

Health Consultation

Analysis of Untreated Residential Ground Water Wells
in the Widefield Aquifer

SCHLAGE LOCK COMPANY

SECURITY, EL PASO COUNTY, COLORADO

EPA FACILITY ID: COD082657420

APRIL 4, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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

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Prepared By:

The Colorado Department of Public Health and Environment
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Foreword

The Colorado Department of Public Health and Environment's (CDPHE) Environmental Epidemiology Section has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances. The Environmental Epidemiology Section (EES) evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding the contents of this health consultation or the Environmental Epidemiology Section, please contact the authors of this document:

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Summary and Statement of Issues

In late 1987, Schlage Lock Company, located in Security, Colorado, discovered that the groundwater beneath their manufacturing facility was contaminated with the chemical tetrachloroethylene, also known as perchloroethylene (PCE). Schlage utilized the solvent as a metal cleaner and degreaser during the production of door locks and related hardware from 1977-1992. Improper disposal and/or storage of spent PCE led to contaminated soil beneath their facility. PCE then leached through the subsurface soil to an underlying aquifer. The contaminated groundwater beneath the facility eventually migrated into the Widefield Aquifer, a major source of drinking water for the surrounding community. PCE was discovered in the first municipal drinking water system in 1990, and an environmental investigation began.

At the request of a concerned citizen and the Colorado Department of Public Health and Environment's (CDPHE) Hazardous Waste and Waste Management Division (HWWMD), the Department's Environmental Epidemiology Section (EES) is conducting an evaluation of the public health impact in the area affected by PCE contamination. The purpose of this evaluation is to identify any prior, existing, or potential health impacts from exposure to PCE contamination originating in the Widefield Aquifer.

The overall evaluation has been divided into specific focus areas to more accurately assess each exposure pathway from a variety of environmental media and conditions. The PCE plume covers a large area and exposure conditions vary dramatically amongst the potentially exposed population. A health consultation has been performed on each of the three public water supply systems that draw water from the Widefield Aquifer including Fountain, Security, and Widefield municipal water districts. In addition, a health consultation was conducted to evaluate exposures from consuming contaminated fish within Willow Springs Ponds, which is located at the distal extent of the PCE plume. The indoor air quality of homes situated over high concentration areas of the plume has also been reviewed. This particular health consultation addresses the public health implications of drinking water from private residential wells that draw water from the Widefield Aquifer.

After a review of the available data it has been determined that low levels of exposure to PCE have been occurring in private, residential wells. However, theoretical cancer risks do not indicate a significant health risk. Therefore, all current and future exposures to PCE from private, domestic-use wells represent no apparent health hazard.

Purpose and Scope

The purpose of this health consultation is to review the available private well data for residences, which draw water from the Widefield Aquifer, and determine the public health implications of exposure to PCE contaminated ground water in these wells. The evaluation focuses on private residential wells that **do not** have a treatment unit installed since the granular activated charcoal (GAC) units have been shown to be very effective at removing PCE from the system.

Background

Site History

The Schlage Lock Company (Schlage), located at 3899 Hancock Expressway, Security, Colorado began operations manufacturing door locks and related hardware in August 1977. From late 1977 until mid 1992, Schlage used PCE as a metal cleaner and degreaser. In mid-July 1987, Schlage discovered PCE contamination in the subsurface soil on their property during an excavation for plant expansion. A preliminary investigation, conducted in 1987, revealed that the PCE had leached down to groundwater beneath the site. It was later found that the contaminant had migrated into the Widefield Aquifer, the primary source of drinking water for the surrounding communities.

The plume of PCE-contaminated groundwater currently extends from the Schlage Lock facility in a west-southwest direction below the Little Johnson Reservoir, then turns and proceeds south-southeast as it intersects with the Widefield Aquifer, just south of Bradley Road (Figure 1). The contaminant plume then travels within the Widefield Aquifer towards Willow Springs Ponds, which is the distal extent of the PCE plume. The shape of the contaminant plume is constrained by paleo-channels in bedrock and channel deposits in the Widefield Aquifer. The overall length of the plume is approximately four and a half miles.

Following the identification of subsurface PCE contamination, a variety of remedial measures have taken place to remove and control the migration of PCE through the environment. Soil Vapor Extraction (SVE) systems were installed in two source areas at the Schlage facility in 1989 and in a third source area in 2000. In 1990, Schlage installed an on-site groundwater recovery and treatment system to treat PCE-contaminated groundwater and in 1992, they began operation of an additional system between their property and the former Little Johnson Reservoir. The treated water is discharged under a permit to the Security Water and Sanitation District sanitary sewer.

The levels of PCE in the Widefield Aquifer appear to be decreasing. In 1999, maximum concentrations of PCE within the plume were over 1,000 ppb in the vicinity of Little Johnson Reservoir, less than 100 ppb south of Bradley Road, and less than 50 ppb south of Fountaine Boulevard. Maximum PCE concentrations detected during the 2nd quarter of 2004 were below 800 ppb in the vicinity of Little Johnson Reservoir, less than 50 ppb south of Bradley Road, and less than 10 ppb south of Fountaine Boulevard. An upgraded groundwater remediation system, described as the Bradley Road/Little Johnson Reservoir Groundwater Recovery, Treatment, and Injection System, has been operating since 1999. The system is designed to halt any further movement of contaminated groundwater from the aquifer beneath the facility into the Widefield aquifer.

Private residential well data is available for approximately 27 homes in the vicinity of Schlage Lock. Ten out of 27 wells have had treatment systems installed, which remove PCE prior to distribution within the household. The private wells with treatment units are sampled before, between, and after treatment to ensure timely replacement of the granular activated charcoal (GAC) canisters before the saturation level has been reached. It has

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been concluded that the GAC treatment units have been well maintained and are very capable of removing PCE to non-detectable levels of contamination. Therefore, the private, residential wells with GAC treatment units installed are not considered further in this assessment.

