



# Public Health Assessment for

**BARITE HILL/NEVADA GOLDFIELDS SITE  
McCORMICK, McCORMICK COUNTY, SOUTH CAROLINA  
EPA FACILITY ID: SCN000407714  
MAY 11, 2010**

For Public Comment

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

**Comment Period Ends:**

**JULY 12, 2010**

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release 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. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude 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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You May Contact ATSDR Toll Free at  
1-800-CDC-INFO or  
Visit our Home Page at: <http://www.atsdr.cdc.gov>

PUBLIC HEALTH ASSESSMENT

BARITE HILL/NEVADA GOLDFIELDS SITE

McCORMICK, McCORMICK COUNTY, SOUTH CAROLINA

EPA FACILITY ID: SCN000407714

Prepared by:

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

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# **STATEMENT OF ISSUES AND BACKGROUND**

## **Statement of Issues**

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment to evaluate, based on the information currently available, any known or potential adverse human health hazards related to exposures to chemicals at the Barite Hill/Nevada Goldfields Site. The site, primarily used for gold mining, is located in a remote, rural area of McCormick, South Carolina.

The U.S. Environmental Protection Agency (EPA) proposed the Barite Hill/Nevada Goldfields Site to its National Priorities List (NPL) of hazardous waste sites in September 2008. The site was officially listed on the NPL in April 2009. The NPL is part of the EPA Superfund cleanup process and is primarily intended to guide EPA in determining the hazardous waste sites that warrant further investigation and possible clean-up. ATSDR has become involved with the Barite Hill/Nevada Goldfields Site because Congress mandates that ATSDR conduct public health activities at Superfund sites that EPA proposes to its NPL.

## **Background**

The Barite Hill/Nevada Goldfields Site (referred to in this document as the Barite Hill Site) is located approximately 3 miles southwest of the town of McCormick, South Carolina. Three highways near the site include Highway S-33-30, Highway S-33-34, and Highway S-33-248. The site covers about 795 acres. Mining operations encompassed approximately 135 acres, and the remaining 660 acres served as a buffer zone to not be disturbed beyond their natural state (1). The area surrounding the site is rural, undeveloped, and sparsely populated.

A private groundwater well survey conducted in 2004, indicated that no wells were identified in the immediate area of the site. Only one distant private well was located within 2.5 miles of the site. Homes and businesses in the vicinity of the site receive their drinking water from a public (or municipal) water supply. No public supply wells were located within in 4-mile radius of the Barite Hill Site (1).

Access to the site is restricted by fences, two gates, and natural barriers. However, there has been evidence of the occasional trespasser that may access the site on all terrain vehicles. People also stated they frequently used the property for recreational activities when they were questioned about their activities at the site by EPA (2).

Fishing occurs where Hawe Creek enters Strom Thurmond Lake about 2.2 miles downstream of the Barite Hill Site. According to an EPA report, fish species caught in the area include striped and largemouth bass and flathead catfish. Information on the amount of fish caught on an annual basis was unavailable (2).

The Barite Hill Site was previously owned by Nevada Goldfields, Inc. who operated a gold mining business on the property. The site was actively mined from 1991 to 1995. Some records indicate that minimal silver mining was also conducted at the site. From 1995 until Nevada Goldfields, Inc. filed for Chapter 7 Bankruptcy in 1999, the reclamation of the site was being addressed by Nevada Goldfields, Inc. On July 7, 1999, Nevada Goldfields, Inc. handed the keys to the facility over to the South Carolina Department of Health and Environmental Control (SCDHEC) and abandoned the site (3).

Operations at the site involved the use of a cyanide solution in a heap leach process to extract gold from ore using conventional open pit methods. Fractured rock was crushed into smaller pieces and a dilute cyanide solution was then sprayed over the rock heaps and allowed to percolate thorough the ore which dissolved the gold from the rock and into the solution. The gold-bearing solution (also referred to as pregnant solution) was drained from the heaps and sent to an on-site process plant. At the processing plant, gold recovery from the process solution began by the adsorption of the dissolved gold onto activated carbon and then stripped to collect the gold (3).

The site consisted of two open mine pits: the 17-acre Main Pit (located in the northeastern part of the site) and the 4-acre Rainsford Pit (located in the southwest portion of the site). A reusable heap leach facility consisting of an asphalt-lined leach pad, a permanent leach pad, eight ponds, two waste disposal areas, and diversion ditches were used during operations and are present at the site (2). A site map detailing the various areas of the site is located in Figure 1. When the mine was abandoned, the Main Pit flooded. The waste rock stockpiles previously surrounding the eastern and southeastern portions of the Main Pit were a source of acid rock drainage. The Main Pit contains approximately 60 million gallons of water with a historical pH of approximately 2 and a high dissolved metal content (4). Seeps from the Main Pit containing acidic water and dissolved metals have been released to the northern unnamed tributaries of Hawe Creek which borders the pit, depicted as Previous Outfall 3 on Figure 1 (3).

