ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

RAVENSWOOD PCE GROUND WATER PLUME SITE
RAVENSWOOD, JACKSON COUNTY, WEST VIRGINIA
EPA FACILITY ID: WVSFN0305428
MARCH 14, 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

RAVENSWOOD PCE GROUND WATER PLUME SITE

RAVENSWOOD, JACKSON COUNTY, WEST VIRGINIA

EPA FACILITY ID: WVSFN0305428

Prepared by:

West Virginia Department of Health and Human Resources
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Foreword

This document summarizes public health concerns related to the presence of tetrachloroethylene (PCE) in the groundwater under a portion of the City of Ravenswood and in the public water supply of the Ravenswood Municipal Water Works. People who use the Ravenswood Municipal Water Works water in their homes or businesses may be exposed to the PCE when they drink the water or inhale vapors during showers. People who live or work over the PCE-contaminated groundwater might breathe PCE if vapors accumulate in their homes or businesses. Finally, people who are close to the air stripper near the water plant might breathe the PCE vapors that are emitted from the unit.

A number of steps are necessary to complete this document.

Evaluating exposure: The West Virginia Department of Health and Human Resources ATSDR Cooperative Partners Program (WVDHHR) starts by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present where it is found on the site, and how people might be exposed to it. WVDHHR typically does not collect environmental samples. WVDHHR relies on information provided by the West Virginia Department of Environmental Protection (WVDEP), U.S. Environmental Protection Agency (EPA), other governmental agencies, businesses, and other sources of valid information.

Evaluating health effects: If there is evidence that people are being exposed, or could be exposed, to hazardous substances, WVDHHR scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health ─ the health impact on the community as a whole. The evaluation is based on existing scientific information.

Developing recommendations: In this report the WVDHHR outlines its conclusions regarding any potential health threat posed by this site and offers recommendations for reducing or eliminating human exposure to contaminants. The role of the WVDHHR at these sites is primarily advisory. For that reason, these reports will typically recommend actions to be taken by other agencies, including the WVDEP and the EPA.

Soliciting community input: The evaluation process is interactive. WVDHHR starts by soliciting and evaluating information from various governmental agencies, the organizations responsible for cleaning up sites, and the community surrounding the site. Any conclusions about the site are shared with groups and organizations that provided the information.

If you have questions or comments about this report, we encourage you to contact:

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Executive summary

Tetrachloroethylene (PCE) is in the groundwater used for the public water supply by the Ravenswood Municipal Water Works. Public water from this source is supplied to about 6,000 people. This document also reviewed exposure via vapors migrating from PCE in groundwater into homes and businesses in the City of Ravenswood.

West Virginia Department of Health and Human Services Cooperative Partners Program (WVDHHR) concludes that exposures to PCE at this site pose *no apparent public health hazard for the past and present.* Although people at this site are exposed to PCE, the exposures estimated are not expected to cause adverse noncarcinogenic health effects in children or adults for current or past exposures. The estimated excess cancer risk from PCE exposures at this site is 1 in 10,000 or less, a very low risk of developing cancer.

WVDHHR concludes that there is an *indeterminate public health hazard* for future exposures to PCE in the finished water blend of the Ravenswood Municipal Water Works. PCE-contaminated groundwater more concentrated than is currently entering the public water supply was found about 150 feet from the well field. If water with this degree of contamination enters the well field, there may be enough PCE in the finished water blend to be of public health concern. WVDHHR cannot estimate the amount of PCE in the finished water blend should this occur. The water plant operator has several options to reduce the amount of PCE in the finished water blend. These include the use of more than one air stripper, blending the contaminated water with a large volume of lesser contaminated water, pumping the water but not using it in the public water supply, or not using water from the contaminated well. If data becomes available suggesting that human exposure to PCE at levels of public health concern is occurring or likely to occur, WVDHHR will review the data and make recommendations to protect the public health.

Statement of issues and background

Tetrachloroethylene (PCE) is in the groundwater used for the public water supply by the Ravenswood Municipal Water Works. The contaminated groundwater is under a portion of the City of Ravenswood. This public health assessment determined whether exposure to site-related contaminants has occurred in the past, is occurring, or will occur in the future and whether adverse health effects could result.

The following routes of exposure were reviewed. People are exposed to PCE when they drink the PCE-contaminated water or inhale PCE from this water when showering. People may inhale PCE vapors in structures while living or working over PCE-contaminated groundwater. Finally, people who work in the water plant might breathe PCE vapors emitted from clear well or the air stripper. Determinations for the potential for adverse health effects from these exposures were made.

This site was proposed for the National Priorities List (NPL) on March 8, 2004, because the PCE-contaminated groundwater plume (plume) is impacting the public water supply of approximately 6,000 people. The Agency for Toxic Substances and Disease Registry (ATSDR) and WVDHHR prepared this public health assessment for the Ravenswood PCE Ground Water Plume site. Congress has asked ATSDR to evaluate public health issues at all sites proposed for the NPL. WVDHHR prepared this public health assessment under a cooperative agreement with the ATSDR.

Site description and history

The Ravenswood PCE Ground Water Plume Site (site) consists of the area over the plume to the south and east of the Ravenswood Municipal Water Works water plant. The site includes five of the seven wells used by the public water system. These five wells, all constructed prior to 1977, are in a 3- to 4-acre area in and near the Ravenswood Public Service Building/Maintenance Garage. The water plant is adjacent to the Maintenance Garage. Two additional water wells drilled and put in service in 2004 are northeast of the plume. The Ravenswood Municipal Water Works supplies water to 6,090 persons through their system and the Silverton Public Service District (PSD).

The site is a mixed residential and commercial area. The site center is the maintenance garage portion of the Ravenswood Public Service Building, 329 Virginia Street, between Sycamore Street and Plaza Drive. The site is bounded by Sandy Creek to the south, Water Street to the west, Plaza Drive to the north, and Henrietta Street to the east [1]. The overall area is approximately 30 city blocks. The Ravenswood Public Safety Building/Maintenance Garage is surrounded by grassy areas and asphalt parking lots [2]. It is bound to the south Sandy Creek, Water Street to the west, Plaza Drive to the north, and Henrietta Street to the east [1]. Ravenswood High School is about 500 feet away from the plume. The property line of Ravenswood Middle School is at the edge of the plume. (Figures 1 & 2)

Children are present at three locations near this site. The Ravenswood High School and Ravenswood Middle School are close to the Ravenswood Public Service Building/Maintenance Garage but are not over the plume. A public playground is south of the library (Figures 1 & 2).

The City of Ravenswood is located on the eastern bank of the Ohio River in Jackson County, West Virginia. Groundwater comes from rain and snow percolating to the water table from the surface and the Ohio River. Soil under the site consists of sand with some clay near the surface [3]. Groundwater normally flows toward a large river. The municipal well field, pumping an average 650,000 gallons of water a day, influences the groundwater flow in this area. The apparent groundwater capture area extends to the Ohio River and Sandy Creek [4]. However, recent data suggests an apparent groundwater flow divide between the well field and the Ohio River.

The plume extends southward from the area of Well #3 on Virginia Street approximately 1,400 feet to Broadway Street (Figure 2) [2]. The data that delineated the plume came from five municipal water wells, four EPA groundwater monitoring wells, seven WVDEP groundwater monitoring wells, and 55 Geoprobe® locations. The plume is about 400 feet wide in the upper portion of the water-bearing zone (about 60 feet below ground surface) and 100 feet wide in the lower portion (about 90 feet below ground surface). Groundwater in the upper portion of the plume contains more PCE than at lower levels [1, 2]. The EPA found the most PCE in groundwater in a monitoring well about 20 feet from the front of the library. They found 470 micrograms of PCE per liter of water or parts per billion (µg/L or ppb) [5] in this well.

