Oregon Department of Human Services
Superfund Health Investigation and Education Program (SHINE)

Public Health Assessment

Union Pacific Railyard
City of Eugene, Lane County, Oregon

PUBLIC COMMENT RELEASE

Prepared by the
Oregon Public Health Division
Superfund Health Investigation and Education Program

Under Cooperative Agreement with the
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 and the risks it poses to human health and the environment. ODEQ and the Oregon Toxics Alliance both requested SHINE's 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 have entered groundwater beneath portions of the River Road and Bethel Drive (Trainsong) neighborhoods, including tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1-dichloroethylene (DCE) and vinyl chloride.

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 neighborhood adjacent to the rail yard and may be causing contamination of indoor air in private homes. Vapors from contaminated groundwater are apparently making their way into the crawlspaces of homes in the River Road and Trainsong neighborhoods and potentially into indoor air inside the living spaces of the homes. The levels of VOC vapors detected in crawlspaces, which at maximum levels exceed health guidelines, are determined to be a public health hazard because action is needed to prevent future exposure to residents in these homes. SHINE recommends that homes located in areas where the VOC plume is or has been documented be tested for indoor air concentrations of PCE and TCE, and that in homes where the TCE or PCE concentrations exceed health-based standards, vapor barriers and/or ventilation systems be installed to reduce the exposure to contaminated indoor air.

Second, the groundwater contamination has extended to several irrigation wells used by private homeowners in the neighborhood. SHINE 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 home 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.

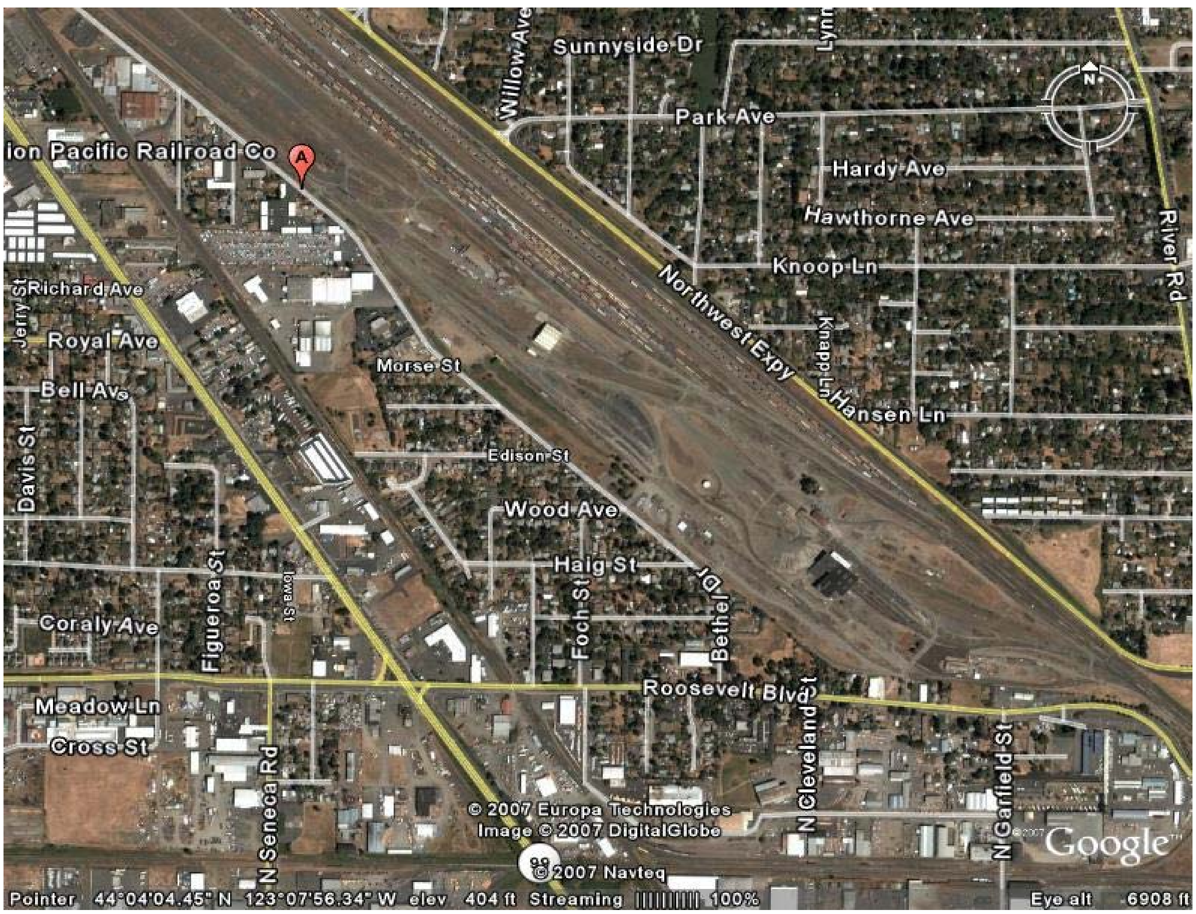
Purpose and Health Issues

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 Railroad (UPRR) site in Eugene, OR. In November 2006, The Oregon Toxics Alliance (OTA) petitioned the Superfund Health Investigation & Education (SHINE) program at the Oregon Public Health Division (OPHD) 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 the railyard 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. (Kennedy-Jenks Consultants, HHRA)