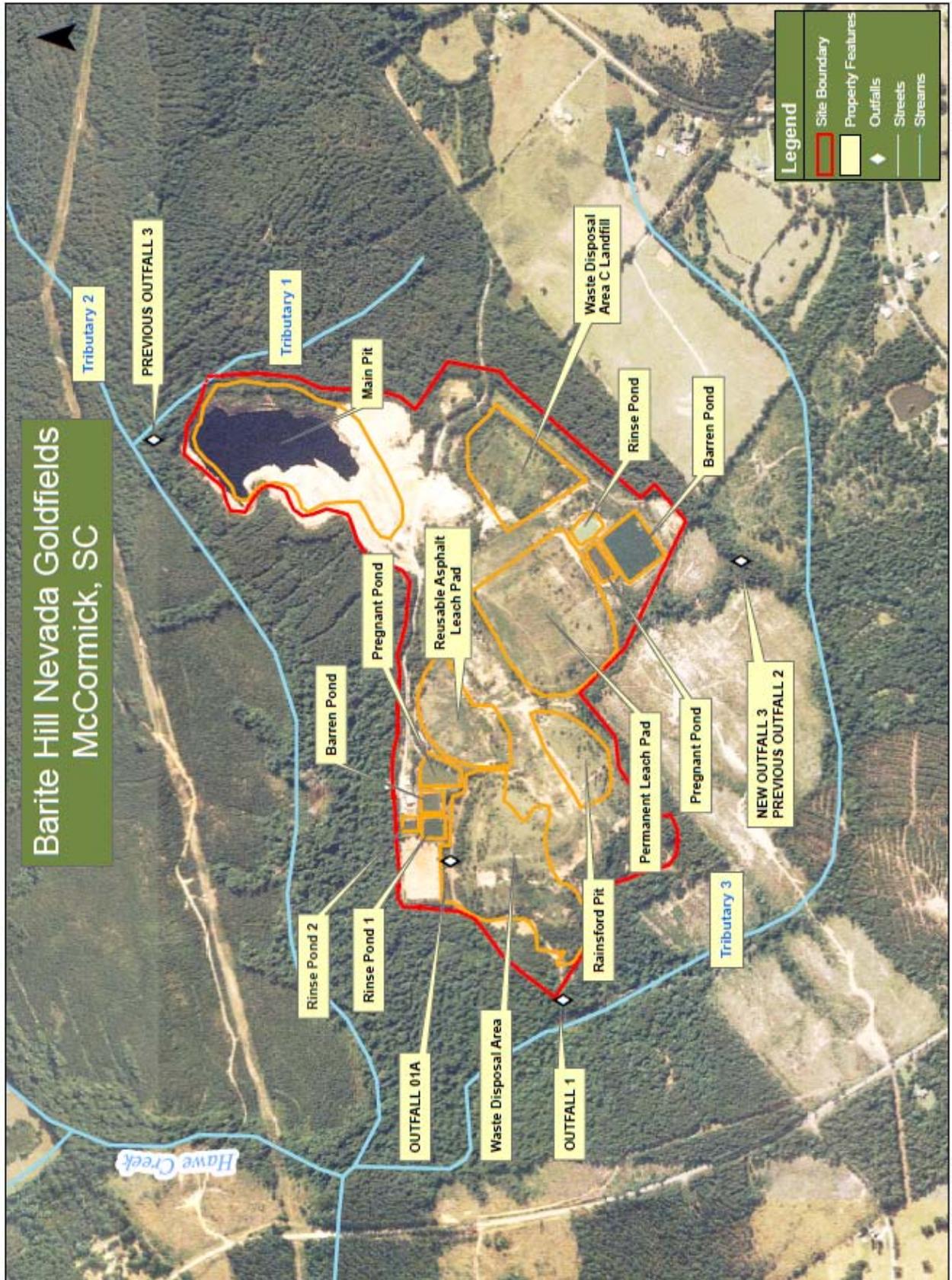


FIGURE 1: SITE MAP

## **Land Use and Demographics**

According to U.S. 2000 Census data, only 17 people live within a half-mile radius while 218 people live within one mile of the site. Approximately 65% of the population within a half-mile (or 11 individuals) are black while 30% are white. Within one mile, 60% of the population is black and 40% of the population is white. While 89 housing units are located within a mile of the site, only 6 housing units are found within a half-mile of the site. Only two children aged 6 and under are located within a half-mile of the site. Approximately 25 children aged 6 and under are located within one mile of the site. Additional demographic information for the community in the vicinity of the site is presented in Figure 2.

## **Previous Investigations at the Barite Hill Site**

Before Nevada Goldfields, Inc. ceased reclamation activities at the site in July 1999, the water in the Main Pit was treated with lime to reduce the acidity (3).

In 2003, South Carolina Department of Health and Environmental Control (SCDHEC) visited the site and noticed a heavy sulfur odor at the main entrance continuing to the Main Pit area. Testing of the water in the Main Pit indicated a pH of approximately 2.0, considered to be highly acidic. Concerns at that time focused on the prevention of acid generation and run-off from the Main Pit to nearby tributaries and impacts to area groundwater (1).

In 2004, SCDHEC conducted additional activities including a Preliminary Assessment/Site Inspection (PA/SI) at the Barite Hill Site. Surface water and sediment samples were collected from on-site process ponds, the Main Pit, surrounding tributaries, and Hawe Creek. The sampling results indicated arsenic, barium, cadmium, copper, lead, and zinc in sediment samples collected from unnamed tributaries at concentrations three times or more greater than levels of metals that naturally occur in that area (also referred to as background levels). Barium, copper, and lead were detected in surface water from unnamed tributaries at concentrations three times or more greater than background levels. The PA/SI report identified several areas of concern at the site; however, the Main Pit was identified as the greatest potential for adverse impacts to groundwater and surface water (1).

Efforts continued at the site including a site reconnaissance in January 2007. During this effort by US EPA and SCDHEC, a seep from the northern side of the Main Pit was observed to be discharging to the northern unnamed tributary of Hawe Creek. This seep was found to contain high dissolved metal content and was highly acidic (2).

In March 2007, SCDHEC, EPA, and the Bureau of Reclamation conducted an environmental assessment of the site which resulted in an EPA emergency response which included the demolition of a furnace building and neutralization of over 2,000 pounds of acid-producing waste rock adjacent to the Main Pit.

In June 2007, EPA contractors conducted expanded site investigation (ESI) activities to further evaluate the condition of the surface water and sediment associated with the Barite Hill Site. This included the collection of samples from six on-site ponds, one on-site depression, Tributary 1, Tributary 2, Tributary 3, an unnamed tributary, and Hawe Creek. Tributaries 1,2, and 3 are unnamed tributaries of Hawe Creek. Conclusions of this work indicated that surface water and sediment from each of the surface water bodies sampled contain levels of cadmium, copper, lead, mercury, nickel, selenium, vanadium, zinc, and cyanide which may be of concern for ecological receptors (1). No specific human health conclusions were indicated in the document for these surface water bodies.

From October 2007 through October 2008, activities involved a cap for the waste rock, Main Pit neutralization, and cyanide deactivation in one of the on-site process ponds. Water in the Main Pit continues to be monitored on a monthly basis and treatment activities have been determined to be successful by EPA (5).