Possible sources of PCE contamination are one or more of three former dry cleaning establishments, the Ravenswood Public Service Building either under its present use or when it was an electrical power plant, a former dump site, and the site of a former hospital [2].

PCE was found in the municipal water in September 1989. The first test for PCE, in June 1989, did not detect this chemical in the municipal water. The water system has found PCE in three of the five public water wells near the water plant [1]. PCE was detected in Well #2 when the most contaminated well (#3) was out of service. Data from the individual wells shows that the plume continues to be gathered by Wells #3 and #5 and has not migrated to the other wells used by the water plant [6].

The water system has routed water from Wells #3 and #5 through an air stripper since June 2000. The air stripper allows some of the PCE to evaporate from the water into the air. The water is returned to the water plant where is it blended with water from the other wells before it is supplied to the public. The water supplied to the public is called the finished water blend.

PCE in the finished water blend has averaged 0.67 µg/L in samples collected between January 2000 and January 2006 with no sample over 1.5 µg/L. The amount of PCE in the finished water blend exceeded the EPA’s Maximum Contaminant Level (MCL), 5 µg/L, on six occasions. The last time that the finished water contained PCE above the MCL was November 1999 when PCE was found at 5.6 µg/L [6]. The highest amount of PCE found in the water, 10.8 µg/L, was found in March 1998. The more contaminated groundwater found near the library, about 200 feet away from the public well field, may be pumped into the public wells in the future. If this occurs the water plant operator has several options to reduce the amount of PCE in the finished water blend. The options include the use of additional air strippers, blending the water with a larger volume of lesser-contaminated water, pumping the water but not using it in the public water supply, or not pumping more-contaminated water. Because of these options, an estimate of future exposures to PCE in the finished water blend is not possible.

The EPA plans to remove some of the PCE from the groundwater before it reaches the municipal water supply. Sparging wells, one method of removal, will be evaluated. Sparging wells bring groundwater to the surface where some of the PCE evaporates into the air before the groundwater is pumped back underground. The sparging wells may be installed along Sycamore Street. Before completing the installation, the EPA may begin this process with a pilot project to determine how much PCE the sparging wells will remove at this site.

The EPA funded the construction of two additional water wells for the Ravenswood Municipal Water Works. These wells are outside of the plume. The wells were placed in service in 2004.

Tetrachloroethylene (PCE)

PCE is used as a dry cleaning solvent and metal degreasing agent. PCE is a volatile chemical that evaporates easily into the air and becomes a gas. PCE can move from the water into the air as a vapor when water is heated. Exposure to PCE can occur in several ways. People can be exposed to PCE in the air during hot showers. Some PCE can be absorbed into the body when it is in contact with the skin. PCE in groundwater can evaporate into the soil above the groundwater table and move as a vapor through the soil into buildings located over the contaminated groundwater. People living or working in buildings above PCE-contaminated groundwater can be exposed to these vapors. People could be exposed to PCE released into the air from the air stripper near the water plant.

Studies in humans and animals indicate that PCE might cause cancer in humans. People exposed to PCE at work develop more cancers than those who were not exposed. However, these people were exposed to other chemicals that could cause the cancer. Animals exposed to very high levels of PCE have developed liver and kidney cancers from these exposures. The International Agency for Research on Cancer classifies PCE as “probably carcinogenic to humans based on limited human evidence and sufficient evidence in animals." The National Toxicology Program classifies PCE as "reasonably anticipated to be a carcinogen." The EPA is reviewing data on the potential of PCE to cause cancer in humans and has no cancer classification for this chemical.

Demographics

The Ravenswood Municipal Water Works supplies water to 5,453 persons in Ravenswood and 2,478 persons in the nearby city of Silverton. This includes 2,079 students in five schools [2]. Some students are from homes served by the water company and others live in areas outside of the water company distribution system.

The population of this area consists of 21% under the age of 18 and 13% over the age of 65 [7].

Discussion

Data review

The conclusions in this report are affected by the availability and reliability of the information reviewed. Not all the data was collected and analyzed following EPA-approved sampling and analytical methods. WVDHHR assumed that all data used in this report would be acceptable had it undergone full data validation procedures.

Water supplied by the Ravenswood Municipal Water Works

PCE is the only chemical that meets the criteria as a chemical of concern at this site [8]. We reviewed the analysis of finished water blend of the Ravenswood Municipal Water Works on file in the WVDHHR offices. These samples were taken from June 1989 through January 2005. The water system operator took the samples to comply with the National Primary Drinking Water Regulations and by the EPA. Samples were collected quarterly beginning March 1998 and monthly since January 2001.

WVDHHR based the exposure estimates on PCE found in the finished water blend, not data from individual wells. People are not exposed to water from the individual wells.

The highest amount of PCE found in the finished water blend, 10.8 µg/L, was found in March 1998. No test has exceeded the MCL since November 1999 when PCE in the water was 5.6 µg/L. PCE in the finished water blend has averaged 0.67 µg/L in samples collected between January 2000 and January 2006 with no sample over 1.5 µg/L.

As a worst case estimate, the analysis of the exposure to PCE in the finished water blend used 10.8 µg/L. This means that the estimated exposure doses are likely to overestimate the actual exposures.

Groundwater monitoring wells

Vapor intrusion occurs when chemicals move from the groundwater through the soil as a vapor (gas) and accumulate inside buildings. We reviewed the volatile chemicals found in 11 groundwater monitoring wells between August 2003 and June 2004. PCE is the only volatile chemical found in high enough concentrations to be considered for the vapor intrusion pathway.

The data showed that 470 µg/L PCE was in the groundwater in front of the library [5]. It is important to note that the highest amount of PCE found in the other 10 groundwater monitoring wells was 130 µg/L. This was found in a sample from a well centrally located between Mulberry, Virginia, Walnut, and Sycamore streets.

Samples from the monitoring well located near the confluence of Sandy Creek and the Ohio River did not detect PCE. This is the background location for this site.

PCE may vary depending on where the sample was taken within the water table. PCE is typically found in higher amounts in samples taken at higher levels, i.e., closer to the ground surface. The groundwater monitoring well near the library was sampled 8 feet below the water table while other wells were sampled in the middle of the aquifer, about 15 feet below the water table.

The analysis of the potential for exposure to PCE from the vapor intrusion pathway used 470 µg/L, the highest PCE concentration found in the groundwater monitoring wells.

Soil gas data

WVDHHR also used soil gas data to assess potential exposures to PCE through the vapor intrusion pathway. The EPA collected 170 soil gas samples in 1999 to assess the extent of the plume. They took samples 100 feet apart in a 75-acre area. Most samples were taken 4 feet (ft) below ground surface (bgs). Other samples were taken between 6 and 8 feet bgs. PCE was found at only two locations. A hole was bored through the concrete of the sump in the Ravenswood Public Service Building. PCE was found there at 178 parts per billion by volume (ppbv) at 4 ft bgs and at 217 ppbv at 8 ft bgs. Two samples under the paved parking lot at the south end of the Ravenswood Public Service Building contained PCE at 68 ppbv [9].