Demographics

Approximately 38,750 people live in the area of the PCE plume extending from the Schlage Lock facility to Willow Springs Ponds, located at the distal extent of the plume (Census 2000). This figure is an approximation and overestimates the actual number of people that could be exposed to PCE through the private residential well exposure scenario since a large majority of this population is served by a municipal water system that complies with state and federal standards for drinking water. Schlage Lock has identified approximately 19 residential wells that could potentially be impacted by the contamination. The average household size, according to the Census 2000 data, is 2.99 people resulting in approximately 59 individuals potentially exposed in this scenario. No specific demographic information on this subpopulation exists. However, no striking demographic features exist for this general population located over the plume in comparison to national statistics.

Community Health Concerns

Community health concerns regarding the PCE contamination within the Widefield Aquifer were solicited and documented in the “Community Involvement and Health Issues Communication Plan” (CDPHE 2004). In addition, Schlage Lock and the Hazardous Waste and Waste Management Division (HWWMD) at CDPHE have also conducted public involvement activities in the affected communities. Their findings were documented in the “Community Involvement Plan for the Schlage Lock Company Site” (Schlage 2001). Community concerns from both documents are summarized below.

Previously Identified Community Concerns (Schlage 2001):

- Safety of the drinking water supply,
- Property Values,
- Progress on the Willow Springs Ponds remediation, and
- Testing of pumping wells west of U.S. Highways 85 and 87.

Current Community Concerns (CDPHE 2004):

- The possibility of PCE exposure causing brain cancer, lymphatic cancer, or other types of cancer,
- The possibility of PCE exposure resulting in respiratory problems, and
- The health of domestic dogs that have swam in Willow Springs Ponds.

The primary health concerns within the community from exposure to PCE appear to be cancer and other non-carcinogenic health effects, such as respiratory problems. The intent of this health consultation is to evaluate any potential adverse human health effects,

including cancer, from exposure to PCE in untreated residential wells. Other pathways of exposure have been evaluated for carcinogenic risk in separate health consultations. Please see the “Public Health Action Plan” section of this document for a list of all other health consultations available on this site.

Discussion

Data Used

Schlage Lock’s environmental contractors have collected the groundwater data used in this assessment on a quarterly basis since 1996. The samples were sent to an Environmental Protection Agency (EPA) contract laboratory and analyzed for VOCs by EPA method 524.2 and/or method 624. Standard Contract Laboratory Program guidelines for validation were utilized and all data during this time period was deemed useable and appropriate for assessing exposure. Approximately seventeen untreated, private wells have been monitored since 1996. Of the untreated wells that have been monitored, 1 well (I-49) is used for irrigation purposes at a local nursery and in 5 wells (R-7, R-34, R-64, R-65, and R-66) PCE has not been detected during sampling events. These wells were excluded from further evaluation since no adverse health effects are likely to occur from the use of the irrigation well or the wells that have not shown PCE contamination. The summary statistics on the remaining 11 wells is located in Table 1.

Exposure Evaluation

The initial steps of the assessment process involve screening the available environmental data for contaminants and then comparing this information to conservative, health-based environmental guidelines. Exposures to contaminated sources below the environmental guidelines are not expected to result in adverse or harmful health effects. If the concentration of a particular contaminant is above the chosen environmental guideline, the contaminant is normally retained for further analysis as a contaminant of potential concern (COPC). However, exceeding the screening value does not necessarily mean that the contaminant poses a public health hazard, only that further evaluation may be necessary. CDPHE’s Environmental Epidemiology Section also consider sampling location, data quality, exposure probability, frequency and duration; and community health concerns in determining which contaminants to evaluate further.

If the contaminant is selected for extended evaluation, the next step is to identify pathways of probable exposure that could pose a hazard. Simply having the substance present in the environment does not necessarily mean that people will come into contact with it and subsequently experience adverse health effects. An exposure pathway consists of five elements: a source, a contaminated environmental medium, and transport mechanism, a point of exposure, a route of exposure, and a receptor population. Exposure pathways are classified as either complete, potential, or eliminated. Only complete exposure pathways can be fully evaluated and characterized to determine the public

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health implications. Site-specific contaminants of concern and completed exposure pathways are discussed further in the section below.

Conceptual Site Model

Three major routes of potential exposure exist when considering the use of private ground water wells for domestic use as the sole source of water; these include: ingestion of water, inhalation of PCE vapors from domestic use of water; and dermal absorption of PCE during bathing and performing other household activities. The most common route of exposure to domestic water sources is oral ingestion. Generally speaking, consumption of water is considered the most important route of exposure in terms of public health. However, some evidence suggests that inhalation of VOCs while showering and performing other activities may be equal to or exceed the dose received from ingestion of contaminated water (Andelman 1985, 1990).

VOCs also have the ability to cross the skin barrier and enter the bloodstream when a person comes into contact with them. Dermal exposures to PCE will not be assessed quantitatively on a well-by-well basis in this analysis. Rather, a “worst-case scenario”, based on the maximum exposure point concentration, will be discussed to demonstrate the contribution of dermal PCE exposures in the household.

Another potential route of exposure to PCE is the consumption of fruits and vegetables from domestic gardens, which are irrigated with contaminated ground water. It is possible for plants to take up and accumulate contaminants from the contaminated water and soil and be ingested while eating the plant. Considering the low levels of PCE encountered in this assessment and the release of PCE to air during irrigation, this pathway was not considered significant and is not evaluated quantitatively in this assessment.

COPC Selection

The screening values used in this assessment to select contaminant levels of potential concern are the EPA Region 3 Risk-Based Concentrations (RBC) based on the cancer effects and ATSDR’s comparison values (CVs) based on the non-cancer effects. The EPA Region 3 RBC of 0.1 ug/L (ppb) for PCE is based on inhalation and ingestion exposures to contaminated drinking water. The RBC calculation is age-adjusted to account for both children and adult carcinogenic health risk over a 30-year time period beginning at the time of birth (6 yrs. as child, 24 yrs as adult). ATSDR’s CVs for non-carcinogenic health effects are 100 ppb and 400 ppb for children and adults, respectively. None of the data gathered for this assessment exceeds the non-cancer CVs for children or adults. Therefore non-carcinogenic adverse health effects are not likely to occur from the exposures discussed in this assessment. However, the RBC value for carcinogenic effects of PCE exposure was exceeded by the maximum detected concentration in each of the 11 wells described above and will be retained as a COPC on this basis.