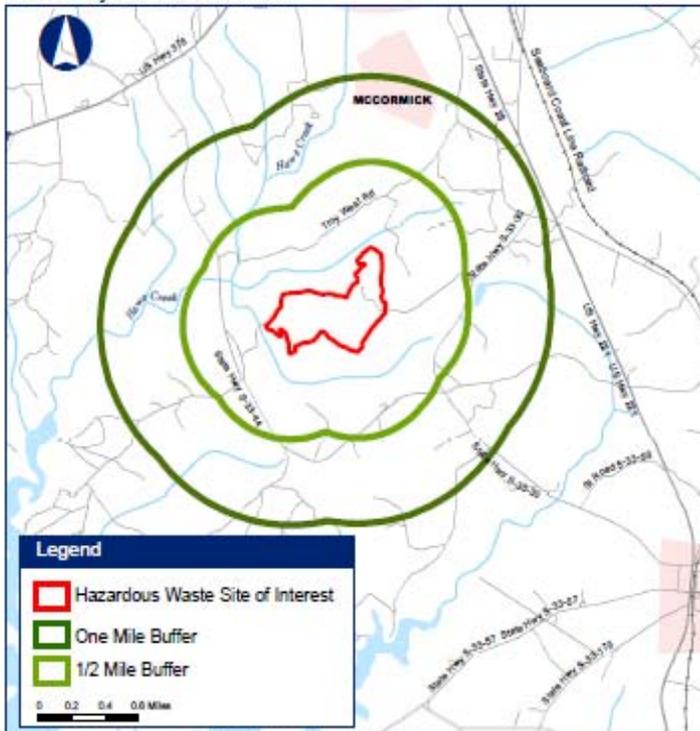
At this time, EPA continues its efforts at the Barite Hill Site and will collect additional environmental data during its Remedial Investigation which is part of the EPA Superfund process. More information on the EPA Superfund Process and their efforts at the Barite Hill Site can be found on the following EPA websites.

- Details on the EPA Superfund Process can be found at: <http://www.epa.gov/superfund/>
- Additional information on EPA's on-going efforts at the Barite Hill Site can be found at: <http://www.epa.gov/region4/waste/npl/nplsc/baritehillsc.html>

**Barite Hill/Nevada Goldfields  
McCormick, SC**



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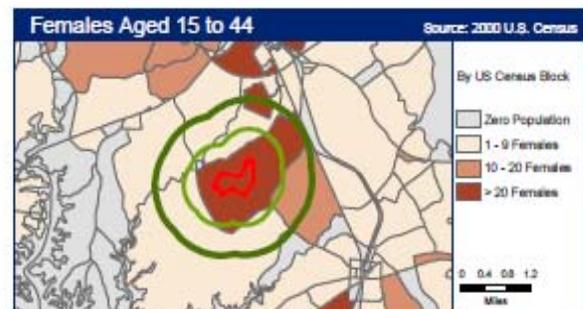
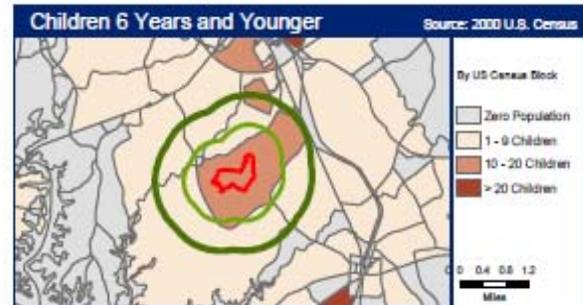
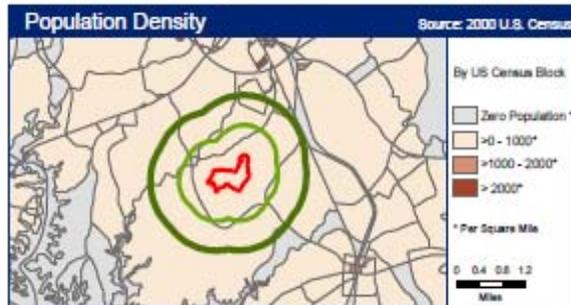


**Demographic Statistics  
Within Area of Concern\***

	1 mile	1/2 mile
Total Population	218	17
White Alone	86	5
Black Alone	130	11
Am. Indian & Alaska Native Alone	0	0
Asian Alone	1	0
Native Hawaiian & Other Pacific Islander Alone	0	0
Some Other Race Alone	0	0
Two or More Races	1	0
Hispanic or Latino**	0	0
Children Aged 6 and Younger	25	2
Adults Aged 65 & Older	32	2
Females Aged 15 to 44	48	4
Total Housing Units	89	6

Base Map Source: Geographic Data Technology, May 2005.  
 Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).  
 Coordinate System (All Panels): NAD 1983 StatePlane South Carolina FIPS 3900 Feet

Demographics Statistics Source: 2000 U.S. Census  
 \* Calculated using an area-proportion spatial analysis technique  
 \*\* People who identify their origin as Hispanic or Latino may be of any race.



\*project=00415+&ac=SC+&city=McCormick County, SC+&keywords=SCN000407714, Barite, Hill



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Figure 2

## **ENVIRONMENTAL DATA CONSIDERED**

As part of this public health assessment, ATSDR considered environmental samples collected from: (1) on-site ponds, nearby tributaries, and Hawe Creek; as well as (2) the Main Pit.

- ATSDR considered the surface water and sediment samples collected by U.S. EPA in June 2007 during expanded site investigation (ESI) activities. Samples collected from six on-site ponds, Tributary 1, Tributary 2, Tributary 3, an unnamed tributary, and Hawe Creek have been reviewed by ATSDR as part of this PHA (1). Upon review of the 2007 ESI data and site conditions, it has been determined by ATSDR that people are not likely to come in contact with the chemicals in these areas during swimming. Therefore, these areas are not further evaluated in this public health assessment. A detailed discussion of ATSDR's rationale is presented in the Pathway Analysis section of this public health assessment.
- ATSDR also considered surface water samples collected from the Main Pit area during 16 sampling events conducted by U.S. EPA from October 2007 through November 2009 (4). Although exposure to surface water in the Main Pit is unlikely, ATSDR has determined that it is possible for people to have come in contact with chemicals in this area. Therefore, the remainder of this public health assessment focuses on evaluating environmental samples collected from the Main Pit.

