

# Health Consultation

Indoor Air Quality Assessment  
Buckle My Shoe Early Learning Center  
Frank Wear Cleaners Site  
Yakima, Yakima County, Washington

January 4, 2012

**Prepared by**

**The Washington State Department of Health  
Under a Cooperative Agreement with the  
Agency for Toxic Substances and Disease Registry**



## Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to releases of hazardous substances. This report was supported by funds from the Comprehensive Environmental Response, Compensation, and Liability Act through a cooperative agreement with ATSDR. It was completed in accordance with approved methodologies and procedures existing at the time the health consultation was initiated. However, it has not been reviewed and cleared by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

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For people with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TTY/TDD call 711).

For more information about ATSDR, contact the CDC Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's Web site: [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov).

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## Summary

### Introduction:

At the request of the Washington Department of Ecology (Ecology), the Washington Department of Health (DOH) reviewed indoor air chemical data collected by Ecology at the Buckle My Shoe Early Learning Center, which operates as a childcare center in Yakima, Washington. The childcare center is located adjacent to the former Frank Wear Cleaners property where a release of the dry cleaning chemical, tetrachloroethylene (commonly known as „Perc” or PCE) occurred sometime in the past to soil and groundwater. Other dry cleaning related chemicals may have also been released. The purpose of the review was to determine whether the concentration of chemicals found by Ecology during indoor air testing at the childcare center on September 25 and October 20, 2011 pose a health threat to children and adults at the facility.

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### Conclusion:

DOH concludes that breathing the maximum concentrations of chemicals found in indoor air at the Buckle My Shoe Early Learning Center for approximately one year, while Ecology takes steps to clean up the nearby portion of the Frank Wear Cleaners site, is not expected to harm the health of children or adults.

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### Basis for decision:

The amounts of chemicals found in indoor air are well below concentrations expected to cause harmful non-cancer health effects. Additionally, the amounts pose an insignificant increased theoretical cancer risk. Actual cancer risks could be as low as zero.

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### Next steps:

1. DOH will mail the final health consultation report to Ecology, Yakima Health District, Washington Department of Early Learning, and the Buckle My Shoe Early Learning Center operator.
  2. DOH will post the health consultation report on its web site. The report will also be posted on Agency for Toxic Substances and Disease Registry’s web site.
  3. DOH will provide fact sheets summarizing the health consultation report findings to Ecology, Yakima Health District, Washington Department of Early Learning, and the Buckle My Shoe Early Learning Center operator when the final health consultation is released.
  4. Ecology will conduct multiple indoor sampling events at the Buckle My Shoe Early Learning Center after the soil vapor extraction (SVE) system is operational in early 2012.
  5. DOH will evaluate future indoor air data to determine if harmful health effects are possible.
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### For More Information:

Please contact Barbara Trejo at 360-236-3373 or 1-877-485-7316 if you have any questions about this health consultation.

## Glossary

<b>Acute</b>	Occurring over a short time [compare with <b>chronic</b> ].
<b>Agency for Toxic Substances and Disease Registry (ATSDR)</b>	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
<b>Aquifer</b>	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
<b>Cancer Risk Evaluation Guide (CREG)</b>	The concentration of a chemical in air, soil, or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
<b>Cancer Slope Factor (CSF)</b>	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
<b>Carcinogen</b>	Any substance that causes cancer.
<b>Chronic</b>	Occurring over a long time (more than 1 year) [compare with <b>acute</b> ].
<b>Comparison Value (CV)</b>	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
<b>Contaminant</b>	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
<b>Dose (for chemicals that are not radioactive)</b>	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

<b>Environmental Media Evaluation Guide (EMEG)</b>	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a comparison value used to select contaminants of potential health concern and is based on ATSDR's minimal risk level (MRL).
<b>Environmental Protection Agency (EPA)</b>	United States Environmental Protection Agency.
<b>Exposure</b>	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
<b>Groundwater</b>	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
<b>Hazardous Substance</b>	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
<b>Ingestion</b>	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
<b>Inhalation</b>	The act of breathing. A hazardous substance can enter the body this way [see <b>route of exposure</b> ].
<b>Media</b>	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
<b>Minimal Risk Level (MRL)</b>	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see <b>reference dose</b> ].
<b>Monitoring Wells</b>	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
<b>Organic</b>	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.

