Public Health Assessment for

RYELAND ROAD ARSENIC SITE
HEIDELBERG TOWNSHIP, BERKS COUNTY, PENNSYLVANIA
EPA FACILITY ID: PAD981033459
SEPTEMBER 30, 2008

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

RYELAND ROAD ARSENIC SITE

HEIDELBERG TOWNSHIP, BERKS COUNTY, PENNSYLVANIA

EPA FACILITY ID: PAD981033459

Prepared by:

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

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Summary

The Ryeland Road Arsenic Site (the site) comprises an approximately 7-acre area on the north and south sides of West Ryeland Road in Heidelberg Township, Berks County, Pennsylvania. A portion of the site on the north side of Ryeland Road was formerly utilized as a manufacturing facility for pesticides, paints, varnishes, and sulfuric acid. A vacant lot on the south side of Ryeland Road was utilized for dumping of waste materials from the manufacturing processes. A large fire destroyed the manufacturing facility in 1940, and the building was demolished. The northern portion of the site has been subdivided into four contingent residential properties that are bordered to the north by railroad tracks, to the east and west by residential properties, and to the south by Ryeland Road. The southern portion of the site has remained a vacant lot and is bordered to the north by Ryeland Road, to the east and west by residential homes, and to the south by a wooded area.

In preparing for this public health assessment, the Pennsylvania Department of Health (PADOH), working under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), reviewed environmental sampling data from the United States Environmental Protection Agency (EPA), visited the site, reviewed health outcome data, and gathered community concerns during discussions with residents in their homes and telephone conversations. Several EPA clean-up actions have taken place at the site since discovery of the contamination in 1983; however, arsenic, lead, and copper contamination still exists at the site in surface and subsurface soil, groundwater, surface water, and sediments. The site was formally proposed to the National Priorities List (Superfund) in March of 2004. The EPA commenced a Remedial Investigation and Feasibility Study (RI/FS) at the site shortly thereafter, in the summer of 2004. The RI/FS was completed in June 2005, and the evaluation of the additional environmental data was included in this public comment version of the public health assessment.

After reviewing all of the referenced environmental data, potential exposure scenarios, health outcome data, human health studies, and contaminant toxicology information, PADOH and ATSDR conclude the following (Please note that it is possible for these conclusions to change in the future as the site is remediated and/or additional data are available for public health evaluation):

1. Past and current residential exposure to arsenic-contaminated surface soils, and potentially lead- and copper-contaminated surface soils, at the Ryeland Road Arsenic Site may have occurred and may be occurring to children and adults at the site. However, “surface soil” samples were taken at depth intervals of 0-6, 0-12, and 0-24 inches rather than at the depth of 0-3 inches or less. ATSDR typically assesses depth of 0-3 inches for the ingestion of surface soil exposure scenario. Sampling at depths greater than 0-3 inches makes it difficult to determine if exposures to chemicals in surface soils are likely or not likely to result in adverse health effects; therefore this exposure pathway is categorized as an ***indeterminate public health hazard***. Although average inorganic surface soil concentrations were used in this public health assessment to determine a possible exposure, without surface soil data of 0-3 inches, it is not possible to accurately assess the likelihood of adverse health effects to community members who reside in the vicinity of the site.

2. Prior to residential development, past exposures to children playing on waste piles formerly located on the north side of the Ryeland Road Arsenic Site represents a ***past public health hazard***. The waste piles were remediated by EPA in 1985, and therefore this particular exposure is no longer possible for children currently playing on the site.

3. Since there is an extensive amount of subsurface soil contamination, the potential exists or has existed for soluble metals to contaminate groundwater beneath the site. Recent environmental data shows that groundwater in the shallow aquifer at the site is contaminated by arsenic, lead, and copper (levels above site-specific background). The intermediate and deeper aquifers did not reveal elevated levels at the sampling locations. Those who use private wells in the study area, however, utilize the deeper aquifer for potable water, which does not appear to be currently impacted by the contamination at the site. These residential wells were sampled in the study area and were not impacted by contaminants at levels of health concern at the tap. Therefore, this exposure pathway is categorized as ***no apparent public health hazard***. Some sampling results from homes did exhibit elevated lead levels at sampling points prior to the tap, but water is not accessible for consumption from these sampling points. The planned remediation effort at the site, which will remove the subsurface soil contamination, will also eliminate the potential for this exposure pathway in the future.

4. Exposure to contaminants in surface water and sediments in the onsite drainage swale, spring-fed creek, spring-fed pond, tributary to Tulpehocken Creek, and the Tulpehocken Creek, represents ***no apparent public health hazard*** because of the very limited duration of exposure at the levels sampled. Results from the June 2005 RI/FS delineated the extent of contamination that originated on-site and migrated via the surface water and associated sediment pathway. The planned remedial activities at the site will address this contamination, which is anticipated to eliminate this exposure pathway.

5. The indoor dust pathway represents ***an indeterminate public health hazard***. Dust wipe samples were collected from inside residences near the site but the results of the sample analysis were inconclusive. No widespread contamination problems were discovered from the results of the dust wipe samples. Furthermore, potential sources of arsenic, lead and copper contamination are mostly covered with vegetation, which would prevent air deposition or tracking of contaminated dust into homes.

6. Currently there is no exposure through onsite subsurface soils because the general public is unlikely to have routine/long-term contact with subsurface soils. Residential exposure to onsite subsurface soil is categorized as ***no apparent public health hazard***. However, some subsurface soils have been brought to the surface by activities, such as pool or shed installations that have become mixed with surface soils, and then would be classified as such. The surface soil data collected thus far is insufficient to make a health determination for any such exposures; refer to conclusion #1.

7. Blood-lead screening was offered to children who reside or are known to frequent areas of the remaining contamination from the site. Several children near the site that were tested in October 2004 were found to have blood-lead concentrations less than 10 µg/dL; therefore, it currently doesn’t appear that these children are being exposed to lead at levels and durations that would result in adverse health effects from exposure to lead. Blood-lead screening is recommended for all children under the age of six and females who could become pregnant and reside in the vicinity of the site.

8. Community concerns gathered to date included the following: past exposures to site contaminants (former waste piles, bricks from former manufacturing facility, subsurface soils), future sampling and remediation activities at the site, cancer rates in community, and pet exposure to site contaminants. Responses to these concerns can be located in the *Questions from the Community* section in this public health assessment document. ATSDR and PADOH will collect additional community concerns at a public availability session during the public comment period for this document.

The interpretation, conclusions, and recommendations regarding the Ryeland Road Arsenic Site are site-specific and do not necessarily apply to any other site.

Purpose and Health Issues

In March 2004 the United States Environmental Protection Agency (EPA) proposed the addition of the Ryeland Road Arsenic Site in Heidelberg Township, Berks County to the National Priorities List (NPL). The Ryeland Road Arsenic Site was formerly utilized for manufacturing of pesticides, paints, varnishes, and sulfuric acid from approximately 1920 to 1940, when a fire destroyed the facility. After demolition of the pesticide facility that was formerly located on the north side of Ryeland Road, the northern property was subdivided into four adjacent parcels of land, which now each contain a residential home. The former pesticide facility also owned a parcel of land on the south side of Ryeland Road, which was used for waste disposal. The Division of Environmental Health Epidemiology, Bureau of Epidemiology, Pennsylvania Department of Health (PADOH) has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for hazardous waste sites in Pennsylvania. PADOH completed this public health assessment under this cooperative agreement.

A public health assessment is a tool used to determine if and what kind of activities are needed to protect the health of a community residing/working near a hazardous waste site, and to determine the need for follow-up health activities (e.g., health study). To achieve this goal, this assessment contains three types of evaluations: (1) the identification of pathways of exposure to site contaminants and an evaluation of public health implications; (2) a summary of relevant and available health outcome data (e.g. cancer registry data); and (3) evaluations of specific community health concerns about the site. The first type of evaluation addresses the contaminants that are present at the site above comparison values, the determination of exposure pathways and the potential for those chemicals to enter people's bodies.

Background

Site Description

The Ryeland Road Arsenic Site (site) is located in a residential area of Heidelberg Township. Heidelberg Township is in a rural area of Berks County, Pennsylvania (Figures 1–3). The approximately seven acre site is located on the north and south sides of Ryeland Road. A portion of the site was formerly utilized by Standard Chemical Works Corporation (SCWC), and later by Allegheny Chemical Corporation (ACC). The northern portion of the site has been subdivided into four contingent residential properties that are bordered to the north by railroad tracks, to the east and west by residential properties, and to the south by Ryeland Road. The southern portion of the site has remained a vacant lot and is bordered to the north by Ryeland Road, to the east and west by residential homes, and to the south by a wooded area. Bethany Children's Home, an orphanage for children, is located on the south side of Ryeland Road, approximately 0.5 miles from the Site. A spring-fed creek and pond are situated north of the Site, beyond the railroad tracks.

Site History

From approximately 1920 to 1940, SCWC, and subsequently ACC, manufactured pesticides, paints, varnishes and sulfuric acid [1]. The manufacturing building was located on the north side of Ryeland Road. As part of the manufacturing process, arsenic was converted to arsenic acid; by-products included lead arsenate, calcium arsenate, and copper acetoarsenate [1]. Wastes generated during the manufacturing processes were reportedly disposed of on a parcel of land on the south side of Ryeland Road, across the street from the facility property [1]. After a large fire destroyed the facility in 1940 and the demolition of the building, the facility property was subdivided into four parcels, which now each contain a residence [1]. The area reportedly used by the facility for waste disposal is located on an undeveloped parcel on the south side of Ryeland Road [1]. Figure 2 in the appendix shows the former location of the facility building and the reported waste disposal area.

In October 1983 a resident near the site notified the former Pennsylvania Department of Environmental Resources (PADER) of the presence of whitish material in soil along Ryeland Road. The PADER collected two samples of the grayish white material: one from a waste pile on the south side of Ryeland Road and one from the north side of Ryeland Road. The waste pile on the north side of Ryeland Road was reportedly 75 to 100 feet in diameter. The property has since been graded, and the estimated area is 30 by 20 yards. The visibly affected area on the north side of Ryeland Road was approximately 20 by 6 feet. PADER estimated the actual volume of contaminated soil to be large because the contamination also extended beneath the ground surface. The analytical results of the soil samples collected by PADER revealed the presence of total arsenic and lead at concentrations of 5,666 and 2,900 milligrams per kilogram (mg/kg), respectively [1].

In 1984 PADER conducted a preliminary assessment (PA) of the former pesticide facility, which led to a site inspection (SI) conducted in March 1985. Groundwater, surface water, sediment, and waste pile samples were collected as part of the SI. Analytical results of groundwater samples collected from the residential wells documented arsenic, copper, and lead concentrations below corresponding drinking water standards. A sample collected from the spring located north of the disposal areas contained 535 micrograms per liter (µg/L) of arsenic [1]. A composite sample collected from the waste pile located on the north side of Ryeland Road revealed the presence of arsenic and lead at concentrations of 5,200 and 1,200 mg/kg, respectively. A composite sample collected from the waste pile located on the south side of Ryeland Road yielded arsenic and lead concentrations of 4,600 and 258 mg/kg, respectively [1].

In response to the levels of arsenic and lead found in the waste piles and the proximity of the waste piles to residential homes, the EPA conducted a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal action at the site from August 1985 to November 1989. During a two-phase removal action, approximately 5,400 cubic yards (yd^3) of waste material and contaminated soil were removed from the north and south sides of Ryeland Road and disposed of at an off-site location. Contaminated soil was excavated to a depth of 2 feet below ground surface (bgs) during Phase II of the removal. Further sampling indicated that contaminated soil extended onto the property owned by Conrail. EPA notified Conrail regarding the presence of contaminated soil on their property. There was no action taken by Conrail [1].

During July 2001 the property owner of the parcel on the south side of Ryeland Road excavated and graded his property in order to construct a home. EPA was notified of the activities and subsequently conducted an extent of contamination study. The study identified contaminated soils at depths from zero to nine feet bgs containing up to 26,000 and 36,000 mg/kg of arsenic and lead, respectively. EPA reactivated the CERCLA removal action that was initiated in 1985 and removed the stockpiled soil excavated by the property owner. Additionally, EPA excavated and removed two feet of soil from non-vegetated areas of the southern parcel of land. Approximately 4,470 tons of contaminated soil were removed and disposed of at an off-site location. Arsenic and lead-contaminated surface soils, as delineated by the sampling conducted during the removal action, were not removed from heavily vegetated areas [1].

In November 2001 groundwater samples were collected from five private drinking water wells near their holding tanks on Ryeland Road near the pesticide facility's former disposal areas. Analysis of the samples for total metals revealed concentrations of lead above EPA's national priority drinking water action level of 15 µg/L set under the Safe Drinking Water Act [1]. EPA provided the five residences with bottled water for consumption from approximately the summer to the fall of 2002. Subsequent to fall of 2002, analytical results of additional samples from these homes at the taps for dissolved metals did not reveal the presence of lead above the action level [1].

