ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

UNION PACIFIC RAILYARD
CITY OF EUGENE, LANE COUNTY, OREGON
EPA FACILITY ID: ORD009049412
OCTOBER 29, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

UNION PACIFIC RAILYARD

CITY OF EUGENE, LANE COUNTY, OREGON

EPA FACILITY ID: ORD009049412

Prepared by:

Oregon Department of Human Services
Environmental Health Assessment Program
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary

In 1994, an environmental investigation of the Union Pacific Railroad (UPRR) Yard in Eugene led to the discovery of groundwater contamination, including impacts to private wells in neighborhoods next to the Eugene Yard. Since that time, the Oregon Department of Environmental Quality (ODEQ) has overseen a study of the contamination, possible remediation options, risks posed to human health and the environment, and has overseen several interim cleanup measures. ODEQ and the Oregon Toxics Alliance both requested the Environmental Health Assessment Program's (EHAP), involvement in reviewing data and determining the possible health effects of exposure to air and groundwater contamination in the neighborhoods surrounding the UPRR site. Groundwater studies indicate that solvent chemicals used at the Eugene Yard, including tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1-dichloroethylene (DCE) and vinyl chloride, have entered groundwater beneath portions of the River Road and Trainsong neighborhoods.

Two major concerns exist related to possible exposures that could present a public health risk. First, the plume of volatile organic compounds (VOC's) extends into the neighborhoods adjacent to the Railyard and may be contributing to contamination of indoor air in private homes. The levels of VOC vapors detected in some crawlspaces have, at maximum levels measured, exceeded health guidelines. Recent sampling indicates that levels measured are well below levels of health concern, but the data are insufficient to determine if a health hazard exists. EHAP recommends that additional rounds of data be collected in residential crawlspaces that could be affected.

Second, the groundwater contamination has extended to several irrigation wells used by private homeowners in the River Road neighborhood. EHAP concluded that levels of TCE and PCE in the irrigation wells do not pose a public health hazard if residents do not consume the water, and only use it to irrigate gardens or to hose off outside surfaces, and recommends that residents in homes with irrigation wells should limit their use of the water to irrigating garden and hosing off outside surfaces and use alternative water sources for drinking purposes.

Purpose and Health Issues

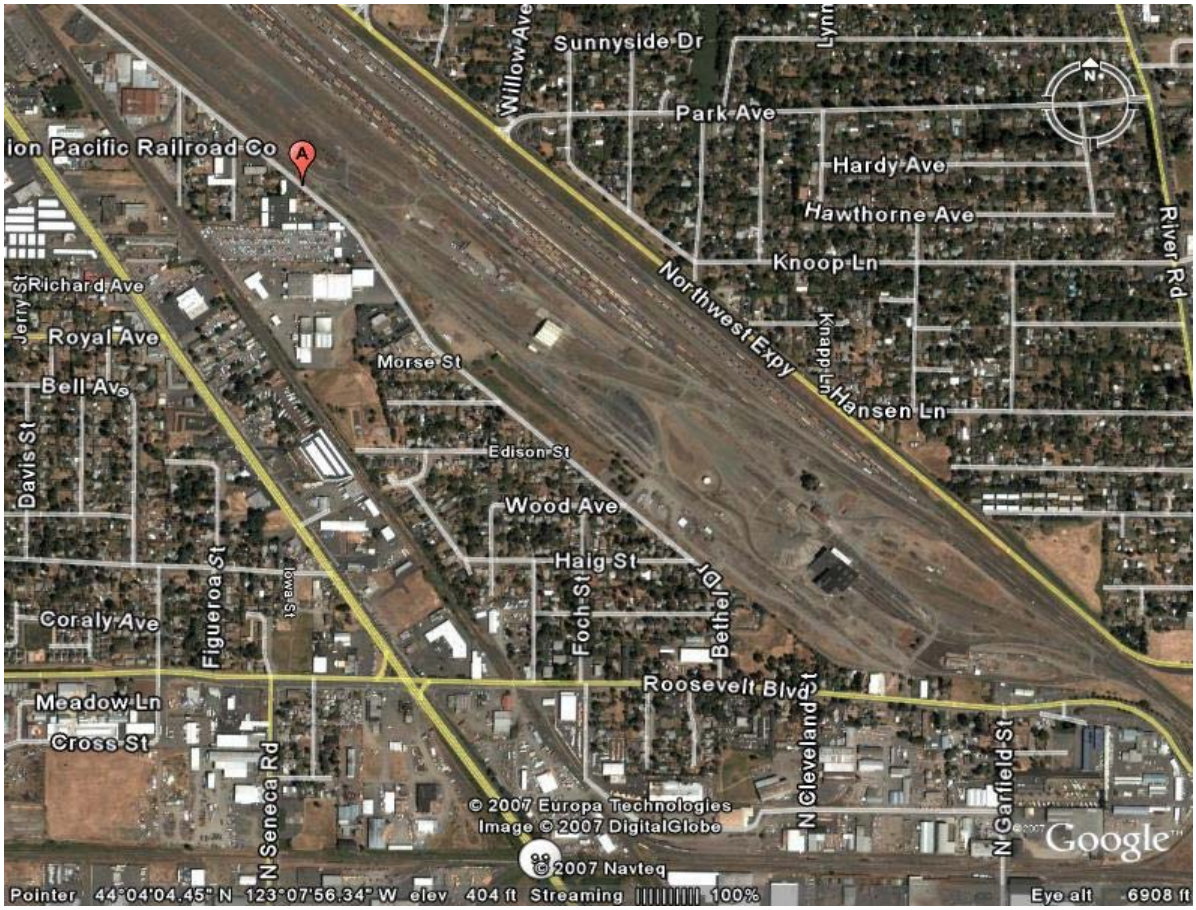
The purpose of this public health assessment is to evaluate the exposure and public health implications for local residents from groundwater contaminated with volatile organic compounds (VOCs) which are present in the groundwater, soil and air in neighborhoods surrounding the Union Pacific Railyard (UPRR) in Eugene, OR. In October 2006 the Oregon Department of Environmental Quality (ODEQ) contacted the Environmental Health Assessment Program (EHAP) at the Oregon Public Health Division (OPHD) to enlist EHAP's assistance in considering the human health effects of possible exposure to VOC's. In November 2006, The Oregon Toxics Alliance (OTA) petitioned program to evaluate the health risks to local residents from the UPRR site.

Background – Site Description and History

Portions of the River Road and Trainsong neighborhoods in Eugene, Oregon are located adjacent to the Central Industrial Area (CIA) of what is currently known as the Union Pacific Railroad (UPRR), a railyard that has been in continuous operation for over 100

years (See Figure 1). The railyard originally began operations in the late 1800's as a small regional railroad. In 1907 the former Southern Pacific Transportation Company (SPTC) took over the railyard and used it for locomotive maintenance and fueling, railcar repair, wood treatment, and wastewater treatment and disposal. This property has been used continuously since 1918 for maintenance, sorting, switching, repair, and washing of railroad cars and engines. A wood-treatment facility also operated at the site until 1962. In 1999, UPRR began operations at the Eugene site, and has used the site for railcar switching and refueling of locomotives. In addition to UPRR's activities, the Central Oregon and Pacific Railroad leases the diesel shop. [1]

Figure 1 – Union Pacific Railyard and Surrounding Neighborhoods



Investigations by Oregon DEQ have concluded that throughout the decades of rail operations at the site, drips, spills and operating practices associated with use and disposal of creosote, polycyclic aromatic hydrocarbons (PAH's), heavy metals, and volatile organic chlorinated solvents (VOCs), contaminated the soil and groundwater at the railyard. This contamination migrated into the groundwater off-site in the neighborhoods adjacent to the railyard. Most of the contaminants listed above are contained within the boundary of the railyard, but evidence that the volatile solvents (TCE, PCE, DCE and Vinyl Chloride) migrated off-site led to concern about the potential

health risks to local residents from exposure to contaminated groundwater. (http://www.deq.state.or.us/wmc/cu/WR/UPRREugene/index.htm)

In 1994, under the Oregon DEQ's Voluntary Clean-up Program (VCP), SPTC installed temporary and permanent groundwater monitoring wells. Data collected from these wells indicated the potential for off-site migration to the neighborhoods to the north and south of the railcar repair yard. The groundwater monitoring well data have been used since 1997 to characterize and depict the nature and extent of the VOC contamination at the Railyard and in the neighborhoods surrounding the railyard. The groundwater monitoring data indicates that the VOC plume extends north into the River Road neighborhood and south into the Trainsong neighborhood. A comparison of plume maps from 1997, 2003, and 2006 indicates that the plume has changed shape over time. (See Appendix B – Plume Maps).

Three off-site wells were installed in the neighborhood in April 1995. Five residential wells, used for irrigation only, were tested for the presence of solvents. Trace concentrations, below the maximum contaminant levels (MCLs), were detected in some wells, while others indicated no detection of VOCs. Flux chamber testing was performed in 1999 to measure VOC flux from shallow groundwater to outdoor residential air in the Trainsong neighborhood. Flux chambers are used to determine levels of volatile organic compounds emitted from land or liquid surfaces. Groundwater sampling of residential irrigation wells in the Trainsong and River Road neighborhoods was conducted in 1995, 1997, 1998, 2000, 2004, and 2006. [2] Soil gas, ambient air and crawlspace sampling was conducted in 2004, 2006 and 2007. Data were collected from locations both inside and outside of the VOC plume.

In January 2006, a draft report detailing the Human Health Risk Assessment (HHRA) related to groundwater contamination was released by Kennedy-Jenks Consultants. The HHRA identified possible exposure to adults and children exposed to groundwater from irrigation wells "during outdoor activities (e.g., washing cars, filling wading pools and irrigating home gardens) and through dermal contact, incidental ingestion and inhalation of aerosol emissions from groundwater." Inhalation of ambient and indoor air from contaminated groundwater was also considered in the risk assessment as a potentially complete exposure pathway. However, the HHRA did not draw any conclusions about the risk from groundwater to indoor and ambient air because these pathways were still under evaluation at the time the draft risk assessment was completed. [1]

In November 2006, the Oregon Toxics Alliance (OTA) petitioned the Superfund Health Investigation & Education (EHAP) program at the Oregon Public Health Division (OPHD) to evaluate the health risks to local residents from the UPRR site. At that time representatives of the EHAP program met with several stakeholders related to the site, including OTA and other concerned residents of the neighborhood, UPRR and their consultants from Kennedy-Jenks Consultants and CH2M Hill. As a result of these meetings, EHAP determined that a public health assessment was warranted to evaluate the potential health effects from irrigation wells contaminated with VOCs, and from VOC vapors potentially intruding into the indoor air space of homes located over the VOC plume.

In April 2006, EHAP released a draft public health assessment (PHA) which concluded that maximum levels of TCE and PCE detected in crawlspaces constituted a public health hazard. Since that document was released, additional samples were collected in April and August 2007 by CH2M Hill, a new consulting group working on behalf of UPRR. Samples were also collected by ODEQ during the August 2007 sampling event to verify the accuracy of the samples collected by CH2M Hill. These new data and additional analysis are included in and inform this final version of the PHA.

Demographics

Table 1 - Demographic Information for River Road, and Trainsong Neighborhoods

	River Road	Trainsong (Bethel Drive)
Total Population	11,731	1,775
Percent of Total Eugene Population	7.30%	1.50%
Male	5,741 (49%)	943 (53%)
Female	5,990 (51%)	832 (47%)
Race or Ethnicity		
White	10,440	1,452
Black	123	13
American Indian Alaskan Native	180	22
Asian	98	13
Native Hawaiian, Pacific Islander	24	6
Hispanic or Latino	721	306
Other race	368	169
Two or more races	498	100
Number of Households	4,686	713
Renter Occupied	1,498 (32%)	436 (61%)
Owner Occupied	3,042 (65%)	212 (30%)
% of Population Below Poverty Level in 1999	12.60%	38.40%

As Table 1 shows, the Trainsong neighborhood has a smaller population than the River Road neighborhood, has a larger proportion of renters compared with home owners, and has a larger proportion of residents who were living below the poverty level in 1999. As depicted in the 1997, 2003, and 2006 plume maps (Appendix B), data indicate that the VOC plume extends from the UPRR central industrial area into both of these neighborhoods.

Community Concerns

In June 2006, an EHAP representative met with representatives from the Oregon Toxics Alliance. In October 2006, OTA held a public meeting to collect and address issues of concern to local residents related to the UPRR site. OTA reported that local residents are concerned that they and their children could be exposed to contaminants through use of water in their yards, and that the solvents in groundwater could be volatizing inside and outside of homes in the Trainsong neighborhood, whether or not residents are using the groundwater. Based on these concerns, they expressed the need for sampling of air inside homes and the concern that residents with low incomes won't have the needed resources to protect their health. Residents also expressed frustration over the length of time it is taking to implement a plan to clean up contamination in groundwater, and concern that this area of the state has been underserved by the health division.

In May 2007, EHAP held a public meeting to provide local residents and other interested parties with information from the draft health assessment and to answer questions they might have about the health issues associated with exposure to VOC's in irrigation wells and indoor air. Over 100 people attended the meeting, and although concerns about health issues were expressed, the majority of questions and concerns expressed at the meeting related to the need for better communication from ODEQ and UPRR about specific data from residences, clean-up actions and the effect of the contamination on property values. ODEQ has been working with representative from the city of Eugene and other community group to facilitate the development of a Community Advisory Group (CAG) which would serve as an organizing body to foster communication among local residents, stakeholders and state environmental and health agencies.

Discussion

Data from groundwater monitoring reports indicated the presence of several VOC's in the area around the UPRR railyard, including TCE, PCE, DCE and vinyl chloride. Concentrations of TCE and PCE are at levels of concern in groundwater, and are the focus of this public health assessment. As depicted by the maps characterizing the TCE and PCE plumes (See Appendix B), the neighborhoods to the south (Trainsong) and northwest (River Road) of the central industrial area of the Railyard are the areas of focus in the investigation. Based on the available environmental data, EHAP has determined that the most significant potential threat to local residents is from the contamination of shallow groundwater with VOCs. EHAP reviewed the possible exposures that residents might experience and identified two likely scenarios; 1) from the use of shallow groundwater from contaminated irrigation wells, and 2) from inhalation of VOC vapors in residences over the VOC plume.

Pathways Analysis and Public Health Implications

Five elements of an exposure pathway were evaluated to determine whether people are being exposed to vapors from solvent contaminated groundwater and VOC vapors in the neighborhoods around the UPRR site. If all the criteria are met for the five elements, then

the exposure pathway is 'completed'. The five elements for a completed exposure pathway are listed below and specifically laid out in Table 2.