<u>Figure 1 – Union Pacific Railyard and Surrounding Neighborhoods</u>



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 and 2003 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 indoor residential air in the Bethel Drive 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 Bethel Drive and River Road neighborhoods was conducted in 1998, 2000, 2004, and 2006. [1]

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 did not draw any conclusions about the risk from VOCs in soil and groundwater because these pathways were still under evaluation at the time the draft risk assessment was completed. The HHRA did identify possible exposure to adults and children from "groundwater 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. [2]

In October 2006, Kennedy-Jenks Consultants conducted sampling events to collect groundwater, soil gas, crawlspace, and ambient air data to evaluate the contribution from the VOC plume to outdoor and indoor air in the Trainsong neighborhood. Data were collected from locations both inside and outside of the VOC plume. Sampling of irrigation wells in the Trainsong and River Rd. neighborhoods also took place in October 2006.

In November 2006, The Oregon Toxics Alliance (OTA) petitioned the Superfund Health Investigation & Education (SHINE) 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 SHINE 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, SHINE determined that a public health assessment was warranted to evaluate the potential health effects from wells contaminated with VOCs, and from vapors from VOCs intruding into the indoor air space of homes located over the VOC plume. (See Appendix B – Plume Maps)

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 and 2003 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, a SHINE 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.

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 A), 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, SHINE has determined that the most significant potential threat to local residents is from the contamination of shallow groundwater with VOCs. SHINE 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.

<u>Pathways Analysis and Public Health Implications</u>

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 one of the sources of TCE and PCE contained in plume. Other sources in the area are also known to exist.
- *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 Soil and 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 soil gas.
- *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	Air	Residences, Indoor Air	Inhalation	Local Residents	Past - Yes Present - Yes Future - TBD
Private Irrigation Wells	VOC Plume	Groundwater	Residences, Outside Tap	Ingestion Dermal Contact	Residents with Irrigation Wells	Past - Yes Present - Yes Future - TBD

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 and present 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. This public health assessment recommends specific actions to eliminate exposure pathways in the future.

