2014	Main Office	1.4	<1	< 1E-06
10/10/2014		0.98	<1	< 1E-06
5/5/2015		0.75	<1	< 1E-06
5/4/2016		1.3	<1	< 1E-06
11/22/2016		<1.1	<1	< 1E-06

Source: [7,15]
Abbreviations:
PCE: tetrachloroethylene
µg/m3: micrograms per cubic meter
DTSC-SL: California Department of Toxic Substances Control screening level [1].

Table B4. Past exposures for workers: indoor air measurements from Service Cleaners, Modesto, California, 2011 and 2013.

Sampling date*	Location	PCE in indoor air ($\mu g/m^3$)	Comparison to Indoor Air Screening Values for Workers ($\mu g/m^3$)	
			DTSC-SL (non-cancer) 150	DTSC-SL (cancer) 2.0
			Hazard Quotient	Cancer risk
10/26/2011	Main Office	640	**4.1**	**3.0E-04**
	Bathroom	630	**4.1**	**3.0E-04**
5/22/2013	Main Office	6.6	<1	**3.1E-06**
	Bathroom	6.2	<1	**2.9E-06**
11/15/2013	Main Office	1.5	<1	< 1E-06
	Bathroom	<2.3	<1	<1.1E-06

Source: [7]
Abbreviations:
µg/m3: micrograms per cubic meter
DTSC-SL: California Department of Toxic Substances Control screening level
* Soil Vapor Extraction (SVE) system was installed April 2013.

Table B5. Past exposures for residents: indoor air measurements, Modesto, California, 2010 - 2012.

Sampling Location	Sampling Date	PCE in indoor air (µg/m^3)	Comparison to Indoor Air Screening Values for Residents (µg/m^3)			
			DTSC-SL (non-cancer) 37	DTSC-SL (cancer) 0.46	ATSDR MRL (non-cancer) 40.7	ATSDR CREG (cancer) 3.8
			Hazard Quotient	**Cancer Risk**	**Needs further evaluation?**	
Home A	4/22/2010	6.3	<1	**1.3E-05**	No	**Yes**
	11/28/2012	7.6	<1	**1.6E-05**	No	**Yes**
Home B	4/22/2010	0.79	<1	**1.7E-06**	No	No
Home C	4/22/2010	1.1	<1	**2.3E-06**	No	No
Home D	4/22/2010	5.3	<1	**1.1E-05**	No	**Yes**
Home E	4/22/2010	13	<1	**2.8E-05**	No	**Yes**
Home F*	4/22/2010	200	**5.4**	**4.3E-04**	**Yes**	**Yes**
	4/22/2010	200	**5.4**	**4.3E-04**	**Yes**	**Yes**
Home G*	4/22/2010	23	<1	**5.0E-05**	No	**Yes**
	11/28/2012	0.49	<1	**1.0E-06**	No	No
Home H*	4/22/2010	17	<1	**3.6E-05**	No	**Yes**
Home I	4/22/2010	1.1	<1	**2.3E-06**	No	No
	4/22/2010	1.4	<1	**3.0E-06**	No	No
Home J	3/8/2011	0.33	<1	<1E-06	No	No
Home K	3/8/2011	0.79	<1	**1.7E-06**	No	No
	3/8/2011	0.4	<1	<1E-06	No	No
Home L	3/8/2011	<1.2	<1	**2.6E-06**	No	No
Home M	3/8/2011	0.36	<1	<1E-06	No	No
Home N	3/8/2011	<0.24	<1	<1E-06	No	No
Home O	3/8/2011	0.68	<1	**1.4E-06**	No	No
Home P*	11/28/2012	<0.22	<1	<1E-06	No	No

Source: [7,16]

* EPA installed a “sub slab depressurization system” underneath the building in 2010
Abbreviations:
PCE: tetrachloroethylene
µg/m3: micrograms per cubic meter
DTSC-SL: California Department of Toxic Substances Control screening level
MRL: Agency for Toxic Substances and Disease Registry’s minimal risk level
CREG: Agency for Toxic Substances and Disease Registry’s Cancer Risk Evaluation Guide for one in 1 million increased cancer risk

Table B6. PCE in soil gas concentrations at 5 feet depth taken in 2014 through 2016 and distances to Service Cleaners, Modesto, California, 2014-2016

