Health Consultation

Evaluation of Tetrachloroethylene Vapor Intrusion into Buildings Located Above a Contaminated Aquifer

SCHLAGE LOCK COMPANY

SECURITY, EL PASO COUNTY, COLORADO

EPA FACILITY ID: COD082657420

NOVEMBER 30, 2006

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

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, 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
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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, which is 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.

To date, Schlage and other stakeholders have collected a large amount of environmental data to determine the extent of contamination and to guide remedial work plans for removing PCE from the environment. 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 to contaminated fish within Willow Springs Ponds, located at the distal extent of the PCE plume. Private residential wells, which also draw water from the Widefield Aquifer, will be addressed in a separate health consultation. This particular health consultation was conducted to evaluate indoor air quality in homes located above high concentration areas of the PCE plume.

After reviewing all of the available indoor air data, the EES has determined that inhalation of PCE vapors from the Widefield Aquifer presents no apparent public health hazard to Security-Widefield residents.

Purpose

The purpose of this health consultation is to evaluate exposures to PCE in indoor air via the vapor intrusion pathway. EES has reviewed all of the known, available indoor air data that has been collected to date in the area of the PCE plume in Security, CO. This information serves as the basis of the public health implications discussed in this document.

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.

Tetrachloroethylene

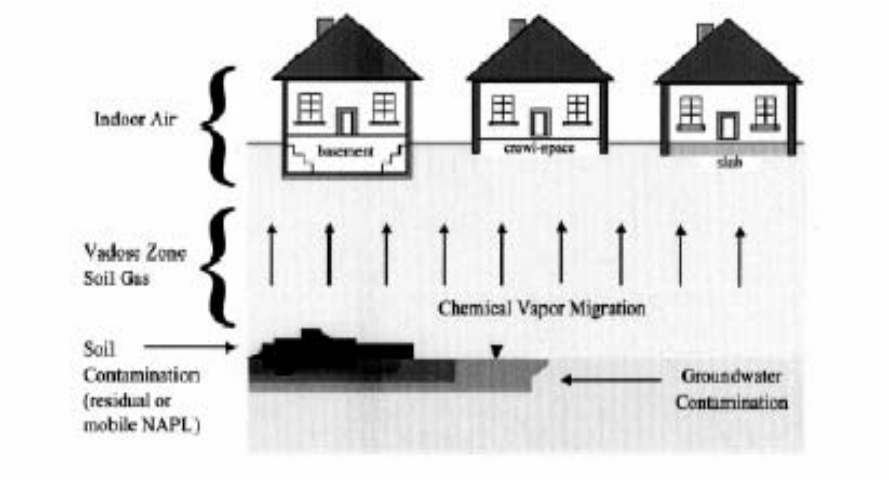
Tetrachloroethylene is an organic solvent, which consists of carbon and chlorine atoms. Tetrachloroethylene is primarily used as a chemical intermediate in the production of chlorofluorocarbons. It is also known by the names perchloroethylene (PCE), perc, tetrachloroethene, or ethylene tetrachloride. Throughout the remainder of this document, tetrachloroethylene will be referred to as PCE. Other common uses of PCE are in the dry-cleaning and textile production industries, where PCE serves as a cleaner or degreaser. Individuals may be exposed to PCE in a variety of ways including household chemicals, dry-cleaned clothes, occupational exposures, or environmental contaminated media (ATSDR 1997). Appendix B contains an ATSDR fact sheet with additional information on PCE. Due to widespread use of PCE in the dry cleaning, household products, and other industries, PCE is a common environmental contaminant. Environmental exposures to contaminated groundwater and surface water can occur as a result of PCE environmental releases from industrial wastes, leakage from underground storage tanks, and on-site spills.