Data

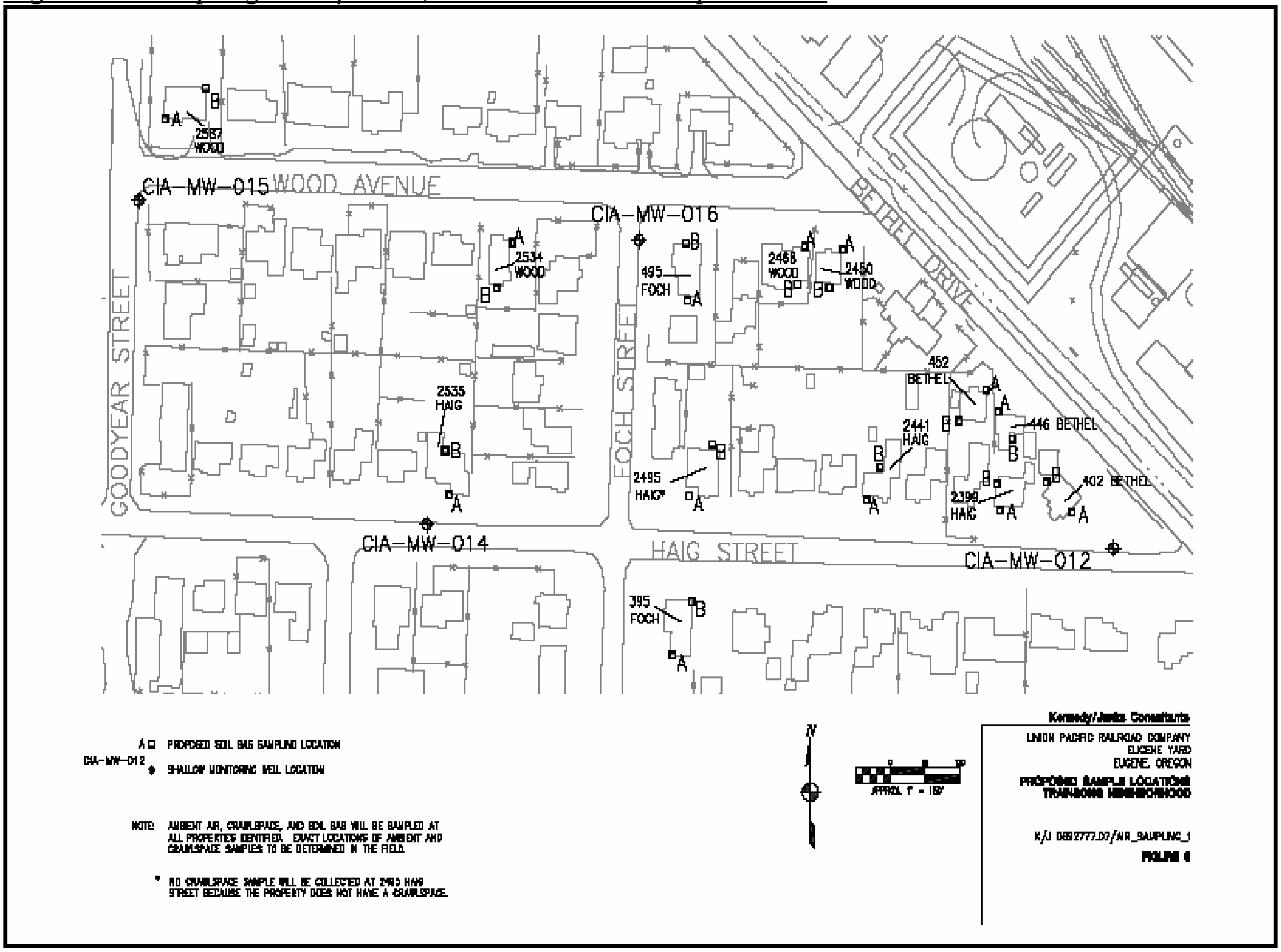
Data from monitoring wells has been used to characterize the nature and extent of the contamination in the areas around the railyard (See Figure 1). These data have also been used to identify specific areas where more data were needed to determine potential exposure to local residents. In addition to data from groundwater monitoring wells, data have been collected on ambient air, soil gas, residential crawlspace, and residential irrigation wells. Based on the pathways analysis (see above), SHINE determined that the potential exposures of most concern were from inhalation of indoor air and incidental ingestion of irrigation well water. No air data were collected from inside homes, so for the purposes of this PHA, crawlspace data were used to estimate the levels of VOC's that residents might be exposed to in indoor air.

There is some uncertainty about the relationship between the VOC plume and the levels of VOC's found in indoor air, since the data on groundwater levels and crawlspace levels are poorly correlated, and we would expect to see evidence of a clearer relationship between the two. It is possible that another source of VOC's, including other industrial sources or even products used or brought into residents homes (such as dry cleaning) could be contributing to the levels found in residents' crawlspaces. However, because of the presence of the plume and the lack of specific evidence of other sources, we consider the plume to be a primary contributor to the VOC levels in irrigation wells and indoor air.

<u>VOCs in Indoor Air</u>

Since 2004, soil gas, crawlspace, and ambient air data, in addition to groundwater samples have been collected in the neighborhoods near UPRR affected by the VOC plume. (See Figure 2 - Sampling map)

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



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 [3]. Table 3 provides a summary of the crawlspace data from the 2007 report, and health risks associated with concentrations of VOC's in residential crawlspaces as calculated by SHINE. Crawlspace data, collected from homes both inside and outside of the plume area, were used in this investigation as a surrogate measure for the levels of TCE and PCE in air that residents might be exposed to inside their homes.

Homes with crawlspaces tested in this sampling event 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. Some of the homes tested in this sampling event are outside of the plume as it is currently depicted, but there is evidence that the plume has receded over time. Therefore we assume that levels detected in the homes where samples were taken may also indicate what the levels may have been previously in homes located over the plume in the past.

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

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 do not have measurements of indoor air. In order to be protective of health, we must assume that all TCE and PCE found 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.

Based on these data, SHINE estimated the dosages of TCE and PCE that residents might receive from breathing the indoor air with these concentrations of the contaminants. It was assumed that adults and children would reside in the home 50 weeks per year, and that exposure would occur for children for a period of 6 years and for adults for a period of 30 years. Detailed exposure assumptions are described in Appendix D.