Public Health Implications

The purpose of this evaluation is to determine whether exposures to PCE in domestic wells that exceed the environmental health based guideline (or RBC) might be associated with adverse health outcomes. This requires a calculation of site-specific exposure doses based on the appropriate PCE exposure point concentration and comparison with an appropriate toxicity value (or health guideline). The maximum concentration of PCE in each of the 11 untreated wells exceeded the RBC of 0.1 parts per billion (ppb). The exposure point concentration (EPCs) for each domestic well and dose calculations are discussed in Appendix A. To calculate theoretical cancer risks for the ingestion and inhalation pathways, the inhalation and ingestion dose of PCE is multiplied by the cancer slope factor (or health guideline) in accordance with the EPA Region 3 Risk-Based Concentrations methodology. The results of these calculations are presented in Table 1. The available toxicity values (or health guidelines) utilized to evaluate the likelihood of possible harmful cancer and noncancer effects are discussed in Appendix B.

The theoretical cancer risk range for the untreated residential wells is $2.5 * 10^{-6} - 8.1 * 10^{-6}$ (2.5 to 8.1 excess cancer cases per million people exposed). This range describes the theoretical cancer risk of ingestion and inhalation exposures for the 11 untreated wells described above. As mentioned earlier, dermal dose contribution is not assessed for every household in this assessment. Instead, the dermal dose was calculated for the highest EPC of all wells (Well R-11, EPC = 0.81 ppb). The dermal dose result is based on an adult and a child taking a 35-minute bath per day, 350 days per year for 30 yrs and 6 years, respectively (Appendix A). The resulting estimated dermal cancer risk is $3.0 * 10^{-6}$. Thus, the highest total theoretical cancer risk estimated by summing the dermal cancer risk and the ingestion/inhalation cancer risk is $1.1 * 10^{-5}$ (11 excess cancers per million people exposed). These theoretical cancer risks estimates are not considered to represent significant potential risks because they are based on the conservative assumption of 30 years exposure duration.

In general, CDPHE strives to achieve a target cancer risk level of $1 * 10^{-6}$ or no more than 1 excess cancer case out of a million people for all site-related environmental exposures. The USEPA considers a risk level of $1 * 10^{-6}$ to $1 * 10^{-4}$ as the acceptable range of risk. The low level of excess lifetime cancer risk predicted in this assessment does not represent an immediate action due to the fact that the ground water is currently being remediated to further reduce PCE concentrations in the Widefield Aquifer. Based on the available data at this time, domestic use of untreated, private residential wells is not likely to result in adverse health effects for all current and future exposures.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances.

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Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health. For example, infants can be exposed to PCE that has been transferred into breast milk. Additionally, PCE can also cross the placenta. Therefore, the developing fetus and infants should be considered a susceptible population for exposure to PCE.

In this consultation, the health-based values include theoretical risks to children as well as adults. The results indicate that no significant health hazards to children are likely.

Conclusions

Low levels of PCE have been found in private, untreated, residential wells in the Security-Widefield community. Based on the available information, non-cancer adverse health effects are not likely to occur from the exposures identified in this assessment. In addition, the low levels of excess lifetime theoretical cancer risks predicted in this assessment does not represent immediate action due to the fact that the Widefield Aquifer is currently being remediated, which will further reduce exposures to PCE. Therefore, the use of private, residential wells for domestic use represents no apparent public health hazard for all current and future exposures.

Recommendations

In order to reduce the exposures in private, residential wells the EES makes the following recommendations:

- Schlage Lock should continue the remediation of the PCE plume in the Widefield Aquifer.
- Schlage Lock and their environmental contractors should continue quarterly groundwater monitoring of private, residential wells until remedial action is complete in the Widefield Aquifer.
- Residents should ensure that indoor sources of VOCs (e.g., paints, and household cleaners) are stored in sealed containers preferably outside the home (e.g., garage). In addition, dry-cleaned clothes should not be stored in plastic bagging for extended periods of time and should also be kept in well-ventilated areas.

Public Health Action Plan

The public health action plan describes the actions designed to mitigate or prevent adverse human health effects that might result from exposure to hazardous substances associated with site-related contamination. The EES at CDPHE commits to do the following public health actions related to private, residential well exposures to PCE in the Security-Widefield community:

- By request, EES will evaluate any additional ground water data that may be collected in the future.
- EES will present the findings of this document to the Security-Widefield community by means of a public information session.
- EES will also make this document available to the public through the information repositories located in the Security-Widefield community.

Other ATSDR health consultation documents currently available on the Schlage Lock site:

- Assessment of Drinking Water Quality, Fountain Municipal Water District published in 2004
- Assessment of Drinking Water Quality, Security Municipal Water District published in 2004
- Assessment of Drinking Water Quality, Widefield Water and Sanitation District published in 2005
- Exposure and Health Effects Evaluation at Willow Springs Ponds following PCE Contamination of the Widefield Aquifer published in 2006
- Evaluation of Tetrachloroethene Vapor Intrusion into Buildings Located Above a Contaminated Aquifer published in 2006.