The main health outcome of concern amongst the Security-Widefield community related to PCE exposure appears to be cancer. At the current time, the International Agency for Cancer Research (IARC) has classified PCE as a Group 2a carcinogen (IARC 1995). This category indicates that the substance is “probably carcinogenic to humans” based on sufficient experimental animal data and a limited amount of human data. The U.S. Environmental Protection Agency (EPA) is currently reviewing toxicity information on PCE and no cancer classification is available in the Integrated Risk Information System (IRIS) (EPA IRIS 1998).

Volatile Organic Compounds—Vapor intrusion pathway

PCE belongs to a class of organic compounds called Volatile Organic Compounds or VOCs. VOCs have high vapor pressures, which enables their vapors to readily enter the atmosphere. Vapor intrusion refers to the migration of VOC vapors from a subsurface source, through the vadose zone (subsurface area over the source), and into homes and buildings where people can be exposed. Subsurface sources may include contaminated groundwater and/or soils. Typically, vapors are released from the subsurface source,

migrate through soils, and into indoor air spaces of overlying buildings. The figure below is a generalized schematic of the vapor intrusion pathway (EPA 2002).



(Source: EPA 2002)

It should also be noted that environmental contamination is not the only source of VOCs in indoor air. VOCs are present in a number of household sources including building materials, cleaners, furniture treatments, paint, plastics, sealants, and cosmetics. In fact, studies have found that the levels of VOCs in indoor air may be as high as five times the levels found in outdoor air regardless of if the building was located in industrialized, urban areas or rural settings (EPA 2006b).

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 inhalation of PCE vapors in indoor air. The drinking water quality of all municipal water systems that were affected by PCE contamination within the Widefield Aquifer has been evaluated 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

The indoor air quality data used as the basis for this assessment was collected during four major sampling events conducted in 2000 and 2001. Ten residences and one elementary school were sampled for PCE as per the guidelines set forth in the "Indoor Air Assessment Work Plan" that was approved by CDPHE's Hazardous Materials and Waste Management Division (Schlage 1998). The buildings that were selected for sampling are located above areas of the contaminant plume where the concentration of PCE exceeded 50 μg/L. All residences and the school completed a pre-assessment interview to determine the likelihood of interference with household materials containing PCE. Visual inspections of each building were also conducted prior to sample collection to avoid canister placement near known sources of VOCs.

Harding Lawson and Associates collected a total of 30 indoor and 10 outdoor air samples for this assessment with the industry standard, Summa or Silco canisters. Canisters were placed at or near the lowest point of the structure due to the fact that PCE is denser than air. After collection, the canisters were sent to John-Mansville laboratory in Littleton, CO for analysis by EPA Method TO-15 with a Gas Chromatograph equipped with an SIM detector (Harding 2000, 2001a,b,c). All of the collected data was validated and inserted into a spreadsheet for analysis. The indoor air results from the laboratory were adjusted for the temperature and pressure readings reported by the contractor on the date the data was collected. This data is presented 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. However, exceeding the screening value does not necessarily mean that the contaminant poses a public health hazard, only that further evaluation may be necessary. ATSDR and 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 health implications. Site-specific contaminants of concern and completed exposure pathways are discussed further in the section below.

COPC Selection

The screening values utilized in this assessment are the Environmental Protection Agency's Region 3 Risk-Based Concentration (RBCs) and ATSDR's Chronic Minimal Risk Level for PCE (EPA 2006a, ATSDR 1997). The Region 3 RBC for PCE is based on an age-adjusted exposure covering 30 years from the time of birth to the age of 30 with an exposure frequency of 350 days per year. In addition, the inhalation RBC for PCE of 0.31 $\mu g/m^3$ indicates that no more than 1 theoretical excess cancer case out of one million would be expected from exposures to this concentration in air. ATSDR's comparison value of 300 $\mu g/m^3$ is based upon noncarcinogenic health effects from chronic exposure to PCE. The maximum detected concentration of the PCE found in the indoor air samples from the Security, CO area is 3.5 $\mu g/m^3$. Therefore, noncarcinogenic health effects are not likely to occur from chronic exposures to the levels of PCE in indoor air encountered in this assessment. However, PCE is retained as a COPC for carcinogenic health effects.