EPA is currently in the process of collecting additional environmental samples to better understand the surface water, soil, sediment, and groundwater conditions at the site. These data will be summarized in the Remedial Investigation for this site. When available, ATSDR will review the new information and prepare additional public health assessments, as necessary.

## **PATHWAY ANALYSIS**

ATSDR's pathway analysis determines whether people have come into contact with chemicals from a site and whether these contacts were substantial enough to cause harm. The purpose of ATSDR's Pathway Analysis is to focus the public health assessment on the areas of the site that contain chemicals that people may come into contact with based on the environmental information available from EPA. To make this determination, ATSDR identifies exposure pathways or ways in which chemicals associated with the site could enter a person's body.

As outlined in ATSDR's Public Health Assessment Guidance Manual, an exposure pathway contains five major elements:

1. a source of contamination,
2. transport through an environmental medium,
3. a point of exposure,
4. a route of exposure, and
5. an exposed population.

If an exposure pathway contains all five elements and exists now or existed in the past the pathway is considered complete. Completed exposure pathways are evaluated further by ATSDR to determine whether health effects could occur. A potential exposure pathway exists if information on one or more of the five elements is missing or unknown, but exposures may have occurred, are currently occurring, or could occur in the future. An exposure pathway is considered incomplete and is eliminated from further evaluation when one of the five elements is known to be absent (6). As EPA activities continue and more data becomes available, ATSDR will prepare additional public health assessments for identified completed and potentially completed exposure pathways, as necessary.

#### Drinking Water Exposure Pathway

Homes and businesses in the vicinity of the site receive their drinking water from a public water supply which is monitored routinely to ensure that chemicals do not exceed health-based standards. It is important to understand how site conditions may affect any private well users in communities impacted by hazardous waste sites as private wells are not routinely monitored by the local municipality and testing is the responsibility of the home owner in most cases. A private drinking water well survey was conducted in 2004 that indicated that no wells were identified in the immediate area of the site. Only one distant private well was located within 2.5 miles of the site. In addition, no public supply wells are located within in 4-mile radius of the Barite Hill Site (1). ATSDR considered this information and determined that the private well exposure pathway is incomplete, based on the available information and requires no further evaluation at this time.

#### Surface Soil Exposure Pathway

ATSDR is aware that individuals (likely teenagers) have been reportedly using all-terrain vehicles (or four-wheelers) on the site. Future data collected from EPA is expected to provide ATSDR with the information needed to evaluate the health implications for people who may be exposed to chemicals in dust and soil while riding all-terrain vehicles on the site. Site trespassers also may access the site and walk around on the property (i.e., hiking). Until adequate surface soil data is available from EPA, this pathway is considered a potential exposure pathway which cannot be further evaluated at this time.

## Surface Water and Sediment from Tributaries and Hawe Creek Exposure Pathway

ATSDR considered the available surface water and sediment data from Tributaries 1, 2, and 3 as well as Hawe Creek as part of this public health assessment. Although some samples collected from these surface water areas have been found to contain metal concentrations in excess of normal background and of ecological concern, these surface water bodies are located in extremely remote areas and people do not routinely come into contact with the surface water or sediment in these areas. According to water measurements provided by the SCDHEC, the water levels have ranged from 0.3 feet to approximately 3.2 feet which makes the conditions unlikely for frequent swimming. A beautiful recreational area is located within 2 miles of the sites at Strom Thurmond Lake. ATSDR has received several reports from residents and local government officials indicating that people would be unlikely to swim, wade or fish in the areas near the Barite Hill Site and would instead utilize the nearby Strom Thurmond Lake for these types of recreational activities.

The remote areas of Tributaries 1,2, 3 and Hawe Creek, as well as their shallow depth, do not make these areas likely places for people to access for swimming or other recreational activities. Therefore, ATSDR has determined this exposure pathway to be incomplete at this time. If additional information becomes available to ATSDR which change the assumptions of this assessment, further consideration of this pathway by ATSDR will be necessary.

Fish Ingestion Pathway: Some areas of surface water in the vicinity of the Barite Hill Site have been impacted by site activities. In particular, surface water in tributaries near the Main Pit has been found to have high acidity as well as concentrations of metals that are higher than normal background levels. At this time, the impacts to fish and other ecological implications are being considered by the EPA as part of their Remedial Investigation efforts. While people have not reportedly fished in the surface water on or very near the site, the nearby tributaries connect with Hawe Creek which enters Strom Thurmond Lake approximately 2 miles downstream. People have been known to fish recreationally in Hawe Creek as well as Strom Thurmond Lake. ATSDR does not have the information needed to evaluate possible impact to humans from consuming fish caught in surface water that has been impacted by the site. ATSDR will review and evaluate fish tissue data that is collected by EPA at the site as necessary.

Surface Water from the Main Pit Exposure Pathway: ATSDR has identified surface water from the Main Pit area as the one completed exposure pathways for the Barite Hill Site, based on the environmental data available at this time. While the site is fenced and located in a very remote location, there is evidence that people access the site. The water in the Main Pit area is deep enough to support swimming activities although ATSDR has not received any reports of people swimming there. However, ATSDR has applied a very health-protective approach and evaluates the rare occasion of a site trespasser swimming in the Main Pit in this public health assessment. These hypothetical individuals may be exposed to chemicals in surface water in the Main Pit through incidental (or accidental) exposure and direct skin contact during swimming.

## DISCUSSION

The first step in ATSDR's evaluation process is to select the chemicals of concern, also described as the chemicals that require further evaluation. ATSDR selects chemicals of concern on the basis of whether the maximum detected concentrations of the chemical are found to exceed applicable, health-based comparison values. Here are some important factors to understand about ATSDR's comparison values.

- Chemicals found at levels below the health-based comparison value are not expected to result in health effects.
- Chemicals found at levels that exceed a comparison value indicate that a more detailed analysis is necessary for that chemical.
- Levels of chemicals greater than comparison values do not necessarily mean that adverse health effects will occur. The amount of the chemical, the duration of exposure, the route of exposure (i.e., ingestion, inhalation, and direct skin contact), and the health status of exposed individuals are also important factors in determining the potential for adverse health effects.
- When concentrations of a chemical exceed comparison values, a more detailed assessment of the site-specific exposure factors is necessary to understand if health effects are expected for a particular community.

