Health Consultation

LAURELDALE LANE SITE

GRANTS PASS, OREGON

Prepared by the
Oregon Department of Environmental Quality

OCTOBER 7, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Oregon Department of Environmental Quality
Under Cooperative Agreement with the
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Health Consultation Memorandum

October 7, 2009

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Summary

Introduction

The Environmental Health Assessment Program's (EHAP's) top priority is to ensure that residents living in the Laureldale Lane area have the best information possible to safeguard their health.

Laureldale Lane is a rural residential area located in Grants Pass in southwest Oregon. In 2003, the Oregon Department of Environmental Quality (DEQ) detected the solvent trichloroethylene (TCE) in the groundwater under Laureldale Lane. DEQ identified eight domestic wells that were affected by the contamination, and installed filtration systems to prevent residents from coming in to contact with TCE in these wells. In 2008, DEQ requested that the U.S. Environmental Protection Agency (EPA) Region 10 conduct a site assessment at Laureldale Lane in order to characterize the extent of groundwater contamination, and determine if there were any other wells that were contaminated with TCE. As part of this investigation, DEQ requested EHAP's assistance in answering questions and providing information to residents with health-related concerns. This letter health consultation provides EHAP's evaluation based on the most recent environmental sampling data, along with our conclusions and recommendations.

Conclusion

EHAP concludes that drinking or breathing TCE in untreated water from private wells at Laureldale Lane for a year or longer could harm people's health. Prior to the use of filtration systems, residents who used well-water in this area could have come into

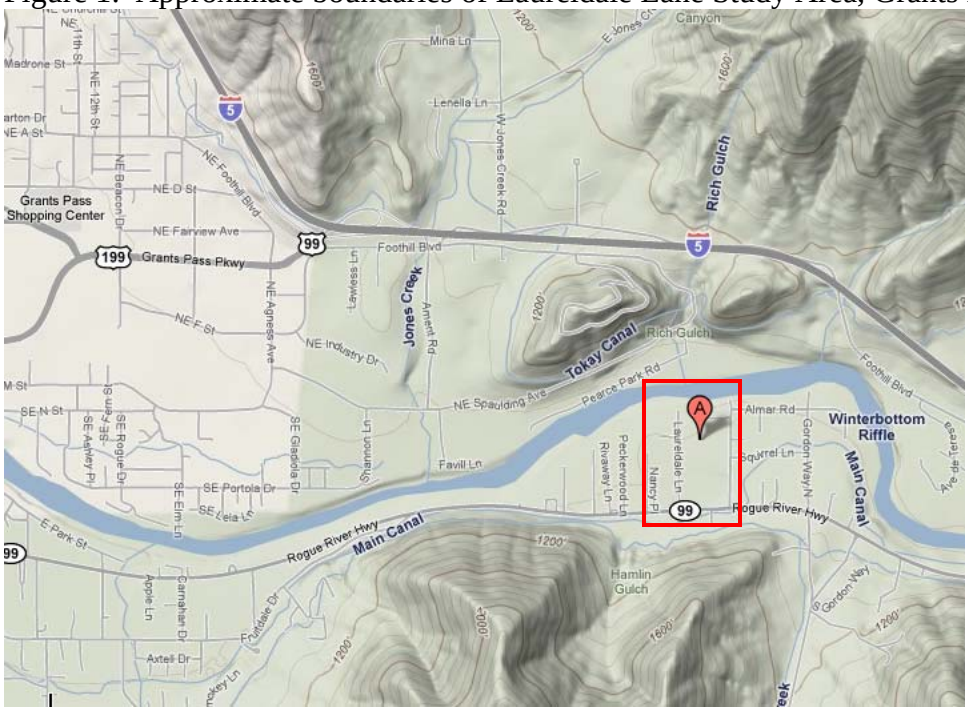
	contact with unsafe levels of TCE in the past. Currently, all Laureldale Lane residents who use water from contaminated wells have treatment systems (filters) that remove the TCE from their water. EHAP does not anticipate that using filtered water for drinking, cooking, showering or other every day activities could be harmful to people's health.
Basis for Decision	TCE was found in the groundwater at Laureldale Lane at levels that could cause increased risks for cancer if the untreated water is used on a daily basis for drinking, cooking, showering and other every day activities.
Next Steps	Residents in homes with contaminated wells should ensure that they use filtered water for their drinking, cooking, showering and all other home water uses. Residents should work with DEQ to ensure that the water filtration systems are properly maintained, and that TCE is being removed from their well-water.
For More Information	If you have concerns about the findings of this report, you should contact the Environmental Health Assessment Program at 971-673-0977 or ehap.info@state.or.us. You can also call ATSDR at 1-800-CDC-INFO and ask for information on the Laureldale Lane site.