- *A contaminant source or release* – The UPRR railyard is the source of TCE and PCE contained in groundwater plume. Other sources may exist in the area and may be contributing to levels being detected in ambient and crawlspace air.
- *A way for the chemical to move through the environment to a place that contains the contaminant* – VOC Contaminated Groundwater
- *Exposure point or area* – Private irrigation wells; Vapors in indoor air
- *Route of exposure or a way for the contaminant to reach a population* – Ingestion or dermal contact with irrigation well water; Indoor air contaminated by VOC's in groundwater, soil gas and ambient air.
- *A population that comes in contact with the contaminant* – Residents in homes over the plume

Table 2 - Exposure Pathway Analysis

Pathway Name	Exposure Pathway Elements					Completed Exposure Pathways
	Source	**Environmental Medium**	**Point of Exposure**	**Route of Exposure**	**Potentially Exposed Population**	
Indoor Air	VOC plume, ambient air	Air	Residences, Indoor Air	Inhalation	Local Residents	Past - Yes Present – No Future - Indeterminate
Private Irrigation Wells	VOC Plume	Groundwater	Residences, Outside Tap	Ingestion Dermal Contact	Residents with Irrigation Wells	Past - Indeterminate Present - No Future – No

The pathways identified in Table 2 indicate that dermal exposure and ingestion of solvents present in groundwater and inhalation of solvent vapors in indoor air represent past complete exposure pathways. If inhaled, ingested or dermally exposed at sufficient concentrations, VOC's are known to have adverse health effects (see Appendix A) on humans and animals. Levels of VOC's measured in ambient air are consistent with levels measured in many industrial settings in the United States, and no single specific source has been identified. [3]

Data

Data from monitoring wells has been used to characterize the nature and extent of the contamination in the areas around the railyard (See Appendix B). These data have also been used to identify specific areas where more data were needed to determine potential exposure to local residents. In addition to data from groundwater monitoring wells, ambient air, soil gas, residential crawlspace, and residential irrigation wells have also been repeatedly sampled. Based on the pathways analysis (see Table 2), EHAP determined that the potential exposures of most concern were from inhalation of indoor air and incidental ingestion of irrigation well water.

The data that were available at the time of the release of the draft report indicated relatively stable levels of TCE and PCE in groundwater, soil gas, ambient air, and crawlspaces in the neighborhoods affected by the VOC plume. Additional samples were collected in April and August 2007 using a method described by UPRR's contractors, and approved by ODEQ, as more reliable due to improved detection limits, more representative sampling and reduced possible cross-contamination. [4] Based on the assertion that the new method used was more reliable, EHAP requested that ODEQ provide a quality assurance test on the method and collect additional samples during the August 2007 sampling event. The quality assurance testing conducted by ODEQ verified the accuracy of the samples collected by CH2M Hill. All of the data collected from 2004 to 2007 were used for this PHA.

VOCs in Indoor Air

Crawlspace Sampling

The majority of samples from residences in the Trainsong neighborhood were collected from crawlspaces, with a very limited number of samples were taken from indoor air in August 2006 as part of a pilot study to test vapor barriers. Because of the very limited availability of indoor air data, crawlspace data were used to estimate the levels of VOC's that residents might be exposed to in indoor air.

Soil gas, crawlspace, and ambient air samples collected since 2004 were collected from locations in neighborhood locations identified in Figure 2. These data were reported by Kennedy-Jenks Consultants in January 2007 in the *"Groundwater, Soil Gas, Crawlspace and Ambient Air Summary Report, Eugene Railyard"* report [5] and were supplemented by data collected at these and additional locations in April and August, 2007 as reported to ODEQ by CH2M Hill.

The samples from residence crawlspaces fall into one of four categories (See Table 3); the data from all samples were analyzed together and separately. The samples in categories A and B (n=18) provide a picture of current conditions only, while samples from categories C and D (n=14) provide both current and historical information.

Table 3 – Number of Samples Collected in Trainsong Locations

Category	Number of Samples	Sampling Dates	Number of Sampling Locations (N=32)	Locations
A	1	8/07	14	3,4,6,9,11,15,16 17,19,23,24,26,3 0,31
B	2	4/07 and 8/07	4	1,2,10,32
C	2	10/06 or 3/06 and 8/07	6	7,8,12,14,20,22
D	3 or more	5/04 to 8/07	8	5,13,18,21,25, 27,28,29

Figure 2 –2004-2006 Sampling Sites for Air, Soil Gas and Crawlspace Data

The Source of VOC's in Indoor Air

There is uncertainty about the relationship between the VOC plume and the level of VOC's found in crawlspace air. When groundwater is contaminated with VOC's, the route of exposure is from groundwater to soil gas to outdoor and indoor air. We therefore expect to see a clear association between levels detected in groundwater, soil gas and air. In this case, there were instances when the VOC levels measured in groundwater and soil gas were poorly correlated, and instances where levels measured in soil gas and indoor air also showed a weak association. Conversely, levels detected in outdoor (ambient) and indoor air showed an association, indicating that the VOC plume may not be the only source of vapors detected in residential crawlspaces.

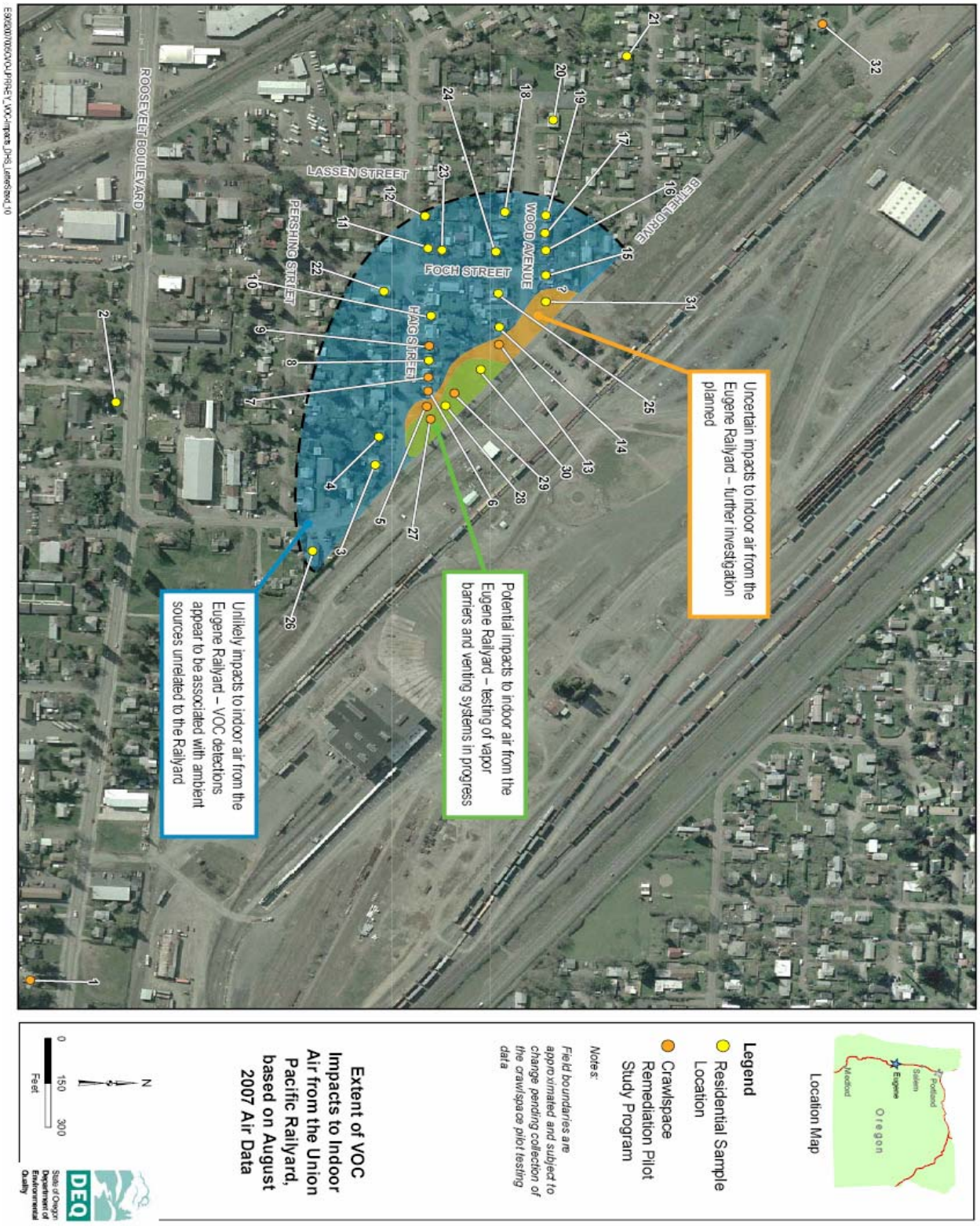
Based on past soil gas and air data, ODEQ believes that there appears to have been a contribution from the Railyard of VOCs in crawlspaces in a small area of the Trainsong neighborhood. Outside this area, ODEQ believes that VOCs detected in crawlspace air are likely related to ambient VOCs, and not the Railyard. Specific ambient sources have not been identified, but typically include dry cleaning, metal degreasing, adhesives, paint removers, and other cleaning products. Studies currently being overseen by ODEQ in the Trainsong neighborhood will be used to further evaluate the magnitude and extent of the VOC contribution from the Railyard. Based on groundwater data, DEQ has concluded that River Road neighborhood crawlspace air is not adversely impacted by groundwater contamination from the railyard [6]

Based on August 2007 soil gas and air data, DEQ has concluded that that there is currently a potential contribution of VOCs from the Railyard to crawlspace air in a small area of the Trainsong neighborhood immediately next to the Railyard. Figure 3 provides a visual representation of three categories of homes and DEQ's assessment of the likelihood that contamination measured in these homes is associated with the Railyard. The categories are defined as:

- Category 1 - includes Locations 27, 28, 29 and 30 and is defined as homes that are *potentially impacted by the Railyard*; testing of vapor barriers and venting systems is in progress in these homes.
- Category 2 - includes Locations 5, 13, and 31 and is defined as locations where it is *uncertain whether there are impacts to indoor air from the Railyard*; further investigation is planned at these homes.
- Category 3 includes all remaining homes and is defined *unlikely that there are impacts to indoor air from the Railyard*; VOC detections appear to be associated with ambient sources unrelated to the Railyard.

Homes with crawlspaces tested in the sampling events occurring prior to August 2007 represent a random sample of homes located over the VOC plume. (See Appendix B – Plume Maps) We assumed that the levels of TCE and PCE found in crawlspaces reflect the levels that would have been found in other homes in the area located over the plume had they been tested during those same sampling events. Some of the homes tested in these sampling events are outside of the plume as it is currently depicted, but there is evidence that the plume has receded over time. [7] Therefore we assume that samples may indicate the past levels in homes previously located over the plume.

Figure 3 - Extent of VOC Impacts to Indoor Air from the Union Pacific Railyard, based on August 2007Air Data



We cannot determine the effect that time has had on the relationship between the plume as it previously existed and levels of TCE and PCE in air in homes which are currently outside the plume. However, it is reasonable to consider that those homes which were at one time located over the plume were similarly affected in the past by the presence of VOC's in the groundwater and soils in these areas.

Health Risk Associated with Exposure to Indoor Air

VOC levels detected in residential crawlspaces were compared to ATSDR's comparison values and Oregon's Risk Based Concentration (RBC) levels to determine if further evaluation was warranted. Comparison values are media specific concentrations of contaminants that are considered to be safe levels of exposure. Exceeding a given comparison value does not mean that adverse health effects would be expected to occur. Only one sample in one home exceeded ATSDR's comparison value, but several samples exceeded Oregon's RBC for TCE and PCE, so it was determined that additional assessment of the data was indicated.

As stated above, concentrations of TCE and PCE in air detected in home crawlspaces are being used as surrogates for air in the living spaces of people's homes. This is being done because we have very limited measurements of indoor air. In order to be protective of health, we must assume that 100 percent of TCE and PCE measured in crawlspaces is making its way into air inside living spaces. However, it is important to note that people living in homes over the plume are likely to be exposed to lower levels that those detected in crawlspaces because air is generally not fully exchanged between crawlspaces and indoor air.

To assess the human health risk from exposure to indoor air contaminated with TCE and PCE, EHAP reviewed all of the crawlspace data collected from 2004 to 2007. Maximum and median concentrations detected in crawlspaces were used to identify the "worst case" (maximum) and the most likely case (median) concentrations in air that residents might be exposed to, and were used to calculate acute (non-cancer) and chronic (cancer) risk from inhalation exposure. The calculations are presented in Appendix C.

Estimating Cancer Risk

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 always expressed as the number of excess cancers expected in a specific population given a lifetime of exposure.

- Moderate risk = 1.0E-3 *(about 1 in 1,000 people)*
- Low risk = 1.0E-4 *(about 1 in 10,000 people)*
- Very low risk = 1.0E-5 *(about 1 in 100,000 people)*
- Slight or negligible risk = 1.0E-6 *(about 1 in 1,000,000 people)*

It is important to note that this is a theoretical risk of cancer. It does not mean that additional cancers *will* occur among the people exposed to VOC's at the site; only that it *could* occur. EHAP considers cancer risk above 1.0E-04 to exceed health guidelines.

Based on the data available, EHAP calculated the potential for both non-cancer and cancer risks to residents from breathing the indoor air with these concentrations of the contaminants.

Cancer Risk

Cancer risk was calculated using the unit risk factor (URF) to estimate the probability of a person contracting cancer as a result of constant exposure to a concentration of one microgram per cubic meter of a substance over a 70 year lifetime. (See Appendix C)

In samples collected between 2004 and 2006 two locations (8 and 27) exceeded health guidelines at the maximum levels detected and 11 locations (5, 7, 12, 13, 14, 18, 20, 22, 25, 28, and 29) exceeded health guidelines at the median and maximum levels detected.

Median concentrations for all samples collected at each location indicated a theoretical cancer risk that ranged from 4.02E-06 (4 additional cancers cases per 1 million people) to 5.43E-04 (5.4 additional cancers per 10,000 people). The median level concentration represents the level that is the mid-point of all of the detected levels and the most likely exposure level that people might experience.

Maximum concentrations for samples collected at each location indicate a theoretical cancer risk that ranged from 6.93E-03 (6.9 additional cancer cases per 1,000 people) to 3.14E-06 (3 additional cancer cases per 1 million people).

The determination of risk based on the maximum concentration is important to the assessment of health risk because it is the most health protective. It is important to note however that it is a very conservative and theoretical estimate of risk. Specifically, the determination was based on use of the maximum levels found in any home and the use of crawlspace data as a surrogate for indoor air. Based on the assessment of dose and risk, EHAP has determined that if residents were exposed to the maximum levels of PCE and TCE in indoor air, it would pose an unacceptable cancer risk for both adults and children. However, this is not the most likely scenario.

Based on the most likely exposure scenario (median level concentrations in crawlspace air) we do not expect that levels of VOC vapors measured in the existing data will result in adverse health effects. However, the potential risks indicate that steps should be taken to eliminate the intrusion of vapors into homes and into the breathing space of residents.

Additional Levels of Analysis

Two important elements of analysis were added to this health assessment since the time the draft report was issued, including a geographic analysis of the data and a review of concentrations in crawlspace air measured over time. These additional analytic steps have yielded important information related to how health risk was assessed and understood.