The analysis of the potential for exposure to PCE through the vapor intrusion pathway used 217 ppbv, the highest soil gas test result.

PCE emissions from air stripper

WVDEP did not require the City of Ravenswood to obtain a permit for the air stripper because the emissions were less than 2 pounds of PCE per hour [10]. The West Virginia Division [Department] of Environmental Protection (WVDEP) estimated that 0.011 pounds of PCE per hour would enter the air from the air stripper. Their model assumed that the water entering the unit at 350 gallons per minute and contained 70 µg/L PCE. The model estimated that the air stripper would remove 93% of the PCE from the water and 100% of the PCE removed would enter the air.

The WVDEP model overestimated the amount of PCE entering the air from the air stripper. The amount of PCE in the water going into the air stripper has been 47.6 µg/L or less. The average amount of water going through the air stripper has been 340 gallons per minute. The measured reduction of PCE in water by the air stripper has been 84%, less than 93% estimated by the model [6].

Selection of chemicals of concern

The first step in the assessment of human health risk is the selection of chemicals of concern. This process compares data from the site to environmental guideline comparison values (CVs). CVs are used as screening tools. Comparison values are established on the basis of an evaluation of toxicology literature for a given substance. Many safety factors are included in the derivation of these values, making them very conservative (i.e., protective of public health). Exposure to a chemical below its corresponding CV indicates that adverse health effects are unlikely. Chemicals found above the selected CVs are called chemicals of concern. Exposure to chemicals above a CV *does not necessarily mean* that an adverse health effect will result. It simply indicates a *need for further evaluation* to determine if they *could be associated with* adverse health effects at this site. Some chemicals have both carcinogenic and non-carcinogenic CVs. The lowest (i.e., most conservative) comparison value for PCE using the ATSDR hierarchy system was selected.

WVDHHR selected the EPA maximum contaminant level (MCL) for PCE, 5 µg/L, as the most appropriate CV for the finished water blend. We reviewed data from 79 samples. Six of the 35 PCE detections were above 5 µg/L. PCE met the criteria for a chemical of concern in the finished water blend.

We used two factors to select the chemicals of concern for the vapor intrusion pathway. PCE was the only chemical that was volatile enough and toxic enough to be reviewed for possible health effects for this pathway. The PCE in the groundwater monitoring well near the library, 470 µg/L, and the soil gas found 8 ft bgs in the Ravenswood Public Service Building, 217 ppbv, were used in the vapor intrusion pathway model.

Human exposure pathway analysis

An exposure pathway consists of five parts:

1. a source of contamination,
2. movement of the contaminant(s) into and through the environment (in soil, air, groundwater or surface water) to bring it into contact with people,
3. a place where humans could be exposed to the contaminant(s),
4. a way for humans to be exposed to the contaminant(s) (such as by drinking the water or breathing the air), and
5. a receptor population, one or more people who may have contacted the contaminant(s).

Exposure pathways are considered *complete* when all five of these elements existed at some point in the past, exist in the present, or are likely to occur in the future. Exposure pathways are considered *potential* when one or more of the elements are missing or uncertain but could have existed in the past, could be occurring now, or could exist in the future. Pathways are considered *eliminated* when one or more of these five items do not exist or where conditions make exposures highly unlikely.

A completed pathway means that people have been exposed to chemicals. That said, however, the existence of a completed pathway *does not necessarily mean that a public heath hazard existed* in the past, exists currently, or is likely to exist in the future.

People could come in contact with PCE at this site in three ways;

- by drinking water containing the chemical (ingestion),
- by skin contact (dermal), and
- breathing air containing PCE vapors (inhalation).

The pathway analysis table is in Appendix B.

Ingestion, inhalation, and dermal exposures to PCE-containing water from the Ravenswood Municipal Water Works – completed pathway for the past, present, and future

PCE is currently in the finished water blend in low levels. PCE is likely to be in the water supply in the future. It was originally detected in the water supply in 1989. The source of the PCE in the groundwater used by the Ravenswood Municipal Water Works is unknown. Residents, schoolchildren, and people who work in the area where this water is supplied could be exposed to PCE in the three ways, by drinking, inhaling the vapors or by absorption through the skin. PCE is a volatile chemical and vaporizes into the air when water comes from the tap. People who shower could inhale the PCE. There is a potential for dermal exposure during showers and other activities where water is in contact with the skin. Dermal absorption of PCE, however, is not as important as absorption via inhalation [11]. The ingestion, inhalation, and dermal exposure pathways for exposure to PCE-containing water is completed for the past, present, and future.

Inhalation of PCE from vapor intrusion into residences and businesses – completed pathway for the past, present, and future

The EPA found PCE in groundwater and soil gas south and east of the water plant. PCE will remain in the groundwater until it is removed by the EPA sparging wells or the public water wells. PCE has the potential to move from the groundwater into buildings over the plume by moving as a vapor through the soil and entering buildings through cracks and crevices. Vapors from PCE might accumulate inside buildings at levels that cause adverse health effects. Horizontal movement of vapors along underground pipes was not considered at this site due to the sandy nature of the soil.

PCE is a chemical that is able to move through the soil as a vapor, is sufficiently toxic, and found in concentrations where exposures to PCE via this route are possible. Therefore, the vapor intrusion pathway is complete for the past, present, and future.

Ingestion of PCE-containing water from private water wells - potential pathway in the past

A few residents of Ravenswood used private water wells in the past. At least one well was used in the area where the plume has been identified. No data are available to know if the contaminant was in the water in these wells. No private wells are currently known to exist. This is a potential pathway because it is not known if private well water used in the past contained PCE.

Inhalation of PCE from the emissions from the air stripper used by the Ravenswood Municipal Water Works – eliminated pathway for the past, present, and future

PCE enters the atmosphere at the air stripper located near the water plant. The EPA determined that the highest annual average concentration due to the amount of emissions from the air stripper, 0.077 $\mu g/m^3$ (0.01 ppb), would be found 108 meters (approximately 350 feet) from it (Appendix C). They used the SCREEN3 model. This amount was compared to the ATSDR chronic environmental media evaluation guide (EMEG) for PCE, a health-based CV, of 40 ppb.

The PCE in air from the air stripper is substantially below the CV at its highest (modeled) value, 350 feet from the unit. The model estimated that all other points, closer and further from the air stripper, would have PCE air concentrations lower than 0.077 $\mu g/m^3$ (0.01 ppb). Therefore, the pathway is eliminated for the past, present, and future because significant exposures to PCE via inhalation from air stripper releases are highly unlikely.

Inhalation of PCE vapors from the water in the clear well under the Ravenswood Municipal Water Works – eliminated pathway for the past, present, and future

PCE could enter the air in the workroom of the water plant. A tank called the clear well is under the water plant. This is where water from all the wells is mixed before it is sent to customers. PCE vapors may enter and accumulate in the workroom where workers may breathe the chemical. The EPA estimated the amount of PCE in the workroom (Appendix C). The PCE indoor air concentration was 4.79 µg/m^3 (0.71 ppb) when the PCE concentration of the water in the clear well was 47.6 µg/L. This amount was compared to the ATSDR chronic environmental media evaluation guide (EMEG), a health-based CV, of 40 ppb. The estimated amount in the air is substantially below the CV. Therefore, the pathway is eliminated for the past, present, and future because significant exposures to PCE via inhalation in the workroom are highly unlikely.

