

Health Consultation

Fruit Valley Neighborhood – Residential Indoor Air Test Results
Cadet Manufacturing and Former Swan Manufacturing Sites
Vancouver, Clark County, Washington

December 4, 2007

Prepared by

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



DOH 334-143 December 2007

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 hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed 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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Glossary

Acute	Occurring over a short time [compare with chronic].
Agency for Toxic Substances and Disease Registry (ATSDR)	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.
Cancer Risk Evaluation Guide (CREG)	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).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with acute].
Comparison value	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.
Contaminant	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.
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. 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.
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Exposure	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].

Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	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 reference dose].
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
No Observed Adverse Effect Level (NOAEL)	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Plume	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.
Route of exposure	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].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as trichloroethylene, tetrachloroethylene, benzene, toluene, and vinyl chloride.

Summary and Statement of Issues

Past releases of solvents at the former Swan Manufacturing Company (Swan) and the Cadet Manufacturing Company (Cadet) sites have resulted in plumes of solvent contaminated groundwater underlying a portion of the Fruit Valley neighborhood, located in Vancouver, Clark County, Washington. Much of the Fruit Valley neighborhood underlain by the plume is in a residential area. The location of the two sites and the approximate boundaries of the residential area underlain by the solvent contaminated groundwater are shown on Figure 1.

Figure 1 – Cadet/Swan Sites and Approximate Boundaries of the Fruit Valley Neighborhood Residential Area underlain by Solvent Contaminated Groundwater



Residents of the Fruit Valley neighborhood get their drinking water from the City of Vancouver. This drinking water is not affected by the contamination from the Cadet or Swan sites. Although residents are not drinking the contaminated groundwater, environmental studies conducted by Cadet and the Port of Vancouver (Port), which are being monitored by the Washington Department of Ecology (Ecology), show that solvents found in shallow groundwater are evaporating and moving up through the soil and entering some neighborhood homes. Based on indoor air testing, however, the solvents, when entering homes, are low and often similar to levels found in outdoor air. A small amount of the solvents might also be entering outdoor air.

However, outdoor testing suggests that if this is happening, the solvents are quickly mixing with outdoor air and becoming diluted.

The Washington State Department of Health (DOH) has been reviewing the indoor air testing results for the Fruit Valley neighborhood since monitoring started in 2002. A health consultation report prepared by DOH in 2003 addressed the 2002 indoor air test results and summarized DOH's health findings.(1) DOH has also discussed its health findings at various community meetings and has talked with individual homeowners. DOH has also provided its health findings to Ecology, who has included this information in fact sheets and letters mailed to the community.

Because of ongoing community health concerns associated with the solvents found in indoor air, DOH has prepared this health consultation report to provide more information about what these low levels of solvents in indoor air mean to the health of the community. Much of this information was presented to the community during the March 6, 2007, public meeting held at the Fruit Valley Elementary School in Vancouver. DOH conducts health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

The Swan property is located just southwest of the intersection of Fourth Plain Boulevard and Mill Plain Boulevard in Vancouver (Figure 1). Electric heaters were manufactured at this property from 1956 to 1964. In 1964, the company moved its operation to 2500 Fourth Plain Boulevard, which is located northwest of the Swan property (Figure 1). In 1972, Swan sold the business to Cadet, who continues to produce electric heaters at the 2500 Fourth Plain Boulevard location. Both the Swan and Cadet properties are now owned by the Port.

Trichloroethylene (TCE), a solvent, was used by Swan and Cadet at both properties to clean metal heater parts before they were painted. This practice reportedly stopped sometime after Cadet took over the business at the 2500 Fourth Plain Boulevard location. It had been reported that Cadet continued to use small amounts of TCE in its operation. However, this practice reportedly stopped within the last year. Spills or other types of releases of TCE, which is often contaminated with other solvents like tetrachloroethylene (also known as PCE), happened at both locations, resulting in solvent contaminated soils and groundwater below the two properties. The contaminated groundwater from both properties then moved eastward and became mixed below the portion of the Fruit Valley neighborhood south of Fourth Plain Boulevard. Some of the contaminated groundwater from the Cadet property also flowed north and northeast.