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References

- Agency for Toxic Substances and Disease Registry (ATSDR 2005). *Public Health Assessment Guidance Manual*, Revised January 2005. Available on the Internet at: <http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html>, accessed March 2007.
- Agency for Toxic Substances and Disease Registry (ATSDR 1997). *Toxicological Profile for Tetrachloroethylene*, September 1997. Available on the Internet at: <http://www.atsdr.cdc.gov/toxprofiles/tp18.html>, accessed February 2007.
- Andelman, Julian B. (Andelman 1985). *Inhalation Exposure in the Home to Volatile Organic Compounds of Drinking Water*, December 1985. *Science of the Total Environment*, Vol. 47: 443-460.
- Andelman, Julian B. (Andelman 1990). *Total Exposure to Volatile Organic Compounds in Potable Water*, 1990. Significance and Treatment of Volatile Organic Compounds in Water Supplies, 485-504.
- California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (Cal EPA 2001). *Public Health Goal for Tetrachloroethylene*, August 2001.
- Colorado Department of Public Health and Environment, Environmental Health Studies Program (CDPHE 2004). *Security-Widefield Site, Health Issues and Communication Plan*, June 2004.
- International Agency for Research on Cancer (IARC 1995). *Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 63: Dry Cleaning, Some Chlorinated Solvents, and Other Industrial Chemicals*, 1995. Available on the Internet at: <http://www.iarc.fr/> , accessed March 2007.
- U. S. Environmental Protection Agency, Integrated Risk Information System (EPA 1998). *Full IRIS Summary: Tetrachloroethylene*, last update January 1998. Available on the Internet at: <http://www.epa.gov/iris/subst/0106.htm> , Accessed March 2007.
- U.S. Environmental Protection Agency, (EPA 2004). *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*; July 2004. Available on the Internet at: <http://www.epa.gov/oswer/riskassessment/ragse/index.htm>, Accessed March 2007.
- U. S. Environmental Protection Agency, Region 3 (EPA 2006a). *Human Health Risk Assessment, Risk-Based Concentration Table*; last update April 2006. Available on the Internet at: <http://www.epa.gov/reg3hwmd/risk/human/index.htm>, Accessed February 2007.

Tables and Figures

Table 1. Summary Statistics and Theoretical Cancer Risk for Untreated, Private Residential Wells in the Vicinity of Schlage Lock

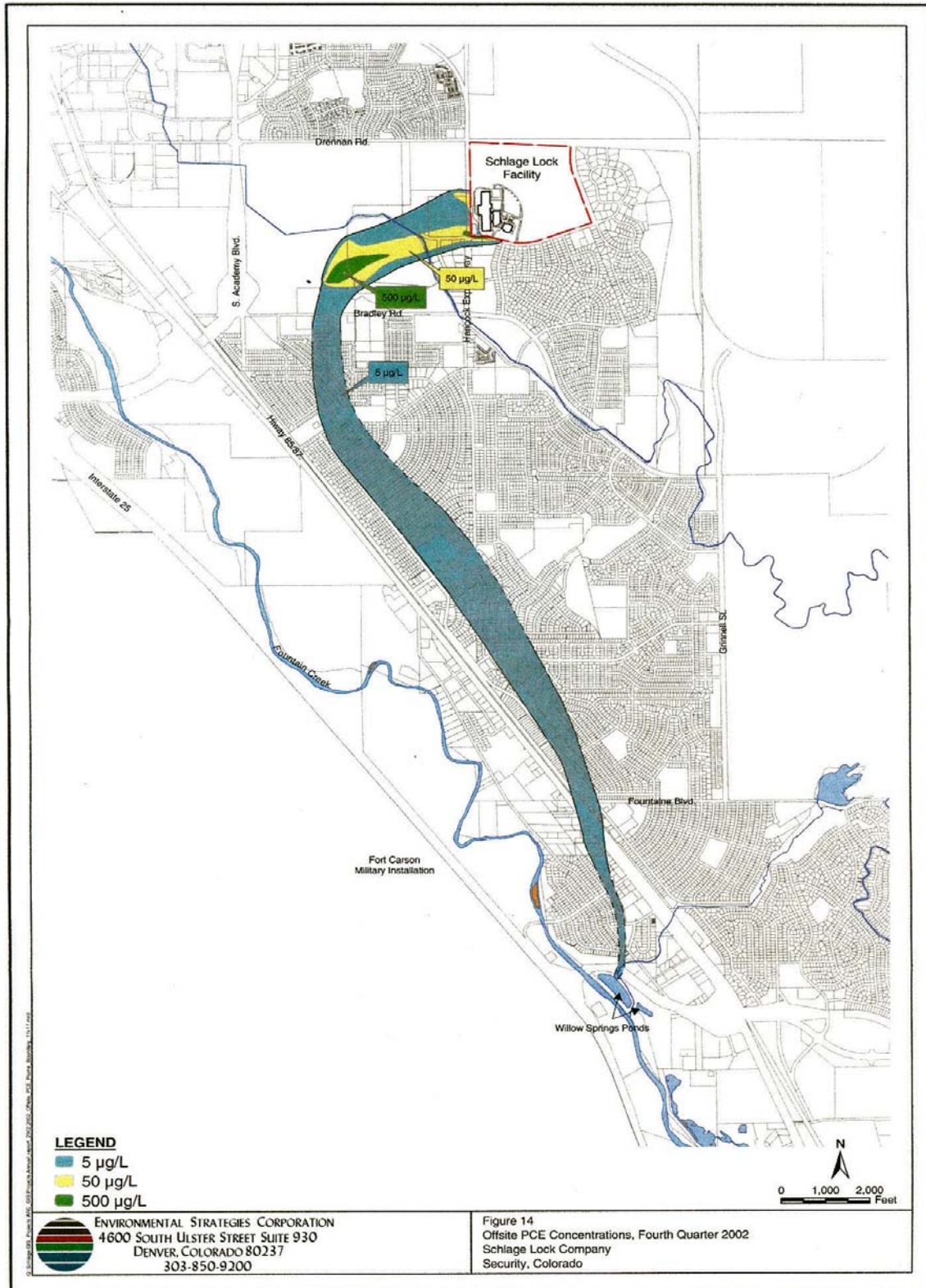
Well Number	EPC	Min	Max	Mean	Median	<i>n</i>	Detection Frequency	Theoretical Cancer Risk*
R-03	0.26	0.16	0.38	0.25	0.25	40	15%	2.60E-06
R-05	0.29	0.13	0.7	0.27	0.25	44	23%	2.90E-06
R-10	0.42	0.15	2.19	0.34	0.25	44	64%	4.20E-06
R-11	0.81	0.11	2.83	0.46	0.3	39	72%	8.10E-06
R-17	0.28	0.15	0.51	0.26	0.25	42	76%	2.80E-06
R-19	0.32	0.1	1.3	0.27	0.25	42	40%	3.20E-06
R-60	0.55	0.25	0.92	0.47	0.41	22	95%	5.50E-06
R-61	0.53	0.25	0.79	0.48	0.45	24	96%	5.30E-06
R-62	0.29	0.25	0.7	0.27	0.25	27	4%	2.90E-06
R-63	0.25	0.098	0.25	0.23	0.25	23	17%	2.50E-06
R-67	0.66	0.13	1.3	0.38	0.25	22	50%	6.60E-06