Exposure to PCE in the soil – eliminated pathway for the present and future

Years ago an acceptable disposal practice for PCE was to pour it on the ground. Once people realized that this contaminated groundwater, the practice stopped. PCE may have been present in the soil in the past near businesses that are suspected as being the source of the chemical contaminant. Since PCE evaporates in the air easily and PCE is not known to be currently released in the environment at this site, current exposures to PCE in the soil are highly unlikely. This pathway is eliminated for the present and future. No data are available to assess the potential exposures in the past.

Exposure analysis

Estimating exposure doses

Exposure doses are estimates of how much chemical gets into a person's body based on their actions and habits. The estimates rely on environmental data and assumptions such as how often and how long a person may come into contact with a chemical. Exposure dose calculations and assumptions are outlined in Appendix C.

Selection of chemicals to be reviewed for noncarcinogenic health effects

Exposure doses found to be above another set of CVs, called health-based comparison values, were selected for further review. These are values below which exposures would not be expected to cause adverse noncarcinogenic health effects. When estimated exposure doses are below these health-based comparison values, the chemical of concern is eliminated from further review. This means that exposures to chemicals at the estimated levels *are not expected to result in adverse health effects*. Exposure to chemicals above a CV does not necessarily mean that adverse health effects will occur. It simply indicates *a need for further evaluation* to determine if they *could be associated with* adverse health effects.

As noted below, the estimated exposure doses in the finished water blend were compared to an EPA reference dose (RfD) for oral exposures and an EPA provisional reference concentration (RfC) for inhalation exposures over a lifetime. The estimated exposures were all below the RfDs. Therefore, no additional evaluation was needed to conclude that adverse health effects from drinking and showering are not likely.

The model used for PCE in soil gas indicated that exposure to PCE via vapor intrusion was below levels where adverse health effects were considered likely.

Selection of chemicals to be reviewed for carcinogenic health effects

The review of carcinogenic effects of chemicals generally uses recent or current environmental data. Most cancers develop over many years. Estimates of exposures causing cancers assume that the environmental data used in the report reflect the exposures in the past, even though environmental data for the past is generally not available. It is likely that PCE was discovered in the finished water blend at the time when the plume reached the public well field. If so, exposures to PCE in the finished water blend are well characterized.

The EPA Office of Emergency and Remedial Response (OERR) adopted a provisional Cancer Slope Factor (CSF) for PCE. The CSF is 0.54 milligrams per kilogram per day $(mg/kg/day)^{-1}$ [12]. WVDHHR used this CSF to calculate a theoretical excess cancer risk for exposures to PCE. The estimate obtained for each age group was added together and averaged over a 70-year lifetime. This gives a theoretical excess cancer risk for a person who is exposed to PCE in the finished water blend over a 46-year period.

The true risk of developing cancer from exposure to PCE in the finished water blend is unknown and could be as low as zero. The calculation of excess cancer risk assumes no safe level for exposure to a carcinogen. In addition, the method computes the 95% upper bound for the risk, rather than the average risk. The use of many conservative assumptions means that there is a very good chance that the risk of cancer is actually lower than estimated, perhaps by several orders of magnitude.[1]. The method used to calculate the theoretical excess cancer risks are described in Appendix C.

A risk of 1 in 10,000 is considered a very low risk and no assessment of risk is required.

Possible health consequences from exposures to PCE at this site

<u>*Ingestion*</u>

We assumed that people have ingested water containing 10.8 µg/L in the past and would continue to ingest it over a 46-year period. This assumption uses the highest amount of PCE found in the water. Based on the average amount of PCE in the water since May 2000, 0.58 µg/L, the estimated exposure doses are much higher than the actual exposures found at this site. Water contained 10.8 µg/L for a brief period in 1998. Exposures to PCE will occur in the future until PCE is removed from the groundwater used by the public water supply.

The highest estimated exposure dose from drinking the finished water blend was 10 times less than the selected CV (Table 1). Therefore, no adverse noncarcinogenic health effects would be expected from drinking this water. Estimates of excess cancer risk are 1 in 10,000, for an adult exposed continuously over a 24-year period or for a person exposed for 46-year beginning as a child.

1 One order of magnitude is 10 times greater or lower than the original number. Similarly, two orders of magnitude are 100 times, and three orders of magnitude are 1,000 times greater or lower than the original number.

Table 1. Estimated exposure doses from PCE in drinking water					
	Child	Child	Adolescent	Adult	Reference Value
Age (years)	0-1	2-6	7-16	≥18	
Noncarcinogenic intake rate (mg/kg/day)	0.001	0.001	<0.001	<0.001	0.01 mg/kg/day (Oral RfD for chronic exposures)
Theoretical excess cancer risk (number in 10,000 people)	<1	<1	<1	1	0.54 $(mg/kg/day)^{-1}$ (Provisional CSF [12])

<u>Dermal</u>

Although exposure to PCE through the skin is possible, PCE is more easily absorbed when it is inhaled than it is through the skin. We assumed that all the PCE in the water used in the shower was inhaled and, therefore, no PCE was absorbed through the skin. This assumption overestimates the amount of PCE inhaled. Since inhaled PCE is more readily absorbed than dermally-applied PCE, the end result is an overestimation of PCE exposure.

<u>Inhalation</u>

WVDHHR used two methods to estimate the amount of PCE inhaled during a shower. These methods are outlined in Appendix C.

The estimates were compared to the EPA Provisional Chronic Reference Concentration (RfC) of 0.6 mg/kg/day. All exposure dose estimates were at least ten times less than the RfC (Table 2). All estimates of excess cancer risk are less than 1 in 10,000 people, even for exposures 350 days a year over a 46-year time period. Therefore, no adverse health effects would be expected from PCE inhaled during showers.

Table 2. Estimated exposure doses from PCE inhaled during showers*					
	Child	Child	Adolescent	Adult	Reference Value
Age (years)	0-1	2-6	7-16	≥18	
Noncarcinogenic intake rate (mg/kg/day)	n/a**	0.002 (0.004)	0.001 (0.002)	<0.001 (0.001)	0.6 mg/kg/day (Provisional RfC for chronic exposures)
Theoretical excess cancer risk (number in 10,000 people)	n/a**	<1 (<1)	<1 (<1)	<1 (<1)	0.02 $(mg/kg/day)^{-1}$ (Provisional EPA inhalation cancer slope factor)
Estimates using Method 1 are listed on the first line. The estimates using Method 2 are shown in parentheses					
***Children under 2-years-old do not shower.*					

Vapor intrusion

The Johnson & Ettinger Model was used to estimate vapor intrusion in the library. The model is used as a screening tool to identify conditions where additional monitoring should be considered [13].

The highest amount of PCE found in the groundwater, 470 µg/L, was found in a well close to the library. The model determined that the excess cancer risk was well below 1 in 10,000 people. No indoor air monitoring is recommended.

The soil vapor model is based on a number of assumptions that are used to simplify the complex process of the movement of vapors through the soil and into buildings. Soil vapor levels can be affected by water and air movement through the soil, temperature variations in the soil and groundwater, precipitation, biodegradation, barometric pressure, building structures, and pressure differences between the inside and outside of buildings. Many of the assumptions used in this model are noted and discussed in Appendix C. The health consultation published January 2, 2004 determined that the amount of PCE found in soil gas under the Ravenswood Public Service Building/Maintenance Garage was not high enough to likely cause adverse health effects to the people who worked in this area [8].

The PCE found in groundwater at this site is below the levels where a further evaluation using indoor air samples would be recommended. No levels of PCE were modeled that would likely cause any adverse health effects in people who live and work in the buildings over the plume at this site.