<p style="text-align: center;"><b>Plume</b></p>	<p>A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.</p>
<p style="text-align: center;"><b>Route of Exposure</b></p>	<p>The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].</p>
<p style="text-align: center;"><b>Surface Water</b></p>	<p>Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with <b>groundwater</b>].</p>
<p style="text-align: center;"><b>Volatile Organic Compound (VOC)</b></p>	<p>Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.</p>

## Summary and Statement of Issues

At the request of the Washington Department of Ecology (Ecology), the Washington Department of Health (DOH) reviewed indoor air chemical data collected by Ecology at the Buckle My Shoe Early Learning Center, which operates as a childcare center in Yakima, Washington. The childcare center is located adjacent to the former Frank Wear Cleaners property where a release of the dry cleaning chemical, tetrachloroethylene (commonly known as „Perç” or PCE) occurred sometime in the past to soil and groundwater. Other dry cleaning related chemicals may have also been released. The purpose of the review was to determine whether the concentration of chemicals found by Ecology during indoor air testing at the childcare center on September 25 and October 20, 2011 pose a health threat to children and adults at the facility. DOH conducts health consultations in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR).

## Background

The former Frank Wear Cleaners property is located at 106 South Third Avenue in a commercial area in Yakima, Yakima County, Washington. The property is currently vacant. Dry cleaning operations occurred on the property from the early 1940s to 2000. It is unknown how the property was used prior to 1940. Stoddard solvent, a petroleum mixture, was reportedly used as a dry cleaning fluid until sometime in the 1970s when the business switched to using PCE. It is unknown how the Stoddard solvent wastes were handled or whether releases occurred. However, it is reported that until 1985, the PCE sludges generated during the dry cleaner operation were spread on the gravel parking area located west of the building. After that, sludges were reportedly transported to a Safety-Kleen recycling facility. It is also reported that leaks, spills, and overflow of PCE occurred at the cleaner property and likely discharged outside the building via floor drains and sumps.(1)

Groundwater at the Frank Wear Cleaners site is predominantly contaminated with PCE. The PCE groundwater plume reportedly flows from the former dry cleaner property to the south/southeast, traveling under the Buckle My Shoe Early Learning Center. The extent of the plume is currently unknown, but Ecology is working to define it. The highest detected PCE concentration at the site (43,500 micrograms per liter ( $\mu\text{g}/\text{l}$ )) was found at monitoring well MW-10, which is located just north of the Buckle My Shoe Early Learning Center building.

The Buckle My Shoe Early Learning Center is located directly south of the former dry cleaner property at 108 South Third Avenue. The childcare center reportedly began operation in July 2011 (personal communication between Dick Bassett, Ecology and Barbara Trejo, DOH on December 16, 2011). Typically occupants of the childcare care center are in the building nine hours a day, five days a week.(2)

The structure occupied by the childcare center was built in the 1920s.(2) A furniture repair business is the earliest recorded use of the building. In approximately 2007, a children’s bookstore operated in the building.(1) The building is serviced by city water.(2) When Ecology learned in 2011 that the building had recently been occupied by the childcare center, they began plans for testing soil gas below the building (i.e., sub-slab), indoor air, and nearby outdoor air because of the contaminated



soil and groundwater under the building. Ecology inspected the building for visible cracks or other opening in the concrete slab. However, none were noted (personal communication between Dick Bassett, Ecology and Barbara Trejo, DOH on October 21, 2011).