*Represents theoretical cancer risk resulting from ingestion and inhalation exposures to private residential well users.

Note: Theoretical cancer risks were calculated by dividing the RBC by the exposure point concentration and multiplying by 1×10^{-6} .

EPC= Exposure Point Concentration, which represents the 95% upper confidence limit on the mean or the maximum detected value

Figure 1. Approximation of PCE plume in the Widefield Aquifer (based on data)



Source: ESC 4th Quarter Report 2002

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Figure 2. Residential Wells (North)

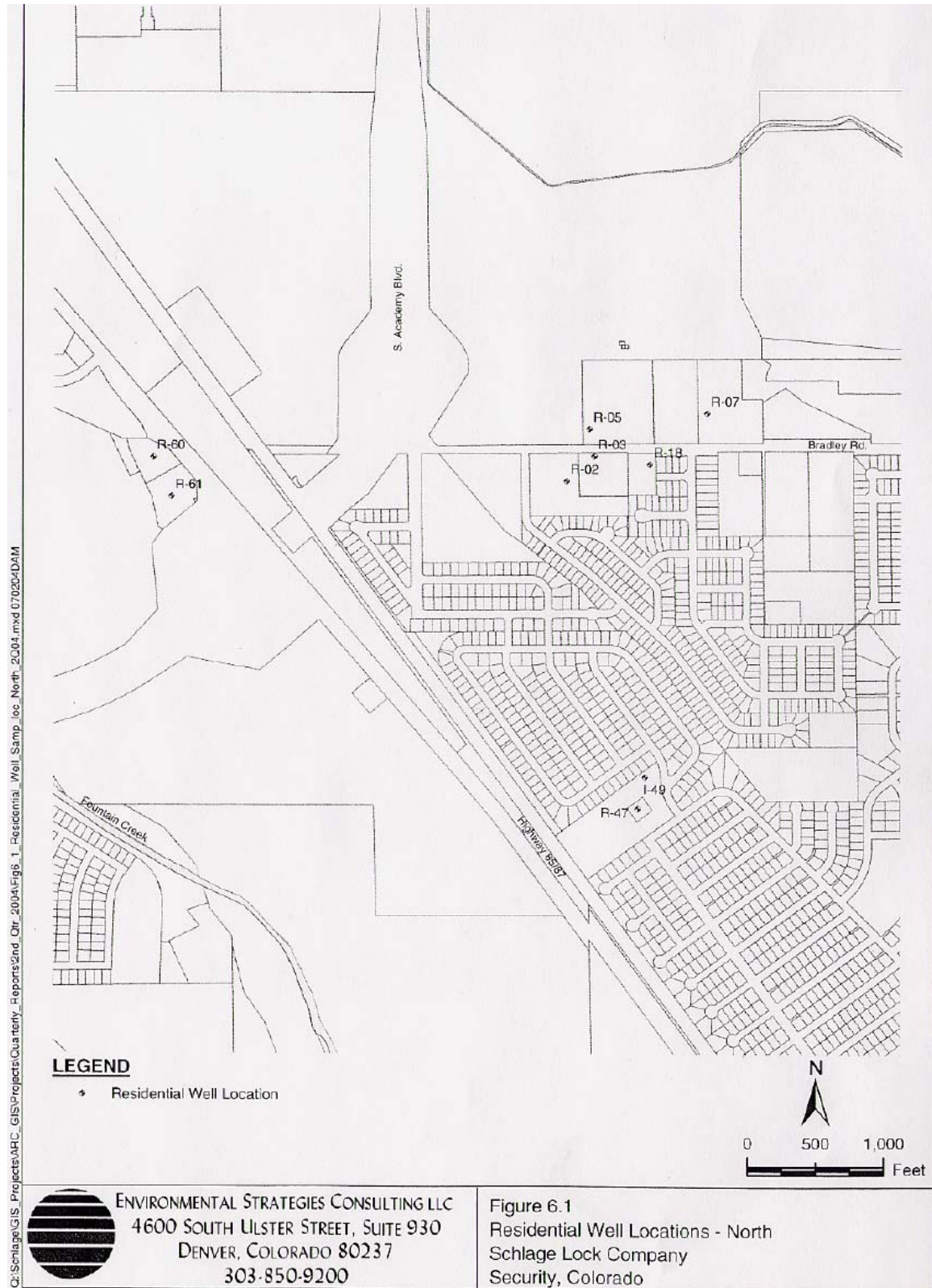
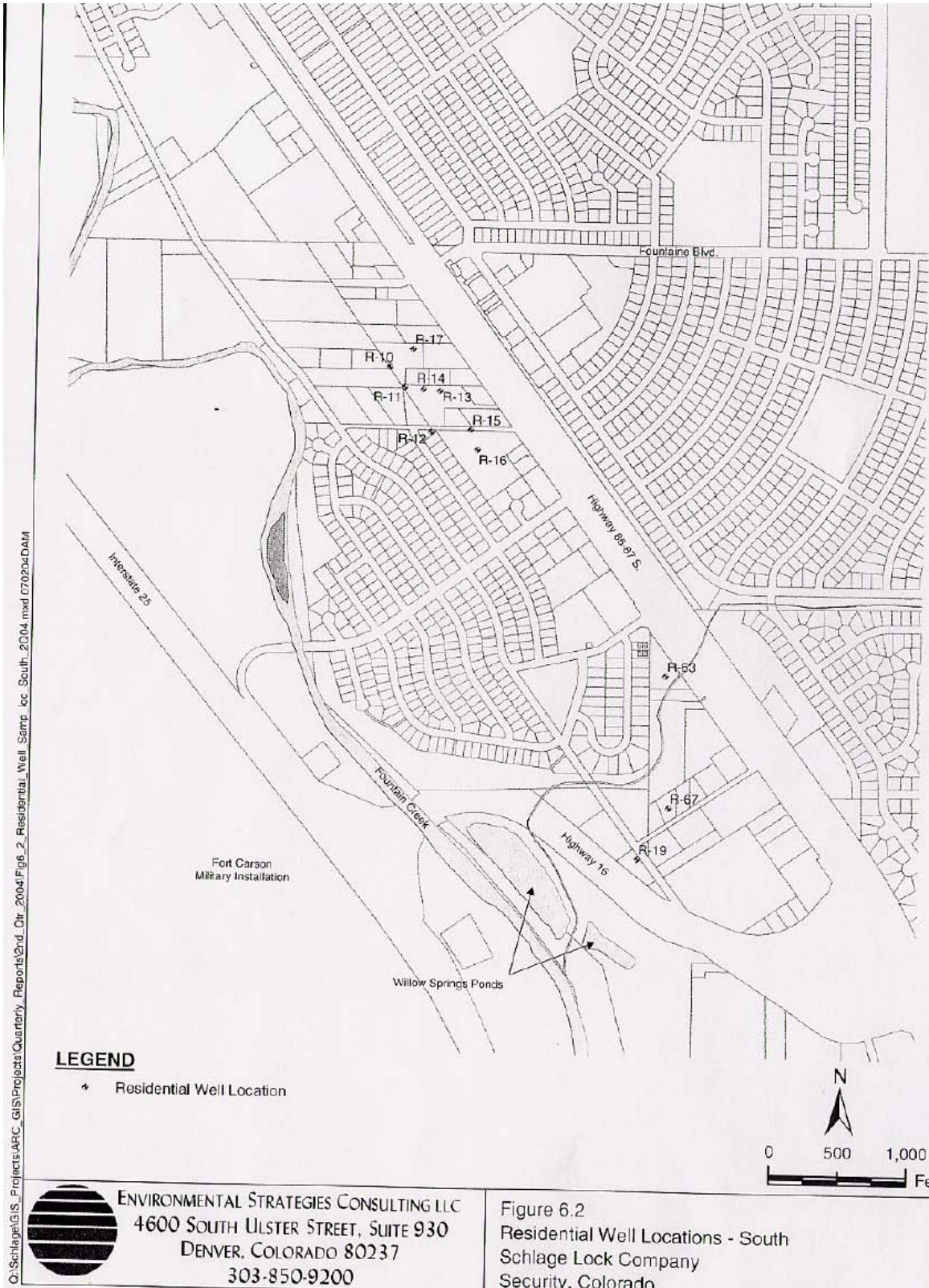