Table 3 Sampling Results and Health Risks of VOC Vapors in Residences

	Comparison Values		**Air Concentrations**	
Volatile Organic Compound	**Reference Concentration RfC** ug/m^3	**Unit Risk Factor (ug/m$^{3)}$**	**Maximum Air Concentration** [ug/m3]	**Median Air Concentration [ug/m^3]**
TCE	40	1.1E-04	63	2.65
PCE	300	5.9E-06	13	0.93
	Maximum Dose		**Median Dose**	
	Hazard Quotient Adult and Child	**Cancer Risk Adult and Child**	**Hazard Quotient Adult and Child**	**Cancer Risk Adult and Child**
TCE	1.58	6.93E-03	0.07	2.9E-04
PCE	0.04	7.67E-05	0.00	5.5E-06
Total Cancer Risk		**7.01E-03**		**3.0E-04**

Table 3 presents the information used to calculate risk from exposure to VOC vapors in indoor air. Comparison values represent levels above which health effects have been documented in animals and/or humans. Maximum and median concentrations detected in crawlspaces between 1996 and 2006 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 cancer and non-cancer risk. Cancer risk was calculated using the unit risk factor to estimate the probability of a person contracting cancer as a result of constant exposure to an ambient concentration of one microgram per cubic meter of a substance over a 70 year lifetime. 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. [4]

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. Hazard quotients were calculated for both maximum and median concentrations. At t 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. The data were also used to calculate excess cancer risk, which represents the risk of people developing excess cases of cancer above the expected number of cases in a given population over a lifetime of exposure. The data indicate that, at the median concentrations detected, adults and children are at risk of about 3 additional cancer cases per 10,000 persons.

SHINE considers the level of exposure to median levels of PCE and TCE to be very low. The median level concentration represents the level that is the mid-point of all of the detected levels detected and, based on the available information; the median represents the most likely exposure level that people might experience.

Both adults and children would be at a higher risk for cancer for both TCE and PCE if they were exposed at the maximum concentrations detected than for exposure to the median air concentrations. Specifically, the data indicate a theoretical risk of about 7 additional cancer cases per 1,000 persons exposed over a lifetime. This 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 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. The actual concentration inside the home is likely to be lower than the levels in the crawlspace and most individuals will not be exposed at maximum concentration levels. Based on the assessment of dose and risk, SHINE 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.

In January 2007, 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. SHINE expects that information collected as part of this pilot project will be useful in helping to determine 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

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

SHINE 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. We assumed that adults would be exposed to well water 1 hour/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 E for Exposure Assumptions)

SHINE 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 or 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 SHINE determined that additional risk calculations for this scenario were not necessary.

Table 4 Irrigation Well Usage and Sampling Data

Location	TCE [ug/l]	PCE [ug/l]	Historical Use	Current Use	Future Use	Frequency of Use
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

Table 5 – Cancer and Non-Cancer Risk from Exposure to Groundwater from Irrigation Wells

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**
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	0.06	0.01	5.7E-07	6.1E-07
PCE	4.75	0.19	0.04	1.0E-07	1.1E-07
Dermal Exposure					
TCE	2.24	0.00	0.00	2.3E-09	5.1E-09
PCE	4.75	0.01	0.00	4.0E-10	9.0E-10
			Total Cancer Risk	**6.7E-07**	**7.3E-07**
	Maximum Level [ug/l]	**Hazard Quotient Child**	**Hazard Quotient Adult**	**Child Cancer Risk**	**Adult Cancer Risk**
Incidental Ingestion					
TCE	15.2	0.01	0.00	8.4E-08	9.0E-08
PCE	50.7	0.02	0.00	9.4E-09	1.0E-08
Dermal Exposure					
TCE	15.2	0.00	0.00	3.4E-10	7.6E-10
PCE	50.7	0.00	0.00	3.7E-11	8.4E-11
			Total Cancer Risk	**9.4E-08**	**1.0E-07**

Based on the presented in Table 5, and the exposure assumptions for adults and children described in Appendix E, SHINE 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

SHINE 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 SHINE were derived from comparison values that incorporate a high level of protectiveness for children.

Conclusions

- VOC vapors from contaminated groundwater are making their way into the crawlspaces of homes in the River Road and Trainsong neighborhoods and potentially into indoor air inside the living spaces of the homes. There are no data on the concentrations of VOC's in indoor air, so data from crawlspaces were used to assess the human health risk of exposure to these vapors. The levels of VOC vapors detected in crawlspaces, which at the maximum levels exceed health guidelines, are determined to be ***a public health hazard*** because action is needed to prevent future exposure to residents in these homes.
- Inhalation exposure to VOC vapors in indoor air at the median levels found in crawlspaces are unlikely to result in adverse health effects.
- The levels of TCE and PCE in the irrigation wells posed ***no apparent public health hazard*** if residents use the water to irrigate gardens or to hose off outside surfaces.

Recommendations

Efforts should continue to identify homes where crawlspace air testing indicates exceedances of health-based standards. These, and the homes already identified as having exceedances, should be tested for indoor air concentrations of PCE and TCE.