Conceptual Site Model

The scenario under consideration in this health consultation, involves a PCE-contaminated groundwater source that has the potential to release vapors into the indoor space of overlying buildings. PCE is a VOC, which has the ability to release vapors from the aquifer and travel through subsurface soil to enter cracks and crevices in the foundations of overlying buildings and become available for inhalation. Once the vapors are inside the building, they can become trapped in low ventilation systems and increase in concentration to levels of health concern.

Individuals living above the contaminant plume are the only receptors under consideration in this health assessment. All of the houses sampled receive municipal

water, which has been treated to control levels of PCE below the Maximum Contaminant Level. Therefore, other potential contributors to PCE concentration in indoor air such as showering and dishwashing were not considered in this assessment. In addition, biodegradation byproducts of PCE were not evaluated because this phenomenon has not been observed in the Widefield Aquifer. The major products of PCE degradation by methanotrophic bacteria are trichloroethylene, dichloroethylene, and vinyl chloride. These compounds have not been found at an elevated level in water samples collected from the Widefield aquifer.

Demographics

Approximately 38,750 people live in the area of the PCE plume extending from the Schlage Lock facility to Willow Springs Ponds, which is the distal extent of the plume (Census 2000). This figure is an approximation and may over-or underestimate the actual number of people that could be exposed to PCE through the indoor air pathway due to a lack of a clear boundary of the plume and the use of old census data. No striking demographic features exist for this population when compared to national statistics.

Toxicological Evaluation

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 B 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.

The USEPA has not established an inhalation reference concentration or a carcinogenicity assessment for lifetime exposures to PCE in the EPA Integrated Risk Information System (IRIS). In the absence of relevant values in IRIS, the USEPA Office of Solid Waste and Emergency Response (OSWER) recommends using the California EPA's carcinogenic inhalation cancer slope factor or toxicity factor per mg/kg/day of PCE (EPA, 2003, OSWER Directive No. 9285.7-75). CDPHE's Hazardous Waste and Waste Management Division also adopted the Cal EPA inhalation cancer slope factor, which results in RBC of 0.31 $\mu g/m^3$ as a screening value to guide remedial action in 2006.

The resulting RBC used in this assessment is based on age-adjusted theoretical cancer risks spanning 30 years from the time of birth to the age of 30. It accounts for exposure to PCE vapors for 350 days per year over the thirty-year time period and lower body weights of children. Exposure to PCE at this duration and frequency of exposure is expected to result in no more than 1 theoretical cancer case per 1,000,000 people.

Health Assessment

PCE was detected in air at levels above the carcinogenic screening value in 77% (23/30) of indoor samples collected and 60% (6/10) of the outdoor samples. Outdoor samples collected for this assessment are intended to distinguish between the concentration of PCE from domestic sources found inside the home and outdoor sources. The maximum detected concentration in indoor and outdoor air was 3.5 $\mu g/m^3$ and 1.3 $\mu g/m^3$, respectively. The data range for indoor and outdoor air was 0.15-3.5 $\mu g/m^3$ and 0.01-1.3 $\mu g/m^3$ with mean values of 1.04 and 0.50 $\mu g/m^3$, respectively.

The maximum detected concentration of PCE in indoor air can be directly applied to the RBC, or screening value, to evaluate theoretical cancer risks without calculating exposure doses. For example, 3.5 $\mu g/m^3$ is divided by the RBC of 0.31 $\mu g/m^3$ and then multiplied by the 10^{-6} cancer risk level [(3.5 / .31) * 10^{-6}]. In this case, the theoretical cancer risk level is equivalent to 1.1 * 10^{-5}, which indicates that no more than 11 excess cancer cases out of 1 million would be expected to occur under these exposure conditions (Duration = 30 yrs., Frequency = 350 days/year). The estimated theoretical excess cancer risk for each house is shown in Table 1.