Air Testing

Because solvents can evaporate from shallow groundwater, move through spaces between the soil particles as contaminated soil gas, and enter indoor air in homes, indoor air testing began in the north part of the Fruit Valley neighborhood (the part of the neighborhood located north of Fourth Plain Boulevard) in 2002 in an area where the highest levels of solvents were found in groundwater. Sampling containers called Summa canisters were placed in basements, crawlspaces, and living spaces to test indoor air. Some basic information about the Summa canisters is provided in Appendix A. The Summa canisters were sent to an analytical laboratory

and the captured air was tested for 10 solvents that either had been found in the shallow groundwater in the neighborhood or are possible breakdown products of one of those solvents:

- 1,1,1 Trichloroethane
- 1,1 - Dichloroethane
- 1,1 - Dichloroethene
- Cis – 1,2 - Dichloroethene
- Trans -1,2 - Dichloroethene
- Trichloroethylene (TCE)
- Tetrachloroethylene (PCE)
- 1,2 - Dichloroethane
- Vinyl Chloride
- Chloroethane

There has been more indoor air testing in the north part of the Fruit Valley neighborhood since 2002 and testing was started in the southern part of the neighborhood (the part of the neighborhood located south of Fourth Plain Boulevard) in early 2006. Homes that were thought to be at the most risk were selected for testing. This included, for example, homes located over the part of the plume where the highest levels of solvents were found in the shallow groundwater, homes with basements with holes or cracks in the foundation and homes with closed crawlspace vents. Approximately 130 homes in the Fruit Valley Neighborhood were tested through February 2007, and some of those homes have been tested more than once. Some outdoor air samples were also collected and tested from areas above the groundwater solvent plumes as well as outside the plume boundaries.

Table 1 summarizes the range of solvents levels (i.e., lowest - highest levels) found in homes and outdoor areas across the Fruit Valley neighborhood during air testing from 2002 through February 2007. Numbers followed by “U” indicate that the chemical was not detected above that number. The laboratory reports it this way because it is not possible for them to accurately measure chemicals below these levels for a particular sample. Consequently, using this number could result in an overestimation of the indoor air level. Numbers followed by a “J” indicate the chemical was identified but the analytical laboratory was only able to estimate the value because it was below the level where they can accurately measure it.

Table 1: Indoor and Outdoor Air Solvent Ranges (2002 through February 2007)

Solvent Name	Range of Indoor Air Solvent Levels (ug/m ³)	Range of Outdoor Air Solvent Levels (ug/m ³)
1,1,1 Trichloroethane	0.039 - 68	0.038 - 0.56
1,1 – Dichloroethane	0.0024 -27U	0.0036 - 1.5U
1,1 – Dichloroethene	0.046 - 2.7	0.0039J - 0.083U
Cis – 1,2 – Dichloroethene	0.0035 – 27U	0.0073 - 1.5U
Trans -1,2 - Dichloroethene	0.0033 – 27U	0.005J - 1.5U
Trichloroethylene (TCE)	0.0075 - 95	0.0049 - 1.7
Tetrachloroethylene (PCE)	0.031 - 73	0.023J - 2.4
1,2 – Dichloroethane	0.015 – 27U	0.013 - 0.083U
Vinyl Chloride	0.0032 - 7.6U	0.0042J - 0.3
Chloroethane	0.012U - 27U	0.013J - 0.25

ug/m³ - micrograms of contaminant per cubic meter of air

U - Chemical not detected at the laboratory reporting limit

J – Chemical was detected above the method detection limit but below the reporting limit

Cleanup Activities

The Port and Cadet, under Ecology oversight via the Model Toxics Control Act (MTCA) cleanup regulation, have taken steps to clean up the site contamination. The Port has removed a significant amount of contaminated soil below the former Swan property where the solvent release occurred and has taken actions to try to clean up the contaminated groundwater associated with that release. Cadet and the Port have also taken steps to try to clean up groundwater associated with the Cadet site, which includes operating an air sparging/soil vapor extraction system below the Cadet property and a recirculating groundwater remediation well system below the northern part of the Fruit Valley neighborhood. All of this work has reduced solvent levels in groundwater. Cadet also installed soil vapor vacuum systems at homes where the highest levels of solvents have been found in indoor air. The Port is proposing to install a groundwater pump and treat system in late 2008, under Ecology oversight, to further clean up groundwater. It is expected that all of these cleanup activities will continue reducing indoor air solvent levels at potentially affected Fruit Valley neighborhood homes.

Discussion

Solvents were detected in indoor air at all of the approximately 130 tested homes in the Fruit Valley Neighborhood. Indoor air means air in the living space as well as the basement or crawlspace. In all cases, indoor air levels were low compared to levels where harmful health effects would be expected to occur. The same solvents found in indoor air were also found in outdoor air. This was expected because these solvents are commonly used and found in an urban environment.

Because basements and crawlspaces are closest to the ground surface, it was expected that solvent levels at these locations would be higher than levels in living spaces if the solvent contaminated groundwater was affecting indoor air. However, not all homes with basements or crawlspaces appeared to be affected by the contaminated groundwater. In some cases, the living space solvent levels were greater than those found in the basement or crawlspace, which suggests that something in the living space, such as household cleaning products that contain solvents, could be affecting living space air.