Estimates from all routes of exposure

The highest exposure to sources of PCE was to a child 2- to 6-years old exposed to PCE in drinking water and who also inhaled PCE during daily showers. The total exposure dose estimate for these two exposures for noncarcinogenic effects was less than 0.0001 mg/kg/day PCE. This is substantially below the RfD of 0.01 mg/kg/day. Therefore, no adverse noncarcinogenic health effects are likely to be observed in any person exposed to PCE from public water containing 10.8 µg/L over a long period.

A person exposed to 10.8 µg/L PCE in drinking water and inhaling PCE vapors during daily showers for 46 years would have an estimated cancer risk of 1 in 10,000. The theoretical cancer risk for exposures to PCE at this site is a very low risk.

Health outcome data

No adverse health effects are expected using the available environmental data and reasonable exposure dose calculations.

Community health concerns

People in the community have not expressed health concerns to WVDHHR. The Water Quality and Vapor Intrusion Assessment health consultation was distributed to governmental officials and the media. The local newspaper ran a story on the front page regarding this report [14].

No community concerns are known at this time.

Child health considerations

The many differences between children and adults demand special consideration. Children can be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and often use hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults. This means they breathe dust, soil, and vapors close to the ground. Children are smaller than adults which results in a greater dose of a substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. This public health assessment considered potential health effects to children to assist adults who make decisions regarding their children's health.

The consideration of children's health at this site is appropriate because the developing fetus, children, and especially the developing nervous system are particularly susceptible to the toxic effects of PCE [11]. Estimated exposure doses and theoretical cancer risks were calculated. Adverse health effects from past or current exposures are not likely to be observed in children exposed to PCE at this site.

Conclusions

The five public health hazard categories used by ATSDR are; no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

WVDHHR concludes that exposures to PCE at this site pose *no apparent public health hazard for the past and present.* Site specific exposures are not expected to cause adverse noncarcinogenic health effects for past or present to children or adults. The excess cancer risk was determined to be a very low risk, 1 in 10,000 or less.

WVDHHR concludes that there is an *indeterminate public health hazard* for future exposures to PCE in the finished water blend of the Ravenswood Municipal Water Works. The most contaminated groundwater was found in groundwater about 150 feet from the public well field, near the Ravenswood Public Library. If this groundwater enters the public well field, there may be enough PCE in the finished water blend to be of public health concern. WVDHHR could not estimate the human health impact should this occur because the water plant operator has many options to reduce the amount of PCE in the finished water blend. If data becomes available suggesting that human exposure to hazardous substances at levels of public health concern is occurring or is likely to occur, WVDHHR will review the data and make recommendations to protect the public health.

Recommendations

WVDHHR recommends the EPA reduce PCE in the groundwater near the public well field.

Since 1989, the Ravenswood Municipal Water Works operator has treated and maintained the water system to minimize the presence of PCE in the finished water blend. WVDHHR recommends continuation of monitoring and treatment to minimize PCE in finished water.

No adverse health effects are likely from current exposures to PCE in the municipal water. Therefore WVDHHR makes no recommendations to the general public to reduce their exposures.

Public health action plan

1. WVDHHR will provide information to the community to assist their understanding of the report and the issues in it.
2. Should future environmental data indicate that PCE levels are increasing in the finished water blend, WVDHHR will evaluate the potential health effects from PCE exposure to the residents of Ravenswood and Silverton.
3. Projected completion dates for health education activities are 8 months after the release of the final version of the report unless a request for an extension of activities is received from the community.

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Certification

West Virginia Department of Health and Human Resources prepared this public health assessment for the Ravenswood Groundwater Plume Site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry. It was completed in accordance with approved methodologies and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation of ATSDR has reviewed this public health assessment and concurred with its findings.