Proximity to the Railyard

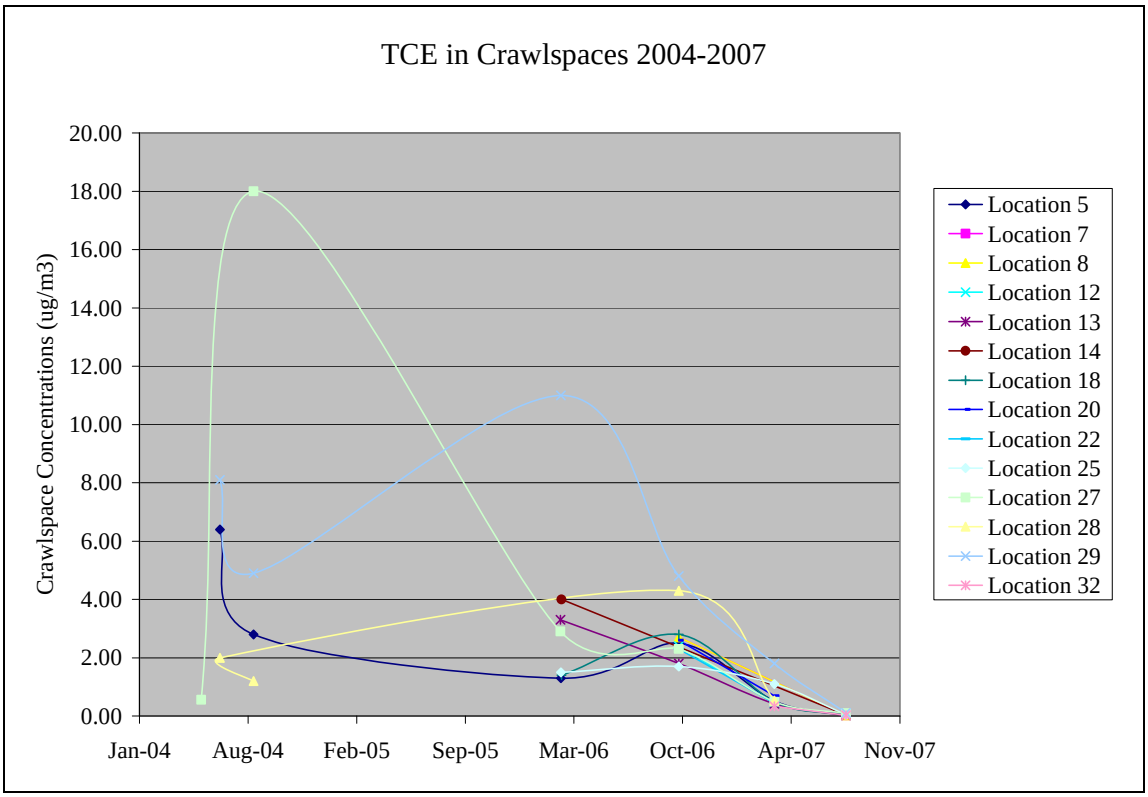
All of the crawlspace data were analyzed from the perspective of the distance from the UPRR Railyard, source of the VOC groundwater plume. Homes further away from the source, had lower levels detected in crawlspaces, which correspond to lower risk of

adverse health effects. A small number of homes located closest to the railyard have the highest documented VOC concentrations detected in crawlspaces. ODEQ has defined this as the area potentially impacted by the railyard (See Figure 3). A review of the data collected from crawlspaces indicates that potential health risks associated with exposure to indoor air contaminated with VOC's are higher in homes closest to the Railyard. This includes a total of 4 homes (Locations 27, 28, 29 and 30). Another group of homes (Locations 5, 13 and 31) are also close, but not immediately adjacent to the Railyard.

Concentrations Measured over Time

Crawlspaces that were sampled multiple times since 2004 show decreasing levels of TCE over time, as depicted in Figure 4. TCE is the chemical having the greatest influence on potential health risks, so although levels of PCE remain relatively consistent over time, risks to human health have decreased with the decrease in TCE levels. This decrease was particularly notable when comparing levels detected April and August 2007 with levels measured in prior sampling events. This depiction includes only locations where recent samples could be compared with samples collected in 2006 and earlier. In addition, one sample collected from location 28 in February 2006, was excluded because it was unusually high (63 ug/m^3) and distorted the scale. In the samples collected in April and August 2007, levels detected in 31 out of 32 homes fell to levels below levels of concern.

Figure 4 - Concentrations of TCE in Crawlspaces over Time



CH2M Hill reported no specific activity related to the remediation of the site that could account for the reduction in measurable concentrations in crawlspace and ambient air, but speculated that variability in wind speed and direction could cause significant fluctuations in concentrations in ambient air. Since ODEQ has determined that ambient air is the likely source of the concentrations measured in locations other than the 7 closest to the Railyard, this could account for the reduction in levels in these crawlspaces as well.

Non-Cancer Risk

Non-cancer risks, referred to as "hazard quotients" are calculated by dividing the level detected by the reference concentration (RfC) The RfC an estimate of a continuous inhalation exposure that is likely to be without risk of adverse non-cancer effects during a lifetime. A hazard quotient exceeding 1.0 indicates a higher than acceptable risk for non-cancer health effects. A hazard quotient is used to calculate the probability of a non-cancer health effect. The USEPA defines a hazard quotient as:

> "The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible. The Hazard Quotient cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur. [8]

Data presented in Appendix C indicate that non-cancer risks were negligible based on comparisons to non-cancer health guidelines of both median and maximum TCE and PCE air concentrations. Hazard quotients were calculated for both maximum and median concentrations. At the maximum level, the hazard quotient indicates a slightly elevated risk for non-cancer health effects and at the median level of exposure, the risk for non-cancer health effects is negligible.

According to the review on TCE conducted by the Committee on Human Health Risks of Trichloroethylene, National Research Council, "Effects from acute (<14 days) exposure to trichloroethylene are widely reported in humans. At lower exposures (50-300 ppm), headache, fatigue drowsiness and inability to concentrate are reported."[3] 50-100 ppm translates to 2,700-5,400 ug/m^3; levels that are far higher than any levels measured in ambient air and crawlspaces sampled in the area.

Vapor Barriers

In January 2007, at the request of ODEQ, Kennedy-Jenks Consultants submitted a proposal to ODEQ to study the effectiveness of vapor barriers and ventilation systems in homes with unacceptable levels of VOC's in the crawlspaces "to evaluate the efficacy of vapor barriers and venting systems, where installed, and how they might impact the possible concentrations of VOC's in indoor air" [9]. Unacceptable levels of VOC's are defined by ODEQ as exceeding State of Oregon Risk-Based Concentrations (RBC's), which are set at levels which could theoretically cause one additional cancer case per one million people. In August 2007, CH2M Hill, under oversight by ODEQ, began the vapor

barrier test by collecting baseline indoor air data, and collecting additional crawlspace, ambient air and soil gas samples at 9 locations (1, 5,6,7,9,13,27,29, and 32). After the baseline data were collected, vapor barriers and venting systems were installed. EHAP expects that information collected as part of this pilot project will be useful in helping to understand the relationship between the VOC plume and levels detected in crawlspaces and indoor air, and in determining what actions should be taken to reduce intrusion of VOC vapors into all homes with unacceptable levels of VOC's in crawlspaces.

VOC's in Irrigation Wells

Irrigation Well Sampling

Between 1995 and 2004, 84 irrigation wells within the vicinity of the railyard were tested as an initial step in characterizing VOC's in the area, and to determine the placement of additional monitoring wells. Twenty-four (24) of the wells were identified for additional sampling based on this testing. Four (4) of the 24 wells could not be tested because of inoperable pumps or pipes. Table 4 provides a summary of the data collected from the 20 irrigation wells tested.

Health Risk Associated with Exposure to Irrigation Well Water

EHAP considered several scenarios to evaluate the exposures for adults and children living in homes with contaminated irrigation wells, and the associated health effects from these exposures. Based on the usage of the wells as described by local residents, we assumed that adults and children would be exposed to well water by gardening, washing cars, and other incidental use of water, and that they were not using the water for drinking or cooking. These exposure scenarios included dermal and incidental ingestion exposures to the well water. Because we assumed that exposure to well water was incidental, we had to calculate a specific dose and from that dose calculate non-cancer and cancer risks rather than use the RfC or unit risk factor to calculate risk, because they assume more common, and higher rates of water use.

It was assumed that adults would be exposed to well water 1 hour per day, 120 days per year for 30 years, and that children would be exposed for 60 days per year for 6 years. For incidental ingestion exposure, we assumed that adults would ingest approximately 50 ml (2 oz.) of water per day, for 120 days per year for 30 years, and that children would ingest approximately 100 ml (4 oz.) of water for 60 days per year for 6 years. It was assumed that inhalation of vapors from this use of the well water would be minimal and was not evaluated further. (See Appendix D for Exposure Assumptions)

Table 4 - Irrigation Well Usage and Sampling Data

Location	TCE [ug/l]	PCE [ug/l]	Historical Use	Current Use	Future Use	Frequency of Use
Average Concentrations by Location (2000-2006)						
Location 1	1.390	5.369	Irrigation, washing things off outside	Irrigation, washing things off outside	Irrigation, washing things off outside	Frequently during summer, occasionally in winter
Location 2	2.013	1.368	Irrigation	Not used	No plans for future use	Not used
Location 3	<1.00	<1.00	Unknown	Not used	No plans for future use	Not used
Location 4	5.156	16.976	Irrigation	Not used	No plans for use	Not used
Location 5	0.379	1.553	Irrigation, car washing	Irrigation, car washing	Irrigation, car washing	Every day in summer, none in winter
Location 6	0.131	1.815	Irrigation	Not used, no pump	Unknown	Not used
Location 7	0.658	3.767	Irrigation	Irrigation	Irrigation	Occasionally during the summer
Location 8	1.347	5.527	Irrigation	Not used	Unknown	Well has not been used for at least 10 years
Location 9	2.625	3.130	Irrigation	Same	Same	Every other day in summer, none in winter
Location 10	2.580	4.480	Irrigation	Same	Same	A lot in summer, none in winter
Location 11	0.915	1.615	Irrigation	Not used	Unknown	Not used
Location 12	1.570	2.250	Irrigation	Same	Same	Every third day in summer, none in winter
Location 13	1.157	1.070	Irrigation	Irrigation	Irrigation	Intermittent use during summer
Location 14	1.57	1.5	Irrigation	Same	Same	Every day in summer, occasionally in winter
Location 15	2.530	3.195	Irrigation	Same	Same	Every day or two in summer, none in winter
Location 16	1.00	3.21	Irrigation	Same	Same	Three times per week in summer, none in winter
Location 17	<1.00	<1.00	Irrigation	Same	Same	Every day in summer, none in winter
Location 18	1.15	1.98	Unknown	Irrigation	Irrigation	Intermittent use during summer
Location 19	1.02	1.42	Irrigation	Same	Same	Two times per week in summer, none in winter
Location 20	1.36	1.62	Irrigation	Same	Same	Occasionally during spring, summer, and fall; none in winter

< = Below reporting limit

Table 5 – Cancer and Non-Cancer Risk from Use of Irrigation Wells

Groundwater Concentrations and Comparison Values					
	Maximum GW Concentration [ug/l]	**Mean GW Concentration** [ug/l] Mean of Fall and Spring Averages 2000-2006		**Oral MRL or RfD (chronic)** [mg/(kg-day)]	**RfC [ug/m^3]. Non-cancer**
TCE	15.2	2.24		0.0003	40
PCE	50.7	4.75		0.01	300
Health Risks					
	Mean Level [ug/l]	**Hazard Quotient Child**	**Hazard Quotient Adult**	**Child Cancer Risk**	**Adult Cancer Risk**
Incidental Ingestion					
TCE	2.24	0.01	0.00	8.4E-08	9.0E-08
PCE	4.75	0.00	0.00	9.4E-07	1.0E-08
Dermal Exposure					
TCE	2.24	0.00	0.00	3.4E-10	7.6E-10
PCE	4.75	0.00	0.00	3.7E-11	8.4E-11
			Total Cancer Risk	**9.4E-08**	**1.0E-07**
	Maximum Level [ug/l]	**Hazard Quotient Child**	**Hazard Quotient Adult**	**Child Cancer Risk**	**Adult Cancer Risk**
Incidental Ingestion					
TCE	15.2	0.06	0.01	5.7E-07	6.1E-07
PCE	50.7	0.01	0.00	1.0E-07	1.1E-07
Dermal Exposure					
TCE	15.2	0.00	0.00	2.3E-09	5.1E-09
PCE	50.7	0.00	0.00	4.0E-10	9.0E-10
			Total Cancer Risk	**6.7E-07**	**7.3E-07**

EHAP considered the risk scenario of adults and children exposed to water in a small backyard pool because this scenario was described in the Human Health Risk Assessment. An initial review of the risk indicated a very low risk of non-cancer or cancer effects from dermal, inhalation and incidental ingestion exposures from pool water. Also, the well survey indicated that no one with irrigation wells was using the water to fill backyard pools so EHAP determined that additional risk calculations for this scenario were not necessary.

Based on the presented in Table 5, and the exposure assumptions for adults and children described in Appendix E, EHAP determined that exposure to irrigation well water does not pose a public health hazard to adults or children. At maximum concentrations, adults and children are at risk of about one additional cancer cases per 10 million persons, a rate well below the level considered to be significant. Hazard quotients indicate that non-cancer risks were well below non-cancer health guidelines.

Child Health Considerations

EHAP and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and to bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Because children depend on adults for risk identification and management decisions ATSDR is committed to evaluating their special interests at sites where they could potential be exposed to hazardous substances. It is important to note that health risks were calculated specifically for children in this assessment and the guidelines used by EHAP were derived from comparison values that incorporate a high level of protectiveness for children.

Conclusions

- Based on the results from the August 2007 sampling event, ODEQ determined that indoor air at 4 locations is potentially affected by the contamination at the UPRR Railyard, and that it is uncertain if 3 additional locations are affected by the contamination at the UPRR Railyard.
- ODEQ also determined that indoor air at the remaining 25 locations in the area of interest are unlikely to be affected by the Railyard, and that other sources contaminating ambient air are likely to be the source of contamination in these locations.
- The levels of VOC vapors detected in crawlspaces samples collected at 11 locations tested between 2004 and 2006 exceeded health guidelines at maximum and median levels; the levels detected are considered to be *a past public health hazard.*
- The levels of VOC vapors detected in 31 of 32 crawlspaces showed a measurable reduction in crawlspace and ambient air samples collected in April and August 2007 as compared with previous samples. The new levels did not exceed health guidelines, however it is unclear why this reduction in measurable contamination occurred.
- Given the uncertainty related to the cause for a reduction in levels measured in crawlspace and ambient air, EHAP considers it plausible that levels could increase above health guidelines in the future; we therefore conclude that an *indeterminate public health hazard* exists currently in locations previously exceeding health guidelines.
- Currently all homes with irrigation wells in the River Road neighborhood receive their drinking water from the municipal supply. Use of irrigation water poses *no apparent public health hazard* to adults or children if the water is used to irrigate gardens or to hose off outside surfaces.

Recommendations

- Studies currently being overseen by ODEQ in the Trainsong neighborhood should continue in order to further evaluate the magnitude and extent of the VOC contribution from the Railyard.
- Additional ambient air and crawlspace samples should be collected to ensure that lower levels measured in April and August 2007 are stable in posing no health threat.
- In homes where the TCE or PCE concentrations exceed health-based standards, and where evidence is suggests that VOC contaminated groundwater is the source of vapors, vapor barriers and/or ventilation systems should be installed to reduce the exposure to contaminated indoor air.
- Residents in homes with irrigation wells should limit their use of the water to irrigating gardens and hosing off outside surfaces. Water from municipal water supply should be used for drinking purposes.
- Preliminary review of data for use of irrigation water in backyard pools does not indicate a health risk; however as a precaution EHAP advises that alternative sources of water be used to fill backyard wading pools for small children.
- ODEQ should evaluate the need for identifying a mechanism to inform future homeowners and/or residents of the need to limit use of irrigation well water to irrigating gardens and hosing off outside surfaces.
- Remediation efforts to neutralize the VOC plume should continue in order to eliminate a potential source of VOC's in irrigation wells and indoor air above DEQ's acceptable levels.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by EHAP and other government agencies at the site. The purpose of the public health action plan is to ensure that this public health assessment both identifies public health hazards and provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of EHAP to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken include the following:

- EHAP conducted a site visit and met with concerned community members and groups,
- ODEQ has been working with the UPRR and their consultants, in consultation with EHAP, to evaluate options for sampling and cleanup of the site that protect public health and reduce risks of exposure and to respond to community concerns,
- EHAP reviewed DEQ sampling plans and remediation activities. ODHS regularly communicates with ODEQ about activities related to this site.
- EHAP conducted a public meeting in order to provide information related to the draft health assessment and to provide a forum for community members to voice their questions and concerns.