In March 2002, an expanded site inspection (ESI) was conducted of the Ryeland Road Arsenic Site. Activities included the collection of groundwater, surface water, sediment, and surface soil samples. Samples collected from domestic drinking water wells near the holding tanks revealed the presence of copper at concentrations ranging from 40 to 1,030 µg/L. Copper was not detected in the background groundwater sample. Concentrations of lead detected in the domestic drinking wells that were sampled at the holding tanks ranged from 4 to 190 µg/L [1]. The analytical results for all downstream sediment samples indicated the presence of arsenic at concentrations ranging from 26.3 to 407 mg/kg, exceeding three times the concentration detected in a background sample collected upstream. One downstream sediment sample contained concentrations of copper and lead exceeding three times the upstream concentration.

XRF analysis of surface soil samples collected from the residential properties on the north side of Ryeland Road contained concentrations of arsenic up to 2,100 mg/kg. As part of the ongoing removal action, EPA excavated, removed, and disposed of two feet of contaminated soil off-site from the two western most parcels of the former pesticide facility on the north side of Ryeland Road. Soil samples collected from test trenches dug on the north side of Ryeland Road during the removal action indicated that arsenic contaminated soil was present at depths ranging from 0 to 7 feet bgs at concentrations up to 44,000 mg/kg. Although arsenic contamination was identified in soil on the adjacent residential property to the west on the north side of Ryeland Road, the owner of the property declined to have EPA remove the contaminated soil [1].

As part of the removal action in August 2002, soil samples were collected from the two eastern most parcels of the former pesticide facility on the north side of Ryeland Road. Analytical results revealed levels of arsenic in the surface soils above 30 mg/kg, the site-specific action level recommended by ATSDR and established by EPA.

The source areas that were evaluated as part of EPA's most current Remedial Investigation/Feasibility Study (RI/FS), completed in June 2005, are the remaining areas that were not excavated during the previous EPA removal actions. This includes soils (subsurface and possibly surface) of the former pesticide disposal area on the south side of Ryeland Road and surface soil on the residential property adjacent to the west side of the former pesticide facility. No other potential source areas of arsenic, copper, and lead have been identified in the area of the site.

Site Demographics

The Ryeland Road Arsenic Site is approximately 0.5 miles southeast of Womelsdorf Borough in Heidelberg Township, Berks County, Pennsylvania. Approximately 2,599 people live in Womelsdorf Borough. As part of the total population, 6.8% (178/2,599) are children under the age of 5 years, and 7.1% (184/2,599) are children ages 5 to 9 years. Heidelberg Township has a total population of 1,636. As part of the township population, 5.3% (87/1,636) are children under the age of 5, and 7.6% (124/1,636) are children ages 5 to 9 years [2].

The property line of the Bethany Children's Home, a residential home for children, is located approximately 100 feet from the western border of the site. The children's home is comprised of nine cottages which are approximately 0.5 miles from the border. At full capacity, the home can accommodate up to 104 children that range in ages from six to 18 years old. The average population during 1997 was 84 children, coming from different regions throughout Pennsylvania. The home also has about 100 staff that reside there, along with approximately 90 children that are at the home for part-time day care [3].

There are approximately 16 residences located within 200 feet of the suspected remaining sources of contamination at the site. The population distribution of the approximately 13,302 people, which is based on known populations of the surrounding communities and a house count (2.56 persons per household for Berks County, 2.58 persons per household for Lebanon County, and 2.71 persons per household for Lancaster County), residing in the study area is as follows [4]:

Table 1. Population distribution in the vicinity of the Ryeland Road Arsenic Study Area

Radius from Site (Miles)	Approximate Number of Residents
0.00-0.25	77
0.25-0.50	248
0.50-1.00	1,371
1.00-2.00	5,028
2.00-3.00	4,838
3.00-4.00	1,740
Total Study Area (0.00-4.00)	13,302

Site Visits

During August 2004, representatives from the PADOH conducted an initial visit of the Ryeland Road Arsenic Site. Staff members from EPA and PADEP assisted PADOH with the tour of the site. PADOH observed the topography of the site, residential locations, a spring-fed pond and creek located north of the site, and areas surrounding the site that included a community park, plant nursery, and children orphanage. PADOH also viewed a brick pile that was located approximately 0.25 miles southeast of the site. These bricks were likely part of the pesticide manufacturing structure on the north side of Ryeland Road. Upon discovery of the bricks, the EPA added the investigation of the pile to the RI/FS to determine if the bricks have sourced an off-site area of contamination.

In October 2004, EPA contracted nursing staff to conduct targeted blood lead screening of children in the vicinity of the Ryeland Road Arsenic Site. The selected group of children, who participated in the blood lead screening effort, either resides near or has the potential to regularly frequent known areas of lead-contaminated surface soil and/or drinking water. The blood lead screening data collected at the site was assessed in the *Health Outcome Data Evaluation* section of this document. Health Assessment Program staff made home visits to individual residences at the time of the lead screening. During the visits, the health assessment program staff gathered the community's concerns, educated the community in regards to potential exposures at the site, and discussed PADOH's involvement with the site and community.

Environmental Contamination and Other Hazards

A necessary component of every public health assessment is to evaluate environmental contaminants on the site. In this section, PADOH has reviewed the contaminants of concern. PADOH evaluated these contaminants in the subsequent sections of the public health assessment to determine whether exposure to them has any public health significance. The results from available environmental testing at the Ryeland Road Arsenic Site are summarized for each one of the different environmental media (e.g., groundwater, surface soil, surface water, etc.)

Concentrations of chemicals in each one of the media have been compared to media-specific health-based comparison values developed by ATSDR to determine whether any of the chemicals need further evaluation. Health-based comparison values are derived using chemical toxicity information and assuming frequent human exposure to the contaminants. For non-cancer toxicity, PADOH typically uses Environmental Media Evaluation Guides (EMEGs) derived from ATSDR's Minimal Risk Levels (MRLs) or the Reference Dose Media Evaluation Guides (RMEGs) derived from EPA's Reference Doses (RfDs). MRLs and RfDs are estimates of daily human exposure to a contaminant that is unlikely to cause adverse non-cancer health effects over a lifetime. At exposures increasingly greater than the MRL and RfD, the potential for adverse health effects increases. Lifetime exposure above the MRL and RfD does not imply that an adverse health effect would necessarily occur. Cancer Risk Evaluation Guides (CREGs) are risk comparison values based on EPA's chemical-specific cancer slope factors and an estimated excess lifetime cancer risk of one in one million. Therefore, if the concentration of a chemical were less than its comparison value, then it is unlikely that exposure to the chemical would result in adverse health effects. Further evaluation of exposures to this chemical would then not be warranted. If the concentration of a chemical exceeds its comparison value, adverse health effects from exposure are not necessarily expected, but potential exposures to that chemical at the site should be evaluated further.

When ATSDR comparison values are not available, PADOH utilizes the EPA Region III Risk-Based Concentration (RBC) Table. The RBC Table contains RfDs and Cancer Slope Factors for 400 – 500 chemicals. These toxicity factors have been combined with "standard exposure" scenarios to calculate RBCs or chemical concentrations corresponding to fixed levels of risk in multiple types of sample media that include: water, air, fish tissue, and soil.

In addition to the health-based comparison values, PADOH also references other standards and regulations when health-based comparison values are not available or when other standards are lower than the health-based comparison values. EPA's Maximum Contaminant Level (MCL) is the highest level of a contaminant that is allowed in drinking water. MCLs are enforceable standards and they are set as close to Maximum Contaminant Level Goals (MCLG) as feasible. MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are non-enforceable public health goals. The Lifetime Health Advisories (LTHAs) are lifetime exposure levels for drinking water at which adverse, non-carcinogenic health effects would not be expected to occur. EPA also recommends secondary standards that are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects (e.g., odor, taste, and color) in drinking water. The secondary standards are not health based and are sometimes 10 to 100 times lower than levels that would induce health effects. PADEP's Statewide Health Standards that include medium-specific concentrations (MSCs) were also used in screening contaminants that were found in the targeted media.

The lowest of all comparison values was used to identify contaminants in differing media for further evaluation. The abbreviations of the above described guidelines, standards, and criteria are summarized in Table 2.

Table 2. Summary of Comparison Values and Environmental Standards for Health Assessment

Guides, Regulations, Standards	Unit	Unit Example	Target Media	Regulatory (Y/N)	Health-Based (Y/N)
CREG	concentration	µg/m^3, µg/kg, µg/L	air, soil, water	N	Y
EMEG	concentration	µg/m^3, µg/kg, µg/L	air, soil, water	N	Y
LTHA	concentration	µg/L	water	N	Y
MCL	concentration	µg/L	water	Y	N
MCLG	concentration	µg/L	water	N	Y
MRL	dose	mg/kg/day	--	N	Y
MSC	concentration	mg/kg, µg/L	soil, water	Y	Y
RBC	concentration	µg/m^3 , mg/kg, µg/L	air, fish, soil, water	N	Y
RfD	dose	mg/kg/day	--	N	Y
RMEG	concentration	µg/m^3, µg/kg, µg/L	air, soil, water	N	Y
Secondary	concentration	µg/L	water	N	N

Table Key	
µg/m^3	microgram per cubic meter
µg/kg	microgram per kilogram
µg/L	microgram per liter
mg/kg	milligram per kilogram
--	not applicable

The public health implications of estimated exposure doses to selected contaminants are evaluated in detail in the discussion section of this health assessment document. With this in mind, the following summary of environmental data highlights the target chemicals that have been found on the site at levels above the comparison values. The sampling location identification numbers in this public health assessment are the same as the reports that were referenced.

Groundwater

Groundwater beneath the Ryeland Road Arsenic Site flows in the northwest direction toward the Tuplehocken Creek. The presence of karst formations and highly fractured bedrock underlying the site and study area allows for the potential for contaminants to migrate off-site through groundwater in the northwest direction. The groundwater is less likely to flow off-site in the south direction because of the low permeability and poorly formed fractures in the granite gneiss of South Mountain and the Hardyston Formation.

There are four water supply authorities that obtain groundwater within the four-mile radius of the site. These public water authorities include: Womelsdorf-Robesonia Joint Water Authority (WRJWA), Newmanstown Water Authority (NWA), Richland Borough Water Authority (RBWA), and Bethany Children's Home (BCH). WRJWA obtains water from four wells within four miles of the site and blends this water for a distribution to approximately 6,930 people. NWA obtains water from two wells within four miles of the site and serves approximately 900 people. RBWA utilizes four wells and a spring for their public water supply. Two of the wells and the spring are located within four miles of the site and serve approximately 1,700 people within the Borough of Richland. BCH's water is supplied by a spring that is fed within the study area. BCH utilizes the water for their orphanage and supplies water to approximately 11 residences along Ryeland Road. According to sampling results that date back to 2002 in PADEP's Public Drinking Water System Information, the four water supply authorities within the four-mile study area have not had levels of site related contaminants that were above an MCL. Historically, it doesn't appear that the site has had an adverse impact on the water quality from the municipal water suppliers throughout the study area. Since the contamination still exists at the site, the possibility still remains for future impacts to groundwater contamination from subsurface contamination the site. The public water supply is monitored regularly, and authorities would be notified of any such impacts, if they were to occur.

Residences that are not served by the public water authorities receive potable water from private residential wells. An estimated 10,694 people are serviced by groundwater sources within a four-mile radius from the site. Approximately 300 of those residents rely on groundwater from private wells within one mile of the site.

During EPA's Expanded Site Investigation (ESI) in 2002, groundwater samples were collected from domestic wells near the site. According to the EPA, the depths of the wells ranged from 80 to 120 feet; however, the depth of some wells were not known. Three samples were collected at each residence; two of these samples were collected from a sampling point nearest the water storage tank prior to filtration, and one was collected from the kitchen tap. Analytical results for groundwater samples collected from private residential wells indicated the presence of lead and copper in samples collected from the sampling nearest the water storage tank (Table 3). Arsenic was not detected in the groundwater samples at levels above the provisional EPA action level (10 µg/L as of January 2006). Copper was detected at concentrations ranging from 40 to 1,030 µg/L in six of the eight unfiltered samples that were collected at the water storage tanks. The EPA action level for copper is 1,300 µg/L. Lead was detected in concentrations ranging from 4 to 190 µg/L in four of the eight unfiltered samples and two of the eight filtered samples that were collected at the storage tanks. The EPA action level for lead is 15 µg/L. The residences where the elevated concentrations of copper and lead were detected in water samples had plumbing systems that were constructed of copper pipes and tested positive for lead solder. No metals were detected above levels of health concern in the samples collected from the kitchen taps. The water that was collected from the sampling point prior to the water storage tank was not used for consumption purposes and was not accessible for children.

The results of the groundwater sampling conducted as part of the June 2005 RI/FS indicated and verified that groundwater contamination in the monitoring wells and residential wells at the site did not exhibit contamination at levels of health concern. Two shallow monitoring wells revealed results greater than 10 µg/L arsenic, but water from this shallow well is not used for drinking water therefore human exposure does not occur to this contaminated water. The sampling results from deeper monitoring wells did not reveal detectable levels of inorganic contamination [15].