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Appendix A. Figures

Figure 1. Site boundaries and area around the municipal well field

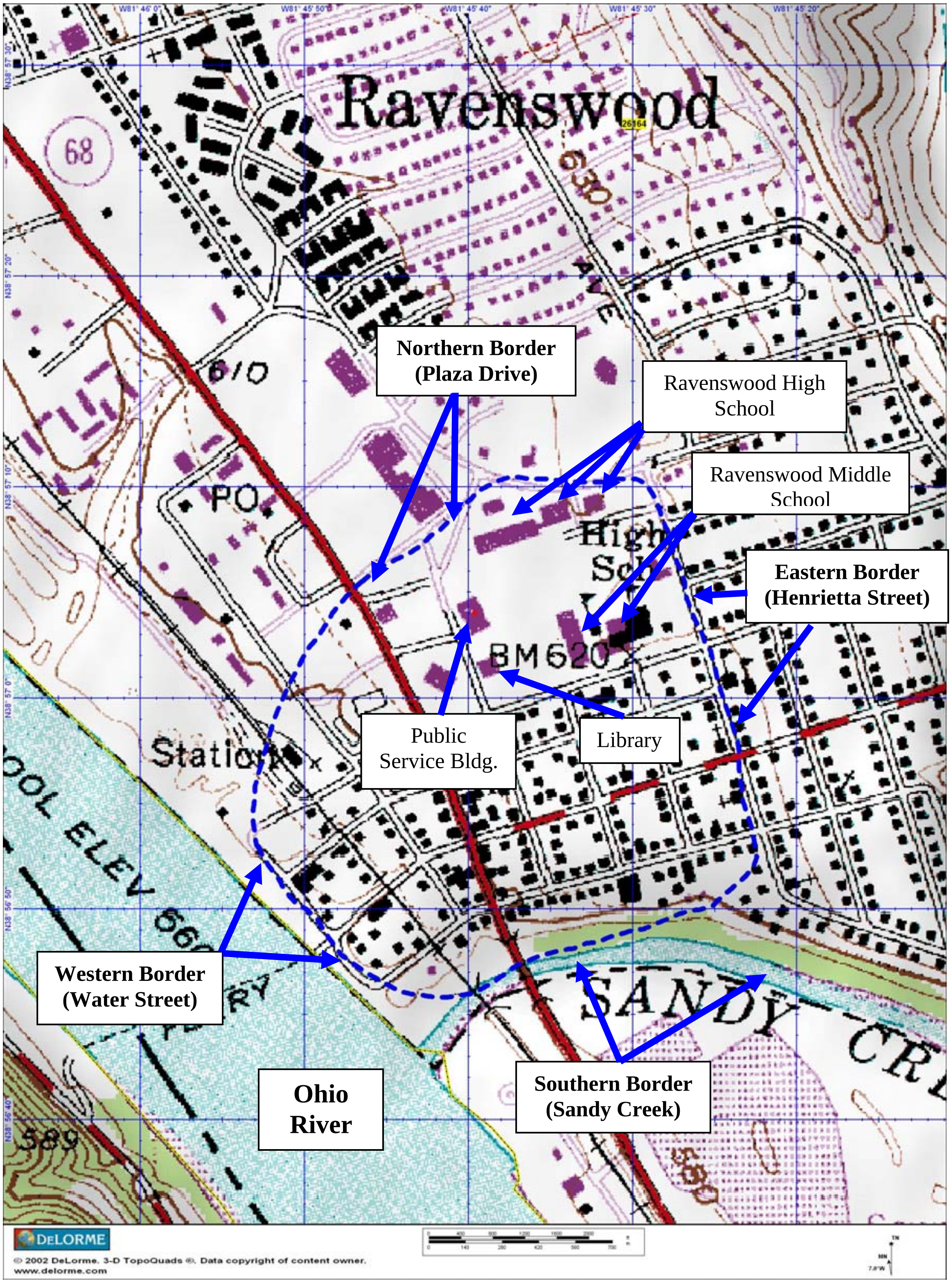
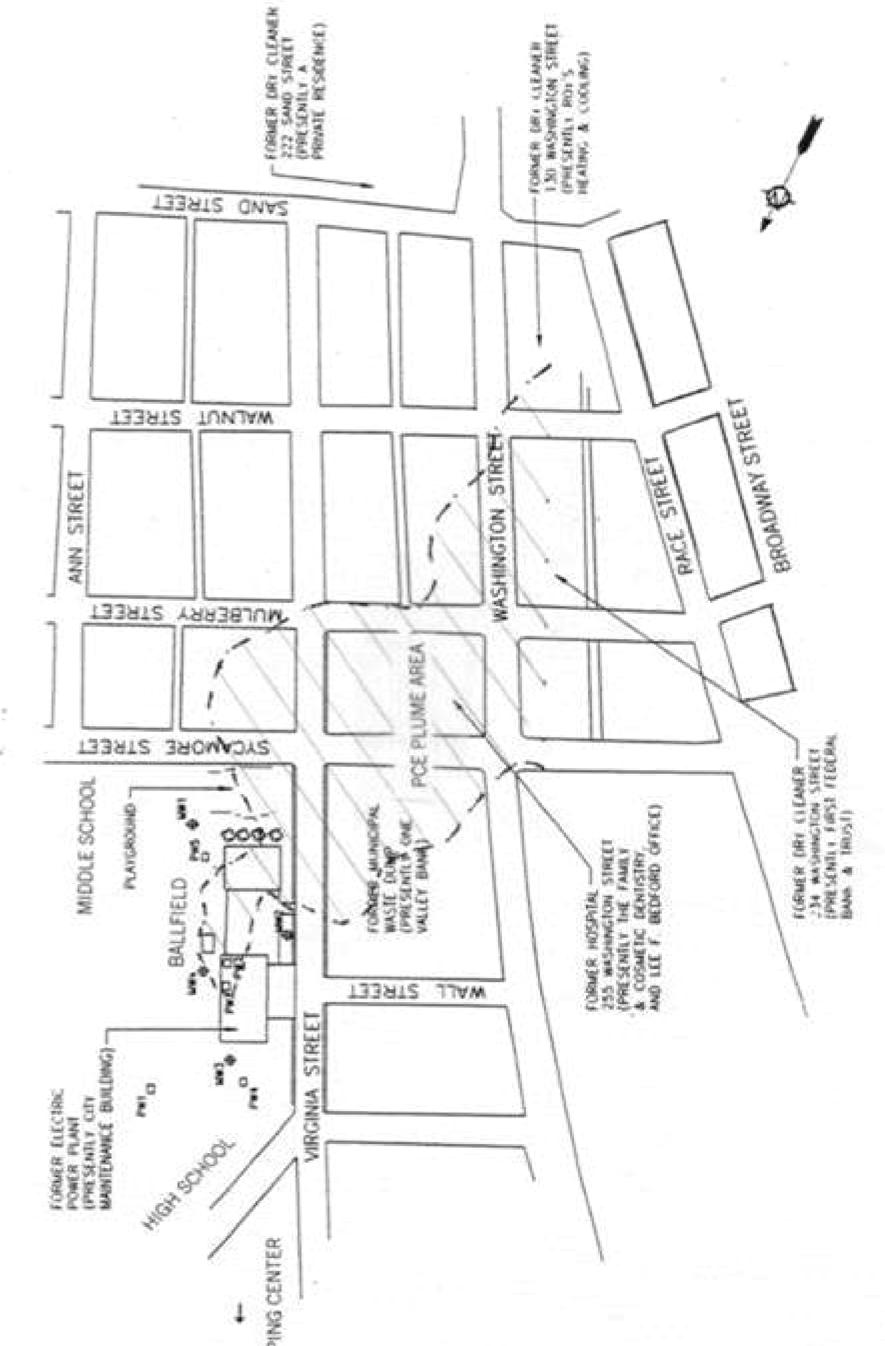


Figure 2. PCE plume area



Appendix B. Pathway analysis table

Table A. Pathway analysis							
Ravenswood PCE groundwater plume Site							
Pathway	Source	Medium	Point of Exposure	Exposure Route	Receptors	Time Frame	Type of Pathway
Groundwater Contamination	Unknown	Public Water Supply (using groundwater)	Water from faucets	Ingestion	Residents; Schoolchildren; workers in businesses	Past, Present, Future	Completed
				Inhalation	Residents; Schoolchildren	Past, Present, Future	Completed
				Dermal	Residents; Schoolchildren; workers in businesses	Past, Present, Future	Completed
Groundwater Contamination	Unknown	Vapors from PCE-containing groundwater	Indoor air	Inhalation	Residents; workers in businesses	Past, Present, Future	Completed
Groundwater Contamination	Unknown	Private water wells (using contaminated groundwater)	Water from faucets	Ingestion	Residents	Past	Potential
Groundwater Contamination	Unknown	Outdoor air	Outdoor air	Inhalation	People near the air stripper at the water plant	Past, Present, Future	Eliminated
Groundwater Contamination	Unknown	Vapors from PCE-containing groundwater	Indoor air	Inhalation	People working in the water plant	Past, Present, Future	Eliminated
Soil Contamination	Unknown	Soil	Soil	Incidental ingestion; Dermal	People contacting the soil	Past	Eliminated

Appendix C. Assumptions and calculations used to estimate exposure doses

Table B. Assumptions used in exposure dose, cancer risk, and modeling calculations					
Age (years)		Child 0-1	Child 2-6	Adolescent 7-16	Adult 18 and over
Body weight	kilograms (pounds)	10 (22)	18 (40)	45 (99)	70 (154)
Ingestion of drinking water	liters/day	1	1	2	2
Frequency people are exposed to public water or vapors inside of buildings	days/year	350	350	350	350
Length of exposure to public water or vapors inside of buildings	years	1	5	10	30
Inhalation rate	cubic meters/ day	15	15	20	20
Time spent in shower and room after shower	hours/day	n/a	1	0.58	0.58
Assumptions are from various sources [15-19]					

Exposure factor calculations

The exposure factor (*ef*) is the time period that exposure to a chemical is assumed to occur divided by the total time period during which the exposures occur.