Background

Previous Investigations

Laureldale Lane is a rural residential area located in Grants Pass in southwest Oregon. In 2003, DEQ detected the solvent TCE in the groundwater under Laureldale Lane. The approximate boundaries of the area are the Rogue River Highway to the south, Whispering Pines Road to the east, Nancy Place to the west and the Rogue River to the north (Figure 1)[1]. The source of the contamination is not known, though DEQ and Region 10 EPA have identified two potential facilities that may have released TCE into the groundwater. Approximately 8,801 people live within four miles of the contamination site[2].

Figure 1. Approximate boundaries of Laureldale Lane Study Area, Grants Pass, OR.



During the 2003 investigation, DEQ identified eight domestic wells that were contaminated with TCE. DEQ installed point-of-entry water filtration systems on these eight wells in order to prevent further exposures to these residents. Because there are no regulated public water systems near these residences, this is the most effective solution for providing a safe drinking and home water supply for these homes. In 2007, DEQ collected water samples from the eight wells to see if the filtration systems were functioning properly, and detected TCE in one post-treatment sample. A follow-up round of sampling in 2008 did not find TCE in any of the post-treatment samples from the eight wells, which indicated that all of the filtration systems were functioning properly at the time.

There have been separate investigations on a private property, which is adjacent to one of the manufacturing facilities that have been identified as a potential source for the groundwater contamination. These investigations have been conducted by consultants hired by the property owner and owners of the manufacturing facility, apparently with little oversight by DEQ or EPA. The soil and groundwater at the private property have been sampled for heavy metals and volatile organic chemicals (VOCs). TCE has been detected in one domestic well and two monitoring wells on this property; the property owner has installed a carbon filtration system on his domestic well.

Current investigation and EHAP's involvement

In 2008, DEQ requested that the U.S. EPA-Region 10 conduct a site assessment at Laureldale Lane. The goal of this assessment was to characterize the extent of groundwater contamination, and determine if any additional wells were contaminated

with TCE. In December 2008, EPA collected water samples from 49 wells using their mobile laboratory. The samples were tested for a suite of VOCs on-site, and then sent to an off-site laboratory for confirmation. DEQ currently plans to continue its policy to provide a safe drinking water supply to any additional homes whose wells have detectable concentrations of TCE. While bottled water can protect residents from being exposed to TCE in drinking water, point-of-entry filtration systems will provide protection from exposures that occur from drinking, cooking, bathing, and other domestic uses of water.

As part of this investigation, DEQ requested EHAP's assistance in answering questions and providing information to residents with health-related concerns. EHAP received inquiries from Laureldale Lane residents during the time the samples were being collected, and after the residents received the laboratory-confirmed results (see Community Concerns section). This letter health consultation provides information to residents and partner agencies on the health risks from exposure to TCE in groundwater at Laureldale Lane and recommendations to protect the health of exposed residents.

Discussion

For this health consultation, EHAP evaluated the data collected by EPA during the December 2008 sampling event. Of the 49 wells sampled during that time, 46 were domestic wells. The domestic wells included the eight contaminated wells that were originally identified in 2003. Samples were also collected from two monitoring wells and one well used by a manufacturing facility for production purposes.