Table 3. Summary of Compounds Detected in Private Wells* in vicinity of the Ryeland Road Arsenic Site 2002 EPA ESI, Heidelberg Township, Pennsylvania

Sample Location	Lead Concentration (µg/L)	Copper Concentration (µg/L)
DW-01	190	1,030
DW-04	--	44
DW-07	48	518
DW-10	--	40
DW-13	35	348
DW-16	33	183
DW-19	36	--

* Detected concentrations were from samples collected prior to the water storage tank, concentrations at kitchen taps were below background (4 µg/L Pb, <25µg/L Cu)+ sample concentrations or not detected for all tap samples.
µg/L micrograms per liter

Soil

To date, there have been several EPA removal actions that addressed contaminated soil on the site. Phase I of the first response action started in August of 1985 and consisted of the removal of the main waste pile on the south side of Ryeland Road. Approximately 2,400 cubic yards of waste material were removed from the site. This initial response action was completed in September 1986.

In May 1987, the second phase of the first site remedial action took place that included the removal of arsenic contaminated soil from three residential yards on the north side of Ryeland Road. These locations were excavated down to approximately two feet bgs and backfilled with clean fill. Since arsenic-contaminated soil remained two feet bgs, a 36-inch diameter pipe was placed behind the residences in the drainage pathway to prevent water from contacting the remaining impacted soils. The sampling and analysis performed during this phase of remediation indicated elevated soil concentrations of arsenic and lead on the Conrail railroad line property that is adjacent to the north of the site [1]. The removal of these contaminated soils was not addressed during this phase due to the potential for disturbing the rail line. The second phase of remediation was completed in November 1989.

Another removal action on the site took place in July 2001, when EPA became aware that a homeowner was excavating soils for a building foundation on the fifth parcel on the south side of Ryeland Road and discovered grayish-white soil stockpiled. EPA then delineated the extent of the arsenic contamination to determine what further removal action was necessary. EPA consulted ATSDR for advice regarding clean-up guidelines that would be protective of human health. Based on ATSDR's recommendation, the stockpiled soils and top two feet of contaminated soils were excavated from the section of the fifth parcel that was not heavily vegetated. Normal household activities (e.g., gardening, mowing, playing) would not likely result in exposure to contaminated soils at depths greater than two feet. It was determined that the vegetation would act as buffers and limit access to the contaminated soils in the heavily vegetated areas with remaining soil contamination within two feet of the surface. This removal action was completed in November 2001. A total of approximately 4,470 tons of contaminated soils were excavated and transported off-site for disposal.

Based on the results of EPA's ESI conducted in 2002, a fourth removal action took place at the site. The top two feet of contaminated soils were removed from the front and backyards of the two western-most parcels of the former pesticide facility on the north side of Ryeland Road. These areas were then backfilled with clean soils. Arsenic contamination was also identified in soil (by x-ray fluorescence from 15 to 83 mg/kg surface soil) on the residential property adjacent to the west side of the former pesticide facility on the north side of Ryeland Road, however, the property owner declined to have EPA remove the contaminated soil [1].

As part of the last removal action in August 2002, surface soil samples were collected at depths of 0-12 inches from the two eastern most residential properties of the former pesticide facility on the north side of Ryeland Road. The analytical results from the laboratory indicated arsenic was present in concentrations greater than 30 mg/kg, the site-specific action level previously established by EPA and supported by ATSDR [1]. However, the PADEP's medium-specific concentration (MSC) for arsenic in residential soils is 12 mg/kg. This more stringent, enforceable statewide health standard would be more protective of sensitive populations such as children exhibiting soil pica behavior.

The surface soil (0-12 and 0-24 inches) sample results indicate that the remaining surficial contamination, in four source areas at the site, is mainly from arsenic. Only one sample collected during EPA's 2001-2002 Removal Action and 2002 ESI at the site yielded elevated concentrations of copper, and two samples from different source areas had elevated lead results. The following table represents a summary of the surface soil sampling results from EPA's 2001-2002 Removal Action and 2002 ESI.

Table 4. Summary of Contaminants Detected in Surface Soils* at the Ryeland Road Arsenic Site, Heidelberg Township, Pennsylvania, Results from 2001-2002 EPA Removal Action and 2002 ESI

Contaminant	Number of detections	Frequency of source areas detected	Range of Concentrations Detected (mg/kg)	Average Concentration Detected (mg/kg)
Arsenic	57	4/4	22 – 11,300 (K)	161†
Lead	2	2/4	870 – 7,420	4,145
Copper	1	1/4	467 (J)	467 (J)

(K) analyte present. Reported value may not be accurate or precise. Actual value is expected to be much lower.
(J) analyte present. Reported value may not be accurate or precise. The direction of the bias, high or low, couldn't be determined.
***** The soil were sampled from depths of 0-12 and 0-24 inches.
† The maximum detected arsenic concentration (11,300 mg/kg) was not used in calculation because of it being an outlier, a potential "hot spot" and unconfirmed result.

There are areas of soil contamination that were not remediated as part of the removal actions and remain on the site. The remaining source areas on the site are covered with vegetation or at a depth of two feet or greater. The Ryeland Road Arsenic Site is not fenced and access is not restricted. The remaining source areas with known soil contamination include: the former pesticide disposal area on the south side of Ryeland Road, the residential property adjacent to the west side of the former pesticide facility on the north side of Ryeland Road, and surface soil on the two eastern-most parcels of the former pesticide facility.

One objective of the June 2005 RI/FS, included the characterization of the nature and extent of this remaining soil contamination that is attributable to the site. As part of this investigation, conducted by EPA's environmental contractor, surface soils were defined as those soils sampled from the depth between zero and 24 inches below the ground surface. Subsurface soils were also collected below the 24 inches horizon. Background samples were also collected as part of the RI. Both surface and subsurface soil samples that were collected at the site exhibited metal concentrations. The mean arsenic and lead concentrations among surface soils taken from the site were 318 ppm and 177 ppm, respectively. The mean arsenic and lead concentrations of the subsurface soils were 1,390 ppm and 1,250 ppm, respectively [15].

The depth of soil contamination varied between the surface (0-24 inches for the purposes of the RI) and 15 feet. According to the RI, the depth of soil contamination depended on whether materials were deposited on the surface (former waste pile) or in a retention pond (former plant area). Human activities (excavation work) also could have influenced the location and depth of contamination at the site, as well as natural phenomena (e.g., flooding, erosion, precipitation, water table fluctuation, etc.) related to the fate and transport of site contaminants.

Surface Water and Sediment

All overland flow from the source areas runs into a drainage swale that transects the site from the south to the north. As the drainage swale exits the site, it flows underneath the railroad tracks and discharges into a spring-fed creek. The spring-fed creek is also fed by overflow from a spring-fed pond on the plant nursery property. Contaminants, mainly lead and arsenic, from the site are potentially released into the drainage swale and could migrate into the surface water of the spring-fed creek. The spring-fed creek flows approximately 0.33 mile northwest before joining an unnamed tributary to the Tulpehocken Creek. From its confluence with the spring-fed creek, the unnamed tributary flows approximately 1.15 miles to the north where it joins the Tulpehocken Creek.

During EPA's 2002 ESI, surface water and sediment samples were collected from the spring-fed creek, the spring-fed pond, and the unnamed tributary to the Tulpehocken Creek. Background surface water and sediment samples were collected from the unnamed tributary to the Tulpehocken Creek, upstream from its confluence with the spring-fed creek. The background surface water and sediment sampling location does not receive runoff from any of the source areas. The results of the laboratory analysis of the surface water and sediment samples are presented in Table 5.

Arsenic, copper, and lead were detected in surface water and sediment samples along the surface water migration pathway downstream of the site at three times above the background sample. Surface water drainage flows through an area of known surface soil contamination at the site before discharging into the spring-fed creek. Shallow groundwater is likely to be in direct contact with areas of known subsurface contamination prior to discharging into the spring-fed creek and pond. Both surface water flowing over the contaminated soils and the discharge of shallow groundwater to surface water are likely to have contributed to the contaminants found in surface water.

Table 5. Off-site surface water and sediment samples results from EPA 2002 ESI, Ryeland Road Arsenic Site, Womelsdorf, Pennsylvania

Sample ID	Sampling Location	Sample Media (units)	Metals Concentration		
			Arsenic	Copper	Lead
RESI-BGSW-01	Upstream of PPE - Background	Surface Water (µg/L)	ND	ND	ND
RESI-BGSD-01		Sediment (mg/kg)	1.9 (K)	20.9	48.4
RESI-SW-01	0.567 mi. downstream of PPE	Surface Water (µg/L)	17.3 (L)	ND	ND
RESI-SD-01	0.567 mi. downstream of PPE	Sediment (mg/kg)	40.8 (K)	ND	ND
RESI-SW-02	0.414 mi. downstream of PPE	Surface Water (µg/L)	23.8 (L)	ND	ND
RESI-SD-02	0.359 mi. downstream of PPE	Sediment (mg/kg)	26.3 (K)	ND	ND
RESI-SW-03	0.060 mi. downstream of PPE	Surface Water (µg/L)	222	ND	5.5 (L)
RESI-SD-03	0.359 mi. downstream of PPE	Sediment (mg/kg)	68.1 (K)	ND	ND
RESI-SW-04	Spring-fed creek at PPE	Surface Water (µg/L)	182	ND	ND
RESI-SD-04	0.157 mi. downstream of PPE	Sediment (mg/kg)	407 (K)	79	435
RESI-SD-05	0.060 mi. downstream of PPE	Sediment (mg/kg)	146 (K)	ND	ND
RESI-SD-06	0.035 mi. downstream of PPE	Sediment (mg/kg)	223 (K)	ND	ND

Table Key	
µg/L	microgram per liter
mg/kg	milligram per kilogram
K	Analyte is present. Reported value is biased high. Actual value is expected to be lower.
L	Analyte is present. Reported value is biased low. Actual value is expected to be higher.
ND	Analyte was not detected in the sample in concentrations above detection limit of instrumentation.
PPE	possible point of entry

The EPA's June 2005 RI/FS also included the analysis of surface water and sediment samples collected from the nearby spring-fed creek, pond, drainage swale, the unnamed tributary to the Tulpehocken to the former Charming Forge Dam located on the Tulpehocken Creek. A total of 57 sampling stations were established, where either surface water samples, sediment samples or both surface water and sediment samples were collected to determine the extent of the contamination to the respective media. The surface water samples collected adjacent to the site contained the most elevated levels of arsenic, as indicated by the unfiltered samples, and then a general decline in arsenic concentrations with distance from the sources of contamination identified at the site. Arsenic levels ranged from 119 to 3,680 µg/L in unfiltered samples collected from the upper tributary/wetland complex. [15]. The filtered surface water samples also had frequent detections of arsenic. The highest filtered arsenic levels in surface water (up to 330µg/L) were collected from the spring-fed pond on the nursery property. The spring feeding the pond contained up to 544 µg/L arsenic. The filtered surface water results revealed that arsenic concentrations decreased by an order of magnitude between the spring-fed creek and the VFW Park, which is about 2,000 feet downstream [15].

Arsenic concentrations in the sediment samples collected from the spring-fed pond and creek and the the stream near the VFW park did not reveal the same pattern as in the surface water samples. The maximum level (818 mg/kg) of arsenic detected in the sediment samples were reported further downstream, approximately 1,200 feet from the headwater area. The mean concentration of arsenic in the upper tributary/wetlands area was 212 mg/kg, and arsenic was detected in all 21 sediment samples with the minimum detection of 2.4 mg/kg. Arsenic levels then decrease as the distance from the confluence between Tupelhocken Creek and the perennial stream increases. The maximum level of arsenic detected in the lower tributary and Tupelhocken Creek sediment samples was 88.9 mg/kg, while the mean among the 18 samples was 17.2 mg/kg arsenic [15].

Indoor Dust

As part of EPA's June 2005 RI, 25 dust wipe samples were collected from six residences near the site. These samples were analyzed for arsenic, lead and copper. The maximum levels of metals detected in the wipe samples were as follows: 106 µg/wipe arsenic; 6,760 µg/wipe lead; and 90.1 µg/wipe copper. Copper and lead were detected in all wipe samples that were analyzed with mean concentrations of 17.3 µg/wipe and 429 µg/wipe, respectively. Only one sample contained a detectable level of arsenic [15].

The surface area from which the wipe samples were collected, was not noted in the RI report. Actual concentrations of the metals in the indoor dust that were analyzed and detected in the wipe samples are not known without this information. Considering the arsenic wipe result, we can assume that some of the contamination from the site is being measured in the wipe sample, but the investigation did not identify widespread indoor contamination. Lead-based paint also could have contributed to the amount of lead detected in some of the wipe samples.

Pathways of Human Exposure

PADOH evaluates the environmental and human components that lead to exposure to contaminants. Human contact with environmental contamination is only possible when a completed pathway exists. A completed exposure pathway exists when all of the five elements are present: (1) source of the contamination; (2) transport through an environmental medium; (3) a point of exposure; (4) a route of human exposure; and (5) an exposed population.