Public health actions to be implemented:

- EHAP and ODEQ will co-sponsor a public meeting in November 2007 to present the findings of this report and the status of cleanup actions and next steps.
- EHAP and ATSDR will continue to provide assistance to regulatory agencies during planning for site sampling and cleanup.
- EHAP and ODEQ will continue to provide updated information as it becomes available and respond to community questions and concerns.
- EHAP will continue to develop fact sheets and other educational materials as indicated.

References

1. Kennedy/Jenks, *Interim Final Baseline Human Health Risk Assessment, Eugene Railyard*. January 18, 2006, Kennedy/Jenks Consultants.
2. Kennedy/Jenks, *Residential Irrigation Well Sampling Summary Report, Trainsong and River Road Area, Union Pacific Railroad Company, Eugene Railyard*. January 19, 2007, Kennedy/Jenks Consultants.
3. Committee, o., Human, Health, Risks, of, Trichloroethylene, *Assessing the Human Health Risks of Trichloroethylene: Key Scientific Issues*, N.R. Council, Editor. 2006, National Academies.
4. Honeyman, G., *Comments in Response to Draft Public Health Assessment*, C.M. Hill, Editor. 2007.
5. Kennedy/Jenks, *Groundwater, Soil Gas, Crawlspace and Ambient Air Sampling Summary Report, Eugene Yard*. January 19, 2007, Kennedy/Jenks Consultants.
6. ODEQ, *Fact Sheet*. 2007.
7. Ochsner, M., *Personal Communication*, J. Douglas, Editor. 2006: Portland.
8. USEPA. *Glossary of Key Terms*. August 23, 2006 [cited.
9. Kennedy/Jenks, *Crawlspace Remediation Pilot Study Work Plan, Eugene Yard*. January 19, 2007, Kennedy/Jenks Consultants.
10. USGS, *Volatile Organic Compounds*. 2006, Toxic Substances Hydrology Program, US Geological Survey.
11. ATSDR, *Toxicological Profile for Trichloroethylene, update*. 1997, US Department of Health and Human Services: Atlanta.
12. ATSDR, *Toxicological Profile for Tetrachloroethylene, update*. 1997, US Department of Health and Human Services: Atlanta.

Public Comment

This document was released for public comment from May 29, 2007 through June 28, 2007. The public comment period is an opportunity for the public to comment on EHAP's findings or proposed activities contained in this draft document. EHAP received 3 sets of comments in that period, and supplemental comments after the period ended. This document includes the summarized comments received during the comment period and EHAP's responses. Comments received after the comment period ended were reviewed and considered in revising this document but are not responded to here.

Comment

"The PHA fails to consider the well-documented and undisputed presence of TCE and PCE in normal outdoor air throughout the Trainsong neighborhood, or the substantial data showing that ambient air is the primary source of vapors detected in crawlspaces."

Response

EHAP assessed the presence of TCE and PCE measured in outside (ambient) air, and determined that the levels detected did not pose a health risk to local residents. This assessment was omitted in the original document, but has been included in this final version. We recognize that there is some uncertainty whether the documented plume emanating from the Railyard is the only source of VOC's contributing to vapors in crawlspaces. It is not EHAP's role to determine the source of contamination, or to resolve uncertainties in identifying sources; this is the role of ODEQ. At the time of the release of draft of this report, ODEQ had not concluded that the plume was not the primary source contributing to crawlspace concentrations of TCE and PCE. ODEQ has now determined that there appears to have been a contribution from the Railyard of VOC's in a small area of the Trainsong neighborhood. Outside this small area, ODEQ believes that VOCs detected in crawlspace air are likely related to ambient VOCs, and not the Railyard.

Comment

… the PHA mentions on page 8 that groundwater concentrations and crawlspace concentrations are poorly correlated. Yet, there is no explanation of what this means or how it could affect conclusions about resident health. What exactly is meant by 'poorly correlated'?

Response

Correlation is a term which is used to indicate that as levels in one media thought to be a conduit of contamination (i.e. groundwater or soil gas) increase or decrease, levels in another media (crawlspace) should increase or decrease accordingly. This is especially important when determining the source of contamination in the second media. In this instance, we would expect that TCE and PCE measured in soil gas would higher than measured in order to produce the levels of TCE and PCE measured in crawlspaces.

Comment

The PHA fails to consider that only a single crawlspace has ever had TCE measured anywhere close to the level that the PHA concludes present a chronic health threat, or that

TCE levels in this one crawlspace were lower on the four other occasions on which it was sampled.

Response
It is true that only one crawlspace measured at the highest concentration (63 ug/m^3) level detected. However, two additional crawlspaces had detections of TCE which measured at levels which correspond to a similar risk level for increased incidence of cancer (i.e. 1 additional cancer case per 1,000 persons). In addition, several homes had detections of TCE which measured at levels which correspond to increased incidence of cancer which is considered unacceptable by public health (i.e., 1 additional cancer case per 10,000 persons). We have modified this report to document the number of homes with levels which correspond to these increased cancer incidence risks. (See Appendix C)

Comment
The PHA fails to consider air samples taken throughout the neighborhood in Spring 2007 showing that no crawlspaces exceeded the TCE or PCE levels that the PHA itself concludes would not be expected to result in adverse health effects.

Response
At the time of the release of the initial draft of the report, these data were not available. They have been included in this final version.

Comment
For now, policy and guidance about vapor intrusion and TCE screening levels and risk factors "vary widely" among agencies… there is no scientific or regulatory consensus, and much uncertainty, about the risks of this chemical.

Comment
The PHA assumes that TCE is fifty-times more toxic than the standards established by the U.S. EPA Office of Air Quality and Planning and the Oregon Department of Environmental Quality Air Toxics Program

Comment
[EHAP's] report should mention that EPA has not completed their most recent assessment of risks of TCE or PCE. It should also acknowledge that different jurisdictions are using different numbers to calculate risks of these chemicals in the meantime, and also different thresholds to designate "acceptable" risk or to trigger the need for cleanup or action to reduce risk. There are choices to be made, and not a single accepted "answer".

Response
SHINE used standards for evaluating the toxicity of TCE that are accepted by Oregon ODEQ's Clean-up Program and Office of Environmental Assessment at Region 10 of the USEPA. (See Appendix D) USEPA Region 10 asserts that

> "it is appropriate, for risk assessment purposes, to use the values provided in the Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft). U.S. Environmental Protection Agency, Office of Research and

Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-01/002A, 2001… The use of the toxicity values in this document has been endorsed by NCEA's Superfund Technical Support Center. The Region 10 risk assessors believe that use of the EPA 2001 external review draft health risk assessment for TCE comports with the requirements of EPA's Information Quality Guidelines, in that the assessment has been externally peer-reviewed and that it represents the best available science.

Comment
The PHA assumes thirty-six years of exposure but calculates risk based on 70 years of exposure

Response
In this health assessment, health effects for were evaluated differently for irrigation well exposure and exposure to VOC vapors in indoor air; both cancer and non-cancer health effects were calculated for both scenarios. For the irrigation well exposure scenario we first had to calculate a dose based on how people reported using their wells because the levels consumed were much lower than commonly accepted amounts of water consumed for drinking and bathing. This dose was used to calculate both cancer and non-cancer risk, Non-cancer risks were calculated assuming an exposure period of 30 years (for adults, 6 years for children). This is based on the idea that an acute or non-cancer effect would present itself in a much shorter timeframe than a cancer effect for cancer effects, a lifetime of exposure (70 years) is used. Additional assumptions about body weight, ingestion rates, skin permeability and number of hours and days per year exposed are detailed in Appendix D.

For exposure to TCE and PCE vapors, we were able to use a reference concentration (RfC) to calculate non-cancer risk and unit risk factor (URF) to calculate cancer risk. Assumptions about levels of exposure, body mass and length of exposure are standardized and already built into the RfC and URF.

Comment
The PHA recommends installation of crawlspace vapor barriers despite the fact that such a system would have no impact of the background levels of PCE and TCE in urban air, which the primary source of crawlspace vapors.

Response
You are correct in saying that vapor barrier would have no impact on background levels of TCE and PCE in the ambient air. However, at the time of the writing of the initial report, and to date it has not been disproved that the solvent plume is responsible for vapors which may be intruding into the indoor air of homes close or adjacent to the Railyard; the data available to date indicate that TCE and PCE levels detected in homes correspond to the plume as it is currently depicted, and higher levels have been detected in homes which are closer to the railyard.

Comment
Are there seasonal variations?

Response
There do appear to be seasonal variations in the concentrations of TCE and PCE detected. Levels measured in groundwater, air, soil gas and crawlspaces increase in the summer months and decrease in the winter months, indicating that when the water table is higher (in the winter months) the concentration of solvents is diluted, and in the summer months it is more concentrated.

Comment
Is the data available to home owners? A home measured high for vapor intrusion is a rental, but renters have not been notified of unsafe levels. Residents only heard about test results from a reporter. Owners have also "Not" received test results. Make all data accessible to public. ***** Both residents and property owners should be provided with all test results in a timely manner**.**

Response
ODEQ has made a commitment to communicate with homeowners and resident tenants.

Comment
Has a survey been conducted to determine the actual health impacts?

Response
No survey has been conducted by state health officials.

Comment
How much longer will it take to clean this up?

Response
Questions related to clean-up remedies and timelines are best responded to by ODEQ.

Comment
Instead of continuing with testing endlessly, let's move to mitigation with vapor barriers.

Response
UPRR's consultants, under the supervision of ODEQ are testing a method to reduce or eliminate solvent vapors intruding into indoor air space. This testing will provide important information about the source of vapors and is an important step in determining the most effective method available to reduce possible exposures.

Comment
Would data be different if neurological impacts were considered?

Comment
The information SHINE provides on health hazards is very skimpy on the neurotoxic effects of both TCE and PCE. Some residents of Trainsong have expressed concerns about neurological symptoms they are experiencing.

Response
The risks of neurological impacts are included in the estimate for “non-cancer” health effects. Risk for neurological have been identified in animal and human health studies as occurring in exposure to as low as 50 to 100 ppm, [3] which translates to 2,700-5,400 ug/m^3; these are levels that are far higher than any levels measured in ambient air and crawlspaces sampled in the area.

Comment
Can TCE be absorbed through skin?

Response
Yes. Dermal absorption of TCE was included in the estimate of risk from exposure to water from irrigation wells.

Comment
There also needs to be a way to ensure that newly arriving residents to the area are informed about the contamination of groundwater, potential exposure via use of well water and vapor intrusion, and suggested restrictions on use of well water.

Response
This has been added as a recommendation to the report.

Comment
What amount of tax-payer money goes towards the RR project?

Response
UPRR is in ODEQ’s voluntary clean-up program. The voluntary clean-up program requires that UPRR pay for all costs associated with the investigation and clean-up of the site.

Comment
Is the crawlspace remediation a "band-aid"?

Response
The remediation of the source of solvents is underway, but it is a long-term project. Until the source of the contamination is eliminated, it may be necessary to take action to prevent exposures to residents in the area of highest concentrations over the plume.

Comment
What about air testing for homes on a slab?

Response
ODEQ and UPRR’s consultants are devising a method to test homes with no basement or crawlspace. This testing will be included in future sampling events.

Comment
These results will reduce property values - is there recourse? Is there compensation? What are the options? Buy-out options like Love Canal?

Response
It is not EHAP's role to advise or comment on legal remedies.

Comment
How much testing just beyond the edge of the plume?

Response
Monitoring wells were used to collect samples used to determine the shape and character of the solvent plume. Those wells with no detectable solvents indicate the outside border of the plume.

Comment
Without doing indoor air testing, can SHINE really determine the level of the health impacts?

Response
Determining the level of health impact is a complex and difficult process. The data used for this assessment only estimates the "theoretical risk" of a health affect; even indoor air testing would only provide us with a way to estimate a theoretical risk. Using the crawlspace data to estimate the possible exposure to residents over-estimates the risk of an adverse health effect for VOC's that come from the groundwater plume, but it is done to be most health protective.

Comment
What about past exposures, current cancer cases / serious health problems?

Response
The data used in this health assessment go back as far at 1997 when sampling began at this site. Although we are able to state that the contamination was probably present prior to that time, we have no data available to identify the concentration of solvents in groundwater, ambient air, soil gas and crawlspaces before 1997, and are therefore unable to estimate possible past exposure.

It is unknown at this time whether there is a measurable relationship between exposure to solvents in groundwater or air and higher than expected rates of cancer or other health effects. However, based on the available data, EHAP does not expect that exposure to the levels measured to date will result in adverse health effects.

Comment
Would you consider studying Railyard workers cancer rates?

Response
Neither state nor federal public health agencies have the authority to investigate cancer rates among active workers. The Oregon Department of Occupational Safety and Health (OR-OSHA) is the agency responsible for investigation health concerns among Oregon workers.

Comment
I do think the report title, "Public Health Assessment, Union Pacific Railyard," is overly broad and should be narrowed so as not to mislead residents that this is a complete assessment of all the risks from railyard pollution associated with this site--certainly not the case.

Response
ATSDR has a specific convention for titling documents stemming from health investigations which requires that the type of investigation (in this instance a Public Health Assessment) is indicated followed by the name of the site (in this instance the Union Pacific Railyard). This is the reason that the initial section specifies the purpose of the document and the scope of the investigation.

Comment
Both in the Summary, and in the Conclusions sections, the report refers to VOCs in crawlspaces and potential contamination of indoor air of homes in River Road as well as Trainsong neighborhoods. At the meeting about this report, SHINE explained that it was an error to have included mention of River Road.

Response
The document has been corrected to exclude River Road as an area potentially affected by vapor intrusion

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Comment
…the reasons for less concern about vapor intrusion in River Road… should be explained in the report, preferably with data to back up the reasoning.

Response
The report has been amended to include information as the reason for less concern about vapor intrusion in the River Rd. area.

Comment
The report states that the Jan. 2006 Draft Human Health Risk Assessment … did not draw any conclusions about the risk from VOCs in soil and groundwater because these pathways were still under investigation. In fact, the HHRA did estimate risks to residents from exposure to VOCs in groundwater:

Response
You are correct. The HHRA did estimate excess risk from exposure to groundwater in irrigation wells. The sentence should have read “The pathway of groundwater to indoor and ambient air was not evaluated in the HHRA.” The document has been corrected.

Comment
SHINE should acknowledge the earlier risk assessment results, and explain how the standards and factors and assumptions you used differ from those used earlier by … that led to higher estimates of risk.

Response
In accordance with regulatory requirements governing clean-up of hazardous waste the Human Health Risk Assessment used Oregon’s Risk Based Concentration (RBC) values to determine the potential risks to human health and to guide the remediation plan. EHAP uses comparison values approved by ATSDR and the USEPA.