At some of those homes where living space solvent levels were greater than basement or crawlspace levels, the basement or crawlspace solvent levels sometimes were greater than outdoor air. This suggests that the solvent contaminated groundwater might have a small effect on the basement or crawlspace air. However, it could also mean that some of the living space air is mixing with the air in the basement or crawlspace. Some of the tested homes had indoor air solvent levels similar to outside air suggesting that contaminated groundwater might have no affect on these homes.

All of these findings were anticipated because the groundwater to indoor air pathway (also known as the vapor intrusion pathway) is very complicated and can be affected by many factors. Table 2 provides some of the environmental and building factors that can affect whether contaminants evaporating from shallow groundwater and moving through the soil might enter buildings and affect indoor air quality.

Table 2: Factors That Can Affect the Groundwater to Indoor Air Pathway

Factors	Examples
<i>Environmental</i>	
Weather	Atmospheric air pressure changes can affect the direction and rate of vapor movement.
	Rain can fill spaces between soil particles and block vapor movement.
Soil characteristics	Different types of soil are made up of different sized soil particles. Sand-sized soil particles have more connected space between each particle than clays, which allows vapors to move more easily through them.
Groundwater Depth	Shallow contaminated groundwater and related vapors are closer to buildings than deep groundwater and its vapors.
<i>Building</i>	
Foundation Characteristics	Holes or cracks in foundation walls or floors can create pathways for vapors to move into buildings.
Building Operations	Heating and ventilation system operation can cause building pressure changes that can cause vapors to be pulled from the ground into a building if cracks or other openings exist in the foundation.
	Exchange rates between indoor and outdoor air can cause diluted indoor air.

Household products like cleaners, paints, and glue can also contribute to or increase solvent levels in indoor air. PCE is commonly used for dry-cleaning clothes and has been found in homes where dry-cleaned clothes are stored.

Because of all these factors, it is often hard to determine what homes are being affected by the contaminated groundwater. Appendix B contains a vapor intrusion pathway fact sheet prepared by DOH that explains more about this pathway.

Health Assessment

To evaluate whether the low levels of solvents found in indoor air in the Fruit Valley neighborhood pose a health threat, DOH followed a four step health assessment process. Those four steps included:

- Identifying chemicals of possible health concern
- Identifying levels of chemicals that could make people sick
- Determining whether long-term exposure to chemicals could make people sick
- Conducting an epidemiologic disease investigation

The health assessment steps and findings are summarized below.

Step 1 – Identifying Chemicals of Possible Health Concern

During the first step of the health evaluation, DOH compared the highest level of each solvent found in indoor air to published health comparison values to identify chemicals that might be of health concern in the Fruit Valley Neighborhood. These published health comparison values are set at levels much lower than levels 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 our lack of certainty regarding low levels of chemical exposure. When there is evidence that a chemical might cause cancer, the lowest comparison value corresponds to a theoretical cancer risk increase of one additional cancer in a population of one million people for a continuously exposed individual. Although this level of risk is not considered to be a health concern, decisions about cleanup of contamination are often made to reduce risks below this level when possible.

The health comparison values used by DOH included the Washington State Model Toxics Control Act (MTCA) air cleanup levels, U.S Environmental Protection Agency (EPA) Region 6 human health air screening levels, and ATSDR air minimal risk levels and air screening levels. Table C-1, Appendix C, provides the health comparison value references. When more than one health comparison value existed for each chemical, DOH selected the lowest comparison value to ensure that the most health protective comparisons were made.

When the highest indoor air solvent level for each chemical did not go above the health comparison value, no further health evaluation of that chemical was determined to be necessary because DOH does not expect that the solvent will cause people to get sick (the chemical is not considered a chemical of health concern). Table 3 shows the range of solvents found in indoor air in the Fruit Valley neighborhood. It also shows the lowest health comparison value used by DOH during its evaluation (column 3) and a note showing whether the levels of chemicals found in homes were greater than the health comparison value (column 4). As shown on Table 3, five of the 10 solvents found in indoor air did not exceed the health comparison levels (column 4). As a result, DOH determined that none of these five chemicals needed further health evaluation because it was not expected that people would get sick from these levels.

The other five solvents, also shown on Table 3, however, are above their respective health comparison values (column 4). A solvent level above a comparison value does not mean that people will get sick. However, it does mean we need to further look at the chemical.

As shown in column 4, most of the homes in the Fruit Valley Neighborhood had indoor air TCE, PCE, and 1,2-dichloroethane levels above health comparison values while only a few homes had indoor air levels of vinyl chloride and chloroethane above health comparison values. These five chemicals are considered possible carcinogens (except for vinyl chloride which is a known human carcinogen) and can also pose some other health risks.