In homes where the TCE or PCE concentrations exceed health-based standards, vapor barriers and/or ventilation systems should be installed to reduce the exposure to contaminated indoor air.

Residents in home with irrigation wells should limit their use of the water to irrigating garden and hosing off outside surfaces. Alternative water sources should be identified and 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 SHINE advises that alternative sources of water be used to fill backyard wading pools for small children.

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.

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 SHINE 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 SHINE to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken include the following:

- OPHD/SHINE 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 OPHD/SHINE, 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,
- OPHD/SHINE reviewed DEQ sampling plans and remediation activities. ODHS regularly communicates with ODEQ about activities related to this site.

Public health actions to be implemented:

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

References

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Public Comment

This document is being released for public comment. The public comment period is an opportunity for the public to comment on SHINE's findings or proposed activities contained in this draft document. The public comment period for this document is from May 29, 2007 through June 28, 2007. Comments are requested and should be directed to:

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Oregon Department of Human Services, Health Services
800 NE Oregon #827
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Or you can call 503-731-4025 to obtain an email address for submitting comments electronically.

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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.

Alan Crawford
Acting Technical Project Officer for Oregon, SSAB, DHAC

I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.

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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 [5].

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 [6, 7]. 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)

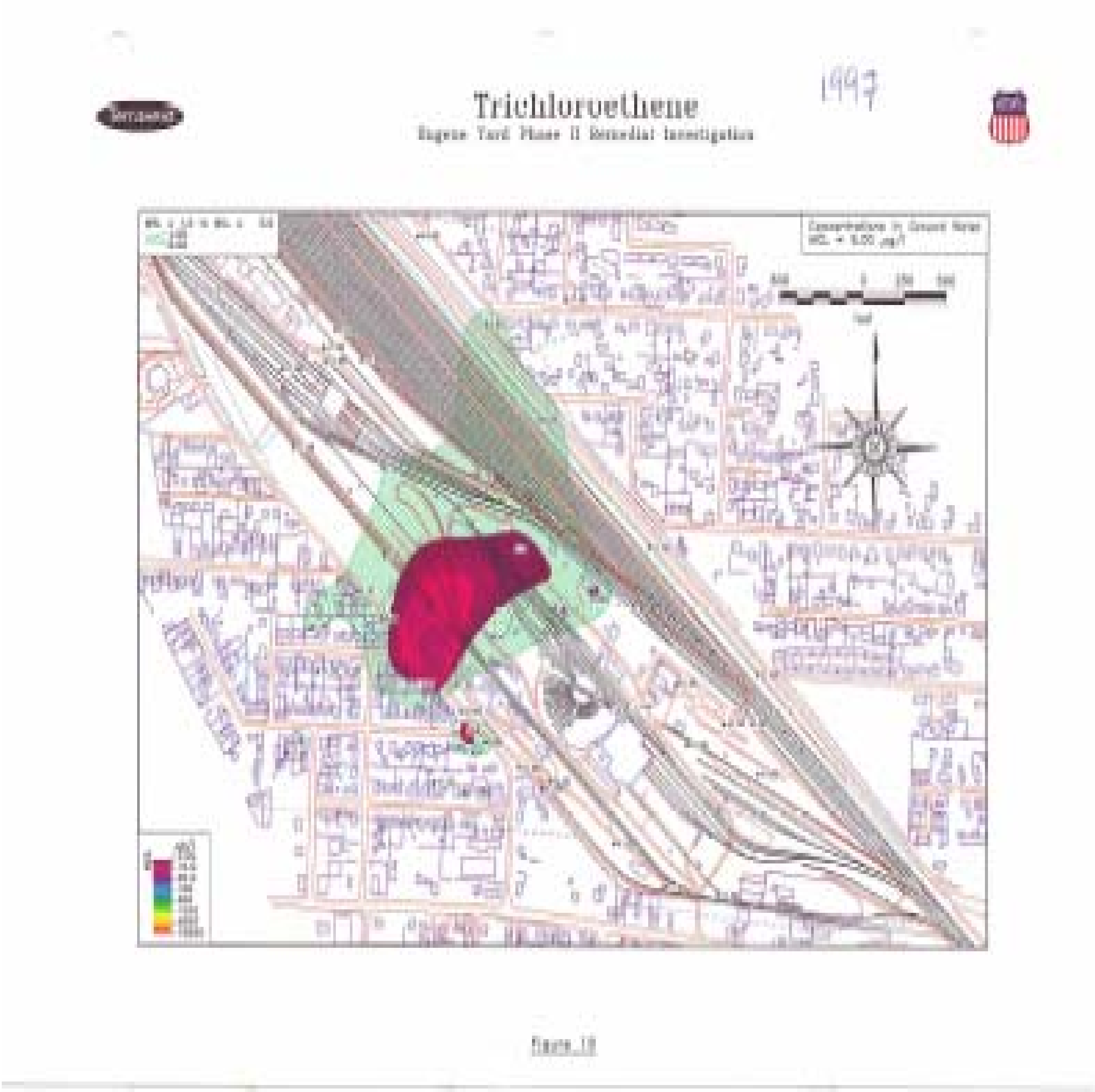
It is uncertain whether people who breathe air or drink water containing trichloroethylene are at higher risk of cancer, or of developing reproductive effects. Several studies suggest that more birth defects may occur when mothers drink water containing trichloroethylene. People who used water for several 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 were 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. [6]