The laboratory results identified the presence of at least one VOC in 14 of the 49 wells. The remaining wells did not have detectable concentrations of any of the VOCs that were tested. The following VOCs were identified at Laureldale Lane: TCE in 9 wells, Freon 113 in five wells, Freon 12 in one well, and trichloromethane (chloroform) in one well. TCE was the only contaminant detected above the laboratory reporting limit of 0.5 ppb (see Preliminary Screening: Comparison to Environmental Screening Values Section). While the source of these other VOCs is unknown, DEQ does not necessarily believe they are related to the TCE plume at Laureldale Lane (personal communication with Don Hanson, 5/8/2009).

Seven of the 9 wells with TCE detections were domestic wells, and the other two wells were monitoring wells. The seven domestic wells serve a total of 11 people. Six of these seven wells have DEQ-installed filtration systems, and the remaining well has an owner-installed filtration system and is reportedly not being used for drinking water. There were two wells with DEQ-installed filtration systems that did not have TCE detected; while these wells had TCE detections in the past, the levels were below the detection limits during the most recent round of sampling.

Exposure Pathway Analysis

EHAP used an exposure pathway analysis to determine how people might be exposed to chemicals in groundwater at the Laureldale Lane site. This analysis involved a consideration of the following elements:

- Source: Where did the chemicals come from?
- Fate and transport: How do the chemicals move in the environment?
- Point of exposure: Where could people come in to contact with the chemicals?
- Potentially exposed population: Who has been (or could potentially be) exposed to the chemicals?
- Route of exposure: How are people coming in to physical contact with the chemicals?

If all of the above elements are known to be present at a site, the pathway is considered to be complete, and that pathway is carried forward for analysis. If one or more elements are known to be missing, the pathway is incomplete, and is not further evaluated. In cases where there is not enough information to determine if one or more elements are present, the pathway is considered a potential pathway. For complete or potential pathways, EHAP also considers whether people were (potentially) exposed in the past, are currently being exposed, or could be exposed in the future.

Table 1. Pathway analysis for Laureldale Lane.

Pathway	Source	Fate and Transport	Point of Exposure	Potentially Exposed Population	Route of Exposure	Pathway Complete?	Time Frame
Groundwater Contamination in Private Wells	Unknown; presumed release from commercial operations	Groundwater (Private Domestic/ Irrigation Wells)	Residences/ Businesses	Residents using private wells for domestic/ irrigation use	Ingestion Inhalation Dermal Contact	Complete	Past
Vapor Intrusion	Unknown; Presumed release from commercial operations	Potential migration of VOCs from groundwater to indoor air	Residences/ Businesses	Residents/workers in buildings above or near contaminated groundwater	Inhalation	Potential	Past Present Future

EHAP identified two exposure pathways at the Laureldale Lane site. The first pathway involves exposures to contaminated groundwater through privately owned domestic and/or irrigation wells. Domestic wells provide water for drinking, cooking, bathing, running appliances, and other household purposes, while irrigation wells primarily provide water for outdoor uses such as watering lawns and gardening. People can be exposed to chemicals in their wells through three routes. The main route of exposure is through ingestion or drinking or swallowing contaminated water. People also can be exposed through inhalation or breathing in chemicals in air. VOCs can easily evaporate from water into the air, and in indoor settings, these chemicals can accumulate and spread through air and be inhaled by people in the immediate area. This is a particular concern

during activities such as bathing, showering, cooking, or using appliances (such as dishwashers or laundry machines that use large amounts of water). Lastly, people can come into contact with small amounts of chemicals in water through their skin (dermal exposure).

All of the privately owned domestic wells with TCE detections have filtration systems to remove TCE from water. Assuming that these filtration systems are working properly, it is unlikely that the residents who use these wells are currently being exposed to TCE in their domestic water supply. However, these residents could have been exposed to TCE in the past. EHAP used the data that were collected during the 2008 investigation to evaluate the health risks from past exposures to TCE. These risks would also apply to any residents who are knowingly or unknowingly using untreated water in the contamination area.