ATSDR categorizes an exposure pathway as a completed or potential exposure pathway if the exposure pathway cannot be eliminated. Completed pathways required that all five elements exist and indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. Potential pathways, however, require that at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. An exposure pathway could be eliminated if at least one of the five elements is missing and will never be present. Table 6, Table 7, and Table 8 summarize the pathways of exposure for the Ryeland Road Arsenic Site. The discussion following these three tables concentrates on the pathways that are of public health significance and relevant to the site. Eliminated pathways are briefly described. As an additional note, even though an exposure pathway might be complete or potentially complete, it does not necessarily mean there is a public health risk. For a public health risk to occur, a substantial exposure dose must be present in a completed or potentially completed exposure pathway.

Completed Exposure Pathways

The completed exposure pathways for the Ryeland Road Arsenic Site is listed on Table 6.

Table 6. Completed Exposure Pathways

Source	Media	Exposure Point	Exposure Route	Exposed Population	Period of Exposure	Exposure Status
Ryeland Road Arsenic Site	surface soil	Ryeland Road Arsenic Site	incidential ingestion	Residents; trespassers	Past	Completed
					Present	Completed
					Future	Potential
Ryeland Road Arsenic Site	on- and off-site surface water	Ryeland Road Arsenic Site and downstream of PPE*	incidental ingestion	residents and community in surface water	Past	Completed
					Present	Completed
					Future	Potential
Ryeland Road Arsenic Site	on- and off-site sediment	Ryeland Road Arsenic Site and downstream of PPE*	incidental ingestion	residents and community in surface water	Past	Completed
					Present	Completed
					Future	Potential
Ryeland Road Arsenic Site	Subsurface soil	Ryeland Road Arsenic Site	incidential ingestion	Workers during construction or remediation on-site/residents during subsurface activities	Past	Potential/ Completed

*PPE possible point of entry

Surface Soil

A completed on-site surface soil exposure pathway exists currently, as well as in the past. Residents, particularly gardeners and children, and trespassers could be exposed to soils that contain elevated concentrations of metals, mainly arsenic. Arsenic and lead in soils were found at levels above corresponding comparison values; therefore, the public health implications of these exposures will be further evaluated. In addition, one surface soil sample collected in the 2002 EPA ESI yielded an estimated copper concentration greater than health-based comparison values. However, this result was not confirmed and may not be accurate due to laboratory error. It is also important to note that a vegetative cover exists above the remaining source areas of surface soil contamination at the site. The vegetation acts as a buffer, limiting human exposure to the contamination.

Since children have been reported to play on and around the waste piles that were formerly located on the south side of Ryeland Road, it is likely that they were exposed to elevated concentrations of contaminants by accidentally eating contaminated soils. Young children and infants could be exposed to contaminants from soil that was carried into the home by older children playing in yards or residents that are involved with activities requiring direct contact with soils (e.g. landscaping, gardening). Young children frequently put objects into their mouths and some children may regularly eat dirt or other non-food items. These children may be exposed to more contamination due to their increased ingestion of soil. In general, exposure to these contaminants through surface soil occurs almost exclusively through ingestion. If you get arsenic-, copper-, and/or lead-contaminated soils on your skin, only an inconsequential amount will pass through your skin into your body, so this is usually not of concern.

ATSDR and EPA have addressed much of the surface soil contamination through recommendations made to protect the public health at the site. Through remediation, most of the surface soil exposure pathway was eliminated. The remaining known areas of surface (and subsurface) soil contamination at the site are planned to be remediated under the current Superfund Removal Action. The discussion of these past exposures, remediation goals, and clean-ups can be found in the *Public Health Action Plan – Completed* section of this document.

Surface Water and Sediment

A completed surface water and associated sediment exposure pathway exists currently, as well as in the past, for individuals who come in contact with the drainage swale that transects the site, a spring-fed creek, in which the drainage swale discharges into off-site, the spring-fed pond, unnamed tributary to the Tulpehocken Creek, and the Tulpehocken Creek. Those individuals include children playing in these bodies of surface water and recreational sportspeople or anglers using the unnamed tributary to Tulpehocken Creek and Tulpehocken Creek. The unnamed tributary to the Tulpehocken Creek and the Tulpehocken Creek are designated fisheries. The unnamed tributary to the Tulpehocken Creek is a Class A Wild Trout Stream from SR3002 bridge in Womelsdorf downstream to its confluence with the Tulpehocken Creek, approximately 0.8 miles. The Tulpehocken Creek is an approved trout water beginning one-half mile below the Charming Forge Dam upstream to the Berks County line. Approximately 3.5 miles of the Tulpehocken Creek fishery lies within 15-miles downstream of the site [1].

No surface water intakes for drinking water purposes are located within 15-miles downstream of the site [1]. The potential for exposure would occur from incidental ingestion of the site-related contaminants that enter the surface water from overland flow or spring-fed sources. Based on the results of surface water samples collected during EPA's 2002 ESI at varying locations downstream from the confluence of the spring-fed creek and unnamed tributary, arsenic was detected in concentrations ranging from 17.3 µg/L to 222 µg/L. Copper was not detected at any surface water sample downstream from the site. Only one surface water sample yielded a detectable level of lead, which was 5.5 µg/L, well below EPA's action level of 15 µg/L.

Based on the data collected from EPA's 2002 ESI, sediments of the watershed associated with the site revealed levels of site related contaminants. Arsenic, copper, and lead were detected at maximum concentrations of 407 mg/kg, 79 mg/kg, and 435 mg/kg respectively. Exposures to these levels of site-related wastes will be evaluated in the *Toxicological Evaluation* sections for each contaminant. Additional surface water and sediment samples were collected as part of the June 2005 RI/FS, and exposures to these levels are also evaluated for potential health effects in this document.

Potential Exposure Pathways

A potential exposure pathway is defined as one where exposure could be possible except that one or more of the five elements is missing. In some cases this means that the exposure is not possible now, but may be possible in the future. In other cases, an exposure may be possible, but cannot be confirmed because environmental sample data are not available. The potential pathways of exposure for the Ryeland Road Arsenic Site are summarized in Table 7.

Table 7. Potential Exposure Pathways

Source(s)	Media	Exposure Point	Exposure Route	Exposed Population	Period of Exposure	Exposure Status
Ryeland Road Arsenic Site, residential plumbing, natural sources	on- and off-site groundwater	wells that draw drinking water from potentially contaminated aquifer	ingestion	people serviced by groundwater sources within a 4-mile radius of the site	Past	Potential
					Present	Potential
					Future	Potential
Ryeland Road Arsenic Site	on- and off-site airborne dust	Ryeland Road Arsenic Site and properties near site	inhalation, ingestion	residents, trespassers, workers during site construction	Past	Potential
					Present	Potential
					Future	Potential

Groundwater

A potential groundwater exposure pathway exists currently, as well as in the past, for residences utilizing private wells and public water systems for drinking water that obtain groundwater from the interconnected aquifers located within a 4-mile radius of the site. There are approximately 30 domestic wells within a one-mile radius and 58 domestic wells within a 4-mile radius of the site [1]. Previous results of residential well sampling (EPA 2001, 2002) near the site indicated that copper and/or lead levels exceeded EPA action levels in five of the eight homes that were sampled. However, it is not known if those domestic wells were impacted by groundwater contamination from the site. All five homes that had elevated levels of lead and/or copper also tested positive for lead solder and copper pipes in their plumbing systems [4]. Groundwater filtration units were offered to the five homes with elevated copper and/or lead levels. Three homeowners allowed such units. In addition, the sampling point that has/had elevated levels of lead and copper is not accessible for consumption, and the levels of contaminants at the taps of these residences were below levels of health concern. *Since there is no point of exposure to the detected groundwater contamination, this pathway is categorized as a potential exposure pathway.*

In addition to the private wells, several public water authorities utilize supply wells located within the study area. The WRJWA, NWA, RBWA, and BCH all draw groundwater for public distribution within the hydrogeologically connected 4-mile radius of aquifers from the source areas. Approximately 11 residences located in the vicinity of or on the site obtain drinking water from BCH, a public source that historically has not been impacted by contamination from the Ryeland Road Arsenic Site [5].

Indoor Dust/Air

A potential indoor dust and outdoor air exposure pathway exist currently, as well as in the past for residents on or near the site. Community members residing on and in the vicinity of the site could be subject to exposure from site related inorganic particulates present in the indoor dust and outdoor air. As part of EPA's 2005 RI/FS, dust wipe samples were collected and analyzed for arsenic, lead, and copper from various homes at the site [15]. The evaluation of this data was discussed in the *Environmental Contamination and Other Hazards* section of this public health assessment.

Eliminated Pathways

Eliminated exposure pathways are defined as when exposure to the contaminants is unlikely and that one or more of the five elements of a completed exposure pathway is missing. This means that exposure is not possible now and it is not likely to be possible in the future. The eliminated pathway for the Ryeland Road Arsenic Site is as summarized in Table 8.

Table 8. Eliminated Exposure Pathways

Source	Media	Exposure Point	Exposure Route	Exposed Population	Period of Exposure	Exposure Status
Ryeland Road Arsenic Site	subsurface soil	Ryeland Road Arsenic Site	incidental ingestion	workers during construction or remediation on-site / residents during subsurface activities	Present	mitigated via 2' soil cover
					Future	mitigated via 2' soil cover

Subsurface Soil

Exposure to on-site subsurface soil is unlikely for the general population. Potential contact with contaminated subsurface soil was possible during past construction or remedial activities. General household activities would not be expected to induce exposure to the subsurface soil contamination. However, subsurface soil that is physically transported to the surface through activities such as: excavation, grading, and/or blasting could pose a risk if arsenic, lead, and copper contaminated soils are brought to the surface of the landscape. At this point, the subsurface soil would technically be reclassified and evaluated as surface soil contamination. ATSDR and PADOH can only make their evaluations based on current or past environmental data and current site conditions. Please refer to the completed pathways section for the evaluation of exposure to surface soils.

Discussion – Adult and Children Health Considerations

After evaluating the site-specific data and information, PADOH determined that there are three completed pathways and two potential exposure pathways through which people could be or could have been exposed to contaminants from the site. It is only possible for adverse health effects to occur from exposure to site contaminants when people come into contact with them at sufficiently high concentrations and durations of exposure. The public health implications of these exposures are discussed in the following sections. In the *Public Health Implications* Section, the actual exposures or doses to these contaminants of concern were evaluated using the estimated exposures, toxicological properties, and epidemiological information for these chemicals.

As part of the ATSDR Children's Health Considerations initiative, and in response to community concerns, PADOH evaluated the susceptibility of young children and developing fetuses to the possible chemical exposures at this site. For example, blood lead data for children who live at or who regularly frequent the site are presented in the *Health Outcome Data Evaluation* Section.

Questions raised by the community during the preliminary stage of the public health assessment process are presented and addressed in the *Questions from the Community* Section.

Public Health Implications

Introduction

A release of a substance does not always result in human exposure, and human exposure does not always result in adverse health effects. This section of the public health assessment evaluates the estimated exposure doses for chemicals of concern for completed and potential exposure pathways for potentially affected populations. In these evaluations, PADOH considered the frequency and duration of the estimated exposures; for cases in which a population is affected by more than one exposure pathway, we also considered the combinations of chemicals and exposure routes. We considered characteristics of the exposed populations—such as age, sex, nutritional status, genetics, lifestyle, and health status—that influence how a person absorbs, distributes, metabolizes, and excretes chemicals; and where appropriate, these characteristics are included in the chemical-specific discussions.

In order to evaluate health effects, ATSDR developed MRLs for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily human exposure to a contaminant below which non-cancerous, adverse health effects are not expected to occur. MRLs are developed for each route of exposure, such as inhalation, ingestion, and for the length of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (greater than 365 days). Acute MRLs are typically higher than chronic MRLs because of the shorter duration of exposure. PADOH also uses EPA's chemical specific RfDs to determine if non-cancer health effects are possible. RfDs, similar to MRLs, are estimates of daily human exposure to a contaminant that is unlikely to result in adverse non-cancer health effects over a lifetime. For chemicals that are considered known, probable, or possible human carcinogens, PADOH utilizes EPA's chemical specific cancer slope factors to calculate a theoretical excess cancer risk. These risks are associated with the exposures that are based on conservative exposure assumptions.

For assessment purposes, average soil concentrations were used for estimating exposure doses for contaminants in surface soil at this site. The exposure scenarios for children were based on a young child (1-6 years old) playing in private yards and an older child (7 years or older) playing in areas other than private yards. PADOH assumed that younger children are more closely supervised and would likely remain in the yard. It was also assumed that older children would not spend more than three days per week playing in an area other than a private yard and young children would spend time outdoors everyday in private residential yards. For adults, PADOH assumed an exposure scenario that included daily residential exposure in their private yards. The other scenario was for an adult resident living near or on the site that occasionally visited areas other than private yards for recreational or personal purposes. Also, people reduce outside activities during the cold winter months and have little or no contact to surface soil. PADOH assumes people are not exposed to surface soil because of snow cover and decreased outdoor activities for three months per year.