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. [7]

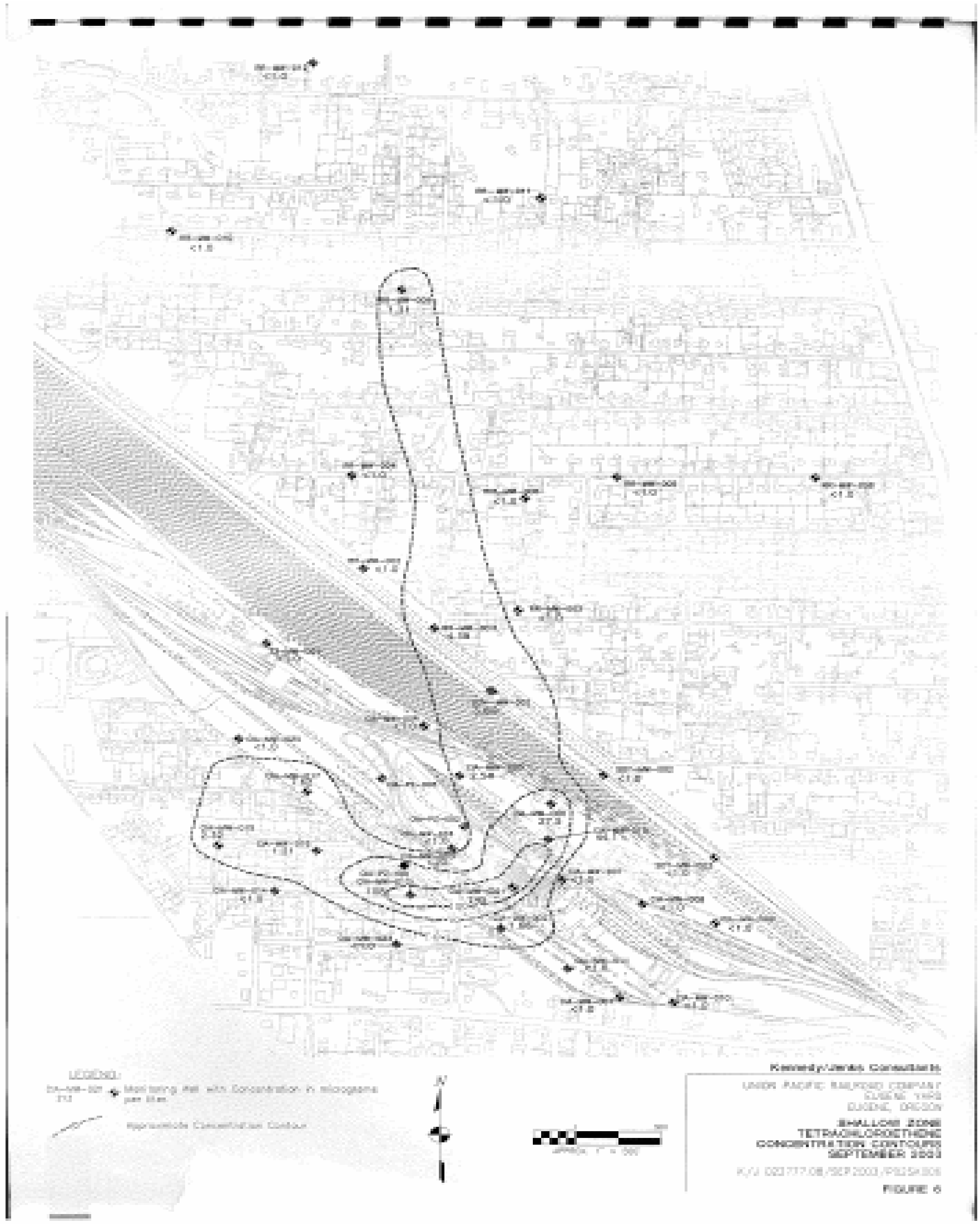
Appendix B - VOC Plume as Depicted in 1997 and 2003