Two rounds of indoor air testing were conducted. The first round occurred on September 25, 2011, when the Buckle My Shoe Early Learning Center building was unoccupied. Consumer products that could potentially affect indoor air quality were reportedly removed three days in advance of the sampling. Windows and doors were shut, use of fans was suspended, and the heating, ventilating, and air conditioning (HVAC) system was turned off during the indoor air testing. Three sub-slab, two outdoor air, and four indoor air samples were collected using Summa canisters. Outdoor temperatures during the September testing ranged from 50 degrees (°) Fahrenheit (F) to approximately 75° F; winds were reportedly calm. The sub-slab samples were collected for one hour while the indoor and outdoor air samples were collected for approximately 24-hours. Two sub-slab samples were collected below a 24-inch concrete slab while the third was collected below a 5-inch concrete slab. One outdoor air sample was collected away from the building; the other was near monitoring well MW-10. Two of the four indoor air samples were collected on the floor where children nap or play. The other samples were collected in the breathing space (3 to 5 feet above the floor).(2)

On October 20, 2011, a second round of indoor air testing was done. Outdoor temperatures during the October testing ranged from 50° F to approximately 70° F; winds were reportedly light.(2) Four 12-hour indoor air samples were collected when the building was occupied. The testing was done at the same locations used in September. However, the sample containers in the child use areas were raised off the floor to prevent the children from playing with them.(2) The HVAC system and fans were operating during the testing (personal communication between Dick Bassett, Ecology and Barbara Trejo, DOH on December 7, 2011). Windows were opened prior to the testing but were closed before the sampling began.(2)

Some chemicals had been stored in the building (e.g., paints, adhesives, cleaners, and disinfectants), but most were removed prior to the indoor air testing. However, adhesives and bottles of bleach were observed in the building during the September testing (2) and bleach was reportedly used by the childcare operator as a cleaning solution during the October testing (personal communication, Dick Bassett, Ecology and Barbara Trejo, DOH in October 2011).

Soil gas, outdoor air, and indoor air samples were analyzed for ten chemicals (as a group these ten chemicals will be referred to as volatile organic compounds or VOCs) based on nearby contaminated soil and groundwater results.(2) Table 1 summarizes the chemicals tested along with the sub-slab and indoor air results.

Table 1: Buckle My Shoe Early Learning Center, Yakima, Washington - September 25 and October 20, 2011 Building and Outdoor Air Results

Chemical	09/25/2011 Sub-slab Soil Gas Concentration Range (ug/m <sup>3</sup> ) <sup>a</sup>	09/25/2011 Outdoor Air Concentration Range (ug/m <sup>3</sup> )	09/25/2011 Maximum Indoor Air Concentration (ug/m <sup>3</sup> )	10/20/2011 Maximum Indoor Air Concentration (ug/m <sup>3</sup> )
Tetrachloroethylene (PCE)	3,600 – 50,000	<0.23 - <0.25	6.6	6.5
Chloroform	7.5 - 27	<0.84 - <0.90	1.4	2.9
trans-1,3-Dichloropropene	< 4.6 <sup>b</sup>	<0.78 - <0.84	<0.95	<0.82
Chlorobenzene	<4.7	<0.79 - <0.85	<0.96	<0.83
1,2-Dichlorobenzene	<12	<1.0 - <1.1	<1.2	<1.1
1,1,1,2-Tetrachloroethane	<7	<5.9 - <6.3	<7.2	<6.2
cis-1,2-Dichloroethene	<4	<0.14	<0.16	<0.14
1,1,1-Trichloroethane	<5.5	<0.19 - <0.20	<0.23	<0.20
1,2-Dichloroethane	<4.1	<0.14 - <0.15	0.15	<0.15
Trichloroethylene (TCE)	<5.5	<0.18 - <0.20	0.27	0.086

<sup>a</sup> micrograms per cubic meter

<sup>b</sup> < - less than the reporting limit

DOH reviewed the indoor air data from the Buckle My Shoe Early Learning Center when it became available in October and November 2011 and verbally informed Ecology that the levels did not pose an immediate threat. DOH also assisted Ecology with the development of health messages, which were used to educate the Buckle My Shoe Early Learning Center operators and the parents of the children attending the center.