An exposure dose, which is the amount of chemical estimated to have entered a person's body, is calculated using exposure duration, body weight and chemical concentration. For example, some young children between 1-6 years old are known to have an appetite for non-food items, including soil. This behavior is referred to as pica behavior and increases their exposure dose to soil contaminants. The default assumptions (see Table 9) used to calculate exposure for a young child are a body weight of 15 kg (approximately 33 pounds) with an average ingestion rate of 200 milligrams (mg) of soil per day and 5,000 mg per day for children exhibiting pica behavior. The assumptions of an older child (7-18 years of age) are a body weight of 45 kg (approximately 100 pounds) and a soil ingestion rate of 200 mg per day. The assumptions for an adult are a body weight of 70 kg (approximately 155 pounds) and a soil ingestion rate of 100 mg per day. In addition, the average concentrations detected in the surface soil were used for estimating exposure doses for this public health assessment, since the zero to three-inch surface soil data were lacking.

For determining the public health implications from exposure to contaminants in drinking water, maximum contaminant concentrations from residential samples are used to estimate exposure doses. Drinking water consumption rates were assumed to be 1 liter per day (L/day) for children less than 6 years old and 2 L/day for individuals greater than 7 years old.

These assumptions are summarized in Table 9.

Table 9. Exposure Assumptions Summary

Exposure Assumptions		**Population***				
		Children less than 7 years old		Children 7-18 years old	Adults (> than 18 years old) - Residents On-site	Adults – Non-Residential Exposure
Body Weight (kg)		15		45	70	70
Surface Soil	Ingestion rate (mg/day)	5,000 (pica)	200 (non-pica)	200	100	100
	Exposure Frequency	270 days/year		3 days/week	270 days/year	1 day/week
Groundwater	Consumption Rate (L/day)	1		2	2	Not evaluated
	Exposure Frequency	Daily		Daily	Daily	Not evaluated
Exposure Duration (Years)†		6		12	30	30

*****assume average lifetime is 70 years

†assume people live in Heidelberg Township for an average of 30 years

Evaluation of Toxicology and Epidemiology by Contaminant

The potential effects of each contaminant are discussed individually in the following section, as well as, any special child health issues related to the exposures and an overall summary of the public health implications of the pathways.

Toxicologic Evaluation of Arsenic Exposure

Arsenic occurs naturally in soils and rocks. Commercial products containing arsenic include, but are not limited to, wood preservatives, pesticides, paints, and leaded gasoline. SCWC, and subsequently ACC, manufactured pesticides, paints, varnishes and sulfuric acid at the site. As part of the manufacturing process, arsenic was converted to arsenic acid; by-products included lead arsenate, calcium arsenate, and copper acetoarsenate [1]. Other industrial processes that could release arsenic are desulfuring of gases and/or fossil fuels, burning preserved wood, and metal alloy production.

There are two chemical forms of arsenic in the environment, organic and inorganic. The inorganic forms are usually more toxic than the organic forms. The standard analytical method to detect arsenic in varying environmental media does not distinguish the specific form of arsenic [6]. To ensure a conservative or protective toxicological/public health estimate, PADOH assumes that all the arsenic detected in this evaluation is inorganic arsenic.

Human studies show that doses as low as 0.05 mg/kg/day of inorganic arsenic may cause edema of the face, and gastrointestinal and upper respiratory symptoms initially, followed in some patients by skin lesions and neuropathy [6]. Other symptoms included the lack of blood cell production, which may cause fatigue, abnormal heart rhythm, blood vessel damage resulting in bruising, and impaired nerve function causing a “pins and needles” sensation in the hands and feet. Chronic exposure to levels as low as 0.014 mg/kg/day may lead to “Blackfoot Disease”, a condition in which blood circulation is lost and ultimately results in necrosis (cell death) in the hands and feet [6]. The most characteristic effect of chronic oral exposure to arsenic is a pattern of skin changes. These include darkening of the skin and appearance of warts on the palms, soles, and upper-body. Some of the warts may also result in skin cancer. EPA classifies inorganic arsenic as a “known human carcinogen”. Exposure to arsenic may increase the risk of liver, bladder, kidney, prostate, and lung cancers.

People can be exposed to arsenic from the environment by eating food, soil, drinking water, or breathing air. Young children may be exposed to arsenic from eating soil because of their tendency to place their hands in their mouths. Dermal contact with soil or water that contains arsenic may be another exposure route, but absorption of arsenic through skin is minimal and not considered a risk factor. As described throughout this public health assessment, elevated arsenic levels were detected in surface soil (22-11,300 mg/kg), surface water (17.3-222 µg/L), and sediment samples (26.3-407 mg/kg).

The depth intervals for surface soil samples were collected from 0-to-12 inches and 0-to-24 inches. In order to more accurately estimate exposure doses and assess the potential human health implications from typical exposure to arsenic in surface soil, it is desirable to have the shallow surface soil (0-to-3 inches) arsenic data. The shallow surface soil data is essential in evaluating exposures because if the soil contamination actually exists beneath the top three inches, the potential for exposure decreases. On the other hand, it is important to note that the concentrations of arsenic from depths of 0-to-12 inches and 0-to-24 inches also might not be representative of the arsenic concentration in the 0-to-3 inches surface soil interval because the arsenic could be diluted with more soil as the sample extends to a greater depth. Therefore, the 0-to-12 inches and 0-to-24 inches of soil concentration of arsenic could under- or overestimate the level of arsenic in the top 3 inches of surface soil. Because of this uncertainty with respect to the actual concentration in the accessible portion of the residential soil, the average concentration of arsenic in the surface soil was utilized as an estimate of a resident's daily exposure.

Following ingestion, the human body absorbs arsenic to a greater or lesser extent depending on the chemical compound and environmental media in which it is contained. Arsenic in soil is absorbed to a lesser extent than the soluble arsenic forms found in groundwater. Animal studies demonstrated that the bioavailability of arsenic in soil might be quite small in some soil types. These studies suggested that arsenic in soil may be imbedded in minerals or occur as insoluble compounds and therefore not taken up by the body from the gastrointestinal tract [6]. This is important for estimating human doses. The current arsenic soil CREG is 0.5 mg/kg that PADOH uses as a screening tool to identify contaminants of concern. The CREG is a theoretical calculation that assumes a consumption of 100 mg of soil per day by a 70 kg person over a lifetime without consideration of absorption rate or the bioavailability of arsenic from soil. This scenario is used for screening purposes and far more conservative than what we would expect in reality.

Based on health studies, PADOH considered the bioavailability of arsenic from ingestion of soil, which is typically quite small in most cases. One study recognized bioavailable arsenic in contaminated soils to range from 4.5% to 25% (+/- 0.8% to 9%) [6]. Another study determined that the bioavailability of arsenic-contaminated soil from 14 soil samples from 12 different sites to be 5% to 31%, with most percentages of bioavailability of arsenic in soil found to be in the 10% - 20% range [16]. To take a conservative approach, for this public health assessment PADOH considered the bioavailability of arsenic to be 50% for all exposure dose calculations. Age-adjusted soil ingestion rates were used to calculate lifetime arsenic exposure doses. The estimated average lifetime daily exposure for people living on or near the Ryeland Road Arsenic Site for 30 years is 2.3E-04 mg/kg/day. This value is lower than the chronic MRL of 3E-04 mg/kg/day. Young children playing in the residential yards daily have an estimated exposure dose of 0.002 mg/kg/day over the course of a year. The shorter-term (within a year) exposure should be more appropriately compared to the intermediate or acute MRL. This level is less than the ATSDR provisional acute MRL for arsenic of 0.005 mg/kg/day. However, a younger child exhibiting soil pica behavior would have an estimated exposure dose of 0.05 mg/kg/day. The pica behavior would result in a dose that exceeds ATSDR's acute MRL for arsenic, but does not necessarily mean that the exposures would result in health effects, due to this estimated calculation without the actual surface (0 to 3 inches) soil data. The dose and end point used in the study to calculate the acute MRL was based on a LOAEL of 0.05 mg/kg/day, which is equal to the calculated dose. This study performed by Mizuta et al. (1956) summarized findings from 220 poisoning cases associated with an episode of arsenic contamination of soy sauce in Japan. The clinical symptoms recorded were edema of the face, and gastrointestinal and upper respiratory symptoms initially, followed in some patients by skin lesions and neuropathy. Other effects included mild anemia and leukopenia, mild degenerative liver lesions and hepatic dysfunction, abnormal electrocardiogram, and ocular lesions. For derivation of the MRL, facial edema and gastrointestinal symptoms (nausea, vomiting, diarrhea), which were characteristic of the initial poisoning and then subsided, were considered to be the critical effects [6].

The MRL for acute exposure to arsenic is supported by the case of a man and woman in upstate New York who experienced gastrointestinal symptoms starting almost immediately after being intermittently exposed to arsenic-contaminated drinking water at an estimated dose of 0.05 mg/kg/day (Franzblau and Lilis 1989). Gastrointestinal symptoms have been widely reported in other acute arsenic poisoning studies as well, although in some cases, the doses were higher and effects were more severe, and in other cases, the dose information was not available. The MRL is actually considered provisional because the gastrointestinal effects are serious and because serious neurological and cardiovascular effects also occurred at the same dose. ATSDR prefers to base an MRL on a No Observable Adverse Affect Level or less serious LOAEL, if the data are available. However, in this case public health concerns regarding arsenic suggested that a provisional value derived from these data would still be useful for the general public [6].

The estimated cancer risk from the average lifetime daily exposure to the average arsenic concentration (318 mg/kg) detected from the most recent 2005 RI in surface soils for residents at the site would be approximately one cancer per 10,000 people or a "low increased risk". After reviewing numerous human studies, as reported in ATSDR's Toxicological Profile for arsenic, the lowest arsenic Cancer Effect Level (CEL) for lung cancer is 0.0011 mg/kg/day; for bladder cancer is 0.0033 mg/kg/day; and for skin cancer is 0.0075 mg/kg/day. The average lifetime exposure dose (0.00034 mg/kg/day) is less than the lowest CELs for arsenic. PADOH does not expect elevated cancer risk from exposure to the average levels of arsenic in soils, depths ranging from 0-to-12 and 0-to-24 inches, at the site. ***Again, it is difficult to make health calls on surface soils at these intervals due to the uncertainty of arsenic levels at shallower depths. It is better to have chemical concentration data from the top three inches of surface soil, since people are typically exposed to shallower soil (0-3 inches). PADOH and ATSDR typically do not assess human exposure to surface soils that are sampled from a deeper stratum.***

Another exposure scenario that was considered involved a child (7-18 years old) that played on the former waste pile on the south side of Ryeland Road three days per week for nine months out of a year and was subsequently exposed to 5,666 mg/kg of arsenic in the pile for approximately 10 years. This childhood exposure scenario would have resulted in an additional cancer risk of 1 in 1,000 or a moderate increased risk of developing cancers associated with exposure to arsenic from the waste piles that were remediated in 1985. In addition, this exposure scenario would have resulted in an exposure dose of 0.023 mg/kg/day, which exceeds the doses known to cause non-cancer health effects, such as Blackfoot Disease.

Toxicologic Evaluation of Lead Exposure

People residing on or near the Ryeland Road Arsenic Site could be exposed to lead in soil, drinking water, surface water, sediments and airborne particulates. These people are potentially exposed to lead through incidental ingestion of contaminated soil and inhalation of airborne particulates. People who frequent the streams that are part of the potentially impacted watershed and linked to the site are subject to incidental ingestion of contaminated surface water and sediments. At low levels, lead occurs naturally in the environment. However, most high levels found throughout the environment come from human activities. As a byproduct of the former manufacturing processes and source of lead contamination at the site, lead arsenate was formed and released into the environment.

Lead was detected in surface soil samples at the site in two discrete locations at concentrations of 870 mg/kg and 7,420 mg/kg. Lead was also detected in two sediment samples at 48 and 435 mg/kg from stream sediments. The 2005 RI/FS delineated the potentially remaining lead contamination in surface soils and sediments. The identified "hot spots" of lead contamination in surface soils and sediments may be isolated areas; therefore, exposure would be limited, unless children and/or recreators frequented these discrete locations on a regular basis. ATSDR has not established any MRLs for lead in soils or sediments, nor has EPA established an RfD. There is evidence that lead poses a human health threat as concentrations approach 500 mg/kg in the soil. Studies have shown that blood lead levels in children may increase 2-to-3 µg/dL for every 1,000 mg/kg in the soil [7]. Clean-up actions on residential properties are typically initiated as soil lead concentrations approach 400 to 500 mg/kg on average [7]. Since exposure to surface soils occurs on a frequent basis in residential soil, the lead concentrations detected in the surface soils on these properties could pose a health threat, and justify a clean-up action.

Groundwater sampling results indicated that lead concentrations exceeded EPA's Maximum Contaminant Level Goal (MCLG) of zero for lead (Table 3). The purpose of this MCLG, established in June 1991, was to promulgate maximum human health protection by reducing lead levels at the taps as close to the MCLG as possible. Currently, there is no MCL for lead, but an EPA action level of 15 µg/L has been established. As discussed earlier, detectable lead concentrations were from samples collected prior to the in-house water storage tank. Concentrations at kitchen taps were either below background sample concentrations or not detected for all tap samples. The EPA also assisted in mitigating this potential exposure pathway by installing in-line sediment filters at residential locations that accepted this offer. The RI/FS was designed to delineate the extent of the groundwater contamination at this site. The aquifer that residents receive their drinking water from private wells was not impacted according to the results in the 2005 RI/FS.