As noted above, a solvent level above a health comparison value does not mean that people will get sick if they are breathing these levels of solvents. However, the more a level exceeds a health comparison value and approaches a level where we would expect people to get sick, the more concern we have. Where the highest indoor solvent level was greater than the health comparison level, the chemical was further examined in Step 2.

Table 3: Fruit Valley Neighborhood Indoor Air Results, Health Comparison Values, and Health Threshold Levels

Chemical Name	Ranges of Indoor Air Results from Fruit Valley Neighborhood* (ug/m ³)	Step 1		Step 2	
		Lowest Air Health Comparison Value (ug/m ³)	Building Levels Exceed Lowest Health Comparison?	Lowest Air Health Threshold (ug/m ³)	Building Level Exceeds Lowest Health Threshold?
1,1,1 Trichloroethane	0.039 - 68	2,300	No		
1,1 - Dichloroethane	0.0024 -27U	160	No		
1,1 - Dichloroethene	0.046 - 2.7	81	No		
Cis – 1,2 - Dichloroethene	0.0035 – 27U	37	No		
Trans -1,2 - Dichloroethene	0.0033 – 27U	32	No		
Trichloroethylene (TCE)	0.0075 - 95	0.017	Yes, Most Buildings	267,894	No
Tetrachloroethylene (PCE)	0.031 - 73	0.33	Yes, Most Buildings	67,894	No
1,2 - Dichloroethane	0.015 – 27U	0.074	Yes, Many Buildings	202,454	No
Vinyl Chloride	0.0032 - 7.6U	0.1	Yes, Few Buildings	2,045	No
Chloroethane	0.012U - 27U	2.3	Yes, Few Buildings	3,967,607	No

Step 2 – Identifying Levels of Chemicals That Could Make People Sick

To further evaluate those chemicals where the indoor air levels were greater than the health comparison values identified in Step 1, DOH reviewed the available toxicological literature. This information helps DOH determine if the levels found in indoor air would be expected to make people sick, which is the second step in the health assessment process.

Table 3, column 5, shows the lowest appropriate level of each of the five solvents that might make people sick if they are breathing these chemicals. These levels are referred to as “health threshold” levels. Health threshold levels are determined by studying humans or animals that have been exposed to high levels of a chemical, such as might occur in an occupational (i.e., workplace) setting or in a laboratory study of exposed animals. As a result, these levels are always higher than the health comparison values used in Step 1.

Health threshold levels used in Step 2 include levels such as “no observed adverse affect levels” (NOAELs) and “lowest observed adverse affect levels” (LOAELs). A LOAEL is the lowest tested dose of a chemical that has been reported to cause harmful health effects in people or animals. A NOAEL is the highest tested dose of a chemical that has been reported to have no harmful health effects on people or animals. ATSDR uses these values to derive its minimal risk levels and “cancer effect levels” (CELs). When more than one health threshold value existed for each chemical, DOH selected the lowest health threshold value to ensure that most health protective comparisons were being made. Table C-2, Appendix C, summarizes the health threshold values and provides the references.

When looking at Table 3, it is clear that the health threshold levels (column 5) are many times higher than the levels that have been found in indoor air in the Fruit Valley neighborhood (column 2) so **the solvent levels found in the air in the FVN are not expected to make people sick.**

Step 3 – Determining Whether Long-Term Exposure to Chemicals Could Make People Sick

Long-term exposure to single and multiple chemicals over a lifetime (i.e., 75 years) can cause an increased theoretical cancer health risk. The reason cancer risk is considered theoretical is because it is not known if exposure to low levels of contaminants can result in actual cancers in an exposed population. Actual risks can be as low as zero. Long-term non-cancer effects could also occur.

DOH evaluated long-term health risks for single, as well as multiple chemicals, using standard risk assessment methods for the homes where the highest indoor air solvent levels were detected in 2002. The results of DOH’s 2002 indoor air data evaluation are presented in its 2003 health consultation report.(1) It was found during that evaluation that the theoretical cancer risk associated with the solvent levels at some homes was above a one in a million cancer risk. Again, however, the actual risk could be as low as zero. Based on these findings, Ecology asked Cadet to install soil vapor vacuum systems at six homes where indoor air posed the highest theoretical cancer risk. It should be noted that the solvent levels in these homes were

significantly lower than the levels where we would expect people to get sick. However, the systems were installed as a precaution.

Only one home has been found to have higher indoor air solvent levels since the levels found in 2002. However, Ecology and the Port discovered that the solvent levels found at that home were the result of some solvent-containing products stored in the home. After these solvent containing products were removed by the homeowner, the solvent levels in indoor air dropped significantly.