All non-carcinogenic exposure factors use the same number for actual exposure time and total years of exposure. The exposure factor for a person exposed 350 days a year for 30 years is 0.96. The formula used for this example is:

$$\frac{350 \text{ days per year } \textit{[actual exposure time]} \times 30 \text{ years } \textit{[actual exposure time]}}{365 \text{ days per year } \textit{[total days in a year]} \times 30 \text{ years } \textit{[total years of exposure]}}$$

All carcinogenic risks are calculated using a 70-year time period for total years of exposure. This averages the risk of exposure over a lifetime. The difference from the example above is that the total years of exposure is changed to years in a lifetime. The exposure factor for a person exposed to a carcinogenic chemical 350 days a year for 30 years is 0.41. The formula used for this example is:

$$\frac{\text{350 days per year } \textit{[actual exposure time]} \times \text{30 years } \textit{[actual exposure time]}}{\text{365 days per year } \textit{[total days in a year]} \times \text{70 years } \textit{[years in a lifetime]}}$$

These exposure factors are further modified for the calculation of the amount of chemical inhaled during a shower, noncarcinogenic risk, Method 1. The amount of time in the shower and the room after the shower is an additional factor. The exposure factor for a person spending 0.58 hours per day in the shower and shower room 350 days a year for 30 years is 0.023. The formula used for this example is:

$$\frac{\text{350 days/ year } \textit{[actual exposure]} \times \text{30 years } \textit{[actual exposure]} \times \text{0.58 hours/day } \textit{[actual exposure]}}{\text{365 days/ year } \textit{[total days in a year]} \times \text{30 years } \textit{[total years of exposure]} \times \text{24 hours/ day}}$$

Calculations of exposures from drinking water, noncarcinogenic risk

The exposure dose formula for ingestion of water used in this document is:

$$ed = \frac{c \times cf \times r \times af \times ef}{bw}\text{, where}$$

ed = exposure dose (milligrams per kilogram per day [mg/kg/day]),

c = 10.8 micrograms per liter (µg/L) PCE in water,

cf = conversion factor (1 milligram/1000 micrograms),

r = liters of water ingested in a day (using the assumptions in Table B.),

af = absorption factor of “1” (PCE is assumed to be 100% absorbed),

ef = exposure factor (using the assumptions from Table B and the exposure factor calculation above), and

bw = body weight (using the assumptions from Table B).

Calculation of the amount of chemical inhaled during a shower, noncarcinogenic risk

WVDHHR used two methods to estimate the amount of PCE inhaled during showering. Method 1 estimated a higher exposure than Method 2.

Method 1: Assume that the chemical inhalation during the shower inhalation is equal to the exposure from ingesting 2 liters of drinking water a day.

The EPA Risk Assessment Forum developed this model in 1991 [20]. This estimate takes into account both inhalation and dermal exposures. The model assumes that the exposures are approximately equivalent to ingestion of 2 liters of water a day, within an order of magnitude (i.e., plus or minus a factor of 3). The variation is due to differences in shower design, ventilation rates, activity patterns, etc. WVDHHR multiplied the estimated exposure doses for the finished water blend by three to take into account these variations.

Method 2: Calculate the amount of PCE in the air in the bathroom during and after a shower.

This estimate of inhalation of PCE in the air during showering used the following formula:

$$ed = \frac{c \times cf \times ir \times vf \times ef}{bw}$$, where

ed = exposure dose (milligrams per kilogram per day [mg/kg/day]),

c = 10.8 micrograms per liter of PCE in water (µg/L),

cf = conversion factor (1 milligram/1000 micrograms),

ir = the cubic meters of air inhaled per day (using the assumptions from Table B.),

vf = volatilization factor of 0.5 liters per cubic meter [21],

ef = exposure factor (using the assumptions from Table B and the exposure factor calculation above), and

bw = body weight (using the assumptions from Table B).

Calculation of PCE in indoor air from the vapor intrusion pathway

The Johnson & Ettinger Model was used to estimate the amount of PCE in indoor air for buildings over the plume. Models do not rely on actual measurements. Models use a theoretical approach to reach an estimate of complex processes. The model made several assumptions. The most notable assumption is that the building above the plume is a residence with a basement. In fact, the building near the most contaminated portion of the plume is the library. Therefore, the model overestimates exposures because it assumed that the vapor would accumulate in a smaller building than the library which has higher ceilings than a residence, the library does not have a basement, and people are inside the library fewer hours than in a home. Some of the assumptions used were:

- The size of the building where the vapors accumulate is 34 x 33 x 12 feet and is a residence.
- PCE enters the building primarily through cracks and openings in the walls and foundation.
- There is no source of PCE contamination inside the building.
- The PCE concentration is the same in all layers of the groundwater.
- All vapors originating in the plume will enter the library over the plume.
- The plume covers an area larger than the foundation of the building.
- PCE is not being chemically altered in the groundwater.
- The depth to groundwater is 60 feet.
- The soil type is sand. The soil type permeability is 1.0×10^{-8}.

Calculation of maximum air concentration of PCE from the air stripper

The EPA used SCREEN3 model and the following assumptions to determine the maximum annual average ambient air concentration of PCE from the air stripper stack (communication from Patricia I. Flores-Brown, Sept. 2005).

Calculation of risk of inhalation of PCE in the workroom of the water plant

The EPA assumed that there was a very large open-topped tank below the water plant workroom. Calculations were based on a two-film model and simplified indoor air model (communication from Patricia I. Flores-Brown, Sept. 2005). The EPA values were recalculated into ppb using the formula: ((1ppm/6780 µg/m^3) x 1000).

Assumptions

- One-one hundredth of the floor space was available for PCE emissions to enter the workroom.
- The dimensions of the workroom are 100 ft long x 100 ft wide x 10 ft high.
- PCE in the water was 47.6 µg/L. This reflects the amount of PCE in water from the most contaminated well which is currently going to the air stripper.

Calculation of risk of carcinogenic effects from PCE exposure

Carcinogenic risks from exposure to PCE in the pubic water supply were calculated using the following procedure. The formulas are the same as that used for noncarcinogenic risk above but the exposure factor used is different, as explained in the "Exposure Factor Calculations" portion of this appendix. This averages the estimated exposure doses over a 70-year time period. The exposure doses were multiplied by the CSF or the inhalation unit risk adopted as a provisional number by the EPA Office of Emergency and Remedial Response [12]. The CSF used for ingestion was 0.54 mg/kg/day^{-1}. The inhalation unit risk is 0.02 mg/kg/day^{-1}.

The theoretical excess cancer risks for children, adolescents, and adults were added together to reflect an excess cancer risk for exposures during the 46-year period of estimated exposure. Exposures were assumed to occur to water containing 10.8 µg/L throughout the total exposure period.

Theoretical cancer risks less than 1 in 10,000 are considered very low risk and are not discussed in the text. Theoretical cancer risks between 1 and 9.9 in 10,000 are classified as a low risk, 10 and 99 as a moderate risk, and greater than 99 in 10,000 as a significant risk.

Appendix D. Glossary

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Absorption factor
The amount of chemical likely to enter the body through the skin, lungs, or gastrointestinal track.

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

AF [see Absorption Factor]

ATSDR
Agency for Toxic Substances and Disease Registry

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

bgs
below ground surface

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer Slope Factor
An estimate of the possible increases in cancer cases in a population, expressed in $(mg/kg/day)^{-1}$. Cancer slope factors are developed by the EPA.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

cm/hour
centimeters per hour

cm^2
square centimeters

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in a receptor population. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway]

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

CSF [see Cancer Slope Factor]

CV [see Comparison Value]

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental Media Evaluation Guide
Estimates of contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects based on ATSDR evaluation. These are calculated for chronic, intermediate or acute exposure scenarios.

EPA
United States Environmental Protection Agency

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

ft
foot

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard
A source of potential harm from past, current, or future exposures.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

LTHA
Lifetime Health Advisory set by the EPA.

mg/L
milligram per liter

mg/kg
milligram per kilogram

mg/kg/day
milligram per kilogram per day

mg/cm^2
milligram per square centimeter

mg/m^3
A measure of the concentration of a chemical (milligrams) in a known volume (a cubic meter) of air, soil, or water.

Maximum Contaminant Level (MCL)
The highest level of a contaminant that is allowed in public drinking water systems with at least 15 service connections or regularly serve 25 people 60 or more days per year. The level is set by the EPA.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

PCE
Tetrachloroethylene.