A complete discussion of ATSDR's evaluation process for chemicals that exceed health-based comparison values is presented in Appendix A of this public health assessment.

ATSDR has evaluated the available surface water data from the Barite Hill Main Pit as part of this public health assessment. Exposures that may occur during swimming include accidentally ingesting a small quantity of water as well as direct skin contact. ATSDR does not have health-based comparison values for surface water, therefore, the available drinking water comparison values have been used. Comparison values developed for drinking water exposures were used in this evaluation as ATSDR has not developed comparison values specifically for direct skin (also referred to as dermal contact). Typical swimming activities are expected to result in a very small amount of water being consumed in comparison to the amount of water that a person might drink each day from their homes. Therefore, ATSDR's approach is considered very protective of human health.

ATSDR has performed two drinking water comparisons to evaluate the conditions of the surface water in the Main Pit. First, ATSDR compared the surface water metals concentrations in the Main Pit before any treatment of the site began. These levels were reported during sampling of the Main Pit in October 2007 and are presented in Table 1. The second comparison performed by ATSDR considered the highest levels of metals detected after the treatment for high acidity began. These values are reported in Table 2 and are based on data collected during 16 sampling events from June 2008 to November 2009.

**Table 1. Surface Water Samples Before Treatment for High Acidity: Comparison of metal concentrations in the Main Pit Area with Health-Based Comparison Values**

Chemical	October 2007 Sampling (mg/L) Pre-treatment	Drinking Water Comparison Value (mg/L)	Exceeds Drinking Water Comparison Value?
Aluminum	224	1,000 (Chronic EMEG) <sup>1</sup>	No
Antimony	0.02	4 (RMEG) <sup>2</sup>	No
<b>Arsenic</b>	<b>0.968</b>	<b>0.02 (CREG)<sup>3</sup></b>	<b>Yes</b>
<b>Cadmium</b>	<b>1.57</b>	<b>1 (Chronic EMEG)<sup>1</sup></b>	<b>Yes</b>
Chromium	0.141	100 (EPA MCL) <sup>4</sup>	No
<b>Copper</b>	<b>287</b>	<b>100 (Inter. EMEG)<sup>5</sup></b>	<b>Yes</b>
Iron	1,150	NA-Essential Nutrient	NA
Lead	0.161	15 (EPA Action Level) <sup>6</sup>	No
Manganese	13.6	500 (RMEG) <sup>2</sup>	No
Nickel	0.404	200 (RMEG) <sup>2</sup>	No
Selenium	0.23	50 (Chronic EMEG) <sup>1</sup>	No
Zinc	40.2	3,000 (Chronic EMEG) <sup>1</sup>	No

NA – Not Available

Bolded information indicates that the health-based drinking water comparison value has been exceeded.

<sup>1</sup>Chronic Environmental Media Evaluation Guides (or Chronic EMEGs) are comparison concentrations below which adverse non-cancer health effects are not expected from long-term (over one year) exposure. These values are derived by ATSDR from its toxicological profiles.

<sup>2</sup>Reference Media Evaluation Guides (or RMEGs) are comparison concentrations below which adverse non-cancer health effects are not expected to occur. These values are derived from EPA’s Oral Reference Doses (or RfDs).

<sup>3</sup>Cancer Risk Guides (or CREGs) are comparison concentration that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

<sup>4</sup>EPA Maximum Contaminant Level (or EPA MCL) is the highest concentration of a chemical that is allowed in a public drinking water supply to ensure that long-term and short-term health effects are not posed from exposure. EPA also considered factors such as economical and technological feasibility when setting these values.

<sup>5</sup>Intermediate Environmental Media Evaluation Guide (or Inter. Chronic EMEG) is a comparison concentration below which adverse non-cancer health effects are not expected from intermediate exposures (15-365 days). These values are derived by ATSDR from its toxicological profiles.

<sup>6</sup> EPA Action Level is the level of a chemical which, if exceeded, triggers water system treatment or other requirements.

**Table 2. Surface Water Samples Following the Start of Treatment for High Acidity: Comparison of maximum detected metal concentrations in the Main Pit Area with Health-Based Comparison Values. Data from 15 Sampling Events (June 2008 – November 2009)**

Chemical	Maximum Detected Concentration (mg/L)	Drinking Water Comparison Value (mg/L)	Exceeds Drinking Water Comparison Value?
Aluminum	0.622	1,000 (Chronic EMEG) <sup>1</sup>	No
Antimony	0.257	4 (RMEG) <sup>2</sup>	No
Arsenic	Not detected	0.02 (CREG) <sup>3</sup>	No
Cadmium	Not detected	1 (Chronic EMEG) <sup>1</sup>	No
Chromium	0.0015	100 (EPA MCL) <sup>4</sup>	No
Copper	0.145	100 (Inter. EMEG) <sup>5</sup>	No
Iron	309	NA-Essential Nutrient	NA
Lead	0.0427	15 (EPA Action Level) <sup>6</sup>	No
Manganese	11.7	500 (RMEG) <sup>2</sup>	No
Nickel	0.163	200 (RMEG) <sup>2</sup>	No
Selenium	0.028	50 (Chronic EMEG) <sup>1</sup>	No
Zinc	1.44	3,000 (Chronic EMEG) <sup>1</sup>	No

NA – Not Available

\*Maximum detected concentrations based on the results of the following 15 sampling events: June 2008, July 2008, August 2008, November 2008 (2 events), December 2008, January 2009, February 2009, April 2009, May 2009, June 2009, July 2009, August 2009, September 2009, and November 2009.

<sup>1</sup>Chronic Environmental Media Evaluation Guides (or Chronic EMEGs) are comparison concentrations below which adverse non-cancer health effects are not expected from long-term (over one year) exposure. These values are derived by ATSDR from its toxicological profiles.