Ecology is currently in the process of designing a soil vapor extraction (SVE) system, which is intended to significantly reduce or eliminate the VOC vapors below the Buckle My Shoe Early Learning Center building and the surrounding area. Ecology had hoped that the system would be operating by late 2011. However, more work will be needed before the system can be installed and begin operation. Recent discussions with Ecology indicate the SVE system should begin operating in early 2012 (personal communication between Dick Bassett, Ecology and Barbara Trejo, DOH on December 2, 2011).

## Discussion

The soil gas, outdoor air, and indoor air data collected by Ecology in September and October 2011 suggest that a small amount of soil gas contaminated with VOCs, like PCE and chloroform, could be moving into indoor air at the Buckle My Shoe Early Learning Center.

As shown in Table 1, PCE and chloroform were the only chemicals found in soil gas above the reporting limit. PCE and chloroform in indoor air were found at concentrations higher than outdoor air suggesting that the chemicals in soil gas below the building could be contributing to the levels in indoor air. TCE and 1,2-dichloroethane were also found in indoor air. However, the concentrations

of these two chemicals are similar to the levels found in outdoor air. This suggests a source other than soil gas may be contributing to the amount of these two chemicals in indoor air. None of the remaining chemicals were detected above the reporting limit in soil gas or indoor air.

Whether the soil gas below the building is the only potential source of PCE and chloroform found in indoor air at the Buckle My Shoe Early Learning Center is uncertain. This is due to the fact that adhesives, which can contain PCE, and bleach, a source of chloroform, were stored in the building during the September and October testing (see background section for details). The building is also serviced by city water, which reportedly is chlorinated and a source of low concentrations of chloroform.(2) Additionally, bleach was used by the childcare center staff for cleaning during the October testing.

### *Exposure Pathways*

Exposure to VOCs in indoor air can occur when someone breathes in the chemicals. However, if someone is exposed there are many factors that determine if the exposure will cause health effects. These factors include the dose (how much), the duration (how long), and how someone comes in contact with the chemicals (breathing in the chemical). A person's age and the number of chemicals they are exposed to are a few other factors.

Inhalation of VOCs is the only expected route of exposure at the Buckle My Shoe Early Learning Center. Exposures to VOCs, if coming from the soil gas, are expected to be eight to nine months because the learning center began operation in July 2011 and Ecology is planning to install a SVE system in early 2012. The SVE system is expected to significantly reduce or eliminate the vapors below the building within a week of startup, resulting in a drop of indoor air VOC concentrations (personal communication between Dick Bassett, Ecology and Barbara Trejo, DOH on December 16, 2011). However, because there is some uncertainty about the exact timing of when the SVE system will be in operation (early 2012), DOH conservatively assumed that inhalation exposures associated with the contaminated soil gas could occur up to one year.

### *Contaminants of Concern*

To begin evaluating the potential health effects associated with exposure to VOCs in indoor air, DOH compared the highest amount of each chemical found in the indoor air samples to both cancer and non-cancer health comparison values. This comparison allows DOH to determine if these chemicals might be of health concern to the children and adults at the Buckle My Shoe Early Learning Center. These health comparison values are set at concentrations much lower than amounts that might cause people to get sick. This is done to be protective of the most sensitive individuals (i.e., children and older adults), as well as to account for the general lack of certainty regarding low levels of chemical exposure.

The cancer and non-cancer health comparison values for air, used by DOH, included the ATSDR Cancer Risk Evaluation Guides (CREGs) and the intermediate Environmental Media Evaluation Guides (EMEGs), or chronic EMEG, when an intermediate EMEG was not available. The air CREG is the concentration of a chemical in air that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. An intermediate EMEG is the amount of chemical in air below which non-cancer health effects are not expected to occur if someone was

exposed 24-hours a day for 15 to 365 days. A chronic EMEG is used if someone were exposed 365 days and longer. Table 2, below, provides a comparison of the maximum indoor air concentration with ATSDR EMEGs and CREGs.