It should be noted that the 2008 EPA data may not accurately represent past exposure conditions, since TCE concentrations in groundwater at Laureldale Lane could be changing over time. In 2006 and 2008, DEQ measured the concentration of TCE in the eight contaminated domestic wells. In 2006, the average concentration was 8.8 ppb and the maximum concentration was 39.1 ppb, and in 2008, the average concentration was 11.9 ppb and the maximum concentration was 42.7 ppb. The data from the most recent EPA sampling in 2008 found TCE at an average concentration of 13.7 ppb and maximum concentration of 43 ppb; note that this average concentration includes data from two monitoring wells, and that the average concentration in domestic wells was 11.3 ppb.

The second exposure pathway at Laureldale Lane is vapor intrusion. Vapor intrusion occurs when chemicals in groundwater migrate through the soil underneath a building and into indoor air. If vapor intrusion is occurring at this site, residents or workers in buildings above or near the contaminated groundwater could breathe in these chemicals in air. EHAP currently does not have enough information to determine if the VOCs in the groundwater at Laureldale Lane are migrating into indoor air. In order to determine if this pathway is complete, additional data need to be collected. These data could include information on groundwater depth, soil characteristics, soil gas and/or indoor air concentrations of VOCs. These data were not collected as part of this preliminary investigation, but may be included in further DEQ and EPA assessments at the Laureldale Lane site. Because there were insufficient data to evaluate the vapor intrusion pathway, EHAP is currently unable to determine if there are any health risks from vapor intrusion of VOCs at Laureldale Lane.

Preliminary Screening: Comparison to Environmental Screening Values

As a next step, EHAP used environmental screening values to identify which contaminants required further evaluation at the Laureldale Lane site. Environmental screening values are developed using toxicity information from human and animal studies, and represent the concentrations of a substance in a specific media (e.g., water, air or soil) that people can be exposed to without any risks to their health. If the concentration of a contaminant is below its screening value, the contaminant does not pose a health risk, and is not included in further analyses. If a contaminant's

concentration is higher than the screening value, it will not necessarily pose risks to people who are exposed, but needs to be examined further. EHAP uses screening values that have been developed by ATSDR, and chooses the lowest (most health-protective) value available for a contaminant. For contaminants that do not have ATSDR developed guidelines, EHAP uses a hierarchy to identify and choose an appropriate screening value[3].

For the Laureldale Lane site, the maximum concentrations of the four VOCs that were detected in water were compared to the environmental screening values for those contaminants in water (Table 2). The only contaminant with an ATSDR guideline was trichloromethane; the child chronic Environmental Media Evaluation Guide (EMEG) is the concentration of trichloromethane in water that children (who represent the most sensitive populations) could be exposed to every day for more than one year without any harm to their health. Oregon DEQ's RBC was used as the screening value for TCE, and is the concentrations of TCE in water that would result in a theoretical cancer risk of 1 additional cancer case in a population of 1 million (or 1E-06 additional cancer risk), which is considered a slight increased cancer risk. EPA Region 3's RBC was used as the screening value for Freon 113 and Freon 12, and is protective of non-cancer health effects from long-term exposures (these chemicals have not been shown to cause an increased risk for cancer). TCE was the only chemical at the Laureldale Lane site that exceeded its environmental screening guideline.

Table 2. Comparison to Environmental Screening Guidelines for Contaminants in Water.

Contaminant	Maximum Sample Concentration (ppb)	Environmental Screening Guideline (ppb)	Exceed Guideline?
TCE	43	0.03 ¥	Yes
Freon 113	1.8	59,000 *	No
Freon 12	0.54	350 *	No
Trichloromethane	0.66	100 ^	No

¥ Oregon DEQ Risk Based Concentrations (RBCs) – for TCE, the RBC represents the concentration in water that would result in a 1E-06 additional lifetime cancer risk using an oral cancer slope factor of 0.04 per mg/kg-day.
*EPA Region 3 RBC for Tap Water
^ATSDR Child Chronic Environmental Media Evaluation Guideline (EMEG)

Health Risks from exposure to TCE at Laureldale Lane

Background on TCE
TCE is a volatile organic compound that is used as a metal degreaser and as a solvent in paint removers and certain types of cleaners and adhesives. TCE enters the environment through improper use and disposal, and is known to affect many groundwater and surface water sources in the U.S. TCE evaporates quickly from surface water, but can persist in contaminated soil and groundwater for long periods of time. TCE was once widely used in some manufacturing industries, though its use in the U.S. has declined in recent years. Most of the exposures that occur in occupational settings are through inhalation of vapors and dermal contact. In community settings, people can be exposed by drinking water

contaminated with TCE, inhaling TCE in air, and absorbing small amounts of TCE through dermal contact with contaminated water or soil. Certain products that contain small amounts of TCE (such as paint removers, correction fluid, and spot removers) also can be a source of exposure [4].