1997 Plume Map - PCE

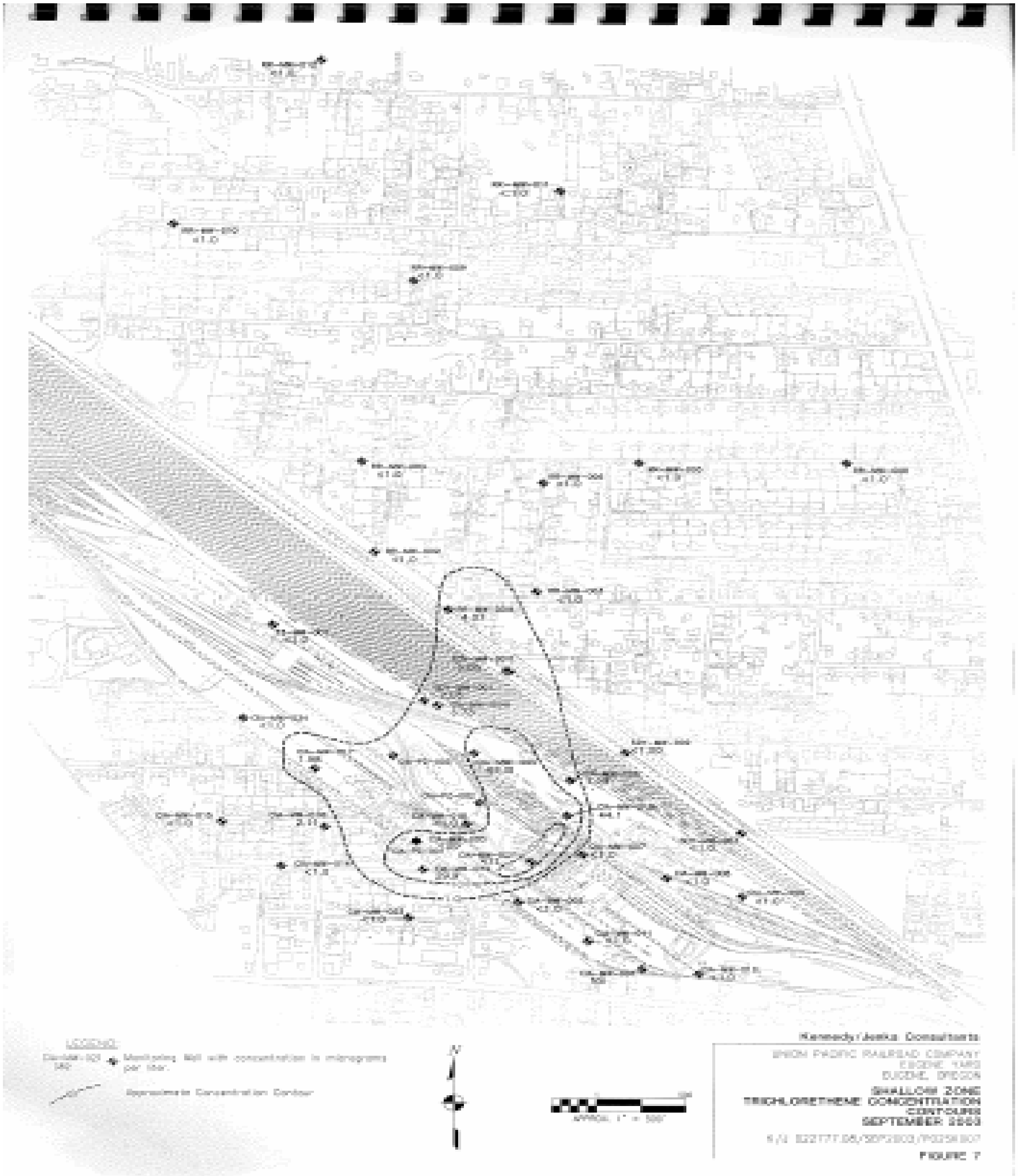
1997 Plume Map – TCE



2003 Plume Map – PCE



<u>2003 Plume Map – TCE</u>



Appendix C – Crawlspace Air Data by Location and Sampling Date

		Volatile Organic Compounds (ug/m^3) [(a)]	
Sample Location	Sample Date	Trichloroethylene	Tetrachloroethylene
Crawlspace Air Samples			
Location 1 - 24H	5/7/2004	0.56	3.2
Location 1 - 24H2	8/11/2004	18.00	1.7
Location 1 - CS	2/27/2006	2.90	2.2
Location 1 - CS Dup	2/27/2006	2.70	2.7
Location 1 - CS	10/3/2006	2.3	0.84
Location 1 - CS Dup	10/3/2006	2.2	0.90
Location 2 - 24H	6/10/2004	2.0	2.1
Location 2 - 24H2	8/11/2004	1.2	0.3
Location 2 - CS	2/28/2006	63.0	1.3
Location 2 - CS	10/3/2006	4.3	0.96
Location 3 - 24H	6/10/2004	8.1	6.0
Location 3 - 24H2	8/11/2004	4.9	13.0
Location 3 - CS	2/28/2006	11.0	1.1
Location 3 - CS	10/3/2006	4.8	1.7
Location 4 - CS	10/3/2006	2.3	0.57
Location 5 - CS	2/28/2006	1.5	4.1
Location 5 - CS	10/3/2006	1.7	1.2
Location 6 - 24H	6/10/2004	6.4	0.64
Location 6 - 24H2	8/11/2004	2.8	2.1
Location 6 - CS	2/28/2006	1.3	0.50
Location 6 - CS	10/3/2006	2.5	0.51
Location 7 - CS	10/3/2006	2.7	0.75
Location 8 - CS	3/1/2006	1.4	0.29
Location 9 - CS	10/3/2006	2.4	0.59
Location 10 - CS	2/27/2006	3.3	14
Location 10 - CS	10/3/2006	1.8	0.78
Location 11 - CS	3/1/2006	4.0	0.21
Location 12 - CS	3/1/2006	1.4	0.12
Location 12 - CS	10/3/2006	2.8	0.78
Location 13 - CS	10/3/2006	2.6	0.50
OVERALL MEAN CONCENTRATION		5.6	2.2

Appendix D – Exposure Assumptions and Cancer Risk for Indoor Air

Exposure Assumptions				
Exposure Factor	**Symbol**	**Value**		**Source/Notes**
		Young Child - less than 5-years-old	***Adult***	
Body Weight [kg]	BW	15	70	ATSDR Public Health Assessment Guidance Manual (Appendix E)
Exposure Frequency [days/year]	F	351	351	DEQ Deterministic HHRA Guidance, Appendix B; away 2 weeks per year
Exposure Duration [years]	ED	6	30	DEQ Deterministic HHRA Guidance, Appendix B