As shown in Table 2, the maximum amount of VOCs detected during the September and October 2011 indoor air testing are well below the non-cancer comparison values. As a result, no further assessments of the non-cancer health effects associated with the VOCs is necessary. The maximum amount of PCE; chloroform; trans-1,3-Dichloropropene; 1,1,1,2-Tetrachloroethane; and 1,2-Dichloroethane, however, did exceed the ATSDR cancer comparison value (i.e.,CREG).<sup>a</sup> As a result, further assessment of the carcinogenic health threats posed by these chemicals is needed. It is important to understand that exceeding the cancer comparison value does not imply that people will develop cancer when exposed to these levels. A more complete discussion of cancer risk follows.

Table 2: Buckle My Shoe Early Learning Center, Yakima, Washington - Comparison of Indoor Air Results with ATSDR Comparison Values

Chemical	EPA Cancer Class	09/26/2011 Maximum Indoor Air Concentration (ug/m <sup>3</sup> ) <sup>a</sup>	10/20/2011 Maximum Indoor Air Concentration (ug/m <sup>3</sup> )	Comparison Value (ug/m <sup>3</sup> )	Comparison Value Reference	Contaminant of Concern (COC)
PCE	C	6.6	6.5	300 0.2	EMEG <sup>b</sup> CREG <sup>c</sup>	No <b>Yes</b>
Chloroform	LI	1.4	2.9	200 0.04	Int EMEG <sup>d</sup> CREG <sup>c</sup>	No <b>Yes</b>
trans-1,3-Dichloropropene	KL	<0.95	<0.82	40 0.3	Int EMEG <sup>d</sup> CREG <sup>c</sup>	No <b>Yes</b>
Chlorobenzene	D	<0.96	<0.83	1000*	Int EMEG <sup>d</sup>	No
1,2-Dichlorobenzene	D	<1.2	<1.1	1000*	Int EMEG <sup>d</sup>	No
1,1,1,2-Tetrachloroethane	C	<7.2	<6.2	0.1	CREG <sup>c</sup>	<b>Yes</b>
cis-1,2-Dichloroethene	IN	<0.16	<0.14	800**	Int EMEG <sup>d</sup>	No
1,1,1-Trichloroethane	IN	<0.23	<0.20	4000	Int EMEG <sup>d</sup>	No
1,2-Dichloroethane	B2	0.15	<0.15	2000 0.04	EMEG <sup>b</sup> CREG <sup>c</sup>	No <b>Yes</b>
Trichloroethylene (TCE)	CA	0.27	0.086	500 0.5	Int EMEG <sup>d</sup> CREG <sup>c</sup>	No No

<sup>a</sup> ug/m<sup>3</sup> – micrograms per cubic meter

<sup>b</sup> EMEG – ATSDR’s Environmental Media Evaluation Guides (child) – Non-cancer

<sup>c</sup> CREG – ATSDR’s Cancer Risk Evaluation Guides

<sup>d</sup> Int EMEG – ATSDR’s Intermediate Environmental Media Evaluation Guides (child) – Non-cancer

LI – EPA: Likely to be carcinogen to human

C – EPA: Possible human carcinogen (no human, limited animal studies)

KL – EPA: Known/Likely human carcinogen

\* - 1,4-Dichlorobenzene was used as a surrogate

\*\* - Trans 1,2-Dichloroethene was used as a surrogate

D – EPA: Not classified as to human carcinogenicity

IN – EPA: Inadequate information to assess carcinogenic potential

B2 – EPA: Probable human carcinogen (inadequate human, sufficient animal studies)

CA – EPA: Carcinogenic to humans

**Bold** – chemical is a contaminant of concern

<sup>a</sup> Although neither trans-1,3-dichloropropene nor 1,1,1,2-tetrachloroethane were detected above the reporting limit, DOH conservatively assumed half of the maximum reporting limit for evaluating inhalation cancer risk.