Figure 3. Residential Wells Location (South)



Appendices

Appendix A: Exposure Dose Calculations

A1. Exposure Point Concentration in Domestic Wells

Exposure point concentrations (EPCs) are reasonable maximum exposure concentrations of PCE in ground water that individuals are likely to be exposed. EPCs were calculated by compiling the available data from 1996 to 2006 and taking the 95% upper confidence limit of the average for each well.

A2. Ingestion and Inhalation Exposure Dose Calculation

The risk-based concentration (RBC), calculated by the U.S. Environmental Protection Agency Region 3, was used to calculate inhalation and ingestion doses of PCE contaminated drinking water. A detailed description of the variables and equation used to derive the dose and RBC is available on the Internet at:

<http://www.epa.gov/reg3hwmd/risk/human/info/tech.htm>.

A3. Dermal Absorbed Dose Calculation for Organic Compounds-Water Contact (Source: EPA RAGS Part E EPA 2004)

DAD (mg/cm²-event) is calculated for Organic Compounds as follows:

$$\text{DAD (mg/cm}^2\text{-event)} = \frac{\text{DAev} * \text{ED} * \text{EF} * \text{SA}}{\text{BW} * \text{AT}} \quad (\text{EPA 2004, Equation 3-1})$$

$$\text{DA event (DAev)} = 2 \text{ FA} * \text{K}_p * \text{C}_w \sqrt{(\tau_{ev} * t_{ev} \div \pi)} \quad (\text{EPA 2004, Equation 3-2})$$

Variable	Units	Description	Adult	Child
DAD	mg/kg-day	Dermally absorbed dose	5.6 * 10 ⁻⁶	1.9 * 10 ⁻⁶
FA	dimensionless	Fraction absorbed water for PCE	1	1
K _p	cm/hour	Dermal permeability coefficient of PCE	3.3 * 10 ⁻²	3.3 * 10 ⁻²
C _w	mg/cm ³	Concentration of chemical in water	8.1 * 10 ⁻⁷	8.1 * 10 ⁻⁷ (Max EPC All Wells)
τ _{ev}	hours	Lag Time per event	0.91	0.91
t _{ev}	hour/event	Event Duration	0.58	0.58
ED	years	Exposure duration	30	6
ET	hours/day	Exposure time	0.58	0.58
EF	days/year	Exposure frequency	350	350
SA	cm ²	Skin surface area available for contact	18,000	6,600
BW	kg	Body weight	70	15
AT _{cancer}	days	Averaging time	25,550	25,550

Appendix B: Toxicological Evaluation for PCE

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects is dependant on dose. The toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (acute, subchronic, chronic or lifetime). In general, acute and chronic neurological changes, and liver and kidney toxicity, have been observed in humans and animals exposed to PCE (See Appendix D for PCE health effect fact sheet). It is important to note that estimates of human health risks may be based on evidence of health effects in humans and/or animals depending upon the availability of data.