<sup>2</sup> Reference Media Evaluation Guides (or RMEGs) are comparison concentrations below which adverse non-cancer health effects are not expected to occur. These values are derived from EPA's Oral Reference Doses (or RfDs).

<sup>3</sup>Cancer Risk Guides (or CREGs) are comparison concentration that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

<sup>4</sup>EPA Maximum Contaminant Level (or EPA MCL) is the highest concentration of a chemical that is allowed in a public drinking water supply to ensure that long-term and short-term health effects are not posed from exposure. EPA also considered factors such as economical and technological feasibility when setting these values.

<sup>5</sup>Intermediate Environmental Media Evaluation Guide (or Inter. Chronic EMEG) is a comparison concentration below which adverse non-cancer health effects are not expected from intermediate exposures (15-365 days). These values are derived by ATSDR from its toxicological profiles.

<sup>6</sup> EPA Action Level is the level of a chemical which, if exceeded, triggers water system treatment or other requirements.

The term pH indicates the acidity or alkalinity of a solution on a scale ranging from approximately 0 to 14. As a frame of reference, pure water has a pH of approximately 7. When an acid is dissolved in water the pH will be less than 7 (or acidic) and when a base (or alkali) is dissolved in water the pH will be greater than 7. Table 3 presents a summary of the available pH readings from surface water in the the Main Pit from July 2007 to September 2009 (4,7). Table 3 also presents common products with similar pH as a frame of reference. While serious health problems are not likely to be associated with contact with the pH levels measured at the site, irritation to skin and eyes may be possible at acidic pH levels.

**Table 3. Historical Main Pit pH Readings (July 2007-September 2009) and Common Products with Similar pH**

Reading Date	pH at 1 meter from surface	pH at 2 meters from surface	Common Products with Similar pH
July 2007	2.4	NA	Vinegar
November 2008	4.4	4.6	Tomato Juice
December 2008	4.9	5.0	Tomato Juice
April 2009	5.1	5.2	Coffee
May 2009	3.1	5.1	Orange Juice/Coffee
June 2009	5.2	5.2	Coffee
July 2009	8.6	8.4	Sea Water
August 2009	6.0	6.0	Milk
September 2009	6.1	6.0	Milk

NA-Not available.

Note: All readings, with the exception of July 2007, are referenced in November 2009 letter report. The July 2007 reading was indicated in the July 5, 2007 letter report to EPA from the South Carolina Department of Health and Environmental Control (7). Common product pH information was indicated at:

<http://disc.sci.gsfc.nasa.gov/oceancolor/additional/science-focus/locus/images/phscale.gif>

Before treatment of the Main Pit water for high acidity, levels of three metals were found at concentrations that exceed drinking water comparison values: arsenic, cadmium, and copper (Table 1). After the start of treatment of the Main Pit, concentrations of metals in the water decreased significantly. In the following 15 sampling events, conducted from June 2008 to November 2009, levels of arsenic, cadmium, and copper did not exceed comparison values during any sampling event (Table 2). In addition, no other metals were found in surface water in the Main Pit at levels above drinking water comparison values once treatment started. A historical evaluation of the pH in the Main Pit indicates that the pH of the water was increased (indicating decreasing acid content) as a result of

treatment (Table 3). It appears that the treatment of water for acidity has also significantly reduced the concentrations of dissolved metals in the water of the Main Pit.

Many physical hazards exist at the site and people are urged not to trespass on site property. While trespassing and swimming in the Main Pit water is illegal and not recommended, the current conditions of the water do not pose a public health hazard to those who may come in contact with surface water in this area of the site. To consider the possibility for health effects to people who swam in the Main Pit water before its treatment began, ATSDR performed an assessment of people exposed to levels of arsenic, cadmium, and copper in the Main Pit based on October 2007 sampling results.

## **PUBLIC HEALTH IMPLICATIONS**

For chemical concentrations found to exceed comparison values, ATSDR performed calculations referred to as exposure doses to assess non-cancer health impacts as well as cancer risk estimates. These calculations estimate the amount of the chemicals of concern that individuals may be exposed to and the likelihood of cancer and non-cancer health impacts. The calculations are based on the types of site-specific activities that individuals may be involved with that result in contact with chemicals in the surface soil. In the event that calculated exposure doses exceed established health guidelines (e.g., ATSDR Minimal Risk Levels or EPA Reference Doses), an in-depth toxicological evaluation is the next step necessary to estimate the likelihood of health effects.

In the past, trespassers may have been exposed to chemicals in surface water in the Main Pit through accidental ingestion and possibility by direct skin contact. In order to evaluate these potential exposures, ATSDR considers the available site-specific information and makes assumptions about how much and how often people might be exposed to the chemicals found in the areas that they access.

For the Barite Hill Site, trespassers are considered to be young adults, aged 16 to 19 and weighing approximately 64 kilograms (or 140 pounds), who accessed the site in the past and swam in surface water from the Main Pit. ATSDR assumed that these persons swam for approximately 15 minutes at a time, two times per month during the five summer months of the year (or 10 days per year). The basis for the swim time of 15 minutes is that the water was found to be highly acidic during the period of time considered. The high acidity of the water may have caused irritation to skin and eyes that decreased the likelihood of a longer swimming duration. During the 15 minute swim time, individuals were assumed to accidentally drink 0.0125 liters of water from the Main Pit. Trespassers have been evaluated for a 10 year exposure duration. This is considered to be a highly conservative assumption, particularly if an individual had an early irritation reaction from swimming in the water making them less likely to swim in the Main Pit again. Upon closer review of the site conditions, ATSDR has not calculated exposure doses for direct skin exposure. The swim duration was likely to be very short and metals are not easily

absorbed into the skin. Therefore, the ingestion of water was the primary exposure route considered by ATSDR in the remainder of this public health assessment.

Additional specific information on the exposure scenarios, assumptions and calculations used to estimate exposures to chemicals in surface water in the Main Pit are discussed in Appendix A of this public health assessment.

As previously discussed, arsenic, cadmium, and copper in Main Pit surface water were the focus on ATSDR's evaluation because they were found at levels that exceed comparison values. Therefore, a complete assessment of these chemical's potential to cause both cancer and non-cancer health effects has been conducted in this public health assessment.