### *Chemical Specific Toxicity*

PCE is widely used for dry cleaning fabrics and is also used as a metals degreaser. It evaporates easily into the air. PCE contaminated soil and groundwater are possible sources of PCE found in indoor air if buildings are located near a PCE contaminated site. Dry cleaned clothes and consumer products like water repellents, silicone lubricants, fabric finishers, spot removers, adhesives, and wood cleaners are other possible sources of PCE in indoor air. The Environmental Protection Agency (EPA) classifies PCE as a possible human carcinogen based on limited animal studies. Human studies of PCE causing cancer have not been conclusive. However, PCE has been shown to cause liver tumors in mice and kidney tumors in male rats. (3)

Chloroform is generally used to make other chemicals and is also used as a fumigant for grain and as a dry cleaning spot remover.(4;5) Like PCE, chloroform evaporates easily. Small amounts of chloroform are produced as an unwanted product when chlorine is added to drinking water and can evaporate into indoor air. Bleach used for domestic cleaning and laundry is another source of chloroform in indoor air.(6) Chloroform contaminated soil and groundwater are also possible sources of chloroform found in indoor air if buildings are located near a chloroform contaminated site.(4) EPA has determined that chloroform is likely to be a human carcinogen based on oral exposure to chloroform. However, ATSDR found no studies regarding cancer in humans or animals after inhalation exposure to chloroform.(4)

Trans-1,3-dichloropropene is a component of 1,3-dichloropropene. 1,3-dichloropropene is used mainly in farming to kill tiny pests called nematodes that eat the roots of crops. It can be released to air at industrial facilities such petroleum refineries, sewage treatment facilities, and electricity-generating power facilities and also during its use as a fumigant. 1,3-dichloropropene contaminated soil or groundwater at hazardous waste sites is another possible source. EPA classifies 1,3 dichloropropene as a known or likely human carcinogen. ATSDR reports that a human study conducted in three agricultural areas suggests that exposure to 1,3-dichloropropene could be a risk factor for pancreatic cancer. Some human cases studies also indicate that 1,3-dichloropropene could cause cancer in humans. An animal study has also shown increased incidence of lung tumors in male rats after inhaling a high concentration of 1,3-dichloropropene.(7)

1,1,1,2-tetrachloroethane is used as a solvent and in the manufacturing of insecticides, herbicides, soil fumigants, bleaches, paints, and varnishes. EPA classifies 1,1,1,2-tetrachloroethane as a possible human carcinogen based on limited animal studies. There is no data to suggest that 1,1,1,2-tetrachloroethane is carcinogenic to humans.(8)

1,2-Dichloroethane is used to make vinyl chloride, which is used to make plastic and vinyl products like polyvinyl chloride (PVC) pipes, packaging materials, plastic furniture, and upholstery. It is also used as a solvent and was added in the past to leaded gasoline to remove lead. EPA classifies 1,2-dichloroethane as a probable human carcinogen. Human studies of 1,2-dichloroethane causing cancer have been considered inadequate. However, animal studies have shown increases in stomach, mammary gland, liver, lung, and endometrial cancers.(9)

## Evaluating Cancer Risk

Some VOCs, like PCE and chloroform, have the ability to theoretically increase people's risk of developing cancer. Theoretical cancer risk is estimated by calculating a dose and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than those encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world exposures. This process involves much uncertainty.

Current risk assessment practice assumes there is no "safe dose" of a carcinogen. Any dose of a carcinogen will result in some additional theoretical cancer risk. Theoretical cancer risk estimates are not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat because any level of a carcinogenic contaminant carries an associated risk. The validity of the "no safe dose" assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. Recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise.(10)

<b>Theoretical Cancer Risk</b>		
Theoretical Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of cancer cases for the number of persons similarly exposed over a lifetime:		
<u>Term</u>	<u># of Excess Cancers</u>	
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

This document describes theoretical cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight, and no significant increase in theoretical cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, as shown in the box above, a low increase in cancer risk indicates a risk estimate in the range of 1 additional cancer case per 10,000 persons similarly exposed over a lifetime. A very low estimate might result in 1 additional cancer case per 100,000 similarly exposed persons over a lifetime and a slight estimate might result in 1 additional cancer per 1,000,000 similarly exposed persons. DOH considers theoretical cancer risk insignificant when the estimate results in less than 1 cancer per 1,000,000 similarly exposed persons over a lifetime.