Comment
How can residents be sure that reasonable and sufficiently protective estimates are used, and that the results are not subject to political pressure and manipulation? I think it is very important that the report explain the inherent uncertainties in the risk estimates for PCE and TCE….and that there is much uncertainty about the actual risks of TCE, and that actual risk could be higher or lower than estimated by the risk factors proposed in the document.

Response
EHAP’s estimates are determined using very conservative assumptions based on the probably exposure scenarios, which increases the likelihood of over-estimating risk and being the most health protective.

Comment
In the absence of indoor air data, SHINE's decision to use crawl space data as a surrogate for indoor air levels seems like a good and conservative choice for those homes that have crawl spaces. However, I imagine that the actual amount of air exchange between a crawl space and indoor air can vary greatly depending on the nature of a home's construction, its ventilation system, whether there are "pathways" (cracks, utility conduits, etc.) for the vapor to travel, etc. And, for homes on slab foundations, the estimate may not be conservative at all--it is plausible that levels of TCE in indoor air might be as high as crawl space levels in other homes. For all these reasons, as SHINE recommends, it would be best to do direct monitoring of indoor air instead of having to estimate exposures based on crawl space data.
Comment
I agree that indoor air testing is the best and most direct way to address residents' concerns about vapor intrusion, and should be done for those who request it or are willing to grant permission.

Response
Indoor air testing would provide the most direct measure of the VOC vapors residents might be exposed to, however indoor air testing can be problematic because of the products that residents may bring into their homes (i.e. dry cleaning, solvents and glues), This may make it difficult to determine which sources are responsible for the levels detected and therefore difficult to determine the best remedy for reducing levels that may be associated with the groundwater VOC plume.

Comment
On page 11, paragraph 3, the first sentence says: "Data presented in Table 3 indicate that non-cancer risks were negligible based on comparisons to non-cancer health guidelines of both median and maximum TCE and PCE air concentrations." The third sentence says that at the maximum level (of TCE) the hazard quotient indicates an elevated risk for non-cancer health effects. Is an elevated risk for non-cancer health effects from TCE the same as negligible, then? Surely not. If so, what is your definition of negligible risk?

I think this whole section would be more readable if there were separate subsections for "non-cancer" and "cancer" effects.

Response
Agreed. The document has been revised.

Comment
On page 12, the report says "SHINE expects that information collected...will be useful in helping to determine what actions should be taken to reduce intrusion of VOC into all homes with unacceptable levels of VOCs in crawlspaces. But what level is deemed unacceptable? This needs to be explained.
Comment
You recommend indoor air testing for homes where crawl space air testing indicates exceedences of health-based standards, but don't specify what those health-based standards are.

Response
For EHAP, unacceptable levels are those that exceed the theoretical risk of one additional cancer case per 10,000 people and where evidence suggests that adverse health effects are likely. This differs from ODEQ which considers a theoretical excess cancer risk greater than one in one million to be unacceptable for the purpose of determining if remedial (clean-up) action is needed.

Comment
[EHAP] mentions that PCE and TCE are classified by EPA as "probable human carcinogens". However, EPA's (2001 draft guidance) says that under proposed cancer guidelines, TCE can be characterized as "highly likely to cause cancer in humans". The latter certainly sounds like a stronger statement, and is based on a newer cancer classification system. According to the National Academy of Sciences, the evidence on carcinogenic risk and other health hazards to humans from exposure to TCE has

strengthened even since 2001 when EPA issued its latest "provisional" estimates of risk--the ones used by [EHAP].

Response
EHAP used the most health protective factors under ATSDR and the USEPA's guidance to assess the risk for both non-cancer and cancer health effects. The National Academy of Sciences took up the question of health risks from TCE exposure because the provisional risk estimates proposed by the USEPA were contested. The NAS found that evidence of TCE's carcinogenicity strengthened, but made no statement that the provisional estimate of risk should be changed.

Comment
In general, [WE] found the analysis presented in this Public Health Assessment (PHA) to be sufficiently thorough and protective. [WE] believe the approach used by the [Environmental Health Assessment Program (EHAP)] is appropriately conservative and that their conclusions and recommendations are appropriate based on existing data. [WE] fully support the recommendations presented in the PHA.

Response
Noted.

Comment
…SHINE's decision to use data from resident crawlspaces as direct surrogates for air in living spaces…. is a very conservative, health-protective approach for assessing risk to human health from vapor intrusion and may even overestimate risk since contaminant levels in crawlspace air will likely decrease because of dilution before reaching above ground living spaces. One potential exception to this may be below ground living spaces, such as finished basement rooms, where crawlspace levels may be much more reflective of actual inhalation levels.

Response
We agree. The use of crawlspace data is likely to be much more reflective of actual levels in home basements if they were sampled.

Comment
The report mentions that Kennedy-Jenks has submitted a proposal to ODEQ to study vapor barriers and ventilation systems in homes with unacceptable concentrations of VOCs in the crawlspaces. This action will need to be further evaluated as it is not discussed in detail in the PHA.

Response
You are correct in saying that the methods being tested to reduce vapor intrusion into the air space of homes will need further evaluation. At the time of the writing of this document no data were available from the pilot project, so we are unable to comment further on the method or the findings of the project.

Comment
Information on the hazards of vinyl chloride should also be included in this section on health hazards of VOCs, given the potential for this chemical to be present, its high toxicity, and the evident problems with the measurement method for this chemical.

Response
You are correct in saying that vinyl chloride is known to be highly toxic. In this instance however, vinyl chloride concentrations were consistently measured below levels of concern.

Comment
One criticism is that the PHA only considers risk from exposure to TCE and PCE since these were the contaminants with concentrations at levels of concern. Yet, TCE and PCE typically degrade to vinyl chloride, a known carcinogen. Perhaps [EHAP] should have attempted an estimation of potential vinyl chloride levels that may result in the future given existing TCE/PCE levels and performed risk estimates for vinyl chloride.

Response
The role of EHAP is to assess risk based on available data, and in some cases to recommend that additional data be collected. In this instance, data were collected on the presence and concentration of vinyl chloride, which as you noted maybe present as a breakdown product of the TCE, PCE and DCE known to be present in the plume. EHAP recommended that sampling and remediation efforts continue and expects that if vinyl chloride levels increase due to the breakdown of TCE, PCE and DCE, we will learn that it has occurred. We will then have data from which to assess the risk based on data, which is preferable to assessing risk based on a model.

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Certification

The Superfund Health Investigation and Education Program of the Oregon Department of Human Services prepared the Union Pacific Railyard, Eugene, Lane County, Oregon Public Health Assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This document is in accordance with approved methodology and procedures.

Robert B. Knowles, M.S., REHS
Technical Project Officer, CAPEB, DHAC
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I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.

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

Appendix A – Volatile Organic Compounds (VOCs) and Health Effects of VOC Exposure

Volatile Organic Compounds (VOC's) are compounds that have a high vapor pressure and low water solubility. Many VOCs are human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants. VOCs typically are industrial solvents, such as trichloroethylene or by-products produced by chlorination in water treatment, such as chloroform. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents. VOCs are common ground-water contaminants [10].

The presence of elevated VOC concentrations in drinking water may be a concern to human health because of their potential carcinogenicity. People who drink groundwater every day, over a lifetime, with the highest concentrations of the contaminants detected in on-site monitoring wells would have an increased risk of getting cancer. These contaminants may not be associated with the same types of cancer. Having an exposure to more than one of these carcinogens can increase a person's risk of getting cancer, above the risks from exposure to individual carcinogens.

PCE and TCE are two types of VOC, and are classified as probable human carcinogens according to the U.S. Environmental Protection Agency (EPA) and International Agency for Research on Cancer [11, 12]. These compounds are also associated with a various non-cancer health effects. Cancer and non-cancer affects are discussed separately. For cancer affects, it is assumed that there is no exposure level at which there is zero risk for cancer but non-cancer risks are assumed to have a threshold below which there is no risk of developing non-cancer health affects. Exposure to more than one of these chemicals may increase a person's risk of getting cancer, above the risks from exposure to individual carcinogens however it research on the actual effects of chemical mixtures is limited. Below is a discussion of the health affects associated with these chemicals based on scientific research.

Trichloroethylene (TCE)

It is uncertain whether people who breathe air or drink water containing trichloroethylene are at higher risk of cancer, or of developing reproductive effects. Several studies suggest that more birth defects may occur when mothers drink water containing trichloroethylene. People who used water for several years from two wells that had high levels of trichloroethylene may have had a higher incidence of childhood leukemia than other people, but these findings are not conclusive. In another study of trichloroethylene exposure from well water, increased numbers of children were reported to be born with heart defects, which are supported by data from some animal studies showing developmental effects of trichloroethylene on the heart. However, other chemicals were also in the water from this well and may have contributed to these effects. One study reported a higher number of children with a rare defect in the respiratory system and eye defects. Another study reported that the risk for neural tube defects and oral cleft palates were higher among mothers with trichloroethylene in their water during pregnancy. Children listed in the National Exposure Sub-registry of persons exposed to

trichloroethylene were reported to have higher rates of hearing and speech impairment. There are many questions regarding these reports. There were small numbers of children with defects and trichloroethylene levels at which the effects occurred was not defined well. Thus, it is not possible to make firm conclusions about the exact effects of trichloroethylene from these studies, and more studies need to be done. [11]

Tetrachloroethylene (PCE)

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that tetrachloroethylene may reasonably be anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that tetrachloroethylene is probably carcinogenic to humans. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant. Rats that were given oral doses of tetrachloroethylene when they were very young, when their brains were still developing, were hyperactive when they became adults. How tetrachloroethylene may affect the developing brain in human babies is not known. [12]

Appendix B - VOC Plume as Depicted in 1997, 2003, and 2006

1997 Plume Map – TCE

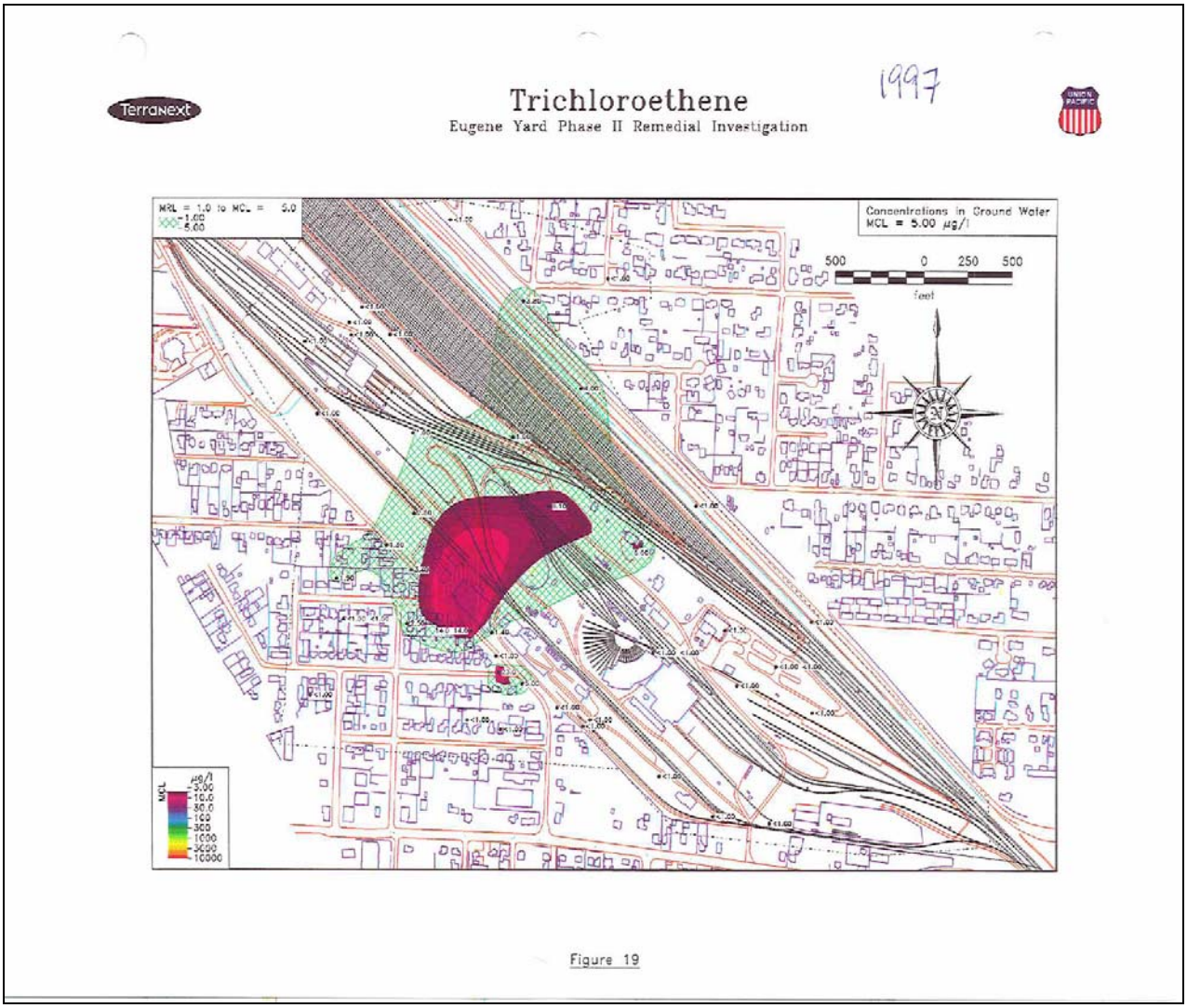
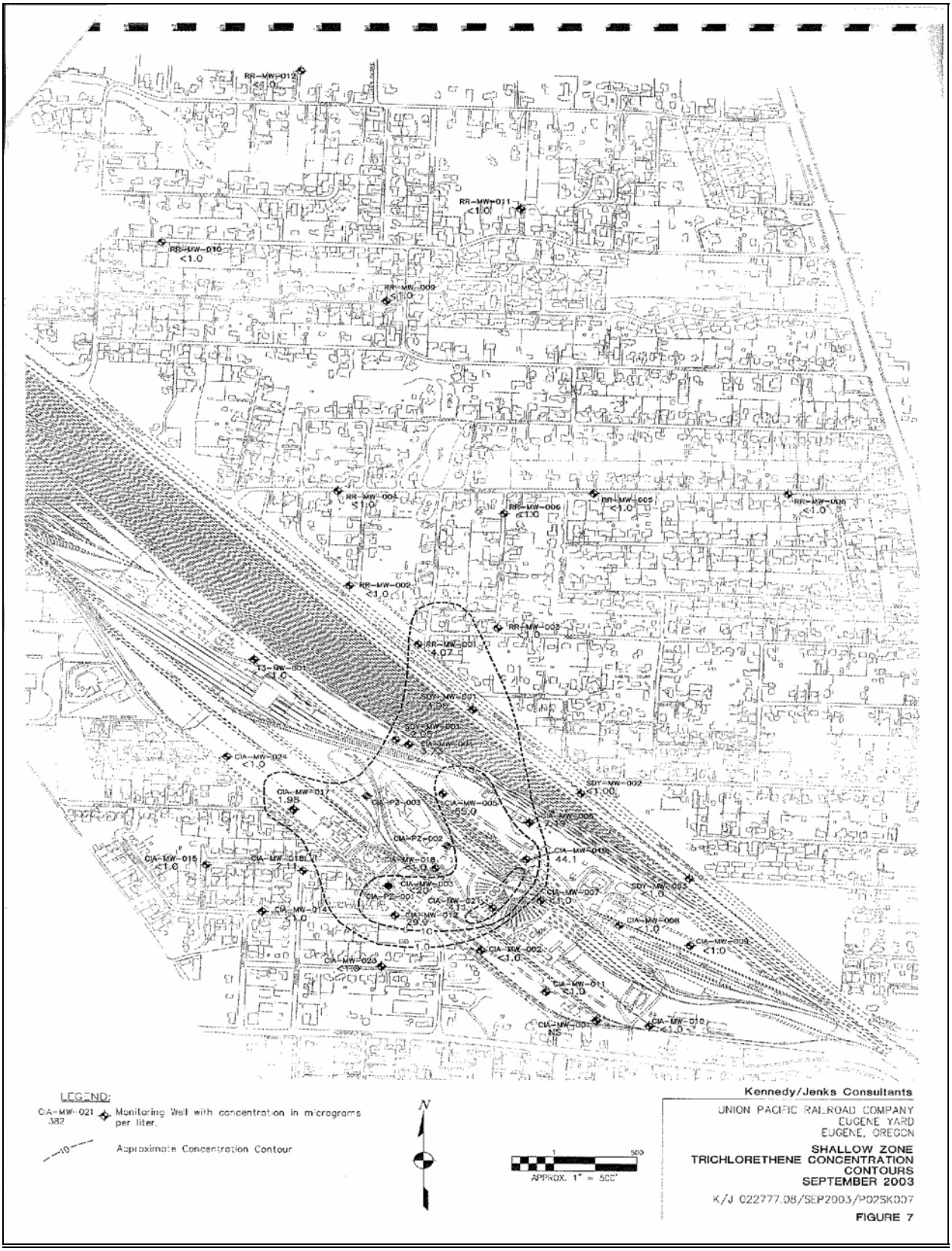
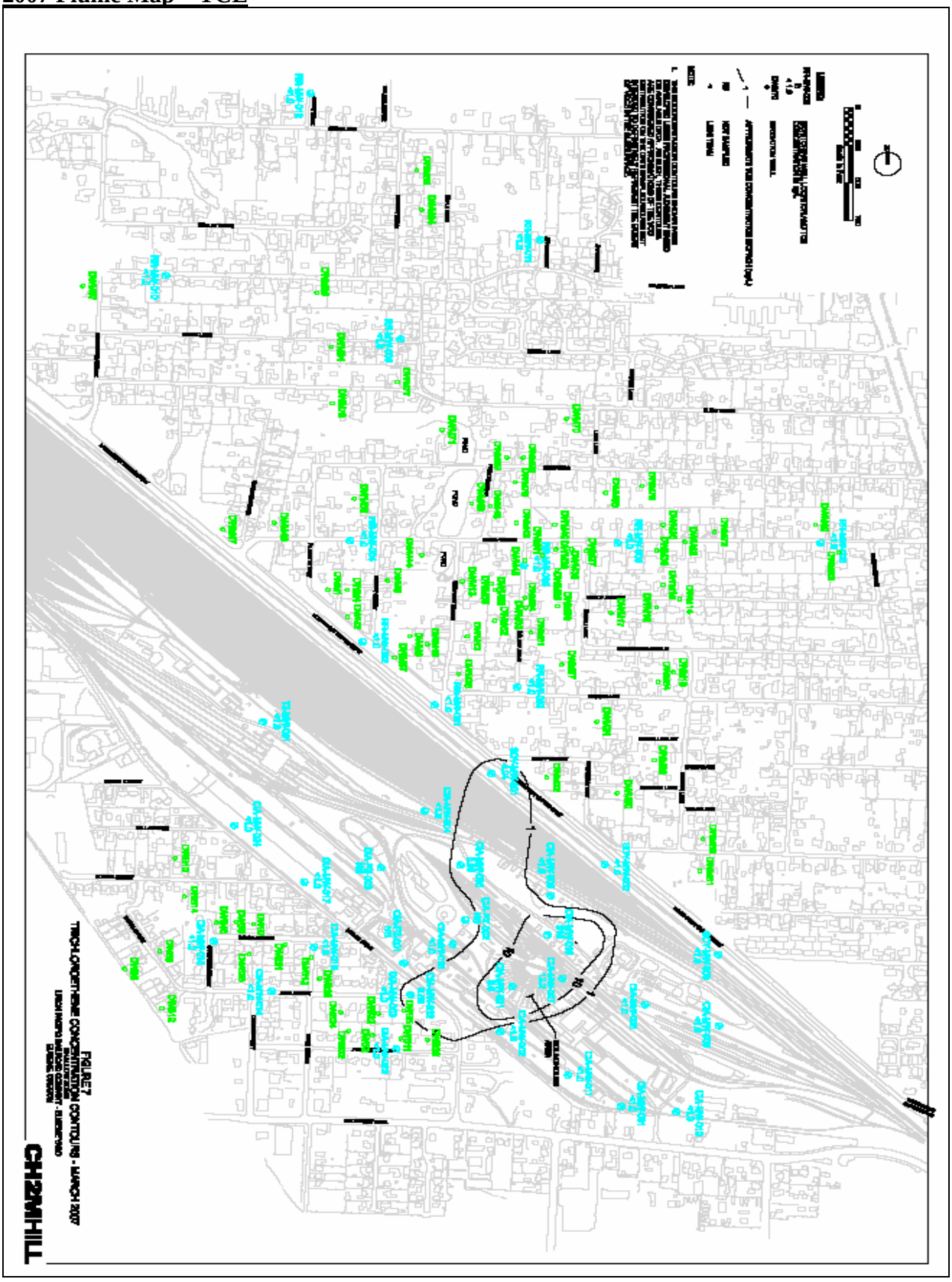