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. All measured indoor air concentrations in this assessment are below the CDPHE risk management action level of 5*10^{-5}. The 2001 data used in this assessment does not appear to represent a significant long-term carcinogenic health risk because of the past and current groundwater remediation underway within the Widefield Aquifer. The PCE concentration has declined significantly in groundwater, which reduces the concentration in indoor air. This assessment also used conservative assumptions of exposure, which likely overestimate the risk to anyone individual.

In addition, the concentrations of PCE found in this assessment are similar to background levels observed in other areas of Colorado. Several domestic products contain PCE, which contribute to low background levels found almost ubiquitously in the ambient air. Other industrial sources such as dry-cleaning facilities also contribute small amounts of PCE to the ambient air. Background levels of PCE have been established through indoor air sampling at two sites in Colorado (Redfield Rifle Scopes site and CDOT's Materials Testing Laboratory). The mean background concentration of PCE found in residential homes near these sites was 1.12 and 1.62 $\mu g/m^3$ with a 95% Upper Confidence Level of the mean of 2.22 and 2.23 $\mu g/m^3$, respectively (Kurtz and Folkes, 2002). In comparison, the mean concentration of PCE found in buildings in this assessment is 1.04 $\mu g/m^3$ with a 95% UCL of 1.37 $\mu g/m^3$.

Noncarcinogenic health risks generally require larger doses to experience adverse health effects when compared to long-term, low dose carcinogenic exposures. The ATSDR's

MRL for chronic inhalation exposures to PCE is 300 $\mu g/m^3$. Therefore, noncarcinogenic adverse health effects are unlikely to occur.

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. 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.

The unique susceptibility of children to adverse health effects to PCE exposure was considered in this assessment. The Risk-Based Concentration that was utilized accounts for time-weighted early life exposures through the age of 30. No special adverse health effects were observed for children.

Conclusions

Individuals living in the Security-Widefield community have been exposed to low levels of PCE in indoor air in the past. However, the PCE concentrations found in this assessment are not likely to result in a significant increase in either theoretical carcinogenic risks or potential noncarcinogenic adverse health effects. The PCE plume in this area is currently under remediation and the concentration of PCE in the Widefield Aquifer appears to be decreasing. Thus, it is unlikely that the indoor air pathway will be significant in terms of public health hazards in the future. As such, the indoor air pathway is considered to represent no apparent public health hazard for all past (2000-present), current, and future exposures. Past exposures prior to the first indoor air sampling conducted in 2000, are considered indeterminate public health hazard because no indoor air data are available for review. For a description of ATSDR's Public Health Hazard Categories, please see Appendix A.

Recommendations

Based on the information and conclusions within this document, CDPHE's Environmental Epidemiology Section (EES) makes the following recommendation to reduce or eliminate exposure to PCE from the indoor air pathway:

CDPHE's HWWMD and Schlage Lock Company should continue with the remediation and removal of PCE from the Widefield Aquifer, which is already in progress to further decrease the concentration of PCE in groundwater.

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 indoor air exposures to PCE in the Security-Widefield community:

- 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.

- By request, EES will evaluate any additional indoor air 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.

- EES will publish a public health consultation on exposures to PCE in private residential wells as part of the overall health evaluation of the Schlage Lock site.