Cancer is a common illness and its occurrence in a population increases with the age of the population. There are many different forms of cancer resulting from a variety of causes; not all are fatal. Approximately 1 in 3 to 1 in 2 people living in the United States will develop cancer at some point in their lives.(11)

To evaluate the inhalation cancer risk associated with PCE, chloroform, and 1,2-dichloroethane found in indoor air at the Buckle My Shoe Early Learning Center, DOH used the maximum detected concentration of each chemical. Neither trans-1,3-dichloropropene nor 1,1,1,2-tetrachloroethane were detected above the laboratory reporting limits. However, because reporting limits are never zero, DOH conservatively used half of the maximum reporting level for evaluating inhalation cancer risks associated with these two chemicals. Because the childcare center first opened in July 2011 and Ecology intends to remediate the contaminated soil gas below the building in early 2012, DOH conservatively assumed exposures would occur for approximately one year. Specifically, DOH conservatively assumed that exposures would be 50 weeks out of the year (2 weeks were allowed for vacations away from the learning center), 5 days per week, and 12 hours per day.

Appendix A contains the formula, input parameters, and results of DOH's estimated theoretical cancer risk evaluation for PCE and chloroform found in indoor air. As noted in Appendix A, Table A2, DOH estimated the following approximate cancer risks for children, older children, and adults similarly exposed over a lifetime to the maximum amount of PCE and chloroform found in indoor air at the Buckle My Shoe Early Learning Center:

- 8 additional cancer cases per 10,000,000 (ten million) similarly exposed children.
- 5 additional cancer cases per 10,000,000 similarly exposed older children.
- 3 additional cancer cases per 10,000,000 people similarly exposed adults.

**When compared to the cancer risk terms provided in the box above, these estimated cancer risks are considered insignificant.** It is important to note that these estimates are for excess cancers that might result, in addition to, those normally expected in an unexposed population. It is also important to note that these are theoretical risk estimates and the actual risk could be as low as zero.

## Child Health Considerations

The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur at levels much lower than those causing other types of toxicity. The following factors contribute to this vulnerability:

- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing bodies or systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may occur.

Children's health was considered during this health consultation and the exposure scenarios treated children as the most sensitive population being exposed. Based on DOH's comparison of the highest indoor air concentration to conservative non-cancer comparison values, adverse non-cancer health effects are not expected at the Buckle My Shoe Early Learning Center. The cancer risk evaluation found that exposure to PCE; chloroform; trans-1,3-Dichloropropene; 1,1,1,2-Tetrachloroethane; and 1,2-Dichloroethane at the maximum indoor air concentrations for approximately one year posed an insignificant theoretical cancer risk.

## **Conclusions**

DOH concludes that breathing the maximum concentrations of VOCs found in indoor air at the Buckle My Shoe Early Learning Center for approximately one year is not expected to harm the health of children or adults, while Ecology takes steps to clean up the nearby portion of the Frank Wear Cleaners site. This is because the concentrations of VOCs found in indoor air are well below what is expected to cause harmful non-cancer health effects and only present an insignificant increased theoretical cancer risk. Actual risks could be as low as zero.

## **Recommendations**

Although the PCE and chloroform found in indoor air at Buckle My Shoe Early Learning Center in September and October 2011 are not expected to cause harmful health effects, DOH recommends that Ecology continue monitoring indoor air at the Buckle My Shoe Early Learning Center to ensure that the VOCs associated with the Frank Wear site, like PCE and chloroform, do not increase in the future. The occurrence and frequency of the Ecology indoor air testing and type of analysis should be based on site specific conditions (e.g., changes in subsurface conditions (e.g., increases or decreases in soil gas, soil, or groundwater contaminant concentrations) and operation of the soil vapor extraction system).