Figure 19

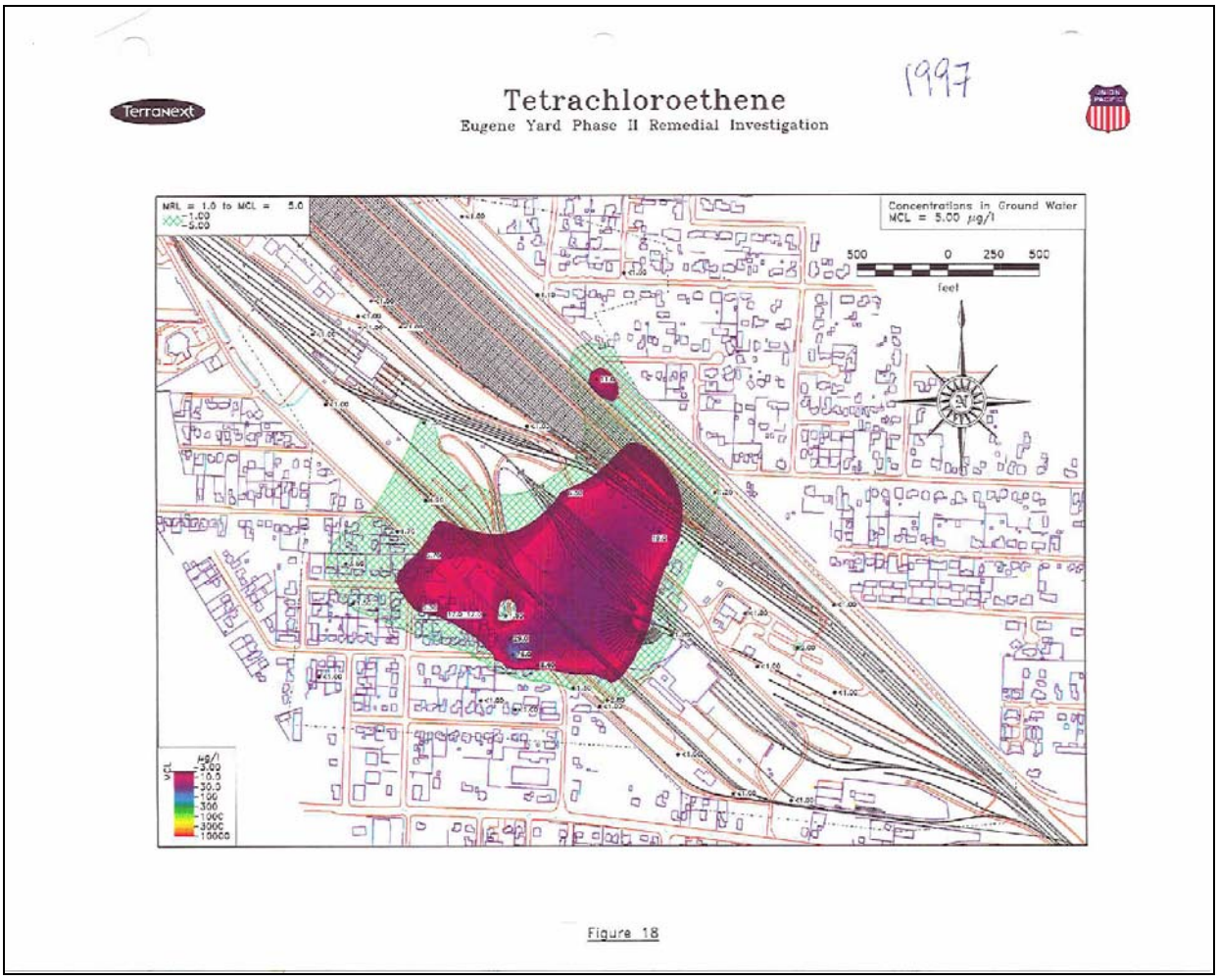
2003 Plume Map – TCE



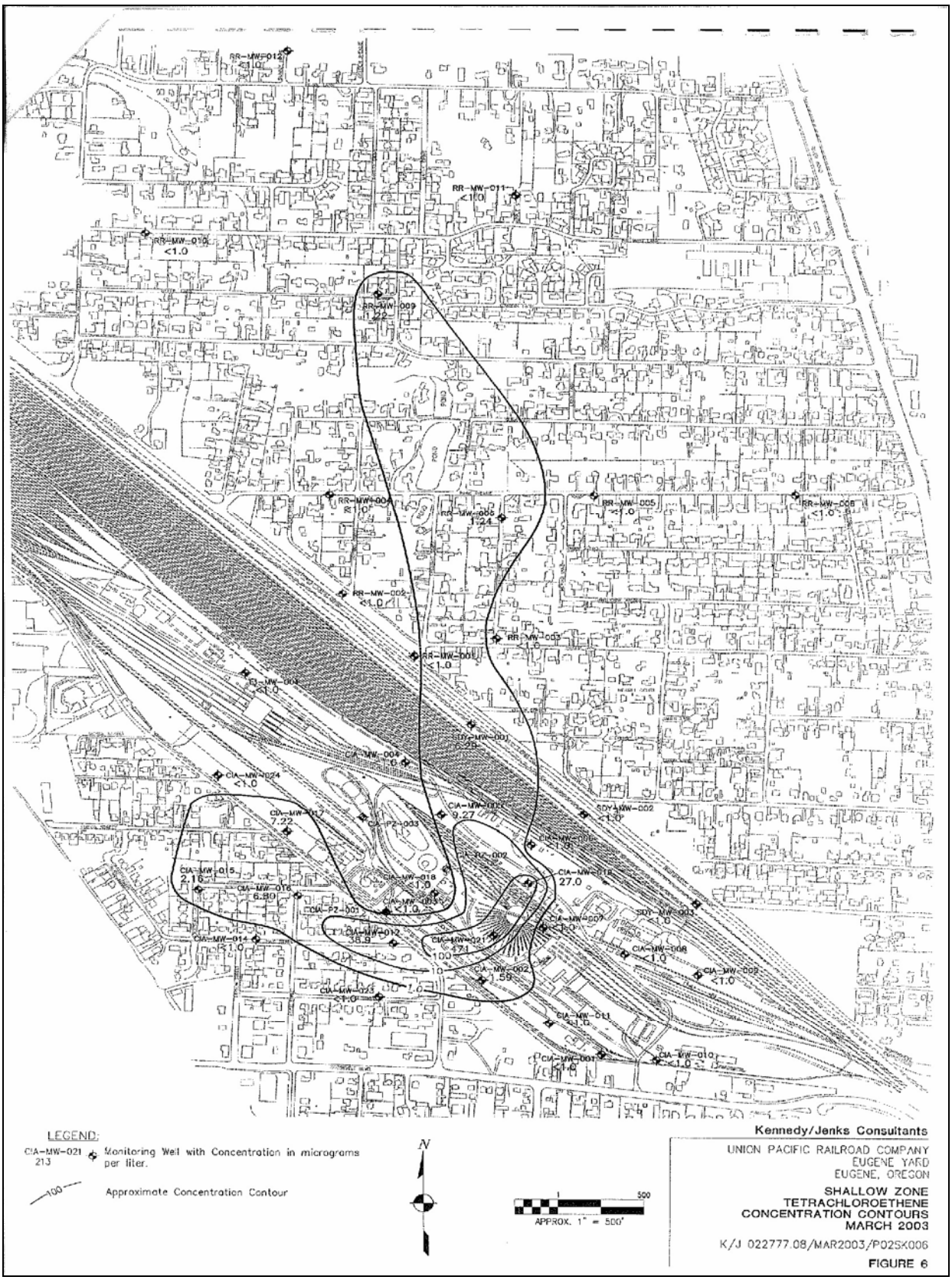
2007 Plume Map – TCE



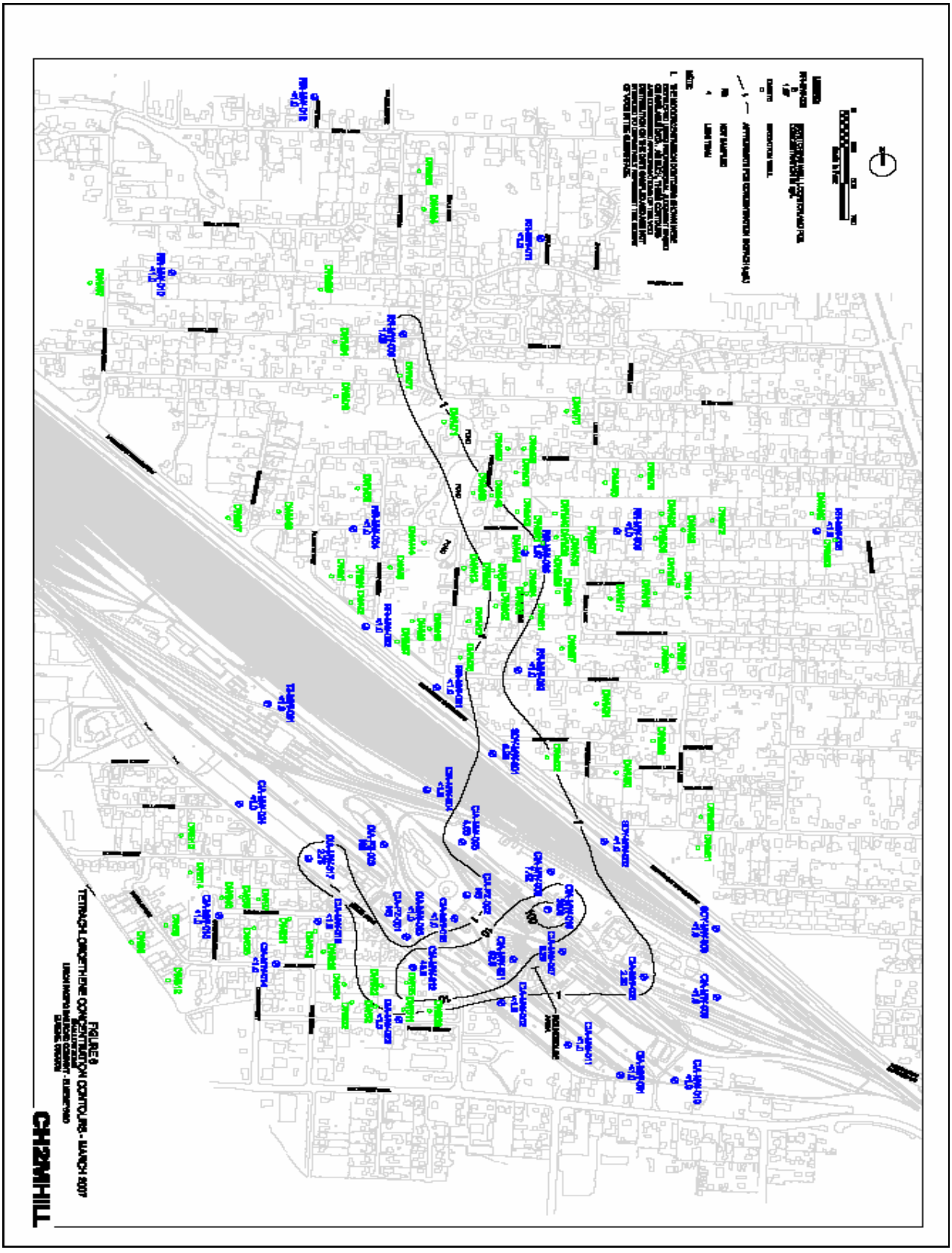
1997 Plume Map – PCE



2003 Plume Map -PCE



2007 Plume Map – PCE



Appendix C – Crawlspace Data and Health Risks by Categories Associated with Proximity to the UPRR Railyard