Health Risks

TCE can affect the central nervous system (causing headaches, dizziness and difficulty concentrating), damage to the kidney and liver, impaired function of the cardiovascular and immune systems, and nerve damage[5]. There is also evidence that TCE exposure can result in reproductive and developmental effects, including an increased risk for birth defects[6]. There is strong evidence that exposure to TCE can increase the risks for several types of cancer, including kidney, liver, lung, prostate, cervical and lympho-hematopoietic cancers[6]. The EPA has set a limit on the amount of TCE in public drinking water systems at 5 ppb.

Exposure Dose Calculation

In order to determine if people at Laureldale Lane were exposed to unsafe levels of TCE in the past, EHAP first calculated exposure doses using the maximum and average concentrations of TCE detected in the domestic wells that were tested. Note that the data from two monitoring wells were excluded in these calculations, since these wells are not used by people for domestic or irrigation purposes. The exposure dose is an estimate of how much TCE a person could come into contact with by drinking contaminated water, and inhaling or absorbing chemicals while showering or bathing (See Appendix A for equations and exposure assumptions). Exposure doses were calculated for children (less than 6 years of age) and adults (18 years and older). EHAP assumed that older children (ages 6-17) would have exposure doses that fall between the estimates for young children and adults. Therefore, any estimates or conclusions about health risks that apply to both young children and adults would also apply to older children.

EHAP made a number of assumptions in calculating the exposure doses, which could introduce some uncertainties in the exposure dose estimates. EHAP assumed that residents were exposed to TCE at the levels detected in their wells during the December 2008 sampling event. However, this may not accurately represent past exposures, since TCE concentrations in the contamination area could be changing over time. Also, EHAP did not have site-specific information on some important factors (such as how long people have been using the water from their wells, how long the water has been contaminated and other information on water use). To account for these uncertainties, EHAP used a health-protective approach by making conservative assumptions about residents' exposures. However, the exposure doses used in this analysis may overestimate or underestimate the actual exposures to residents at Laureldale Lane.

Evaluation of non-cancer health risks

EHAP compared the child and adult exposure doses to non-cancer health guidelines for TCE. Currently, ATSDR and EPA do not have health guidelines or toxicity values for assessing the health risks from TCE exposure. Therefore, EHAP used the reference dose (RfD) that was proposed in EPA's 2001 External Review Draft Health Risk Assessment for TCE. The RfD is the dose of a chemical that a person can be exposed to on a daily

basis without any risks to their health. The proposed RfD of 0.0003 mg/kg-day is derived from the Lowest Observed Adverse Effect Level (LOAEL) for TCE, which is the lowest dose at which harmful health effects were observed in animal studies. These studies showed that mice who ingested the LOAEL dose of 1 mg/kg-day experienced adverse liver effects[6]. The RfD incorporates a series of uncertainty factors to account for differences between animals and humans, issues with experimental study design, and human variations that result in some people being more sensitive to chemical exposures. These uncertainty factors resulted in an RfD for TCE that is 3,000 times lower than the LOAEL. The proposed RfD for TCE is very conservative and is considered to be protective of the health of the most sensitive human populations including children.