## **Public Health Action Plan**

1. DOH will mail the final health consultation report to Ecology, Yakima Health District, Washington Department of Early Learning, and the Buckle My Shoe Early Learning Center operator.
2. DOH will post the health consultation report on its web site. The report will also be posted on ATSDR's webpage.
3. DOH will provide fact sheets summarizing the health consultation report findings to Ecology, Yakima Health District, Washington Department of Early Learning, and the Buckle My Shoe Early Learning Center operator when the final health consultation is released.
4. Ecology will conduct multiple indoor sampling events at the Buckle My Shoe Early Learning Center after the SVE system is operational in early 2012.
5. DOH will evaluate future indoor air data to determine if any changes in indoor air quality have occurred and harmful health effects are possible.



## **Report Preparation**

This Health Consultation for the Frank Wear Cleaners site in Yakima, Washington was prepared by the Washington Department of Health (DOH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner (DOH).

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## Appendix A

This section provides the formula and assumptions used for determining the estimated increased cancer risk associated with a child (0-5 years), an older child, and an adult inhaling the maximum concentration of PCE and chloroform found in indoor air at the Buckle My Shoe Early Learning Center in Yakima, Washington.

$$\text{Estimated increased cancer risk} = \frac{\text{Ca} \times \text{IR} \times \text{EF} \times \text{ED} \times \text{CSF}}{\text{BW} \times \text{AT}}$$

Table A1: Exposure assumptions used to estimate the increased cancer risk associated with maximum concentration of PCE and chloroform found in indoor air at the Buckle My Shoe Early Learning Center, Yakima, Washington.

Parameter	Value	Unit	Comments
Concentration (Ca)	Variable	mg/m <sup>3</sup>	Maximum detected value PCE = 0.0066 Chloroform 0.0029 1,2-Dichloroethane = 0.00015 trans-1,3-Dichloropropene = 0.000475 1,1,1,2-Tetrachloroethane = 0.0036
Inhalation Rate (IR) – child	8.3	m <sup>3</sup> /day	Exposure Factors Handbook (12)
Inhalation Rate (IR) - older child	14		
Inhalation Rate (IR) - adult	15		
Exposure Frequency (EF)	250	days/year	5 days a week with a two week vacation
Exposure Duration (ED)	0.5	years	Maximum half day exposure for 250 days per year
Body Weight (BW) - child	15	kg	0-5 year-old child average body weight (12)
Body Weight (BW) - older child	41		Older child mean body weight (12)
Body Weight (BW) - adult	72		Adult mean body weight (12)
Averaging Time <sub>cancer</sub> (AT)	27375	days	75 years
Inhalation Cancer Slope Factor (CSF)	Variable	mg/kg-day <sup>-1</sup>	PCE = 0.021 (13) Chloroform = 0.019 (14) 1,2-Dichloroethane = 0.091 (15) trans-1,3-Dichloropropene = 0.014 (15) 1,1,1,2-Tetrachloroethane = 0.026 (15)

Table A2: Estimated increased theoretical cancer risk associated with PCE and chloroform found in indoor air at the Buckle My Shoe Early Learning Center, Yakima, Washington.

Chemical	Cancer Risk		
	Child	Older Child	Adult
PCE	3.5E-07	2.2E-07	1.3E-07
Chloroform	1.4E-07	8.6E-08	5.3E-08
1,2-Dichloroethane	3.5E-08	2.1E-08	1.3E-08
trans-1,3-Dichloropropene	1.7E-08	1.0E-08	6.4E-09
1,1,1,2-Tetrachloroethane	2.4E-07	1.5E-07	9.0E-8
Total Cancer Risk	7.8E-07	4.9E-07	2.9E-07