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

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Tables and Figures

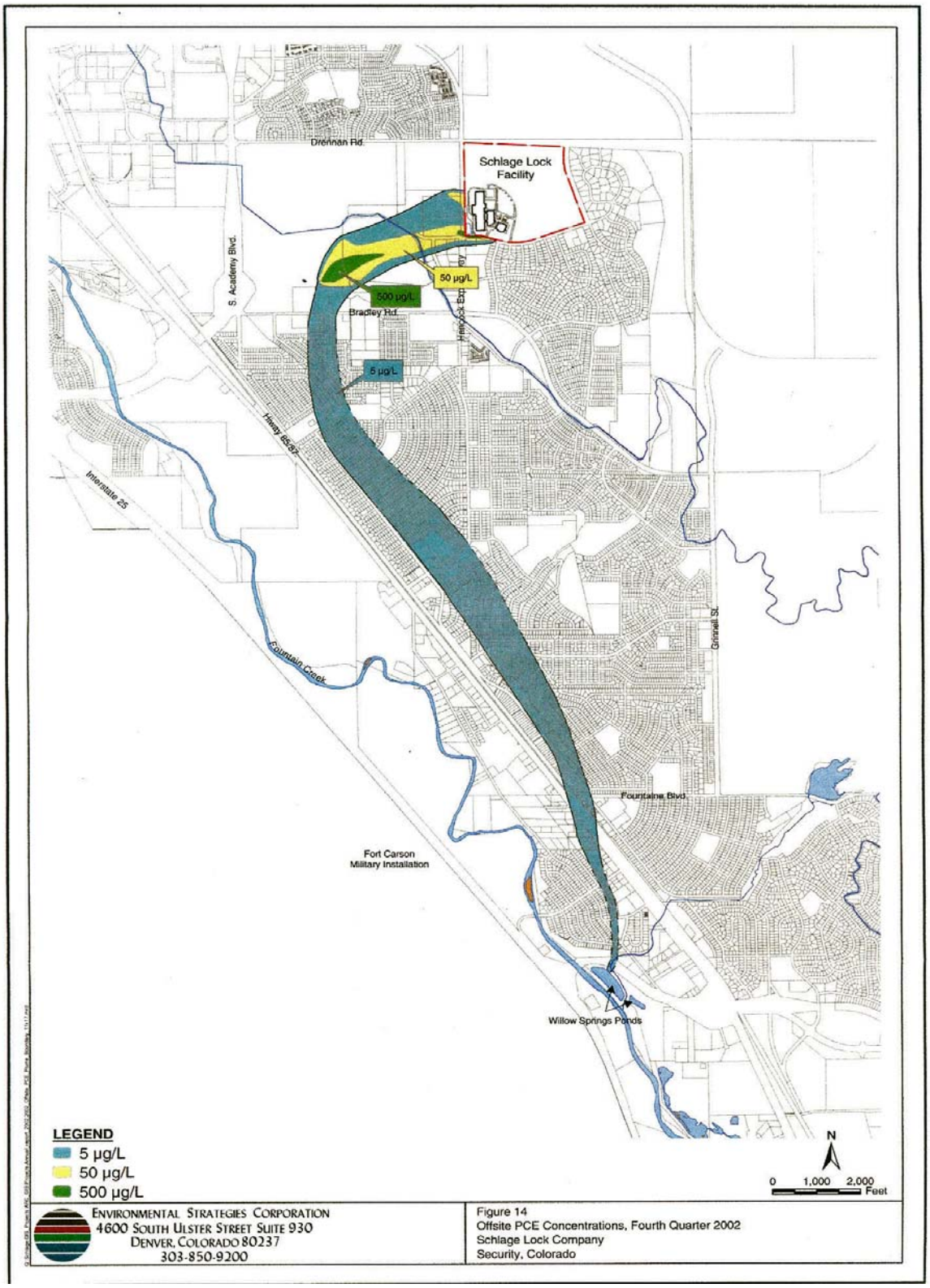
Table 1. Security-Widefield Air Sampling Results and Theoretical Cancer Risks