Sampling Location	Sampling date	PCE in soil gas (µg/m^3)	Soil Gas Concentration x 0.03 (EPA Screening Attenuation Factor)	Approximate Distance to Center of Former Service (feet)
IA3-VMP-1	4/2/2014	**3,600**	**108**	50
	10/10/2014	**5,200**	**156**	
	5/5/2015	**4,700**	**141**	
	5/4/2016	**1,400**	**42**	
	11/22/2016	**410**	**12.3**	
IA3- VMP-2	4/2/2014	**950**	**28.5**	50
	10/16/2014	130	**3.9**	
	5/5/2015	**300**	**9**	
	5/4/2016	130	**3.9**	
	11/22/2016	58	1.74	
IA3-VMP-3	4/2/2014	140	**4.2**	50
	4/2/2014	140	**4.2**	
	10/10/2014	**280**	**8.4**	
	5/5/2015	140	**4.2**	
	5/4/2016	100	3	
	11/22/2016	89	2.67	
IA3-VMP-12	4/2/2014	**600**	**18**	50
	10/10/2014	220	**6.6**	
	5/5/2015	190	**5.7**	
	5/4/2016	110	3.3	
	11/22/2016	100	3	
IA3-VMP-7	4/2/2014	81	2.4	125
	10/10/2014	140	**4.2**	
	5/5/2015	110	3.3	
	5/4/2016	140	**4.2**	
	11/22/2016	78	2.34	
IA3-VMP-5	4/2/2014	**430**	**12.9**	130
	10/10/2014	**460**	**13.8**	
	5/5/2015	**540**	**16.2**	
	5/4/2016	**440**	**13.2**	
	11/22/2016	220	**6.6**	
IA3-VMP-4	4/2/2014	56	1.6	180
	10/10/2014	74	2.2	
	5/5/2015	55	1.6	
	5/4/2016	<8.0	0.24	
IA3-VMP-4 (cont.)	11/22/2016	**390**	**11.7**	

Table B6. PCE in soil gas concentrations at 5 feet depth taken in 2014 through 2016 and distances to Service Cleaners, Modesto, California, 2014-2016

Sampling Location	Sampling date	PCE in soil gas (µg/m^3)	Soil Gas Concentration x 0.03 (EPA Screening Attenuation Factor)	Approximate Distance to Center of Former Service (feet)
IA3-VMP-8	4/2/2014	14	0.4	500
	10/10/2014	36	1.0	
	5/5/2015	23	0.69	
	5/4/2016	20	0.6	
	11/22/2016	18	0.54	
Comparison Values	DTSC SL for soil gas (µg/m^3)	230		
	ATSDR CREG (µg/m^3)		3.8	

Source: [7,15]
SVE system in operation during the sampling.
Abbreviations:
PCE: tetrachloroethylene
µg/m3: micrograms per cubic meter
DTSC-SL: California Department of Toxic Substances Control screening level
CREG: Agency for Toxic Substances and Disease Registry's cancer risk evaluation guide for one in 1 million
Bolded concentrations exceed the DTSC-SL or the ATSDR CREG

Table B7. Tetrachloroethylene (PCE) concentrations in soil gas at 5 feet depth, Modesto, California, 2011-2016.

Sampling Location	Sampling Date*	PCE Concentration ($\mu g/m^3$)
IA3-VMP-1	11/10/2011	1,200,000
	11/10/2011	1,400,000
	2/21/2013	760,000
	5/22/2013	230,000
	7/25/2013	57,000
	7/25/2013	58,000
	11/18/2013	8,400
	4/2/2014	3,600
	10/10/2014	5,200
	5/5/2015	4,700
	5/4/2016	1,400
	11/22/2016	410
IA3- VMP-2	11/10/2011	1,400,000
	2/20/2013	1,800,000
	5/22/2013	98,000
	5/22/2013	100,000
	7/25/2013	17,000
	7/25/2013	17,000
	11/18/2013	950
	4/2/2014	950
	10/16/2014	130
	5/5/2015	300
	5/4/2016	130
	11/22/2016	58
IA3-VMP-3	9/23/2011	1,500,000
	2/20/2013	660,000
	5/22/2013	6,000
	7/25/2013	1,300
	11/15/2013	360
	11/15/2013	380
	4/2/2014	140
	4/2/2014	140
	10/10/2014	280
	5/5/2015	140
	5/4/2016	100
	11/22/2016	89
IA3-VMP-4	9/23/2011	18,000
	2/20/2013	2,700
	5/22/2013	1,900
	7/25/2013	2,200
	11/15/2013	140

Table B7. Tetrachloroethylene (PCE) concentrations in soil gas at 5 feet depth, Modesto, California, 2011-2016.