Step 4 Epidemiologic Disease Investigation

Most published reports indicate cancer of the liver, kidney, and cervix as having a weak, nonetheless, positive association with TCE and related compounds when these chemicals are inhaled at occupational (i.e., workplace) exposure levels. Occupational exposure levels, however, are many times higher than the levels found in indoor air in the Fruit Valley neighborhood. Aside from the three mentioned cancers, there is no definitive indication of any association between breathing TCE and related compounds and other chronic diseases such as arthritis.

Available cancer data was evaluated by DOH to address Fruit Valley neighborhood health concerns. DOH used standard epidemiological methods to assess whether the incidence of cancer in the Fruit Valley neighborhood was significantly different than the incidence across Washington State and Clark County. The cancer data review covered 13 years of data beginning with cancer cases in 1992.

Two steps were taken to complete the epidemiologic disease investigation:

- Step 1: Determine whether the observed numbers for liver, kidney, cervical, and all forms of cancers combined, are significantly different from what would be expected among people living in the Fruit Valley neighborhood.
- Step 2: Identify whether there is spatial clustering of the three cancers in or around the Fruit Valley neighborhood and the Cadet and Swan sites compared to the rest of Clark County.

The details about the approach and the findings are presented in the *Epidemiologic Disease Investigation Report* included in Appendix D. The findings are summarized in the following bullets:

- There were very few observed incident cases of cancer (liver, kidney, and cervical cancer) in the Fruit Valley Neighborhood that might possibly be attributed to exposure to TCE and related compounds.
- The observed incident numbers of liver, kidney, and cervical cancer in the Fruit Valley neighborhood are not significantly different from what is observed across Washington State.
- The total number of all types of cancers found in the Fruit Valley neighborhood is significantly lower than the cancer incident rate for Washington State.

- The spatial cluster analysis did not identify any significant clusters for liver, kidney, and or cervical cancers.

We did not control for known and suspected risk factors for these cancers in the analysis because that information was not available. Because of these findings along with other data or methodological limitations (geocoding to city or zip code level), no additional epidemiologic investigation is necessary.

Children's Health Concerns

The FVN is a residential area where children potentially could be exposed to site contaminants through the indoor air exposure pathway. Children can be uniquely vulnerable to the hazardous effects of environmental contaminants. Children breathe more air per pound of body weight than do adults resulting in higher levels of exposure to contaminants in air. Additionally, the fetus is highly sensitive to many chemicals, particularly with respect to potential impacts on childhood development. For these reasons, it is very important to consider the specific impacts that contaminants may have on children, as well as other sensitive populations.

Exposure to detected indoor air contaminants were evaluated as described in the discussion section, above. These levels are not expected to result in non-cancer health effects for children, or adults. The assessment did find that long-term exposure to single and multiple chemicals over a lifetime (i.e., 75 years) could cause an increased theoretical cancer health risk. However, that risk could be as low as zero.

Conclusions

The levels of chemicals found in indoor air in the Fruit Valley neighborhood from 2002 through February 2007 are not expected to make people sick (i.e., no apparent public health hazard). However, further actions to reduce or eliminate some of these indoor air exposures will occur in accordance with the Model Toxics Control Act (MTCA) cleanup regulation and be monitored by Ecology. These actions might include further groundwater remediation, vapor extraction, and installation and/or operation of soil vapor vacuum systems in individual homes. Such steps will likely reduce or eliminate risks associated with exposure to individual or multiple solvents found at low levels in indoor air.

Recommendations

Future FVN indoor air sampling results should be submitted to DOH for review.

Public Health Action Plan

1. The Port of Vancouver will continue to provide DOH with indoor and outdoor air sampling results for the FVN.
2. DOH will review these FVN indoor and outdoor air results to continue determining whether the levels pose a health threat.
3. A copy of this health consultation report will be placed on DOH's Site Assessment website. <http://www.doh.wa.gov/ehp/oehas/sas.htm>

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Appendices

Appendix A
Summa Canisters

Summa Canisters

Summa canisters are stainless steel containers that have been used to collect indoor and outdoor air from the Fruit Valley neighborhood (Figure A-1). These canisters, which are supplied by testing laboratories, are certified clean and leak free. Each canister is under vacuum, which allows air to be “sucked” into the canister when the sampling valve is open at the start of the testing. A vacuum gauge and flow control device are typically attached to each canister.

The vacuum gauge is used to measure the amount of vacuum in the canister. The indoor air testing must be completed before the Summa canister loses its vacuum otherwise air will not be sucked into the canister. The flow control device controls the amount of air entering the canister so the air can be tested for different time periods. Indoor air testing at homes in the FVN was conducted for 24-hour periods to estimate the levels of chemicals people could be breathing throughout a day.