			Volatile Organic Compounds (µg/m3)						
			TCE			PCE			
Sample Location	Sample Date	Maximum/ Median Levels	ug/m3	Non-Cancer Risk	Cancer Risk	ug/m3	Non-Cancer Risk	Cancer Risk	Total Cancer Risk TCE + PCE
CATEGORY 1 Potential impacts to indoor air from the Eugene Railyard - testing of vapor barriers and venting systems in progress									
Location 27	8/7/07		0.10	0.00	1.10E-05	0.91	0.00	5.37E-06	1.64E-05
	8/7/07		0.06	0.00	6.27E-06	0.68	0.00	4.01E-06	1.03E-05
	8/7/07		0.05	0.00	5.83E-06	0.69	0.00	4.07E-06	9.90E-06
	4/10/07		0.17	0.00	1.87E-05	1.20	0.00	7.08E-06	2.58E-05
	4/10/07		0.10	0.00	1.07E-05	0.93	0.00	5.49E-06	1.62E-05
	4/10/07		0.11	0.00	1.21E-05	0.94	0.00	5.55E-06	1.76E-05
	4/10/07		0.10	0.00	1.07E-05	0.90	0.00	5.31E-06	1.60E-05
	4/9/07		0.06	0.00	6.49E-06	0.53	0.00	3.13E-06	9.62E-06
	4/9/07		0.06	0.00	6.27E-06	0.52	0.00	3.07E-06	9.34E-06
	4/9/07		0.07	0.00	7.26E-06	0.59	0.00	3.48E-06	1.07E-05
	3/28/07		0.49	0.01	5.39E-05	0.89	0.00	5.25E-06	5.92E-05
	10/3/06		2.30	0.06	2.53E-04	0.84	0.00	4.96E-06	2.58E-04
	10/3/06		2.20	0.06	2.42E-04	0.90	0.00	5.31E-06	2.47E-04
	2/27/06		2.90	0.07	3.19E-04	2.20	0.01	1.30E-05	3.32E-04
	2/27/06		2.70	0.07	2.97E-04	2.70	0.01	1.59E-05	3.13E-04
	8/11/04	Maximum	18.00	0.45	1.98E-03	1.70	0.01	1.00E-05	1.99E-03
	5/7/04	Maximum	0.56	0.01	6.16E-05	3.20	0.01	1.89E-05	8.05E-05
		Median	0.11	0.00	1.21E-05	0.90	0.00	5.31E-06	1.74E-05
Location 28	3/28/07		0.41	0.01	4.51E-05	2.80	0.01	1.65E-05	6.16E-05
	3/28/07	Maximum	0.53	0.01	5.83E-05	3.30	0.01	1.95E-05	7.78E-05
	3/28/07		0.42	0.01	4.62E-05	2.70	0.01	1.59E-05	6.21E-05
	10/3/06		4.30	0.11	4.73E-04	0.96	0.00	5.66E-06	4.79E-04
	2/28/06	Maximum	63.00	1.58	6.93E-03	1.30	0.00	7.67E-06	6.94E-03
	8/11/04		1.20	0.03	1.32E-04	0.33	0.00	1.95E-06	1.34E-04
	6/10/04		2.00	0.05	2.20E-04	2.10	0.01	1.24E-05	2.32E-04
		Median	1.20	0.03	1.32E-04	2.10	0.01	1.24E-05	1.44E-04
Location 29	8/7/07		0.11	0.00	1.21E-05	1.40	0.00	8.26E-06	2.04E-05
	3/28/07		1.80	0.05	1.98E-04	1.30	0.00	7.67E-06	2.06E-04
	10/3/06		4.80	0.12	5.28E-04	1.70	0.01	1.00E-05	5.38E-04
	2/28/06	Maximum	11.00	0.28	1.21E-03	1.10	0.00	6.49E-06	1.22E-03
	8/11/04	Maximum	4.90	0.12	5.39E-04	13.00	0.04	7.67E-05	6.16E-04
	6/10/04		8.10	0.20	8.91E-04	6.00	0.02	3.54E-05	9.26E-04
		Median	4.85	0.12	5.34E-04	1.55	0.01	9.15E-06	5.43E-04
Location 30	8/7/07		0.05	0.00	5.72E-06	0.45	0.00	2.66E-06	8.38E-06
CATEGORY 2 Uncertain impacts to indoor air from the Eugene Railyard - further investigation planned									
Location 5	8/7/07		0.03	0.00	2.75E-06	0.44	0.00	2.60E-06	5.35E-06
	3/28/07		0.52	0.01	5.72E-05	0.30	0.00	1.77E-06	5.90E-05
	10/3/06		2.50	0.06	2.75E-04	0.51	0.00	3.01E-06	2.78E-04
	2/28/06		1.30	0.03	1.43E-04	0.50	0.00	2.95E-06	1.46E-04
	8/11/04	Maximum	2.80	0.07	3.08E-04	2.10	0.01	1.24E-05	3.20E-04
	6/10/04	Maximum	6.40	0.16	7.04E-04	0.64	0.00	3.78E-06	7.08E-04
		Median	1.90	0.05	2.09E-04	0.51	0.00	2.98E-06	2.12E-04
Location 31	8/7/07		0.04	0.00	4.73E-06	2.20	0.01	1.30E-05	1.77E-05
Location 13	8/7/07		0.02	0.00	2.53E-06	0.38	0.00	2.24E-06	4.77E-06
	3/28/07		0.42	0.01	4.62E-05	0.20	0.00	1.18E-06	4.74E-05
	10/3/06		1.80	0.05	1.98E-04	0.78	0.00	4.60E-06	2.03E-04
	2/27/06	Maximim	3.30	0.08	3.63E-04	14.00	0.05	8.26E-05	4.46E-04
		Median	1.11	0.03	1.22E-04	0.58	0.00	3.42E-06	1.26E-04

CATEGORY 3 Unlikely impacts to indoor air from the Eugene Railyard - VOC detections appear to be associated with ambient sources unrelated to the Railyard									
Location 1	8/7/07		0.02	0.00	2.31E-06	0.14	0.00	8.26E-07	3.14E-06
	3/28/07	Maximum	0.55	0.01	6.05E-05	0.17	0.00	1.00E-06	3.14E-06
		Median	0.29	0.01	3.14E-05	0.16	0.00	9.15E-07	3.23E-05
Location 2	8/7/07		0.06	0.00	6.05E-06	0.40	0.00	2.36E-06	8.41E-06
	3/28/07	Maximum	0.54	0.01	5.94E-05	0.18	0.00	1.06E-06	6.05E-05
		Median	0.30	0.01	3.27E-05	0.29	0.00	1.71E-06	3.44E-05
Location 3	8/7/07		0.06	0.00	6.05E-06	0.20	0.00	1.18E-06	7.23E-06
Location 4	8/7/07		0.05	0.00	5.06E-06	0.43	0.00	2.54E-06	7.60E-06
Location 6	8/7/07		0.03	0.00	3.19E-06	0.40	0.00	2.36E-06	5.55E-06
Location 7	8/7/07		0.03	0.00	3.41E-06	0.25	0.00	1.48E-06	4.89E-06
	10/3/06	Maximum	2.70	0.07	2.97E-04	0.75	0.00	4.43E-06	3.01E-04
		Median	1.37	0.03	1.50E-04	0.50	0.00	2.95E-06	1.53E-04
Location 8	8/7/07	Maximum	0.05	0.00	5.61E-06	0.53	0.00	3.13E-06	8.74E-06
	3/1/06	Maximum	1.40	0.04	1.54E-04	0.29	0.00	1.71E-06	1.56E-04
		Median	0.73	0.02	7.98E-05	0.41	0.00	2.42E-06	8.22E-05
Location 9	8/7/07		0.06	0.00	6.38E-06	0.31	0.00	1.83E-06	8.21E-06
Location 10	8/7/07		0.05	0.00	5.28E-06	0.70	0.00	4.13E-06	9.41E-06
	3/28/07	Maximum	0.60	0.02	6.60E-05	0.75	0.00	4.43E-06	7.04E-05
		Median	0.32	0.01	3.56E-05	0.73	0.00	4.28E-06	3.99E-05
Location 11	8/7/07		0.08	0.00	8.58E-06	0.42	0.00	2.48E-06	1.11E-05
Location 12	3/28/07		0.44	0.01	4.84E-05	0.21	0.00	1.24E-06	4.96E-05
	10/3/06	Maximum	2.40	0.06	2.64E-04	0.59	0.00	3.48E-06	2.67E-04
		Median	1.42	0.04	1.56E-04	0.40	0.00	2.36E-06	1.59E-04
Location 14	8/7/07	Maximum	0.03	0.00	3.63E-06	0.40	0.00	2.36E-06	5.99E-06
	3/1/06	Maximum	4.00	0.10	4.40E-04	0.21	0.00	1.24E-06	4.41E-04
		Median	2.02	0.05	2.22E-04	0.31	0.00	1.80E-06	2.24E-04
Location 15	8/7/07		0.04	0.00	4.73E-06	0.44	0.00	2.60E-06	7.33E-06
Location 16	8/7/07		0.05	0.00	5.28E-06	0.43	0.00	2.54E-06	7.82E-06
Location 17	8/7/07		0.04	0.00	4.62E-06	0.62	0.00	3.66E-06	8.28E-06
Location 18	8/7/07		0.04	0.00	4.73E-06	0.45	0.00	2.66E-06	7.39E-06
	3/28/07		0.49	0.01	5.39E-05	0.23	0.00	1.36E-06	5.53E-05
	10/3/06	Maximum	2.80	0.07	3.08E-04	0.78	0.00	4.60E-06	3.13E-04
	3/1/06		1.40	0.04	1.54E-04	0.12	0.00	7.08E-07	1.55E-04
		Median	0.95	0.02	1.04E-04	0.34	0.00	2.01E-06	1.06E-04
Location 19	8/7/07		0.04	0.00	4.73E-06	0.51	0.00	3.01E-06	7.74E-06
Location 20	3/28/07		0.69	0.02	7.59E-05	0.26	0.00	1.53E-06	7.74E-05
	10/3/06	Maximum	2.60	0.07	2.86E-04	0.50	0.00	2.95E-06	2.89E-04
		Median	1.65	0.04	1.81E-04	0.38	0.00	2.24E-06	1.83E-04

CATEGORY 3 Unlikely impacts to indoor air from the Eugene Railyard - VOC detections appear to be associated with ambient sources unrelated to the Railyard									
Location 21	4/10/07		0.09	0.00	1.03E-05	0.40	0.00	2.36E-06	1.27E-05
	4/10/07		0.04	0.00	3.96E-06	0.14	0.00	8.26E-07	4.79E-06
	4/10/07		0.02	0.00	2.42E-06	0.14	0.00	8.26E-07	3.25E-06
	4/10/07		0.02	0.00	1.98E-06	0.14	0.00	8.26E-07	2.81E-06
	4/9/07		0.01	0.00	1.43E-06	0.14	0.00	8.26E-07	2.26E-06
	4/9/07		0.02	0.00	1.87E-06	0.14	0.00	8.26E-07	2.70E-06
	4/9/07	Maximum	0.03	0.00	3.19E-06	0.50	0.00	2.95E-06	6.14E-06
	3/28/07		0.34	0.01	3.74E-05	0.23	0.00	1.36E-06	3.88E-05
	3/28/07	Maximum	0.46	0.01	5.06E-05	0.32	0.00	1.89E-06	5.25E-05
		Median	0.03	0.00	3.19E-06	0.14	0.00	8.26E-07	4.02E-06
Location 22	3/28/07	Maximum	0.45	0.01	4.95E-05	1.30	0.00	7.67E-06	5.72E-05
	10/3/06	Maximum	2.30	0.06	2.53E-04	0.57	0.00	3.36E-06	2.56E-04
		Median	1.38	0.03	1.51E-04	0.94	0.00	5.52E-06	1.57E-04
Location 23	8/7/07		0.04	0.00	4.84E-06	0.84	0.00	4.96E-06	9.80E-06
Location 24	8/7/07		0.03	0.00	3.74E-06	0.53	0.00	3.13E-06	6.87E-06
Location 25	8/7/07		0.04	0.00	4.40E-06	0.61	0.00	3.60E-06	8.00E-06
	8/7/07		0.04	0.00	4.62E-06	0.62	0.00	3.66E-06	8.28E-06
	3/28/07		1.10	0.03	1.21E-04	1.60	0.01	9.44E-06	1.30E-04
	10/3/06	Maximum	1.70	0.04	1.87E-04	1.20	0.00	7.08E-06	1.94E-04
	2/28/06	Maximum	1.50	0.04	1.65E-04	4.10	0.01	2.42E-05	1.89E-04
		Median	1.10	0.03	1.21E-04	1.20	0.00	7.08E-06	1.28E-04
Location 26	8/7/07		0.03	0.00	3.52E-06	0.27	0.00	1.59E-06	5.11E-06
Location 32	8/7/07		0.03	0.00	3.52E-06	0.38	0.00	2.24E-06	5.76E-06
	8/7/07	Maximum	0.03	0.00	3.08E-06	0.43	0.00	2.54E-06	5.62E-06
	3/28/07		0.33	0.01	3.63E-05	0.18	0.00	1.06E-06	3.74E-05
	3/28/07		0.33	0.01	3.63E-05	0.16	0.00	9.44E-07	3.72E-05
		Median	0.18	0.00	1.99E-05	0.28	0.00	1.65E-06	2.16E-05

Appendix D - Region 10 Office of Environmental Assessment, Risk Evaluation Unit Statement of the Status of Trichloroethylene (TCE) in Risk Assessments

It is the position of the EPA Region 10 human health risk assessors in the Office of Environmental Assessment that it is appropriate, for risk assessment purposes, to use the values provided in the Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft). U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-01/002A, 2001. This assessment relied on animal studies, as well as human epidemiological studies that were not available when the cancer assessments were prepared for EPA's provisional values (now withdrawn) or Cal-EPA's current cancer toxicity values. The use of the toxicity values in this document has been endorsed by NCEA's Superfund Technical Support Center[1]. The assessment has been subject to a public comment period as well as a formal, largely favorable review by the Science Advisory Board. The Region 10 risk assessors believe that use of the EPA 2001 external review draft health risk assessment for TCE comports with the requirements of EPA's Information Quality Guidelines, in that the assessment has been externally peer-reviewed and that it represents the best available science.