Table 3 provides a summary of EHAP's evaluation of non-cancer health risks at Laureldale Lane. At both the maximum and average concentrations detected (43 and 11.3 ppb respectively), the child and adult doses of TCE exceeded the RfD. If an exposure dose exceeds an RfD, there will not necessarily be any health risks, but it requires further evaluation. As part of this evaluation, EHAP calculated a margin of safety by dividing the LOAEL of 1 mg/kg-day by the exposure dose. This provides a measure of the magnitude of difference between the estimated doses at a site and the lowest doses that could be harmful to human health. For example, at the maximum concentrations detected, the child exposure dose has a margin of safety of 132; this means that the estimated exposure dose is 132 times lower than the lowest dose where harmful health effects have been observed. At the maximum level of TCE, the margin of safety for the adult exposure dose was 370. Generally, EHAP does not consider exposures that have margins of safety greater than 10 to pose any increased health risks. Therefore, it is unlikely that children or adults experienced any non-cancer health risks by using water contaminated with TCE at Laureldale Lane.

Table 3. Evaluation of non-cancer health risks at Laureldale Lane site.

	Dose Comparison	**Maximum Concentration TCE = 43 ppb**		**Average Concentration TCE = 11.3 ppb**	
		Child	**Adult**	**Child**	**Adult**
Non-Cancer Risk	Total Dose* (mg/kg-day)	0.0076	0.0027	0.0020	0.0007
	RfD (mg/kg-day)	0.0003	0.0003	0.0003	0.0003
	Exceed RfD?	Yes	Yes	Yes	Yes
	Margin of Safety	132	370	500	1,428
*Total Dose is the sum of doses from ingestion, inhalation, and dermal routes					

Evaluation of cancer health risks

Cancer risks are evaluated by first examining if there is scientific evidence that a substance causes cancer, and then determining if exposures at a site could theoretically result in increased cancer risk. The theoretical cancer risk is an estimate of the number of

additional cancer cases that would occur if people were exposed to a specific contaminant based on the assumed exposure conditions at a site. The cancer risk is calculated using the site-specific exposure dose and EPA's cancer slope factors (CSF), and is expressed in terms of the additional cancer cases in a population.

EHAP uses the theoretical cancer risk to determine if an exposure could result in slight, low, moderate or high increased cancer risks. For example, exposures that could cause one additional case of cancer in a population of one million are considered to have a slight cancer risk, while exposures that could cause one additional case in 10,000 have a low cancer risk. *It should be noted that the theoretical cancer risk does not predict whether an exposed person will get cancer.* Instead, these risk numbers are used by public health officials to make decisions about appropriate measures to reduce exposures. In general, EHAP considers exposures that exceed a low level of increased cancer risk to pose higher than acceptable risks to human health, particularly when a contaminant is a known or probable carcinogen.

TCE is "reasonably anticipated to be a human carcinogen" by the National Toxicology Program and is classified as a "probable human carcinogen" by the International Agency for Research on Cancer. In 2001, EPA issued a draft health risk assessment for TCE that included a more conservative range for the cancer slope factor (from 0.02 – 0.4 [mg/kg-day]$^{-1}$) compared to previous guidelines. This revision was based on strong evidence from human and animal studies that exposure to TCE can increase the risk for several types of cancer, including kidney, liver, lympho-hematopoietic, cervical and prostate cancers in humans[6]. EHAP used the most health protective end of this range (0.4 [mg/kg-day]$^{-1}$) to assess cancer risks from ingestion and inhalation of TCE in water.

Table 4. Evaluation of cancer health risks at Laureldale Lane site.

	Dose Comparison	**Maximum Concentration TCE = 43 ppb**		**Average Concentration TCE = 11.3 ppb**	
		Child	**Adult**	**Child**	**Adult**
Cancer Risk	Total Dose* (mg/kg-day)	0.00065	0.00116	0.00017	0.00030
	Theoretical Cancer Risk	2.6 in 10,000	4.7 in 10,000	0.68 in 10,000	1.2 in 10,000
*Total Dose is the sum of doses from ingestion, inhalation, and dermal routes					

Table 4 shows the cancer risks for children and adults at the maximum and average concentrations detected at Laureldale Lane (see Appendix A for exposure assumptions and dose calculations). At the maximum concentration of TCE, children had a low level of cancer risk, while adults had a low-to-moderate level of risk. While adult exposures posed a higher than acceptable level of cancer risk, it should be noted that they represent the "worst-case scenario" for past exposures, since they are based on the maximum detected concentrations at this site, conservative assumptions about how people were exposed, and utilize the most conservative estimates of cancer risks.