Lead affects primarily the peripheral and central nervous systems, the blood cells, and metabolism of vitamin D. Lead also causes reproductive toxicity and is classified by the EPA as a possible human carcinogen. The most sensitive target of lead poisoning is in the nervous system. In children, neurological effects have been documented at exposure levels once thought to cause no harmful effects [7].

Neurological deficits, as well as other effects caused by lead poisoning, may be irreversible. Effects in children generally occur at lower blood levels than adults. The developing nervous system in children can be affected adversely at blood lead levels as low as 10 micrograms per deciliter (µg/dL) and perhaps lower. Lead inhibits several enzymes that are critical to the synthesis of heme, the deep red iron-containing prosthetic group of hemoglobin.. However, low-level lead poisoning in children rarely results in anemia. Lead poisoning also interferes with the hormonal form of vitamin D, which affects multiple processes in the body, including cell maturation and skeletal growth. Lead-induced chronic renal insufficiency may result in gout. Furthermore, maternal lead stores readily across the placenta, placing the fetus at a serious risk.

Some persons with lead poisoning may not be overtly symptomatic. Because of the differences in individual susceptibility, symptoms of lead intoxication and their onset may vary. With increasing exposure, the severity of symptoms can be expected to increase. In the early stages of symptomatic lead intoxication or mild toxicity, blood lead levels generally range from 35 to 50 µg/dL in children and 40 to 60 µg/dL in adults. Mild toxicity may result in muscle pain and irritability. Moderate toxicity may result in bone pain, general fatigue, difficulty concentrating, headache, diffuse abdominal pain, and weight loss. Severe lead toxicity may result in encephalopathy, which may lead to seizures. A purplish line on the gums, known as a lead line, is rarely seen today, but if present, usually indicates severe and prolonged lead poisoning.

A blood lead test is the most useful screening and diagnostic test for evaluating a possible exposure to lead. Therefore, blood lead tests were offered to children residing at (or frequently visiting) properties at this site in close proximity to known areas of lead contamination. The blood lead levels and corresponding public health implications associated with the blood lead levels are addressed in the *Health Outcome Data Evaluation* section of this PHA document.

Based on sufficient animal studies, EPA classifies lead as a probable human carcinogen. No cancer slope factor has been developed for lead to evaluate possible cancer risks to people exposed to lead in the study area.

Toxicologic Evaluation of Copper Exposure

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and at low levels, air. Its average concentration in the earth's crust is about 50 mg/kg. Copper is essential for health. However, exposure to higher doses can be harmful. Long-term exposure to copper dust can irritate your nose, mouth, eyes, and cause headaches, dizziness, nausea, and diarrhea. If you drink water that contains elevated levels of copper, you may experience vomiting, diarrhea, stomach cramps, and nausea. Intentionally high intakes of copper can also cause liver and kidney damage and even death. We do not know if copper can cause cancer in humans. EPA has determined that copper is not classifiable as to human carcinogenicity [8].

People living near or on the Ryeland Road Arsenic Site may be exposed to copper in their private wells. However, the source of copper detected in private wells may not be entirely related to the site, or at all. The households with detectable concentrations of copper in their private wells, also had copper plumbing in their homes. Many households with copper plumbing systems have copper concentrations exceeding 1,000 µg/L [8]. Furthermore, tap samples at these homes did not yield detectable concentrations of copper. Only the samples collected prior to the water storage tanks had elevated levels of copper (i.e., a maximum result of 1,030 µg/L). A sample collected at the tap is indicative to what the people are actually being exposed. Adverse health effects would not be expected as long as the trend of declination in copper levels continues at the point where residents may be exposed.

During the 2002 EPA ESI, one surface soil sample collected in a residential yard had an estimated copper concentration of 467 mg/kg. The reported value for this contamination may not be accurate or precise, and could not be confirmed due to limitations of the laboratory analysis of the sample. Copper acetoarsenate was a byproduct from historical manufacturing of pesticides on the site and may be a potential source of the copper surface soil contamination. Since only one sample result yielded a detectable concentration of copper that could not be confirmed due to limitations of the laboratory equipment used to analyze the sample, it does not appear that copper contamination in surface soil is a current health issue, and it would not be accurate to evaluate exposures to an unconfirmed result. Moreover, the potential for adverse health effects from exposure to arsenic and lead in these same locations would be more apparent, likely, and of concern.

ATSDR Child Health Considerations

Children differ from adults in their physiology (e.g., respiratory rates relative to body weight), pharmocokinetics (i.e., distribution, absorption, metabolism, and excretion of chemicals), and pharmacodynamics (i.e., suscepitibility of an organ to the exposure). Therefore, it is always important to address chemical exposures of these sensitive populations. Fetuses, infants, and children are more vulnerable to toxic effects of chemicals because of the following reasons: 1) children are more likely to play in contaminated outdoor areas; 2) children are closer to the ground (shorter), resulting in a greater likelihood to breathe dust, soil, and heavy vapors laying on the ground; 3) children weigh less than adults resulting in a higher body burden to the chemical exposed to; and, 4) the developing body systems of a fetus, an infant, or a child can sustain permanent damage if toxic exposures occur during critical growth stages.

Studies show that adverse reproductive and developmental effects are possible after exposures to significant doses of arsenic and lead. Therefore, fetuses, infants, and children are more susceptible to the effects of arsenic and lead. We estimate that younger children who regularly eat non-food items and frequently contact site contaminants may have exposure doses that exceed ATSDR's acute MRL. Residents that have young children at home should take precautions to not track contaminated soil into their home. PADOH's suggestions are summarized in the *Recommendations* section.

Health Outcome Data Evaluation

The potential for exposures to chemicals to result in adverse health effects are determined by several factors. These include: the toxicity of the chemical, the route of exposure, the amount of exposure, and the duration of the exposure. PADOH evaluated all of these factors during the health assessment process. The potential for non-cancer health effects, such as effects on the fetus and reproduction, were evaluated. The potential for cancer was also considered. Site-specific exposure doses, outlined in the toxicology section, were estimated and used in the public health assessment. Based on the toxicological evaluation, PADOH determined that present and past exposures to contamination at the site represent an indeterminate public health hazard based on lack of sampling data. In addition, no conclusions can be drawn about past exposures other than that they did occur – conclusions about the levels of exposure are unknown.

The public health assessment process uses multiple methods to assess potential impacts in communities. In addition to the evaluation described above, PADOH can examine actual data about cancer cases in residents. However, the population along Ryeland Road is too small for epidemiological investigations to yield meaningful data that could be used for public health assessment purposes. There are only approximately 77 residents in the immediate vicinity of the site. It is generally necessary to examine statistics for a much larger population to have useful results, even for diseases as common as certain cancers. If determinate conclusions can be drawn regarding exposures to levels of carcinogenic chemical that would result in an increased estimated cancer risk, then a cancer study for this area might be warranted.

To determine if residents living near remaining sources of lead contamination at the site were at risk due to exposure to lead contamination, the EPA offered blood lead screening to children who reside on or in close proximity to these areas. The parents of several children accepted such screening for the children. All the children that were tested had blood-lead levels less than 10 micrograms per deciliter (µg/dL), the level that Centers for Disease Control currently considers a health risk.

Questions from the Community

When performing any public health assessment, PADOH gathers health concerns from people living in the vicinity of the site. The concerns that people expressed are used to direct the focus of the public health assessment, so that questions from the community are answered. At the Ryeland Road Arsenic Site, PADOH has collected community questions through the following activities.

- October 2004: Phone calls to individual residents in vicinity of the site.

- October 2004: Individual visitations by PADOH Nursing Services Consultant with residents in their homes.

Based on the responses from the phone calls and individual meetings, the following questions/issues were raised.

1. *Community members stated that children used to frequently play on the waste piles that were formerly located on the south side of Ryeland Road. Were there potential health risks associated with these past exposures?*

Reply: Yes, there are possible adverse health risks associated with past exposures from children who routinely played on the waste piles. When the PADER, now PADEP, was notified of this waste pile of grayish-white material in 1983, the initial investigation included the collection and analysis of samples from this waste pile on the south side of Ryeland Road. The analytical results of the samples collected by PADER revealed the presence of total arsenic and lead at concentrations of 5,666 and 2,900 milligrams per kilogram (mg/kg), respectively. In 1984, another composite sample was collected from the waste pile located on the south side of Ryeland Road yielded arsenic and lead concentrations of 4,600 and 258 mg/kg, respectively.

If a child (7-18 years old) played on the waste pile three days per week for nine months out of a year and was subsequently exposed to 5,666 mg/kg of arsenic in the pile for approximately 10 years, s/he would have an additional cancer risk of 1 in 1,000 or a moderate increased risk of developing cancers associated with exposure to arsenic. Please see the *Toxicological Evaluation of Arsenic* section in this report for a detailed discussion of specific health effects related to non-carcinogenic health effects from exposures to arsenic.

In addition to the increased risk of adverse health effects from the estimated exposures to arsenic, the waste piles also had elevated concentrations of lead. As discussed in the *Toxicological Evaluation of Lead* section of this document, as lead soil concentrations increase by 1,000 mg/kg, children playing in those soils have estimated blood lead levels that increase by 2-3 µg/dL. In addition, these studies indicated that, as soil with lead concentration that approach the 500 mg/kg level, human health might be at risk. Therefore, a child regularly playing on the waste pile as described previously might have had an increased blood lead level. Please see the *Toxicological Evaluation of Lead* section in this report for a detailed discussion of the specific health effects related to exposures to lead.

PADOH concludes that there are possible adverse health risks associated with past exposures from children playing on the waste piles, which were remediated by EPA in 1985. As of EPA's removal action in 1985, these piles no longer exist, and therefore this particular exposure is no longer possible for children currently living or playing near the site.

2. *Community members were concerned about the number of residents living near the site who have or had cancer. Is there an elevated rate of cancer along Ryeland Road and are those cancers caused by exposures to the contamination from the site?*

Reply: PADOH does not expect elevated cancer risk from exposure to average levels of arsenic in soils. The population along Ryeland Road is too small for epidemiological investigations to yield any meaningful data that could be used for public health assessment purposes. There are only approximately 77 residents in the immediate vicinity of the site. It is generally necessary to examine statistics for a much larger population to have useful results, even for diseases as common as certain cancers.

It can not be accurately determined whether exposures to site-related contamination would result in an increased cancer risk to residents living near the site because historic sampling and exposure data are not available. However, for screening and estimation purposes, it was determined that the estimated cancer risk from the average lifetime daily exposure to the average arsenic concentration (318 mg/kg - the greater of the average levels between the 2002 and 2005 environmental studies) in surface soils would be approximately one additional cancer per 10,000 people or a “low increased risk”. PADOH does not expect elevated cancer risk from exposure to average levels of arsenic in soils, depths ranging from 0-to-12 and 0-to-24 inches, at the site. Again, it is not entirely accurate to make health calls on surface soils with analytical data from these depth intervals. It is better to have surface soil data from the top three inches of soil for a more realistic exposure scenario.

3. *There is a pile of bricks on my property that were discovered to be formerly part of the manufacturing facility on the Ryeland Road Arsenic Site. These bricks were contaminated with arsenic and lead. Community members were using these bricks to landscape their driveway and yard. Should the pile of contaminated bricks be covered up? Are there health implications from past exposures of handling these bricks with a front-end loader for 4-to-5 hours for approximately 26 days?*

<u>Reply:</u> PADOH does not expect adverse health effects to result from handling bricks with particles of arsenic and lead on the surface of the bricks. The bricks in contact with contaminated soil would have a higher degree of contamination but proper hygiene (e.g., hand washing) would mitigate potential exposures. In the summer of 2004, the EPA discovered the brick pile during the RI/FS Study. A local resident informed the EPA of the location of the brick pile, which was approximately 0.25 miles southeast of the site. These bricks were screened for arsenic and lead contamination using an x-ray fluorescence (XRF) analyzer. Based on XRF analysis and observation, only the darker colored bricks were confirmed to have arsenic and lead contamination.

If the contaminated bricks were handled using a front-end loader, there was minimal contact with the contaminants on the bricks. Also, if the bricks remained in good condition and were not pulverized, abraded, or grinded, it is not likely that the contaminants on the bricks were released into the air and inhaled or incidentally ingested. Therefore, the exposures to the arsenic and lead contamination on the bricks should have been low, unless any of the aforementioned aggressive techniques were used on the bricks.

If the pile of bricks is not disturbed, it is not likely that the residents will be exposed to the contamination on the bricks, unless the bricks eventually crumble or become in poor condition. The EPA will likely make a determination on whether to remediate the brick piles to when the RI/FS is completed.