**Non-cancer Effects Evaluation:** ATSDR calculated exposure doses for the chemicals (arsenic, cadmium, and copper) detected in surface water to determine the potential for non-cancer health effects from ingestion. Exposure doses are expressed in units of milligrams per kilograms per day (mg/kg/day). The calculated exposure doses were compared with health-based guidelines, when available. Calculated exposure doses below health guidelines indicate that health effects are not expected. When calculated exposure doses for a particular chemical exceed the health-based guidelines (ATSDR Minimal Risk Levels or EPA Reference Doses), it does not necessarily indicate that health effects will occur. Instead, a more in-depth look at the toxicological data available for the chemical is needed to fully evaluate this exposure. ATSDR's guidelines are described in more detail in Appendix A of this public health assessment.

### **Arsenic Evaluation**

General Information - Arsenic is a naturally occurring element that is widely found in the earth's crust. It has also been used historically in many pesticides. Fish and shellfish can accumulate arsenic. However, most of the arsenic in fish is in a form that is found to be much less toxic than other arsenic forms in the environment. Ingesting arsenic is associated with gastrointestinal effects and disruptions in blood cell production. Long-term exposure to arsenic through ingestion is also associated with a pattern of skin changes as well as an increased risk for liver, bladder, and lung cancers (8).

Arsenic in Main Pit at Barite Hill Site - The calculated exposure dose for ingestion of arsenic for trespassers while swimming is 0.000006 mg/kg/day, which does not exceed the selected health guideline of ATSDR's Oral Chronic Minimal Risk Level and EPA's Reference Dose of 0.0003 mg/kg/day. The dose of arsenic associated with site exposures is significantly lower than those associated with health impacts noted in the available scientific literature.

Therefore, past infrequent swimming (10 days per year) in the Main Pit surface water is not expected to result in non-cancer health effects.

### **Cadmium Evaluation**

General Information – Cadmium is a naturally occurring element that is found widely in soils and rocks. Cadmium does not corrode easily and has many uses, including batteries, pigments, metals coatings, and plastics. It is possible for cadmium to be taken up by fish, plants, and animals in the environment. Long-term exposure to cadmium in air, food, or water has been associated with kidney disease, as well as lung damage and fragile bones. Inhalation of cadmium has been associated with cancer; however, ingestion of cadmium has not been determined to cause cancer (9).

Cadmium in Main Pit at Barite Hill Site - The calculated exposure dose for ingestion of cadmium for trespassers while swimming is 0.000009 mg/kg/day, which does not exceed the selected health guideline of ATSDR's Oral Chronic Minimal Risk Level and EPA's Reference Dose of 0.0005 mg/kg/day. The dose of cadmium associated with site exposures is significantly lower than those associated with health impacts noted in the available scientific literature. Therefore, past infrequent swimming (10 days per year) in the Main Pit surface water is not expected to result in non-cancer health effects.

### **Copper Evaluation**

General Information – Copper is a metal that occurs naturally in the environment and also in plants and animals. Low levels of copper are essential for maintaining good health. Copper is used to make many different kinds of products like wire, plumbing pipes, and sheet metal. It is also used for mildew treatment and as a preservative for wood, leather, and fabrics. Ingestion of high levels of copper has been associated with damage to the liver and kidneys. According to the available scientific literature, copper exposure has not been associated with cancer (10).

Copper in Main Pit at Barite Hill Site - The calculated exposure dose for ingestion of copper for trespassers while swimming is 0.002 mg/kg/day, which does not exceed the selected health guideline of ATSDR's Oral Intermediate Minimal Risk Level of 0.010 mg/kg/day. The dose of copper associated with site exposures is significantly lower than those associated with health impacts noted in the available scientific literature. Therefore, past infrequent swimming (10 days per year) in the Main Pit surface water is not expected to result in non-cancer health effects.

*In conclusion, ATSDR has determined that adverse non-cancer health effects are not likely to have occurred to trespassers who swam in the Main Pit water at the Barite Hill Site in the past. A summary of the calculated non-cancer evaluation is presented below in Table 4.*

**Table 4. Summary of Non-Cancer Health Effects Evaluation**

Chemical	Ingestion Dose (mg/kg/day)	Oral Health Guideline (mg/kg/day)	Exceeds Oral Health Guideline?	Further Evaluation by ATSDR?	Conclusion: Are non-cancer health effects expected?
Arsenic	0.000006	0.0003	No	No	No
Cadmium	0.000009	0.0005	No	No	No
Copper	0.002	0.01	No	No	No

mg/kg/day – milligram per kilogram per day

**Cancer Evaluation:** The available scientific literature does not indicate cancerous health effects from exposure to cadmium or copper from the ingestion route. Therefore, a cancer assessment of Barite Hill Site trespassers has not been conducted for cadmium and copper. A review of the toxicological studies of arsenic indicate that exposure may be associated with cancerous effects in human and animal studies. Therefore, ATSDR evaluated the cancer risk associated with arsenic exposure. ATSDR considers similar exposure assumptions as it did for calculating non-cancer exposure doses. However, EPA’s cancer slope factors were applied to the calculated exposure doses to estimate the likelihood of an increased cancer risk (11). Cancer risk estimates are expressed as the risk of an individual developing cancer over his or her lifetime. It should be noted that an increased cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime during his or her lifetime following exposure to a particular chemical. The recommendations of many scientists, including ATSDR and EPA, has been that an increased lifetime cancer risk of one in one million ( $1 \times 10^{-6}$ ) or less is generally considered an insignificant increase in cancer risk. Cancer risk less than 1 in 10,000 (or  $1 \times 10^{-4}$ ) is not typically considered a health concern. Cancer risk greater than 1 in 10,000 may pose a significant concern regarding cancerous effects.

ATSDR’s evaluation of cancer risk indicates that ingestion of arsenic during swimming poses an insignificant increased risk for cancer. Numerically, the calculated cancer risk

was estimated to be 1 extra cancer cases per million people exposed (or  $1.2 \times 10^{-6}$ ), which is considered to be very low and is not at levels of public health concern.