The EPA Office of Research and Development, with support from the National Academy of Sciences, will prepare responses to the SAB comments and evaluate studies that have become available since the external review draft was published. The IRIS review process will occur after this ORD/NAS evaluation has been completed. Once there are cancer and non-cancer toxicity values available on the IRIS database, this regional position statement will be rescinded and the IRIS values will be used.

Following are the TCE toxicity values from the EPA 2001 external review draft health risk assessment.

Oral Cancer Potency Range $[(mg/kg\text{-}day)^{-1}]$	Inhalation Cancer Potency Range $[(mg/kg\text{-}day)^{-1}]$	Oral Reference Dose (mg/kg-day)	Inhalation Reference Concentration (mg/m^3)
0.02 - 0.4	0.02 - 0.4*	0.0003	0.04**

* Converts to an inhalation unit risk range of 5.7E-6 – 1.1E-4 $[(ug/m^3)^{-1}]$, assuming a 70-kg adult inhaling 20 m^3/day.
** Converts to a reference dose of 0.01 mg/kg-day, assuming a 70 kg adult inhaling 20 m^3/day.

TCE Cancer Slope Factor Range

EPA Region 10 risk assessors recommend the use of the high end of the oral and inhalation cancer potency ranges (i.e, 0.4 per mg/kg-day) for assessing lifetime individual excess cancer risks at this time, based upon reasons that are largely associated with the inability to conclude that use of a lower slope factor within the range would be sufficiently protective. These include the following information provided in the 2001 health risk assessment:

[1] E-mail message from Ann Parker of the NCEA Superfund Technical Support Center to Sarah Levinson of EPA Region 1 dated June 20, 2003 (copy available from EPA Region 10 upon request).

- The draft assessment concluded that "TCE is highly likely to be carcinogenic in humans." While the qualitative assessment of cancer risk appears strong, there are many uncertainties in the current ability to quantitatively characterize cancer risks to humans from TCE exposure, due to a number of factors. For example, the results of human epidemiological studies showed a considerably wide range of possible slope factors, contributing to the inclusion of a slope factor range in the draft assessment, rather than a single estimate of the relationship between exposure and risk. It is not certain that even the high end of the slope factor range represents a true upper bound estimate of risk.

- The draft assessment concludes that it appears that children's metabolism may alter their susceptibility to TCE, and that this is an uncertainty that cannot be reduced without additional studies being performed. Therefore, the selection of the high end of the slope factor range is a reasonably prudent decision for the protection of children who may be exposed to TCE.

- Exposures to certain chemicals other than TCE were found to increase TCE's toxicity or potency, and vice-versa. These include exposure via ingestion to such commonly used substances as alcohol and acetaminophen, as well as to other sources of the metabolites of TCE.

- Certain individuals, such as those with diabetes, may be at higher risk for TCE's adverse effects.

- The EPA 2001 TCE health risk assessment (page 1-7) includes the following supportive language for use of the high end of the slope factor range:

The range of cancer slope factors has not been reduced to a single number. A range is reasonable in view of the risk factors that can modify the effects of TCE in different populations…. For most cancer risk factors, however, data that would allow differential risks to be quantified are lacking…Because the modifying effect of most risk factors cannot be quantified at this time, this assessment proposes instead that risk assessors use the upper end of the slope factor range for susceptible populations having risk factors for TCE-induced cancer. Although the extremes of the slope factor range are not based on data from more- or less-susceptible populations, this approach emphasizes the possibility of different risks in different circumstances, identifies risk factors that may increase susceptibility to TCE's effects, and provides a practical way to adjust risk estimates to reflect differential susceptibility… An assessment of maximum individual risk would use the upper end of the slope factor range, while an assessment of the number of cancer cases in a general population could use the midpoint of the range.

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- The quantitative characterization of cancer risk to humans from TCE exposure is likely to be enhanced in the future with the emergence of further studies and additional analyses of human variability and susceptibility. At this time, using the most protective end of the slope factor range is a reasonable choice.

Additional Considerations

Risk-based chemical screening tables developed and used by EPA Region 3 (http://www.epa.gov/reg3hwmd/risk/human/index.htm), Region 6 (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) and Region 9 (http://www.epa.gov/region09/waste/sfund/prg/index.htm) all cite the high end of the slope factor range, to prevent screening out site-related chemicals that may pose significant risk.

EPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (November 29, 2002; http://www.epa.gov/correctiveaction/eis/vapor.htm) incorporates the high end of the slope factor range for evaluating risks from exposure to TCE via the vapor intrusion pathway.

Example Risk Management Information

The following media concentrations of TCE represent cancer risks of 1E-6 using the high end of the slope factor range (0.4 per mg/kg-day) and standard Superfund exposure equations , as presented in the EPA Region 9 Technical Background Document and associated table of Preliminary Remediation Goals, available at http://www.epa.gov/region09/waste/sfund/prg/index.htm.

Residential soil mg/kg	Air ug/m3	Tap water ug/L
5.3E-2	1.7E-2	2.8E-2

The Draft TCE Toxicity Assessment is available online at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=23249

The Science Advisory Board's Review is available online at: http://www.epa.gov/science1/pdf/ehc03002.pdf

Questions concerning this document should be addressed to Marcia Bailey, OEA, 206-553-0684, bailey.marcia@epa.gov.

Appendix E – Exposure Assumptions, Dose Calculations and Cancer Risk for Irrigation Well Exposure to Groundwater

Exposure Factor	*Symbol*	*Young Child - less than 5-years-old, Gardening*	*Adult - Gardening*	*Source*
Body Weight [kg]	BW	15	70	ATSDR Public Health Assessment Guidance Manual (Appendix E)
Exposure Frequency$_{Ingestion\ [days/year]}$	$F_{ingestion}$	60	120	
Exposure Frequency$_{dermal\ [days/year]}$	F_{dermal}	60	120	
Exposure Duration [years]	ED	6	30	DEQ Deterministic HHRA Guidance, Appendix B
Averaging Time - Noncancer [days]	AT_{nonc}	2190	10950	DEQ Deterministic HHRA Guidance, Appendix B
Averaging Time - Cancer [days]	AT_c	25550	25550	DEQ Deterministic HHRA Guidance, Appendix B
Exposure Factor$_{non\text{-}cancer,\ ingestion}$ [unitless]	$EF_{non\text{-}cancer,\ ingestion}$	0.1644	0.3288	EF = (FxED)/AT
Exposure Factor$_{non\text{-}cancer,\ dermal}$ [unitless]	$EF_{non\text{-}cancer,\ dermal}$	0.1644	0.3288	EF = (FxED)/AT
Exposure Factor$_{cancer,\ ingestion}$ [unitless]	$EF_{cancer,\ ingestion}$	0.0141	0.1409	EF = (FxED)/AT
Exposure Factor$_{cancer,\ dermal}$[unitless]	$EF_{cancer,\ dermal}$	0.0141	0.1409	EF = (FxED)/AT
Exposure Time Dermal [hours/day]	ET_{dermal}	2	1	
Groundwater Ingestion Rate [ml/day]	IR	100	50	
Oral Bioavailable Fraction - TCE [%]	BV_{TCE}	1	1	Trichloroethylene Toxicological Profiles (ATSDR)[11]
Oral Bioavailable Fraction - PCE [%]	BV_{PCE}	1	1	Tetrachloroethylene Toxicological Profiles (ATSDR)[12]
Conversion Factor$_{Ingestion}$	$Cf_{ingestion}$	0.000001	0.000001	(1 L/1000g) * (1 mg/ 1 ug)
Conversion Factor$_{Dermal}$	Cf_{dermal}	0.000001	0.000001	(1 L/ 1000 cm^3)*(1 mg/ug)
Skin Permeability Coefficient$_{TCE}$ [cm/hr]	P_{TCE}	0.0002	0.0002	
Skin Permeability Coefficient$_{PCE}$ [cm/hr]	P_{PCE}	0.0002	0.0002	
Surface Area [cm^2]	SA	1000	2100	ATSDR Public Health Assessment Guidance Manual (Appendix E)
Exposure Time [hours/day]	ET	2	2	

DOSE CALCULATIONS	
Incidental Ingestion Dose$_{non-cancer}$ (mg/kg/day) =	$\frac{C \times IR \times EF_{nonc} \times BV \times CF_{ingestion}}{BW}$
Incidental Ingestion Dose$_{cancer}$ (mg/kg/day) =	$\frac{C \times IR \times EF_{c} \times BV \times CF_{ingestion}}{BW}$
Dermal Dose$_{non-cancer}$ (mg/kg/day) =	$\frac{C \times P \times SA \times ET \times EF_{nonc} \times CF_{dermal}}{BW}$
Dermal Dose$_{cancer}$ (mg/kg/day) =	$\frac{C \times P \times SA \times ET \times EF_{c} \times CF_{dermal}}{BW}$

Groundwater Concentrations and Comparison Values

	Maximum GW Concentration [ug/l]	**Mean GW Concentration** [ug/l] (Mean of Fall and Spring Average)	**Oral MRL or RfD (chronic)** [mg/(kg-day)]	**RfC [ug/m^ 3]. Non-cancer**	**Oral Slope Factors (mg/(kg-day)]-1**	**Unit Risk Factor [ug/m^3]$^{-1}$**
TCE	15.2	2.24	0.0003	40	0.4	1.10E-04
PCE	50.7	4.75	0.01	271	0.54	5.90E-06

MAXIMUM DOSES			**MEAN DOSES**		
DOSE ESTIMATES [mg/kg/day]					
Non-Cancer Risk	Child	Adult	**Non-Cancer Risk**	Child	Adult
Incidental Ingestion$_{TCE}$	1.67E-05	3.57E-06	Incidental Ingestion$_{TCE}$	2.45E-06	1.11E-06
Incidental Ingestion$_{PCE}$	5.56E-05	1.19E-05	Incidental Ingestion$_{PCE}$	5.20E-06	5.25E-07
Dermal$_{TCE}$	6.66E-08	3.00E-08	Dermal$_{TCE}$	9.80E-09	4.41E-09
Dermal$_{PCE}$	2.22E-07	1.00E-07	Dermal$_{PCE}$	2.08E-08	9.36E-09
Cancer			**Cancer**		
Incidental Ingestion$_{PCE}$	1.43E-06	1.53E-06	Incidental Ingestion$_{PCE}$	2.10E-07	2.25E-07
Incidental Ingestion$_{TCE}$	4.76E-06	5.10E-06	Incidental Ingestion$_{TCE}$	4.46E-07	4.78E-07
Dermal$_{TCE}$	5.71E-09	1.29E-08	Dermal$_{TCE}$	8.40E-10	1.89E-09
Dermal$_{PCE}$	1.90E-08	4.29E-08	Dermal$_{PCE}$	1.78E-09	4.01E-09
NON-CANCER RISK - HAZARD QUOTIENTS					
Non-Cancer Risk	Child	Adult	**Non-Cancer Risk**	Child	Adult
Incidental Ingestion$_{TCE}$	0.06	0.01	Incidental Ingestion$_{TCE}$	0.01	0.00
Incidental Ingestion$_{PCE}$	0.19	0.04	Incidental Ingestion$_{PCE}$	0.02	0.00
Dermal$_{TCE}$	0.00	0.00	Dermal$_{TCE}$	0.00	0.00
Dermal$_{PCE}$	0.00	0.00	Dermal$_{PCE}$	0.00	0.00
CANCER RISKS					
Cancer Risk Using Slope Factors	Child	Adult	**Cancer Risk Using Slope Factors**	Child	Adult
Incidental Ingestion$_{TCE}$	5.71E-07	6.12E-07	Incidental Ingestion$_{TCE}$	8.40E-08	9.00E-08
Incidental Ingestion$_{PCE}$	1.00E-07	1.07E-07	Incidental Ingestion$_{PCE}$	9.36E-09	1.00E-08
Dermal$_{TCE}$	2.28E-09	5.14E-09	Dermal$_{TCE}$	3.36E-10	7.56E-10
Dermal$_{PCE}$	4.00E-10	9.00E-10	Dermal$_{PCE}$	3.74E-11	8.43E-11
Total -TCE	**5.73E-07**	**6.17E-07**	**Total - PCE**	**8.43E-08**	**9.08E-08**
Total - PCE	**1.00E-07**	**1.08E-07**	**Total - TCE**	**9.40E-09**	**1.01E-08**
Total Cancer Risk	**6.74E-07**	**7.25E-07**	**Total Cancer Risk**	**9.37E-08**	**1.01E-07**

Appendix F - ATSDR Glossary of Environmental Health Terms.

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and provides trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Additive Effect	A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.
Adverse Health Effect	A change in body function or the structures of cells that can lead to disease or health problems.
ATSDR	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level	An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.
Bioavailability	See **Relative Bioavailability**.
CAP	**See Community Assistance Panel.**
Cancer	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
Carcinogen	Any substance shown to cause tumors or cancer in experimental studies.
CERCLA	See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway	
Comparison Value (CVs)	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	**CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concentration	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant	See **Environmental Contaminant**.
Delayed Health Effect	A disease or injury that happens as a result of exposures that may have occurred far in the past.
Dermal Contact	A chemical getting onto your skin. (see **Route of Exposure**).
Dose	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Dose / Response	The relationship between the amount of exposure (dose) and the change in body function or health that result.
Duration	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media U.S.	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Assessment	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Receptor Population. When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.
Frequency	How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.
Hazardous Waste	Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.
Health Effect	ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).
Indeterminate Public Health Hazard	The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.
Ingestion	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation	Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).
LOAEL	**L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.
Malignancy	See **Cancer**.
MRL	**M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.
MCL	**M**aximum **C**ontaminant **L**evel - the highest permissible level of contaminant in drinking water for it to be deemed suitable for human consumption.
NPL	The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.
NOAEL	**N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.
No Apparent Public Health Hazard	The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.
No Public Health Hazard	The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.
PHA	**P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Plume	A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
PRP	**P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.
Public Health Assessment(s)	See **PHA**.
Public Health Hazard	The category is used in PHA's for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.
Health Hazard Criteria	People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).
Reference Concentration (RfC)	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure of a chemical to the human population through inhalation (including sensitive subpopulations), that is likely to be without risk of deleterious non-cancer effects during a lifetime.
Reference Dose (RfD)	An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.
Relative Bioavailability	The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.
Route of Exposure	The way a chemical can get into a person's body. There are three exposure routes – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Safety Factor	Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.

SARA	The **Superfund Amendments and Reauthorization Act** in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.
Sample Size	The number of people that are needed for a health study.
Sample	A small number of people chosen from a larger population (See Population).
Source (of Contamination)	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.
Special Populations	People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Statistics	A branch of the math process of collecting, looking at, and summarizing data or information.
Superfund Site	A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.
Synergistic effect	A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.
Toxic	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology	The study of the harmful effects of chemicals on humans or animals.
Tumor	Abnormal growth of tissue or cells that have formed a lump or mass.
Uncertainty Factor	See **Safety Factor**.