Community Concerns

EHAP received six calls and emails from Laureldale Lane residents who had concerns about the health risks from exposure to TCE in their wells. Almost all of these calls were received during the time that sampling was taking place in December 2008. Most of these questions were related to health risks associated with exposure to TCE, with specific inquiries about cardiovascular and reproductive health, developmental risks, and cancer risks. EHAP provided information on the known risks from TCE exposure, the options and possible limitations of having blood or urine tests for TCE, and advice to follow up with a medical provider to see if medical testing is an option.

Conclusions

EHAP concludes that drinking or breathing TCE in untreated water from private wells at Laureldale Lane for a year or longer could harm people's health. Prior to the use of filtration systems, residents who used well-water in this area could have come into contact with unsafe levels of TCE in the past. Currently, all Laureldale Lane residents who use water from contaminated wells have treatment systems (filters) that remove the TCE from their water. EHAP does not anticipate that using filtered water for drinking, cooking, showering or other every day activities could be harmful to people's health.

Drinking or breathing TCE over many years may increase the risk for certain cancers, including cancers of the liver and kidney, and some types of lymphomas. At Laureldale Lane, residents who had daily contact with TCE-contaminated water in the past could have a low level of increased cancer risk.

Recommendations

Residents in these homes should ensure that they use filtered water for their drinking, cooking, showering, and all other home water uses. Residents should work with DEQ to ensure that the water filtration systems are properly maintained, and that TCE is being removed from their well-water.

Public Health Action Plan

The public health action plan describes the actions that have been or will be taken by EHAP and other government agencies at this site. EHAP is committed to following up on this plan to ensure that actions are taken to protect the health of residents at Laureldale Lane.

Public health actions that have been taken include:

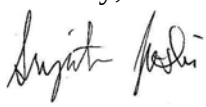
- DEQ and EPA investigations in 2003 and 2008 to understand the extent of the TCE plume and identify homes that are affected by contaminated groundwater.

- DEQ actions to prevent residents' exposures to TCE in contaminated groundwater wells including installing filters on eight homes identified in 2003.
- EHAP assistance in providing health information in a fact sheet and answering questions from residents about health risks from TCE exposure.

Public health actions that will be taken:

- EPA will continue its investigations to identify a source of the contamination, and define the boundaries of the contamination site. There also may be investigations to evaluate whether vapor intrusion could be occurring at this site.
- EHAP will submit this letter health consultation to Region 10 EPA and DEQ.
- EHAP will remain available to provide health information and technical assistance to affected residents and partner agencies.

Sincerely,



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Certification

The Oregon Department of Human Services prepared this Letter Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time this health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

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Technical Project Officer, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry

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

Alan W. Yarbrough
Team Lead, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry

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Appendix A

Equations for calculation of exposure doses

a. Ingestion Dose (mg/kg-day)

$$\text{Dose} = \frac{Cw \times CF1 \times IRW \times EF \times ED}{BW \times AT}$$

b. Inhalation Dose (mg/kg-day)

$$\text{Concentration in Air (Cair)} = \frac{Cw \times K \times FR \times Ts}{Vair}$$

$$\text{Dose} = \frac{Cair \times CF1 \times IR \times Tb \times EF \times ED}{BW \times AT \times CF2}$$

c. Dermal Dose (mg/kg-day)

$$\text{Dose} = \frac{Cw \times (1\text{-}K) \times CF1 \times P \times SA \times CF3 \times Ts \times S \times EF \times ED}{BW \times AT}$$

Evaluation of Health Risks

a. Non-Cancer: To evaluate non-cancer health risks, EHAP first compares the total non-cancer exposure dose to the health guideline for non-cancer health risks. If the exposure dose exceeds the health guideline, EHAP calculates the Margin of Safety (MOS):

$$MOS = \frac{\text{Lowest Observed Adverse Effect Level (LOAEL)}}{\text{Exposure Dose}}$$

Generally, EHAP does not consider exposures that have margins of safety greater than 10 to pose any increased health risks.

b. Cancer: EHAP evaluates cancer risks by calculating a theoretical cancer risk, which is based on the total cancer exposure dose and a contaminant's cancer slope factor.

$$\text{Cancer Risk} = \text{Cancer Dose} \times \text{Cancer Slope Factor}$$

The cancer risk is expressed as additional cases of cancer in a population (for example, 1 additional case of cancer in a population of 1 million, which is sometimes shown as 1E-06 risk).