4. *A resident spent about six months digging a ditch with a backhoe from a swampy area on the south side of Ryeland Road to the natural drainage area near his driveway. Are there health implications from potential past exposures to excavating these potentially contaminated soils?*

Reply: It is not clear to whether the resident was excavating soils that were in the delineated area of soil contamination. If the resident were digging with a backhoe in soils that were impacted with lead and arsenic contamination, the exposure route we would be most concerned about would most likely be the inhalation (subsequent ingestion) pathway. (We assume that the resident did not have much direct contact with the soils while using a backhoe.) If the soils that were excavated were moist from being in a swampy area, the likelihood of dust particles becoming airborne is decreased. But, if the work activities were dusty, and contaminated soil particles became airborne, the inhalation (subsequent ingestion) exposure pathway would be more of a health risk.

To fully answer this question, we would need soil samples from the excavated area and air samples collected during the actual construction activities. The National Institute for Occupational Safety and Health (NIOSH) has set recommended exposure limits (RELs), and/or the Occupational Safety and Health Administration (OSHA) set permissible exposure limits (PELs) for approximately 677 chemicals to be protective of human health in the workplace. The NIOSH RELs for arsenic and lead are 2 $\mu g/m^3$ and 50 $\mu g/m^3$, respectively, based on an average concentration for a 10-hour workday. The OSHA PELs, based on an 8-hour average concentration, for arsenic and lead are 10 $\mu g/m^3$ and 50 $\mu g/m^3$, respectively. With all the unknown variables in this particular worker scenario, we cannot determine if health risks were possible for this individual. We recommend that this individual consult their personal physician if he or she is still concerned. PADOH and ATSDR would be available to consult with this physician directly as well, if the individual provides us with written permission to discuss his or her medical history.

5. *A resident living near the site indicated that their property was not tested for site contaminants. What are the next steps and future plans for the site?*

Reply: The RI/FS, initiated in the summer of 2004, was planned to be a comprehensive study that will delineate the extent of contamination in soil, groundwater, and surface water, originating from the Ryeland Road Arsenic Site. The EPA has indicated that the subsurface soil results indicate extensive soil contamination in three residential properties. Arsenic levels reached 180,000 mg/kg and contamination was found to a depth of 15 feet in some locations.

As support to the EPA, the United States Army Corps of Engineers was tasked for assistance to determine potential relocation benefits for residents at six properties that exhibit contamination. EPA has been also evaluating various future use scenarios for the affected properties. The site remediation, construction, and restoration are targeted for a 2008 completion.

6. *Community members stated that several species of dogs died prematurely due to cancer. Can site-related contaminants induce cancer in dogs?*

Reply: We believe that it is possible that dogs significantly exposed to the site-related contaminants might experience health effects. Several exposure studies involving arsenic and lead as well as dogs are described in the ATSDR Toxicological Profiles for these chemicals. The one study found in the Toxicological Profile for lead involved beagles that were exposed to lead orally in their food for two years. No-observable-adverse-effect-levels (NOAELs) were calculated based on hematological, renal, and body weight health effects. Therefore, dogs might be susceptible to a range of health effects from chronic exposure to lead, depending on the dose.

Two studies that involved dogs were located in the Toxicological Profile for arsenic. In one study beagles were exposed to arsenic in their food for 26 weeks, and NOAELs were calculated for hematological, hepatic, renal, and body weight health effects. In the other study, beagles were exposed to arsenic in their food for two years. This study was also used to calculate NOAELs for hematological, gastrological, cardiovascular, hepatic, renal, and body weight health effects. Therefore, arsenic, like lead is quite toxic to dogs as it is to humans. Dogs could be susceptible to a range of health effects in many different body systems after chronic exposure to ingestion of arsenic, depending on the dose.

The studies mentioned above do not mention cancer effect levels from exposure to lead and arsenic. However, these studies do substantiate health effects are possible in dogs after ingestion of lead or arsenic, which was likely to have happened if the dogs passed through the contaminated areas regularly.

On April 21, 2008, two PADOH representatives, one PADEP representative, one ATSDR Region III representative, and one EPA representative visited the residences and the Bethany Children's Home along Ryeland road near the site in order to: distribute paper copies of the September 14, 2007 Ryeland Road Arsenic PHA for public comment; address any questions or concerns by the residents; and provide information regarding child blood lead testing. Residents not at home during this visit day were subsequently mailed a copy of the PHA, along with contact information should they have any questions or concerns after reading the PHA for public comment. To date, there have been no specific health concerns expressed to PADOH from residents that live near the Ryeland Road Arsenic Site.

Conclusions

1. PADOH has evaluated the exposure pathways related to the Ryeland Road Arsenic Site. The following are ATSDR and PADOH public health conclusions for each of the relevant pathways at this site. Please note that it is possible for these conclusions to change once EPA's latest RI/FS data are available and evaluated from a public health standpoint.

    - At this time it is not known whether children and adults are currently exposed to arsenic-contaminated surface soils, and potentially lead- and copper-contaminated surface soils on the Ryeland Road Arsenic Site. It cannot be fully determined if potential exposures would result in adverse health effects; therefore, this exposure pathway is categorized as a current ***indeterminate public health hazard***. The "surface soil" data evaluated in this public health assessment document was collected from depths intervals of 0-to-12 inches and 0-to-24 inches below ground surface. To accurately assess a residential exposure scenario it is best to use surface soil data from the top three inches of soil. It is important to note that the evaluation of exposures to surface soil contamination will change if the concentrations of metals are different in the top three inches. Without these data, it is not possible to accurately assess the likelihood of adverse health effects to community members who reside in the vicinity of the Ryeland Road Arsenic Site.

    - Past exposures to children playing on waste piles and yards formerly located on the north side of the Ryeland Road Arsenic Site represents a past ***public health hazard***. EPA removed the waste piles in 1985, and therefore exposure to the waste piles is no longer possible for children currently playing near the site. The soil in the yards are currently being or have already been remediated so children will no longer be exposed to the arsenic contamination.

    - There is an extensive amount of subsurface soil contamination, and the potential exists or has existed for soluble metals to eventually contaminate groundwater resources beneath the site and/or migrate to the hydrogeologically, interconnected aquifers in the four-mile radius study area. However, contaminants found in groundwater may only pose a risk to the public if exposure occurs. This exposure pathway is categorized as a past and current ***no apparent public health hazard***. Public water sampling records from the area near the site do not show contamination at this time. Historically, private well sampling from those homes closest to the site (representing the wells most likely to show contamination) has indicated some lead and copper contamination in drinking water samples collected near the water storage tank. However, samples collected from the taps from the same homes yielded results below levels of health concern.

    - Exposure to contaminants in surface water and sediments in the onsite drainage swale, spring-fed creek, spring-fed pond, tributary to Tulpehocken Creek, and the Tulpehocken Creek, represents ***no apparent public health hazard*** because of the very limited duration of exposure at the levels sampled. Results from the June 2005 RI/FS delineated the extent of contamination that originated on-site and migrated via the surface water and associated sediment pathway. The planned remedial activities at the site will address this contamination, which is anticipated to eliminate this exposure pathway.

- Results of the wipe samples could not be interpreted, and therefore the indoor dust pathway represents ***an indeterminate public health hazard***. Dust wipe samples were collected from inside residences near the site. No widespread contamination problems were discovered from the results of the dust wipe samples. Furthermore, potential sources of arsenic, lead and copper contamination are covered with vegetation, which would prevent air deposition or tracking of contaminated dust into homes.
- Currently there is no regular or general exposure to onsite subsurface soils because the general public is unlikely to have contact with subsurface soils. Residential exposure to onsite subsurface soil is categorized as ***no public health hazard.*** At this time, worker exposure to arsenic, lead, and copper contaminated subsurface soil represents a *potential public health hazard* if proper worker protection is not in place, which will not be the case for the site because of a site-specific health and safety plan. Since elevated concentrations of arsenic, lead, and copper have been detected in subsurface soils on the site, workers should follow appropriate OSHA and/or NIOSH regulations if handling these potential chemical hazards.

2. Blood-lead screening was offered to children who reside or are known to frequent areas of the remaining contamination from the site. Several children near the site that were tested in October 2004 were found to have blood-lead concentrations less than 10 µg/dL; therefore, it currently doesn't appear that these children are being exposed to lead at levels and durations that would result in elevated blood lead levels. Information on blood-lead screening for children was again discussed with some residents on April 21, 2008 during the residential site visit.

Recommendations

1. To accurately assess human exposure to surface soil contamination, it is necessary for PADOH and ATSDR to evaluate surface soil data collected from 0-3 inches. PADOH and ATSDR recommend further site characterization of surface soil at a depth of 0-3 inches beyond the areas that will be remediated to fully delineate the extent of surface soil contamination.
2. PADOH will continue to encourage residents with elevated levels of lead and/or copper in their private wells to maintain the effectiveness of the in-line sediment filters, according to the manufacturer recommendations, that EPA has provided them. PADOH carried out this recommendation through site-specific fact sheets and meeting with community members and residents during the residential site visit on April 21, 2008. No elevated levels of inorganic contaminants have been detected at the taps of these residences, however, if contaminants are entering the home via sediments in groundwater, the potential still exists for exposure to occur if an effective mitigation system is not in place. PADOH provided educational materials, and encouraged the residents who rejected such filters from the EPA to install these filters to mitigate their exposure to the chemicals in their drinking water.
3. Arsenic and lead contamination were identified on the residential properties at the Ryeland Road Arsenic Site. In light of the uncertainty of the concentrations of chemicals in the upper three inches of surface soil, residents who reside at or near the site should take steps to reduce their exposure to the chemicals in soil by limiting their contact with the contaminated soils. Through site-specific fact sheets and a public availability session PADOH encouraged

residents at or near the site to take the following steps to reduce their exposures to contaminated soils:

- maintain a dense vegetative cover (i.e., grass) over any bare soil areas in yard;
- do not track dirt into home; leave shoes at the door prior to entering home or wipe feet on door mats;
- spray water on bare soils to keep contaminants from being airborne and inhaled, use disposable gloves, and wash hands thoroughly to reduce exposure to contaminants from gardening and/or landscaping activities;
- educate your children not to dig or play in contaminated soil, and let them know that it could be harmful to them;
- do not garden or work in contaminated soils, or perhaps, container garden with “clean” soil;
- wash hands prior to eating after contacting soil;
- use vacuum with HEPA filter; damp mop hard surfaces
- keep pets from digging in contaminated soils and bathe outdoor pets frequently
- consider providing sand boxes for children

4. Elevated levels of arsenic, lead, and copper in subsurface soil exist beneath the site and have been documented extensively in previous studies. It is apparent that shallow aquifers have been impacted by this contamination because a spring-fed pond, spring-fed creek, and surface water have been impacted by this source of arsenic contamination. The potential for deeper groundwater to be impacted by site contamination exists as long as the source of contamination remains at the site. EPA or PADEP should continue to monitor groundwater resources throughout the study area indefinitely, or until the source of contamination can be remediated below appropriate PADEP/EPA clean-up levels since people are using private groundwater wells.

5. In light of the uncertainty about health effects from exposures at this site, residents concerned with current or past exposures should consult with their personal physicians regarding appropriate follow-up. ATSDR and PADOH are available to discuss possible exposure issues with physicians. Periodic blood-lead testing for children less than 6 years of age and females who are pregnant or desire to become pregnant should be considered for those who might be exposed to lead contamination.

6. If remediation of the source of the contamination is ongoing, as a precaution and as prudent public health practice, site access should be restricted by placing obvious signs or barriers at the site boundaries to prevent the public from entering. PADOH should inform the public about the chemical and physical hazards of site remediation and reconstruction at the site. PADOH supports EPA’s approach regarding relocation, either permanent or temporary, of families residing in proximity to where the remediation is to occur. EPA will need to implement a site health and safety plan in accordance with all federal, state, and local regulations and in place, and require adherence to this plan by anyone who enters the site prior to the commencement of remediation.

Public Health Action Plan

The purpose of the public health action plan is to ensure that this public health assessment not only identifies any current and potential exposure pathways and related hazards, but also to provide a plan of action to mitigate and prevent adverse human health effects resulting from exposures to hazardous substances in the environment. The following sections summarize the completed, on-going, and planned public health actions at the Ryeland Road Arsenic Site.