Building	Location	Date	Sample Duration	PCE Conc. ($\mu g/m^3$)	Theoretical Cancer Risk
House 1	W. Bedroom	Mar. 2000	24 hr. Duplicate	0.82	2.6 E –06
	W. Bedroom	Mar. 2000	24 hr. Duplicate	0.85	2.7 E –06
House 2	S. Bedroom	Mar. 2000	24 hr. Duplicate	0.3	9.7 E –07
	S. Bedroom	Mar. 2000	24 hr. Duplicate	0.27	8.7 E –07
House 3	NW Bedroom	Mar. 2000	24 hr.	2.24	7.2 E –06
	NW Bedroom	Oct. 2000	10 min. (i)	2.64	8.5 E –06
	NW Bedroom	Oct. 2000	24 hr.	2.59	8.4 E –06
	NW Bedroom	Oct. 2000	10 min. (f)	1.38	4.4 E –06
House 4	SE Bedroom	Mar. 2000	24 hr.	0.31	4.8 E –07
	Outdoors	Mar. 2000	24 hr.	0.95	2.2 E –07
House 5	NW Bedroom	Mar. 2000	24 hr.	0.15	4.8 E –07
House 6	Downstairs Bedroom	Mar. 2001	7 min. (i)	1.92	6.2 E –06
	Downstairs Bedroom	Mar. 2001	24 hr.	1.07	3.4 E –06
	Downstairs Bedroom	Mar. 2001	3 min. (f)	0.72	2.2 E –06
	Outdoors	Mar. 2001	24 hr. **	0.94	1.6 E –07
House 7	Downstairs Bedroom	May 2001	24 hr. Duplicate	0.81	2.6 E –06
	Downstairs Bedroom	May 2001	24 hr. Duplicate	0.94	3.0 E –06
	Downstairs Bedroom	May 2001	3 min. (f)	0.72	2.3 E –06
	Downstairs Bedroom	May 2001	7 min. (i)	0.24	7.7 E –07
	Outdoors	May 2001	24 hr.	0.49	1.6 E –06
House 8	Crawl Space	May 2001	Grab (i)	0.46	1.5 E –06
	Crawl Space	May 2001	24 hr.	0.9	2.9 E –06
	Crawl Space	May 2001	Grab (f)	0.74	2.4 E –06
	Outdoor	May 2001	24 hr.	0.78	2.5 E –06
House 9	Downstairs Bedroom	May 2001	Grab (i)	3.53	1.1 E –05
	Downstairs Family Rm.	May 2001	Grab (f)	1.99	6.4 E –06
	Downstairs	May 2001	24 hr.	2.51	8.1 E –06
	Outdoor	May 2001	24 hr.	0.61	2.0 E –06
House 10	Basement Laundry Rm.	May 2001	7 min. (i)	0.21	6.8 E -07
	Basement Laundry Rm.	May 2001	24 hr.	0.71	2.3 E –06
	Basement Laundry Rm.	May 2001	3 min. (f)	0.37	1.2 E –06
	Outdoor	May 2001	24 hr.	1.31	4.2 E –06
North Elementary School	Nurse Room	May 2001	10 min. (i)	0.17	5.5 E –07
	Nurse Room	May 2001	10 min. (i)	0.17	5.5 E –07
	Nurse Room	May 2001	8 hr.	0.84	2.7 E –06
	Nurse Room	May 2001	10 min. (f)	0.86	2.8 E –06

	Rooftop	May 2001	8 hr.	0.76	2.4 E –06

(i) – Initial grab sample
(f) – Final grab sample
* All sample concentrations were adjusted for the temperature and pressure reported on the field sample sheet
** Rain froze on sampler inlet overnight

Figure 1. Approximation of PCE plume in the Widefield Aquifer (based on 2002 data)



Appendices

Appendix A: ATSDR Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
A. Urgent Public Health Hazard 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.	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.	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.
B. Public Health Hazard 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.	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.	**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.**
C. Indeterminate Public Health Hazard **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.**	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.	**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.**
D. No Apparent Public Health Hazard 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.	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.	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.
E: No Public Health Hazard **This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.**	**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**	

Appendix B: 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 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, 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 Schlage Lock 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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