Figure A-1: Summa Canisters

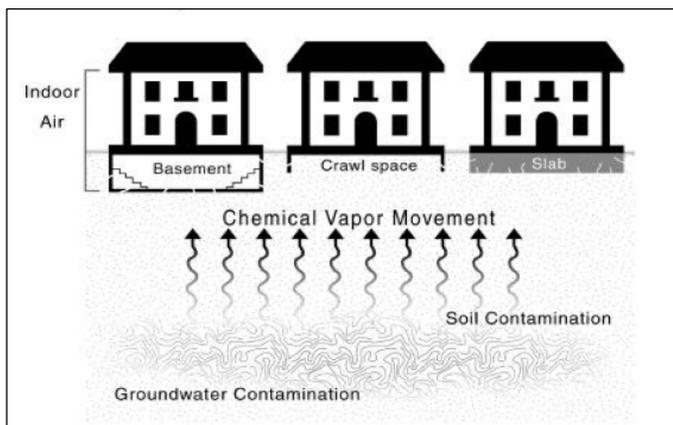


Appendix B
Washington Department of Health
Vapor Intrusion Fact Sheet

DOH PUB 334-133

What is vapor intrusion?

Chemicals that are spilled, dumped on the ground, or leak from an underground storage tank can seep into the soil. If the spill or leak is large enough, it can travel down through the soil and get into the groundwater. When a group of chemicals known as volatile organic compounds (volatile chemicals) are released into soil or shallow groundwater, these chemicals evaporate, producing vapors that travel up through the soil. These vapors can enter nearby homes and businesses through crawlspaces and cracks or other openings in the foundation. This process is known as *vapor intrusion*. When it occurs, vapor intrusion may cause unhealthy indoor air quality.



Reference: New York State, Department of Health, Guidance for Evaluating Soil Vapor Intrusion in the State of New York, February 2005.

What volatile chemicals might enter my home or business through vapor intrusion?

Petroleum products and solvents are common volatile chemicals that can cause vapor intrusion.

Gasoline, diesel fuel, and home heating oil are examples of petroleum products. Examples of solvents include tetrachloroethylene (a common solvent used in the dry cleaning industry, also

known as "Perc" or PCE), and trichloroethylene (a common solvent used for cleaning and degreasing, also known as TCE).

Odors are usually associated with petroleum spills or leaks. However, odors are not usually associated with solvent leaks or spills unless large amounts are released.

What is the health concern associated with volatile chemicals in indoor air?

Low levels of volatile chemicals are normally found in indoor air at a typical home or business. Vapor intrusion can add to these types of chemicals but usually at very low levels.

When volatile chemical levels are high enough, people might temporarily experience headaches, nausea, and/or eye and respiratory irritation. These symptoms usually go away when the person moves into fresh air. If people breathe low levels of these chemicals for many years, there may be a small health risk. Government agencies may take steps to reduce even low levels of volatile chemicals in order to be cautious and protective of people's health.

What other sources of volatile chemicals can make indoor air at my home or business unhealthy?

Paints, paint strippers and thinners, glues, solvents, and air fresheners are examples of products that contain volatile chemicals that can affect indoor air quality. Dry cleaned clothing and cigarette smoke also contribute volatile chemicals to indoor air.

Volatile chemicals occur in outdoor air when they are released from various industries and vehicles. Because buildings are not airtight, outdoor air can enter buildings and affect indoor air quality.

These sources are taken into account when evaluating whether vapor intrusion is contributing to unhealthy indoor air.

Some steps you can take to prevent releases of volatile chemicals from products stored or used at your home or business:

- Do not buy more chemicals than you need at one time;
- Store unused chemicals in appropriate containers in well ventilated areas away from living spaces or work spaces; and,
- Place freshly dry cleaned clothes in a well ventilated area.

What happens if vapor intrusion is a possible problem near my home or business?

When vapor intrusion is suspected, it should be investigated by the party responsible for the contamination. An investigation typically involves testing soil, groundwater, and soil gas (air trapped between soil particles). This testing helps to determine if volatile chemicals might pose an indoor air quality problem.

At many contaminated sites, volatile chemical levels are low and are not considered a problem. Sometimes these levels in soil, groundwater, or soil gas are high enough to cause concerns about indoor air quality in nearby homes or businesses.

When a concern about indoor air quality exists, samples are often collected inside homes or businesses. The samples are needed to determine if the volatile chemical levels in buildings are making indoor air unhealthy and whether vapor intrusion might be responsible. **Any air sampling planned at your home or business requires your permission.**

What happens if a vapor intrusion problem is found?

If soil or groundwater contaminated with volatile chemicals poses a health concern, the most common solution is to install a system that removes the chemicals before vapors enter a home or business. These systems are similar to those installed in homes in regions of the country where radon is an issue and are commonly known as soil vapor vacuum systems.