Sampling Location	Sampling Date*	PCE Concentration ($\mu g/m^3$)
IA3-VMP-4 (cont.)	4/2/2014	56
	10/10/2014	74
	5/5/2015	55
	5/4/2016	<8.0
	11/22/2016	390
IA3-VMP-5	9/22/2011	4,900
	2/20/2013	1,000
	5/22/2013	1,500
	7/25/2013	1,500
	11/15/2013	480
	4/2/2014	430
	10/10/2014	460
	5/5/2015	540
	5/4/2016	440
	11/22/2016	220
IA3-VMP-7	9/22/2011	920
	2/20/2013	330
	5/22/2013	480
	7/25/2013	320
	11/15/2013	150
	4/2/2014	81
	10/10/2014	140
	5/5/2015	110
	5/4/2016	140
	11/22/2016	78
IA3-VMP-8	9/22/2011	83
	2/20/2013	24
	2/20/2013	26
	5/22/2013	63
	7/25/2013	63
	11/18/2013	31
	4/2/2014	14
	10/10/2014	36
	5/5/2015	23
	5/4/2016	20
	11/22/2016	18
IA3-VMP-12	11/10/2011	520,000
	2/21/2013	1,400,000
	5/22/2013	7,000
	7/25/2013	260
	11/18/2013	220
	4/2/2014	600

Table B7. Tetrachloroethylene (PCE) concentrations in soil gas at 5 feet depth, Modesto, California, 2011-2016.

Sampling Location	Sampling Date*	PCE Concentration ($\mu g/m^3$)
IA3-VMP-12 (cont.)	10/10/2014	220
	5/5/2015	190
	5/4/2016	110
	11/22/2016	100

Source: [7,15]
Abbreviation:
µg/m3: micrograms per cubic meter
* Soil Vapor Extraction System (SVE) was installed April 2013.

Table B8. Tetrachloroethylene (PCE) concentrations in soil gas at 5 Feet depth and within 500 feet from the center of former Service Cleaners, Modesto, California, 2001-2003				
Sampling Location	**Sampling date**	**PCE in soil gas (µg/m^3)**	**Soil Gas Conc. x 0.03 (EPA Attenuation Screening Factor for indoor air) (µg/m^3)**	**Approximate Distance to center of former Service (feet)**
IA3-8	11/2/2001	**110,000**	**3,300**	120
	11/2/2001	**150,000**	**4,500**	120
IA3-22	11/2/2001	**46,220**	**1,386**	140
IA3-21	11/2/2001	**43,020**	**1,290**	150
IA3-14	11/2/2001	**220,000**	**6,600**	160
IA3-13	11/5/2001	**1603**	**48**	200
IA3-6	11/2/2001	**1,120**	**33**	230
IA3-9	10/26/2001	**23,000**	**690**	250
IA3-4	11/1/2001	ND	-	300
	11/1/2001	**2,580**	**77**	300
IA3-16	10/26/2001	**5,690**	**170**	360
IA3-25	11/1/2001	**1,938**	**59**	400
IA3-3	11/1/2001	ND	-	450
IA3-7	10/26/2001	ND	-	450
IA3-10	10/26/2001	ND	-	450
IA3-20	11/2/2001	**471**	**14**	450
IA3-1	11/1/2001	ND	-	500
IA3-2	10/26/2001	ND	-	500
IA3-5	10/26/2001	ND	-	500
IA3-26	11/5/2001	**1,000**	**30**	500
CW-SB-100	6/13/2003	ND	-	500
CW-SB-101	6/13/2003	ND	-	500
CW-SB-102	6/13/2003	ND	-	500
Comparison Values	DTSC-SL for Soil Gas (µg/m^3)	230		
	ATSDR (µg/m^3)		3.8	

Source: [6]
Bolded concentrations exceed the DTSC-SL or the ATSDR CREG
µg/m3: micrograms per cubic meter
DTSC-SL: California Department of Toxic Substances Control Screening Level
CREG: Agency for Toxic Substances and Disease Registry's Cancer Risk Evaluation Guide for 1 in 1 million