Completed Actions

1. To date, EPA has conducted several environmental investigations and removal actions to identify and mitigate contaminated surface soils and other waste materials. By removing the source and/or contact with the contaminant, the exposure pathway would be likely eliminated as well. Based on the results of these investigations, EPA conducted the following removal actions at the site:
   - The first removal action was conducted in 1985 and occurred in two phases. Phase I included the removal of the waste pile on the south side of Ryeland Road that was discovered in December 1983. In 1987, Phase II of the EPA removal action included the removal of arsenic-contaminated soil from three residential properties on the north side of Ryeland Road.
   - In July 2001, EPA became aware that the fifth parcel on the south side of Ryeland Road was being regarded and excavated for construction. After the completion of an inspection and removal assessment, contaminated soils were removed down to two feet bgs, leaving arsenic contamination of soils two feet and deeper. The second removal action was completed on this property by November 2001.
   - Based on the results of the second ESI in 2002, EPA conducted a third removal action at the site. This removal action included removing the top two feet of contaminated soils from two residential properties on the north side of Ryeland Road. Again, soil contamination remains at these locations at depths greater than two feet bgs. General household activities would not be expected to result in an exposure to subsurface (>2 feet bgs) in the remediated areas of the site.
2. When studies were initiated at the site in 1985, EPA requested ATSDR's assistance in determining the public health protectiveness of clean-up levels and site remediation efforts to mitigate site contaminants and protect human health. EPA's environmental investigations, which included removal assessments and ESIs, were utilized in making the recommended public health actions. To date, the following health determinations and proposed recommendations have been made by health agencies at this site:
   - In 1985, ATSDR/Centers for Disease Control (CDC) evaluated PADER's (currently PADEP) and EPA's initial site investigation sampling results of surface soils. ATSDR/CDC concluded that a potential public health hazard exists at the site through ingestion of contaminated soil (lead and arsenic) and possible inhalation of contaminated dust from the waste pile and material, which has possibly migrated off-site. ATSDR recommended actions to eliminate this public health threat and sampling of the private wells in the area to determine if they have become contaminated [9]. In addition to this response, ATSDR proposed immediate removal of surface soils containing more than 100 ppm of arsenic and 500 ppm of lead. These

levels were expected to protect the public from further excessive exposure to these contaminants, according to health-based studies released up to 1985 [10].

- In response to EPA's request for assistance, ATSDR evaluated environmental data from EPA's removal assessment conducted in 2001. ATSDR confirmed that the levels of arsenic and/or lead in surface soils posed an imminent and substantial threat to public health and soil removal was warranted. Since the ATSDR Toxicological Profile for Arsenic was updated in September of 2000, the recommended clean-up goals for arsenic-contaminated soil was changed from 100 ppm to 20 ppm [11]. The updated clean-up level of 20 ppm arsenic or less was protective of the most sensitive populations (i.e., children), according to the updated studies.
- At the request of EPA, ATSDR evaluated the private residential well drinking water results from later in 2001 and early 2002. The resultant laboratory data from water samples collected from the residential water distribution system after the storage tank and prior to the drinking water tap indicated elevated lead concentrations. Water samples collected at the tap did not yield detectable concentrations of lead. However, because only a single round of sampling was not sufficient to rule out the potential for future contamination at the tap, ATSDR recommended that appropriate steps be taken to ensure that residents are not consuming water containing unacceptable levels of metals. EPA followed up ATSDR's recommendation with the provision of bottled water to residents for drinking and cooking purposes [12].
- The analytical results from another round of private well sampling in February 2002 indicated a similar trend, whereby lead levels at the tap were not detectable and concentrations of lead collected near the storage tank were elevated. The data suggested that lead concentrations were primarily a result of sediment in the water. Based on those observations, EPA discontinued the provision of bottled water to the residences and installed sediment filters in those residences lacking the filters. ATSDR concurred that those efforts would result in the provision of safe drinking water from the standpoint of lead contamination [13].
- In July of 2002, EPA requested that ATSDR support an action level for clean up of arsenic-contaminated soils at the site. ATSDR supported EPA's action level of 30 mg/kg for arsenic in residential soils. ATSDR also recommended that EPA considered additional soil characterization of residential soils at the site and surrounding areas to determine if contaminants from the former pesticide facility were dumped onto adjoining lots, released from the facility, or the migration of contaminated dust occurred [14].

3. PADOH has met with some homeowners regarding following the manufacturer recommendations regarding the maintenance of their in-line sediment filters on their private wells. PADOH will continue to carryout out these suggestions through community fact sheets and a public availability session.

Actions Taken

1. PADOH and ATSDR visited the site area and vicinity, and met with residents individually on April 21, 2008 during the public comment period of the PHA. Residents not home during the site visit were mailed a copy of the PHA along with a fact sheet and contact information for any questions and concerns. PADOH provided health education through fact sheets and met

with residents in the community to assist residents in mitigating exposure to current site contamination and to answer questions in regards to past exposures to contamination at the site.

2. Ryeland Road Fact Sheets, the Ryeland Road Aresenic Site PHA, and contact information were distributed to Womelsdorf Borough and Heidelberg Township municipal buildings and the Womelsdorf Public Library for interested residents not living adjacent, next to, or in the immediate vicinity of the Ryeland Road Arsenic site.

On-going and Planned Actions

1. In March 2004, the Ryeland Road Arsenic Site was proposed to the NPL (Final in July 2004). To evaluate what remedial action(s), if any, may be appropriate at the Ryeland Road Arsenic Site, an RI/FS was initiated in the summer of 2004. PADOH reviewed this information and determined the public health significance of the data, and reported its findings in this public comment version of the PHA. PADOH made public health action recommendations, as necessary, in light of the degree of public health hazard posed by the existing environmental contamination.
2. The EPA has requested assistance from the United States Army Corps of Engineers regarding relocation benefits for several families as part of the proposed remediation at the site. As of the date of this PHA document, these families have moved to new homes and their previous homes have been demolished as part of site remediation activities.

PADOH and ATSDR will update this public health action plan for the Ryeland Road Arsenic Site as additional data or site conditions warrant.

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Certification

This Public Health Assessment for the Ryeland Road Arsenic site was prepared by the Pennsylvania Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the letter health consultation was initiated. Editorial review was completed by the cooperative agreement partner.

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

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Alan Yarbrough

Team Leader, CAT, SPAB, DHAC, ATSDR

FIGURES

Figure 1

Ryeland Road Arsenic Site Location Map
Heidelberg Township, Berks County, Pennsylvania

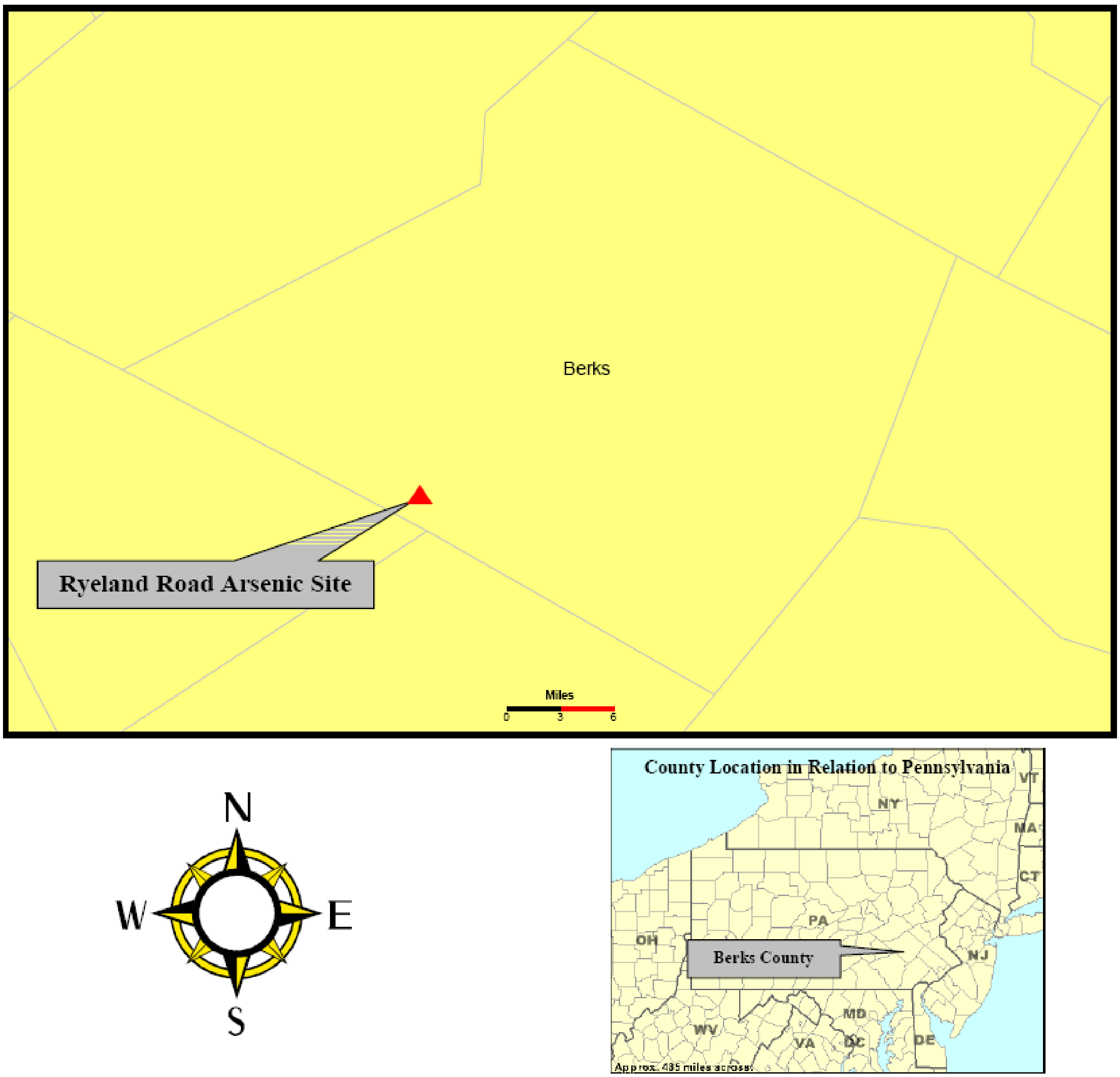
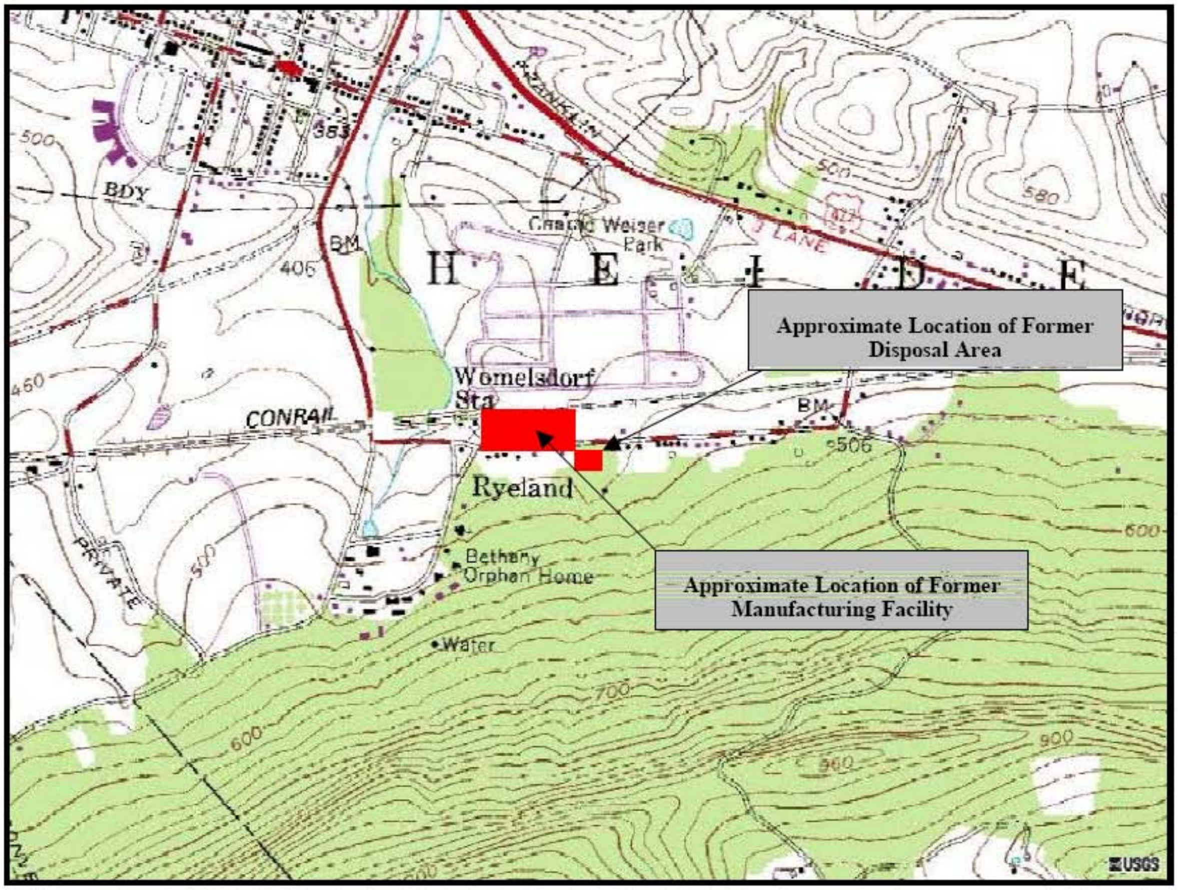


Figure 2

Ryeland Road Arsenic Site
USGS Topographic Map (July 1992)



= approximate site location

Scale: 1 inch = 0.25 mile

Figure 3

Ryeland Road Arsenic Site
USGS Aerial Photograph (April 1999)

= approximate site boundary

Scale: 1 inch = approximately 125 yards