Soil vapor vacuum systems remove the volatile chemicals from the soil below the foundation by sucking the vapors out of the soil. The vapor is moved through pipes and discharged into outdoor air. If the chemical levels are high, the vapors are treated before being discharged. When these systems are needed, the party responsible for contamination usually pays for them.

**Vapor intrusion questions? Please contact:
Washington State Department of Health,
Office of Environmental Health Assessments,
Site Assessment Section**

1-877-485-7316 (toll free)

Appendix C
Health Comparison and Health Threshold Tables

Table C-1: Health Comparison Values and References

Chemical Name	Health Comparison Values (ug/m³)	References
1,1,1 Trichloroethane	2,300	EPA R6(2)
1,1 - Dichloroethane	160	MTCA(3)
1,1 - Dichloroethene	81	ATSDR - Intermediate. EMEG(4)
Cis - 1,2 - Dichloroethene	37	EPA R6
Trans -1,2 - Dichloroethene	32	MTCA
Trichloroethylene (TCE)	0.017	EPA R6
Tetrachloroethylene (PCE)	0.33	EPA R6
1,2 - Dichloroethane	0.074	EPA R6
Vinyl Chloride	0.1	ATSDR - CREG(4)
Chloroethane	2.3	EPA R6

ug/m³ - micrograms of chemical per cubic meter of air

EPA R6 - EPA Region 6 Air Screening Levels

MTCA - MTCA Air Cleanup Level

ATSDR Intermediate. EMEG - ATSDR Intermediate Environmental Media Evaluation Guides

ATSDR CREG - ATSDR Cancer Risk Evaluation Guides

Table C-2: Health Comparison Values and References

Chemicals of Health Concern (COCs)	Inhalation Health Threshold Values (ug/m3)			
	Inhalation Health Effects Carcinogenic	Reference	Inhalation Health Effects Non-Carcinogenic	Reference
Trichloroethylene (TCE)	535,787	CEL (mouse)	267,894(5)	LOAEL (rat) intermediate
Tetrachloroethylene (PCE)	678,937	CEL (mouse)	67,894(6)	NOAEL (human) acute
1,2 - Dichloroethane	NA*	NA	202,454(7)	NOAEL (rat) chronic
Vinyl Chloride	12,781	CEL (rat)	2,045(8)	LEC _{10 HEC} - Intermediate
Chloroethane	39,570,552	CEL (rat, mice)	3,967,607(9)	NOAEL (mice) - acute

Lowest appropriate health threshold value

NA - not available

CEL - cancer effect level

NOAEL - no observed adverse effect

LEC - lowest effect concentration

HEC - human equivalent concentration level

Note: ATSDR reports that so far, exposure to 1, 2-dichloroethane has not been associated with cancer in humans. They also report they are not sure whether breathing 1, 2-dichloroethane causes cancer in animals. There is no information to determine whether children differ from adults in their sensitivity to the health effects of 1, 2-dichloroethane.

Appendix D
Epidemiologic Disease Investigation Report

Fruit Valley Neighborhood Epidemiologic
Disease Investigation Brief Report

Office of Environmental Health Assessments
Environmental Epidemiology Section

September 04, 2007

Epidemiologic Disease Investigation Brief Report Fruit Valley Neighborhood, Vancouver, Washington, September 2007

Background:

In response to citizens concerns, the Environmental Epidemiology Section of the Office of Environmental Health Assessments was requested to conduct a health outcome assessment of the Fruit Valley neighborhood in Vancouver, Washington (Figure 1). This neighborhood is underlain by solvent contaminated groundwater originating at the nearby Cadet Manufacturing Company (Cadet) and former Swan Manufacturing Company (Swan) properties. Trichloroethylene (TCE) and tetrachloroethylene (also known as PCE) are the predominant solvents found in the groundwater. Small amounts of other solvents have also been found in groundwater including 1,1,1-trichloroethane and 1,1-dichloroethane. It is uncertain when the groundwater below the Fruit Valley neighborhood became contaminated but it is expected that the past solvent levels were similar to the levels found before groundwater cleanup activities began in 2003. However, there is some uncertainty associated with that assumption.

Some of the solvents found in groundwater are evaporating, moving through the soil, and have been found in indoor air in some of the neighborhood homes. The solvents found to date in these homes are low and in many cases similar to levels found in outdoor air and are not expected to cause adverse health affects. However, at meetings with the community, health concerns were raised including concerns that the low levels of solvent found in indoor air could be causing rashes, arthritis, and cancer. Because of the uncertainty about past levels, the community also expressed concern that past exposure could be making them sick.