Averaging Time - Noncancer [days]	AT_{nonc}	2106	10530	DEQ Deterministic HHRA Guidance, Appendix B
Averaging Time - Cancer [days]	AT_c	24570	24570	DEQ Deterministic HHRA Guidance, Appendix B
Exposure $Factor_{non-cancer}$ [unitless]	$EF_{non-cancer}$	1	1	(FxED)/AT
Exposure $Factor_{cancer}$ [unitless]	EF_{cancer}	0.086	0.429	(FxED)/AT
Inhalation Rate - Indoor Air	$InhR_{Indoor}$	10	11.3	Exposure Factors Handbook[8]
Conversion $Factor_{Inhalation}$	$Cf_{inhalation}$	0.001	0.001	

	Maximum Air Concentration [ug/m^3]	**Median Air Concentration** [ug/m^3]	**RfC ug/m^3**	**Unit Risk Factor (ug/m^{3})**
Trichloroethylene (TCE)	63	2.65	40	1.1E-04
Tetrachloroethylene (PCE)	13	0.93	300	5.9E-06

	MAXIMUM EXPOSURE		***MEDIAN EXPOSURE***
HAZARD QUOTIENTS			
	Adult and Child		**Adult and Child**
$Inhalation_{TCE}$	1.58	$Inhalation_{TCE}$	0.07
$Inhalation_{PCE}$	0.04	$Inhalation_{PCE}$	0.00
CANCER RISKS			
Cancer Risk Using Unit Risk Factor CR = C_{max}*IUR	**Adult and Child**	**Cancer Risk Using Unit Risk Factor CR = C_{mean}*IUR**	**Adult and Child**
$Inhalation_{TCE}$	6.9E-03	$Inhalation_{TCE}$	2.9E-04
$Inhalation_{PCE}$	7.7E-05	$Inhalation_{PCE}$	5.5E-06
TOTAL CANCER RISK	**7.0E-03**	**TOTAL CANCER RISK**	**3.0E-04**

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 $Factor_{non-cancer, ingestion}$ [unitless]	$EF_{non-cancer, ingestion}$	0.1644	0.3288	EF = (FxED)/AT
Exposure $Factor_{non-cancer, dermal}$ [unitless]	$EF_{non-cancer, dermal}$	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)[6]
Oral Bioavailable Fraction - PCE [%]	BV_{PCE}	1	1	Tetrachloroethylene Toxicological Profiles (ATSDR)[7]
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$_{non\text{-}cancer}$ (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$_{non\text{-}cancer}$ (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) — The concentration of a chemical in air that is very unlikely to have adverse effects if inhaled continuously over 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**.