Cancer

At the current time, the International Agency for Cancer Research (IARC) has classified PCE as a Group 2a carcinogen (IARC 1995). The USEPA has not established in the EPA Integrated Risk Information System (IRIS) an inhalation reference concentration as well as a carcinogenicity assessment for lifetime exposures to PCE. However, in the absence of relevant values in the EPA IRIS, the EPA Office of Solid Waste and Emergency Response (OSWER) recommends using the California EPA oral cancer slope factor of 0.54 per mg/kg-day⁻¹ and inhalation cancer slope factor of 0.021 per mg/kg-day⁻¹ for PCE (EPA, 2003, OSWER Directive No. 9285.7-75). The Cal EPA classifies PCE to be an animal carcinogen and a possible human carcinogen. This classification is based on the observed increased incidence of hepatocellular carcinoma in male and female mice exposed orally to PCE. In addition, human epidemiological studies suggest that PCE is possibly carcinogenic in humans.

The most consistent tumor sites in humans are the esophagus and lymphatic system, but the available information is insufficient to quantify cancer risks. Therefore, quantitative estimates of the potential of PCE to induce human cancer are inferred from animal data. Additionally, estimating the cancer slope factor is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses. Therefore, it is necessary to use mathematical models to extrapolate from the observed high dose data to the desired slope at low dose. In order to account for the uncertainty in this extrapolation process, EPA typically chooses to employ the 95% upper confidence limit of the slope as the Slope Factor. That is, there is a 95% probability that the true cancer potency is lower than the value chosen for the Slope Factor. CDPHE's Hazardous Waste and Waste Management Division has also adopted the Cal EPA inhalation and oral cancer slope factors, which results in RBC of 0.1 ug/L as a screening value.

Non-Cancer

The USEPA IRIS (EPA, 1988) has established an oral reference dose (RfD) of 0.01 mg/kg/day for non-cancer effects. The RfD is based on liver toxicity in mice and weight gain in rats. An RfD is the daily dose in humans (with uncertainty spanning perhaps an order of magnitude), including sensitive subpopulations, that is likely to be without an

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appreciable risk of noncancer adverse health effects during a lifetime exposure. ATSDR has derived an acute-duration oral minimal risk levels (MRLs) for PCE of 0.05 mg/kg/day. The acute MRL is based on an increase in total spontaneous activity (locomotion and rearing) in mice. An MRL is the dose of a compound that is an estimate of daily human exposure that is likely to be without an appreciable risk of adverse noncancer effects of a specified duration of exposure. The acute MRL addresses short-term exposures of 14 days or less. ATSDR has not established intermediate- and chronic-duration oral MRLs for PCE.

Appendix C. ATSDR Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
<p>A. Urgent Public Health Hazard</p> <p>This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.</p>
<p>B. Public Health Hazard</p> <p>This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.</p>
<p>C. Indeterminate Public Health Hazard</p> <p>This category is used for sites in which “critical” data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.</p>	<p>This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.</p>	<p>The health assessor must determine, using professional judgment, the “criticality” of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.</p>
<p>D. No Apparent Public Health Hazard</p> <p>This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.</p>	<p>This determination represents a professional judgment based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.</p>
<p>E: No Public Health Hazard</p> <p>This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.</p>	<p>Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future</p>	

Appendix D: ATSDR Tetrachloroethylene Public Health Statement

Public Health Statement for Tetrachloroethylene

CAS# 127-18-4

This Public Health Statement is the summary chapter from the [Toxicological Profile for tetrachloroethylene](#). It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the [ToxFAQs™](#), is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about tetrachloroethylene and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Tetrachloroethylene has been found in at least 771 of the 1,430 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with tetrachloroethylene may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to tetrachloroethylene, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

What is tetrachloroethylene?

Tetrachloroethylene is a synthetic chemical that is widely used for dry cleaning of fabrics and for metal-degreasing operations. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products. Other names for tetrachloroethylene include perchloroethylene, PCE, perc, tetrachloroethene, perclene, and perchlor. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part in 1 million parts of air (ppm) or more. In an experiment, some people could smell tetrachloroethylene in water at a level of 0.3 ppm.

What happens to tetrachloroethylene when it enters the environment?

Tetrachloroethylene enters the environment mostly by evaporating into the air during use. It can also get into water supplies and the soil during disposal of sewage sludge and factory waste and when leaking from underground storage tanks. Tetrachloroethylene may also get into the air, soil, or water by leaking or evaporating from storage and waste sites. It can stay in the air for several months before it is broken down into other chemicals or is brought back down to the soil and water by rain.

Much of the tetrachloroethylene that gets into water and soil will evaporate into the air. However, because tetrachloroethylene can travel through soils quite easily, it can get into underground drinking water supplies. If it gets into underground water, it may stay there for many months without being broken down. If conditions are right, bacteria will break down some of it and some of the chemicals formed may also be harmful. Under some conditions, tetrachloroethylene may stick to the soil and stay there. It does not seem to build up in animals that live in water, such as fish, clams, and oysters. We do not know if it builds up in plants grown on land.

How might I be exposed to tetrachloroethylene?

People can be exposed to tetrachloroethylene from environmental and occupational sources and from consumer products. Common environmental levels of tetrachloroethylene (called background levels) are several thousand times lower than levels found in some workplaces. Background levels are found in the air we breathe, in the water we drink, and in the food we eat. The chemical is found most frequently in air and, less often, in water. Tetrachloroethylene gets into air by evaporation from industrial or dry cleaning operations. It is also released from areas where chemical wastes containing it are stored. It is frequently found in water. For example, tetrachloroethylene was found in 38% of 9,232 surface water sampling sites throughout the United States. There is no similar information on how often the chemical is found in air samples, but we know it is widespread. We do not know how often it is found in soil, but in one study, it was found in 5% of 359 sediment samples.