Most published reports indicate cancer of the liver, kidney, and cervix as having a weak, nonetheless, positive association with TCE and related compounds when these chemicals are inhaled at occupational exposure levels. Occupational exposure levels are many times higher than the levels found in indoor air in the Fruit Valley neighborhood. Aside from the previously mentioned cancers, there is no definitive indication of any association between breathing TCE and other chronic diseases such as arthritis. Accordingly, an initial exploratory analysis of available cancer data was performed to objectively make a decision on whether or not to investigate this request further.



Figure 1. Cadet & Swan Manufacturing sites, Vancouver, Washington

Objectives:

1. Determine whether the observed numbers for liver, kidney, cervical, and all forms of cancers combined, are significantly different from what would be expected among people living in the Fruit Valley neighborhood.
2. Identify whether there is spatial clustering of the three cancers in or around the Fruit Valley neighborhood and the Cadet and Swan sites compared to the rest of Clark County.

Methods:

Classical epidemiologic methods were used to determine whether the burden of cancer in the Fruit Valley neighborhood is significantly higher than in the State overall, adjusting for the relative size and age composition of Washington State population. Data on incident cases for liver, kidney, and cervical cancers individually as well as all cancers combined were extracted from the Washington State Cancer Registry for the years 1992 to 2004, the years cancer data are available. The 13 years of data were combined because of the small numbers of cases reported each year in the Fruit Valley neighborhood. Age and gender specific populations at the U.S. census block group level were used to derive the respective expected numbers. The difference between the observed and expected numbers of the selected cancers including all forms of cancers combined were examined by calculating the respective p-values to determine if the observed cases in the Fruit Valley neighborhood were significantly different from what would be expected based on the respective background incidence rates in Washington.

In addition, SaTScan® spatial cluster analyses were performed to identify clustering of the three cancers. Analysis was performed at the state and county level. A focused analysis using the locations of the Cadet and Swan facilities was also performed. This type of analysis is based on the assumption that people living closer to contaminated areas are more likely to have a higher level of exposure to the contaminants than people in the general population and therefore have an elevated risk of developing a cancer that is potentially associated with exposure to the environmental toxin. The spatial scan procedure involved drawing circular windows that gradually move across space noting observed to expected cases inside the window at each location. Only cases that geocoded to a street address were included in the spatial analysis. Post Office addresses or addresses that only geocoded to a city or zipcode were not included due to the likelihood of artificial clustering. Age and gender adjusted population data were aggregated at the U.S. census block group level.

Findings:

Comparison of observed and expected cases

The observed crude numbers for liver, kidney, and cervical cancers in the Fruit Valley neighborhood during the years 1992 to 2004 were not significantly different from what was expected based on the respective background incident rates for Washington State. The result from a similar calculation for all cancers combined cancers in the Fruit Valley neighborhood is significantly lower than expected.

Spatial cluster analysis

The spatial cluster analysis at the county level and in the focused analysis on the Cadet and Swan sites did not identify any significant clusters.

Conclusion:

Available information on the health effects of TCE and related compounds; and findings from our initial exploration of existing cancer data do not suggest the need for further epidemiological or spatial investigation for the following specific reasons.

1. There are no strong associations reported in published articles for cancers that are hypothesized to be caused by exposure to TCE and related compounds, even at occupational exposure levels.
2. The observed cases for cancers that might potentially be attributable to exposure to TCE and related compounds in the Fruit Valley neighborhood are very small.
3. The observed crude numbers of liver, kidney, and cervical cancer in the Fruit Valley neighborhood are not significantly different from what is expected based on the respective background incident rates adjusting for the relative size of Washington State population.

4. The observed crude numbers for all cancers combined in the Fruit Valley neighborhood is significantly lower than what would be expected based on the respective background incident rate for Washington.
5. The spatial cluster analysis did not identify any significant clusters for liver, kidney, and cervical cancers that potentially might have a positive association with the contaminants under investigation.

Furthermore, cancer is a more common disease than many realize, affecting one out of three adults some time during their life. Since the risk of developing cancer increases with age, communities with a large population of older adults will typically experience a higher incidence of cancer. This association is also applicable to many other chronic diseases that are not cancerous in origin. While it is possible to develop cancer from exposure to a wide variety of chemical compounds, many other factors contribute to whether an individual will eventually develop cancer. Cancer is also believed to take one or more decades to be apparent, and the reconstruction of exposures that might have occurred decades ago is a challenge. Levels of exposure in community settings are much lower than industrial or agricultural exposure levels to such chemicals where adverse health outcomes, including cancer is likely to occur. Additional information on the occurrence of cancer can be found at:

<http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/Cancer.aspx>.

Certification

This Residential Indoor Air Quality Evaluation health consultation report was prepared by the Washington State Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner

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The Division of Health Assessment and Consultation (DHAC) ATSDR, has reviewed this health consultation report and concurs with the findings.

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