Table A.1: Exposure assumptions used in calculating child and adult exposure doses.

Parameter	Value		Units	Notes
	Child (Less Than 6)	Adult		
Chemical Concentration in Water (Cw)	chemical specific		µg/L = ppb	Maximum/Average Detected Concentration
Conversion Factor (CF1)	0.001		mg/µg	Converts contaminant concentration from micrograms to milligrams
Ingestion Rate Water (IRW)	1.5	2.3	L/day	EPA Exp Factors Handbook[7]
Exposure Frequency (EF)	350	350	days/year	DEQ Deterministic HHRA Guidance[8], Appendix B; Away for 2 weeks per year
Exposure Duration (ED)	6	30	years	DEQ Deterministic HHRA Guidance, Appendix B; Assuming average time at residence = 30 years
Body Weight (BW)	15	70	kg	EPA Exp Factors Handbook
Averaging Time (AT) - Noncancer	2190	10950	Days	DEQ Deterministic HHRA Guidance, Appendix B - Child and Adult
Averaging Time (AT) - Cancer	25550		Days	DEQ Deterministic HHRA Guidance, Appendix B - Child and Adult; 70 years
Inhalation Rate (IR)	10,000	15,200	L/day	EPA Exp Factors Handbook; for child, used rate for child 6-8, for adults (19-65), used rate for men (15,200)
Concentration in Air (Cair)	chemical specific		µg/L = ppb	Maximum/Average Detected Concentration
Time in bathroom (Tb)	0.42	0.5	Hr/day	EPA Exp Factors Handbook - assumed 25 min for child and 30 min for adult
Conversion Factor 2 (CF2)	24		Hr/day	Converts hours to days
Volatilization Factor - (K)	0.6		-	ATSDR Public Health Assessment Guidance Manual 2005 – Appendix G7
Flow Rate (FR)	480		L/hr	Assume shower flow rate of 8L/min, converted to L/hr - ATSDR Standard Assumptions
Air Volume of Bathroom (Vair)	10,000		L	ATSDR Standard Assumptions
Fraction of chemical in water (1-K)	0.4		-	Fraction of chemical remaining in water after volatilization, assuming 60% of chemical is volatilized
Permeability Coefficient (P)	TCE = 0.012		Cm/hr	EPA Exp Factors Handbook
Exposed Body Surface Area (SA)	7280	19400	Cm^2	EPA Exp Factors Handbook; used 50th percentile for males
Conversion Factor 3 (CF3)	0.001		L/cm^3	Converts cm3 to liters
Time in shower (Ts)	0.25		Hr	Assuming 15 minute shower for children and adults
Showers per day (S)	1		1/day	Assume 1 shower per day

Table A.2: Total dose calculation for domestic wells contaminated with TCE.

Dose Calculation	Concentration (ppb)	Population Group	Exposure Scenario			Total Dose
			Ingestion	Inhalation	Dermal	
Non-Cancer Dose	43.0 (Maximum)	Child	0.00412	0.00347	0.00002	0.00762
		Adult	0.00135	0.00134	0.00001	0.00271
	11.3 (Average)	Child	0.00109	0.00089	0.00001	0.00199
		Adult	0.00036	0.00035	0.00000	0.00071
Cancer Dose	43.0 (Maximum)	Child	0.00035	0.00030	0.00000	0.00065
		Adult	0.00058	0.00058	0.00001	0.00116
	11.3 (Average)	Child	0.00009	0.00008	0.00000	0.00017
		Adult	0.00015	0.00015	0.00000	0.00030