In general, tetrachloroethylene levels in air are higher in cities or industrial areas where it is in use more than in more rural or remote areas. You can smell it at levels of 1 ppm in air. However, the background level of tetrachloroethylene in air is usually less than 1 part in 1 billion parts of air (ppb). The air close to dry cleaning shops and chemical waste sites has levels of tetrachloroethylene higher than background levels. These levels are

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usually less than 1 ppm, the level at which you can smell it. Water, both above and below ground, may contain tetrachloroethylene. Levels in water are also usually less than 1 ppb. Levels in contaminated water near disposal sites are higher than levels in water far away from those sites. Water polluted with this chemical may have levels greater than 1 ppm. In soil, background levels are probably 100–1,000 times lower than 1 ppm.

You can also be exposed to tetrachloroethylene by using certain consumer products. Products that may contain it include water repellents, silicone lubricants, fabric finishers, spot removers, adhesives, and wood cleaners. Although uncommon, small amounts of tetrachloroethylene have been found in food, especially food prepared near a dry cleaning shop. When you bring clothes home from the dry cleaners, the clothes may release small amounts of tetrachloroethylene into the air. The full significance to human health of these exposures to small amounts of tetrachloroethylene is unknown, but to date, they appear to be relatively harmless. Tetrachloroethylene can also be found in the breast milk of mothers who have been exposed to the chemical.

The people with the greatest chance of exposure to tetrachloroethylene are those who work with it. According to estimates from a survey conducted by the National Institute for Occupational Safety and Health (NIOSH), more than 650,000 U.S. workers may be exposed.

For the general population, the estimated amount that a person might breathe per day ranges from 0.08 to 0.2 milligrams. The estimated amount that most people might drink in water ranges from 0.0001 to 0.002 milligrams per day. These are very small amounts.

How can tetrachloroethylene enter and leave my body?

Tetrachloroethylene can enter your body when you breathe air containing it. How much enters your body in this way depends on how much of the chemical is in the air, how fast and deeply you are breathing, and how long you are exposed to it. Tetrachloroethylene may also enter your body when you drink water or eat food containing the chemical. How much enters your body in this way depends on how much of the chemical you drink or eat. These two exposure routes are the most likely ways people will take in tetrachloroethylene. These are also the most likely ways that people living near areas polluted with the chemical, such as hazardous waste sites, might be exposed to it. If tetrachloroethylene is trapped against your skin, a small amount of it can pass through into your body. Very little tetrachloroethylene in the air can pass through your skin into your body.

Most tetrachloroethylene leaves your body from your lungs when you breathe out. This is true whether you take in the chemical by breathing, drinking, eating, or touching it. A small amount of the tetrachloroethylene is changed by your body (especially your liver) into other chemicals that are removed from your body in urine. Most of the changed tetrachloroethylene leaves your body in a few days. Some of it that you take in is found in your blood and other tissues, especially body fat. Part of the tetrachloroethylene that is stored in fat may stay in your body for several days or weeks before it is eliminated.

How can tetrachloroethylene affect my health?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Tetrachloroethylene has been used safely as a general anesthetic agent, so at high concentrations, it is known to produce loss of consciousness. When concentrations in air are high—particularly in closed, poorly ventilated areas—single exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with the chemical. As you might expect, these symptoms occur almost entirely in work (or hobby) environments when individuals have been accidentally exposed to high concentrations or have intentionally abused tetrachloroethylene to get a "high." In industry, most workers are exposed to levels lower than those causing dizziness, sleepiness, and other nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not definitely known. However, at levels found in the ambient air or drinking water, risk of adverse health effects is minimal. The effects of exposing babies to tetrachloroethylene through breast milk are unknown. Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known for sure if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that tetrachloroethylene may reasonably be anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that tetrachloroethylene is probably carcinogenic to humans. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant. Rats that were given oral doses of tetrachloroethylene when they were very young, when their brains were still developing, were hyperactive when they became adults. How tetrachloroethylene may affect the developing brain in human babies is not known.

Is there a medical test to determine whether I have been exposed to tetrachloroethylene?

One way of testing for tetrachloroethylene exposure is to measure the amount of the chemical in the breath, much the same way breath alcohol measurements are used to determine the amount of alcohol in the blood. This test has been used to measure levels of the chemical in people living in areas where the air is contaminated with tetrachloroethylene or those exposed to the chemical through their work. Because it is stored in the body's fat and is slowly released into the bloodstream, it can be detected in the breath for weeks following a heavy exposure. Tetrachloroethylene can be detected in the blood. Also, breakdown products of the chemical can be detected in the blood and urine of people exposed to tetrachloroethylene. Trichloroacetic acid (TCA), a breakdown product of tetrachloroethylene can be detected for several days after exposure. These tests are relatively simple to perform. The breath, blood, or urine must be collected in special containers and then sent to a laboratory for testing. Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed only to tetrachloroethylene.

What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and NIOSH.

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for tetrachloroethylene include the following:

The EPA maximum contaminant level for the amount of tetrachloroethylene that can be in drinking water is 0.005 milligrams tetrachloroethylene per liter of water (mg/L) (0.005 ppm).

EPA has established regulations and procedures for dealing with tetrachloroethylene,

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which it considers a hazardous waste. Many regulations govern its disposal. If amounts greater than 100 pounds are released to the environment, the National Response Center of the federal government must be told immediately.

OSHA limits the amount of tetrachloroethylene that can be present in workroom air. This amount is limited to 100 ppm for an 8-hour workday over a 40-hour workweek. NIOSH recommends that tetrachloroethylene be handled as a chemical that might potentially cause cancer and states that levels of the chemical in workplace air should be as low as possible.

1.8 Where can I get more information?

For additional information on tetrachloroethylene, refer to the ATSDR Toxicological Profile at: <http://www.atsdr.cdc.gov/toxprofiles/tp18.html>

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. [Toxicological profile for tetrachloroethylene](#). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

CERTIFICATION

This Untreated Residential Well health consultation was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was conducted. Editorial review was completed by the Cooperative Agreement partner.



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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.



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