Appendix C. Health Risk Equations and Toxicity Factors

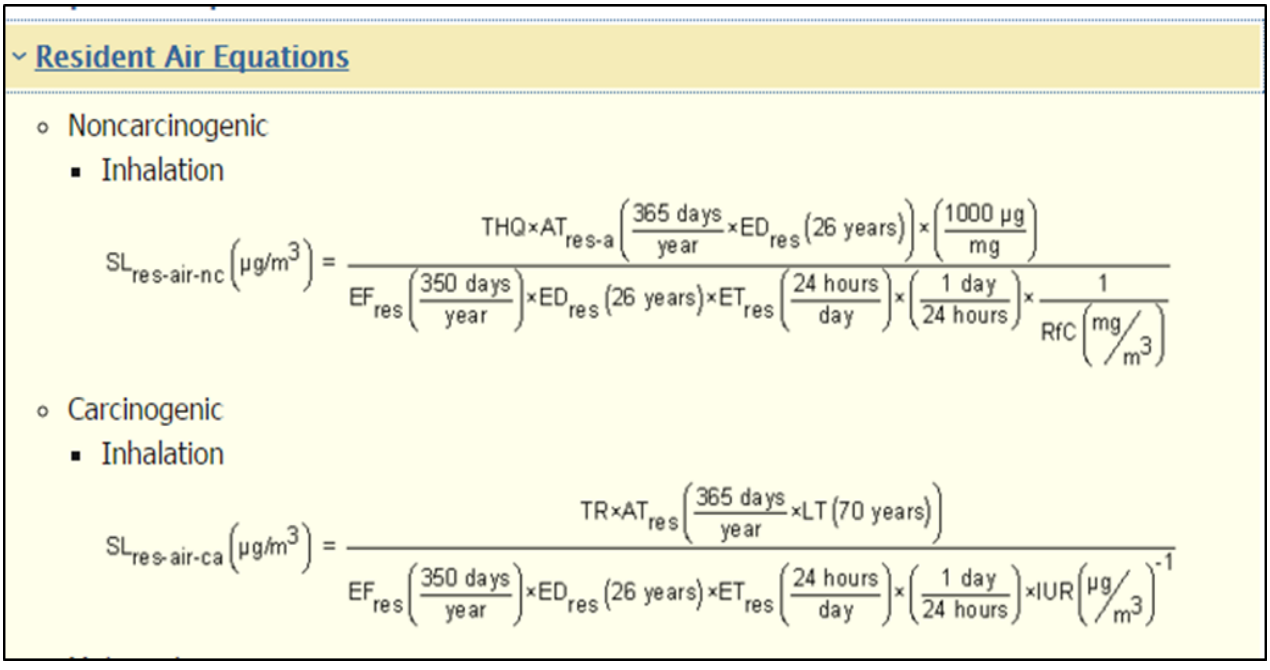
The EPA regional screening level (RSL) calculator is available online at:
https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

The following steps are used to calculate potential cancer and non-cancer risks using the RSL calculator:

1. Open RSL calculator.
2. Select:
   - Scenario: resident
   - Media: air, site specific
   - Chemical info type: User Provided
   - Risk output: yes
   - RfD/RfC type: chronic
   - tetrachloroethylene from menu (click on name, then click on double-right arrows to select)
   - Include metadata: no
   - Retrieve
3. Change RfC to 3.5E-02 and IUR to 6.1E-06
4. Type in measured or estimated concentration of PCE; retrieve.
5. Scroll down for cancer risk and non-cancer Hazard Index

Cal-EPA Inhalation Unit Risk = 6.1E-06 $(\mu g/m^3)^{-01}$ [1]
Cal-EPA Reference Exposure Level = 35 $\mu g/m^3$ (used instead of EPA RfC in the equations below)

Figure: RSL equation for resident and indoor worker air inhalation (all default parameters)



Indoor Worker Air Equations

Noncarcinogenic

- Inhalation

$$SL_{iw\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{iw}\left(\frac{365\ days}{year} \times ED_{iw}\left(25\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{iw}\left(\frac{250\ days}{year}\right) \times ED_{iw}\left(25\ years\right) \times ET_{iw}\left(\frac{8\ hours}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

Carcinogenic

- Inhalation

$$SL_{iw\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{iw}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_{iw}\left(\frac{250\ days}{year}\right) \times ED_{iw}\left(25\ years\right) \times ET_{iw}\left(\frac{8\ hours}{24\ hours}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

Abbreviations from RSL User Guide

https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-may-2016

RfC	Chronic Inhalation Reference Concentration (mg/m3)	Contaminant-specific
IUR	Chronic Inhalation Unit Risk $(\mu g/m3)^{-1}$	Contaminant-specific
TR	target risk 1 x 10^{-6}	Determined in this calculator
THQ	target hazard quotient (1)	Determined in this calculator
ATres-a	Averaging time - resident soil adult (days)	365 x EDres = 9490
ATw (carcinogenic)	Averaging time - composite worker (days)	365 x LT = 25550
EFres	Resident Exposure Frequency (days/year)	350
EFw	Composite Worker Exposure Frequency (days/year)	250
EDres	Resident Exposure Duration (years)	26
EDw	Composite Worker Exposure Duration - (years)	25
ETres	Resident Exposure Time (hours/day)	24
ETw	Composite Worker Exposure Time (hours/day)	8