Permeability coefficient
A measure of the ability of a chemical to move through the skin. This factor is used to estimate the dermal absorption of chemicals from water.

PHA [see Public Health Assessment]

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

ppb
parts per billion

ppbv
parts per billion by volume

ppm
parts per million

PSD
Public Service District

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public meeting
A public forum with community members for communication about a site.

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Substance
A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

µg/L
micrograms per liter

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride and methyl chloroform.

WVDEP
West Virginia Department of Environmental Protection

WVDHHR
West Virginia Department of Health and Human Resources

Appendix E. Comments received

WVDHHR distributed the public comment version of this public health assessment to a variety of governmental officials and community members seeking comment. WVDHHR notified the public of the comment period via a press release. Comments from one source were received.

Text in comments is from the public comment version of this public health assessment.

Comment 1. Page2; Site Description and History; 2nd paragraph. Text indicates that library is about 55 feet away from the Maintenance Garage. Scaling from a 2003 SAMB aerial photograph indicates the distance between the library and the maintenance building to be roughly 130 feet. Reference to the 55 foot distance is made elsewhere in the report.

Response 1. Distance from the well field to the library and the nearby monitoring well is noted at 150 feet.

Comment 2. Page2; Site Description and History; 4th paragraph. The statement "The sand allows water to flow through it between 100 and 300 gallons per minute." without reference to a cross sectional area is technically meaningless.

Response 2. Hydraulic conductivity, how water moves though a formation, is difficult to describe in a non-technical document. This language has been removed from the text.

Comment 3. Page2; Site Description and History; 3rd paragraph. Text states: "However, the volume of water pumped...has lowered the groundwater level to a point where it is believed to flow from the Ohio River toward the well field [5]." The reference indicated by [5] is incorrect. The referenced report, Site Inspection Narrative Report, January 14, 2000 actually reads "The hydraulic connection between the aquifer and the Ohio River is exceptional. The water table rises and falls with changes in river stage, but generally remains higher than pool elevations. Groundwater flows in a southward direction beneath the site." This statement was made without the benefit of adequate water level monitoring points between the well field and the river. Subsequent reports, after the installation of 7 monitoring wells by GAI Consultants in the fall of 2001 do conclude that the apparent flow direction is northerly from the river toward the well field.

It should be noted that a recently completed ground water model completed by CDM Federal Programs Corporation for EPA Region 3 Superfund remedial response section suggests that an apparent ground water flow divide may be present approximately midway between the well field and the river. Current understanding of contaminant distribution in the aquifer in relation to suspected source areas support this hypothesis. Additional data points for collecting water level information would assist in refining the CDM model and overall site conceptual understanding of ground water flow.

Response 3. Language in the 3rd paragraph on page 2 has been modified in response to this information.

Comment 4. Page2; Site Description and History; 5th paragraph. Text states: "...the plume extends southward from the area of Well #3 on Virginia Street....The EPA found the most PCE in groundwater in Well #3 about 20 feet in front of the library." The correct designation is MW-5S installed by DEP in 2001. MW-3, installed summer 1999 by EPA, has been non-detect to date. Production well #3 has historically exhibited the highest levels of contamination detected in the municipal supply wells.

Response 4. MW-3 is now called the monitoring well in front of the library.

Comment 5. Page2; Site Description and History; 5th paragraph Text references 170 GeoProbe® samples. This total is incorrect. Ground water samples were collected at 55 GeoProbe® locations. Samples were taken from the upper and lower portions of the aquifer at each location. Text later in the report mentions 170 samples related to the EPA 1999 soil gas investigation. Perhaps the number "170" of that event was inadvertently attributed to the DEP GeoProbe® investigations.

Response 5. Text corrected to indicate there were 55 GeoProbe® locations.

Comment 6. Page3; Site Description and History; 4th paragraph Text: "The more contaminated groundwater found near the library, about 55 feet away from the public well field...." If this statement is made in reference to data obtained from monitoring wells, the distance of 55 feet is incorrect. Well pair MW-5S/MW-5D is roughly 200 feet from PW #3 and 180 feet from PW #5.

Response 6. The text was corrected to indicate the monitoring well is 200 feet from the well field.

Comment 7. Page3; Site Description and History; 5th paragraph Text: "The EPA plans to remove some of the PCE...They will install a series of sparging wells." Unless the situation calls for an immediate response to abate a public health threat, the approach leading to a remedy selection is a methodical step by step process outlined in the National Contingency Plan (40CFR300.430). Almost certainly sparging will be among the technologies evaluated, however, it is premature at this point to assume that sparging will be implemented.

Response 7. Text was modified to indicate the initial sparging well project is a pilot project.

Comment 8. Page5; Discussion; Data Review; Groundwater monitoring wells; 2nd paragraph. Text: "This was found in a sample from a well centrally located between Mulberry, Virginia, Walnut, and Washington streets." Walnut should be replaced by Sycamore.

Response 8. Sycamore Street replaced Walnut Street in the text.

Comment 9. Page5; Discussion; Data Review; Groundwater monitoring wells; 4th paragraph. Text: "PCE may vary depending on where the sample was taken within the water table. The data did not allow us to determine if this layering is occurring at this site." Monitoring well pair MW-5S/MW-5D located on Virginia Street in front of the library was installed expressly to evaluate the vertical distribution of contamination in the aquifer. MW-5S is screened across the interval

63-73 feet below ground surface. MW-5D is screened across the interval 80.5-90.5 feet below ground surface. Depth to the water table is roughly 58 feet at this location. Samples from the shallower well have exhibited concentrations in the 300-470 µg/L range, whereas samples from the deeper well have historically been less than 10 µg/L. GeoProbe® samples taken from the upper and lower portions of the aquifer further support the conclusion that the upper 10-15 of the aquifer is more severely contaminated. The ESE *Trip Report – December 2004 Sampling Event, Ravenswood PCE Site* (2/28/05) states on page 8 "The data from the monitoring wells indicate the presence of concentration gradients. Higher PCE concentrations typically are found at the middle or top of the screened intervals and lower concentrations are found near the bottom."

Response 9. Text modified to indicate PCE is usually found at the top of the water table.

Comment 10. Page5; Possible health consequences from exposures to PCE at this site; ingestion; 1st paragraph. Text: "Water contained 10.8 µg/L for a brief period in 1989." The correct year is 1998.

Response 10. Year has been changed to 1998.

Comment 11. Figure 1. The scale, ±1" = 2000 ft., does not appear to be correct.

Response 11. The figure, including the scale was used, with permission, from DeLorme, 3-D topoquads.

Comment 12. Appendix C; Page 25; Last bullet. The default Johnson-Ettinger effective soil vapor permeability is 1.0 x 10^{-8}. The Johnson-Ettinger calculated effective soil vapor permeability for sand as a function of the material intrinsic permeability and material relative air permeability is 5.08 x 10^{-8}.

Response 12. The model indicates the practical range of soil vapor permeability for sandy soil is 1.0 x 10^{-6} to 1.0 x 10^{-8}.

Comment 13. Results from a WVDEP Johnson Ettinger simulation using similar values as indicated in the report indicate an increased cancer risk slightly more than 1 x 10^{-4}.

Response 13. Commenter indicates that the WVDEP Johnson Ettinger simulation indicated an increased cancer risk slightly more than 1 x 10^{-6}, not 1 x 10^{-4}. This is similar to the values generated in this review.