*In conclusion, ATSDR has determined that cancer resulting from swimming in the Main Pit at the Barite Hill Site is highly unlikely to have occurred. A summary of the calculated cancer evaluation is presented below in Table 5.*

**Table 5. Summary of Cancer Evaluation**

Chemical	Ingestion Dose (mg/kg/day)	Selected Cancer Slope Factor <sup>(a)</sup> (mg/kg/day) <sup>-1</sup>	Calculated Increased Cancer Risk	Exceeds Suggested Risk Range ( $1 \times 10^{-6}$ to $1 \times 10^{-4}$ ) <sup>(b)?</sup>	<b>Conclusion:</b> Is cancer expected from exposure?
Arsenic	$8.3 \times 10^{-7}$	1.5	$1.2 \times 10^{-6}$	No	No
Cadmium	NA	NA	NA	NA	No
Copper	NA	NA	NA	NA	No

NA – Not Available

mg/kg/day – milligram per kilogram per day

(a) Cancer slope factors are available on the EPA Integrated Risk Information System at <http://www.epa.gov/iris>.

(b) EPA Risk Assessment for Superfund (RAGS). (EPA, December 1989)

## **ATSDR's Community Health Concerns**

ATSDR carefully considers community members' health concerns that relate to a particular hazardous waste site as part of its public health assessment process. On June 23, 2009, environmental scientists and community specialists from ATSDR visited the McCormick community to conduct a site visit and a public availability session. During the site visit, ATSDR was provided with a walk-through of the site property by EPA in order to gain a better understanding of the impacted areas and the possible ways that people may come in contact with them. ATSDR also took a tour around the neighboring community.

On the evening of June 23, 2009 from 5pm to 7pm, ATSDR held a public availability session at the McCormick High School located at 516 Mims Drive in McCormick. ATSDR mailed a flyer announcing the meeting to the local churches, library, schools, colleges, daycare facilities, as well as the local hospital and medical offices. The Mayor and city council members were also provided with the flyer via e-mail or direct mail. In addition, a press release was issued to local newspapers and radio stations to announce ATSDR's public availability session.

Community input helps ATSDR to create reports that accurately reflect how people in this community may have come into contact with chemicals from the site. Community feedback can also help ATSDR to understand individual health concerns as they relate to the site. The public availability session format offered community members an opportunity to meet with ATSDR representatives one-on-one to discuss their personal health concerns related to the site. All conversations were kept confidential. ATSDR also provided a brief overview of the public health assessment process at the session. Approximately 11 community members attended the public availability session.

Through discussions with people in the community, ATSDR did not record any specific health concerns that people had regarding the site. Instead, those in attendance were more interested in who ATSDR was and what they could expect from our efforts. In response, ATSDR provided an overview of our public health assessment process and encouraged community members to contact ATSDR Barite Hill Site Team members if any health concerns should arise in the future.

## **Child Health Considerations**

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposures to hazardous substances. Children play outdoors and typically engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

On the basis of the site-specific evaluation conducted in this public health assessment, ATSDR has determined that children are not known to come in contact with chemicals at the site. The site is located in a very remote location that is not easily accessible. Children would not be able to access the site on their own. The site is currently fenced and posted for no trespassing for the community. Parents are not expected to bring their children to the site to swim or play, based on the information available to ATSDR.

## Conclusions & Public Health Action Plan

In the McCormick community, ATSDR's purpose is to serve the public using the best science, taking responsive public health actions, and providing trusted health information to prevent people from coming into contact with harmful substances. ATSDR's top priority is to ensure that the community has the best information possible to safeguard its health. ATSDR has become involved with the Barite Hill/Nevada Goldfields Site because Congress mandates that ATSDR conduct public health activities at Superfund sites that EPA proposes to its NPL. The Barite Hill Site was proposed to EPA's NPL in September 2008 and officially listed in April 2009.

ATSDR prepared this public health assessment to evaluate, based on the information currently available, any known or potential adverse human health hazards related to exposures to chemicals at the Barite Hill Site. ATSDR has reached several important conclusions about the Barite Hill Site in McCormick, South Carolina. ATSDR also makes recommendations for additional information needed to make public health conclusions that cannot be made at this time, based on the available information.

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**Conclusion 1** Many physical hazards exist at the site and people are urged not to trespass on site property. While trespassing is illegal and not recommended, ATSDR concludes that swimming in the surface water of the Main Pit is not likely to cause serious health effects. Before treatment, the water was very acidic and may have caused some irritation of the skin and eyes.

**Basis** Prior to the start of treatment in 2008, people could have swallowed small amounts of water that contained dissolved metals while swimming. However, the amount of these chemicals that could have gotten into the body is very small and not at levels that would harm their health. The surface water was highly acidic before treatment and may have resulted in an irritation to the eyes and skin. However, long-term cancer and non-cancer health impacts are not expected from exposures occurring before treatment in 2008 or under current conditions in the Main Pit. At this time, the dissolved minerals, previously found in samples before treatment, are found at much lower levels and the water is no longer highly acidic. Therefore, no health effects are likely.

**Next steps** No public health actions are needed regarding the conditions of the surface water in the Main Pit. However, it is recommended that EPA consider posting "No Swimming" signage at the Main Pit.

<b>Conclusion 2</b>	ATSDR concludes that people are not likely to come in contact with metals in sediment and surface water in the tributaries surrounding the site (Tributaries 1, 2, and 3) or in Hawe Creek.
<b>Basis</b>	While some metals have been found in surface water and sediment, the remote locations of Tributaries 1,2, 3 and Hawe Creek, as well as their shallow depth do not make these likely places for people to swim or play resulting in frequent contact with these chemicals.
<b>Next Steps</b>	No public health actions are needed regarding people coming in contact with metals in surface water and sediment in Tributaries 1, 2, 3, and Hawe Creek. Please see Conclusion 5 for information on fish consumption from these surface water bodies.
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<b>Conclusion 3</b>	ATSDR concludes that people living near the site are not exposed to unacceptable levels of chemicals in their drinking water supply.
<b>Basis</b>	A well survey conducted by EPA indicated that there were no homes in the immediate vicinity of the site that had private wells used for drinking water. Homes in the area receive their drinking water from a public water supply system that is routinely tested to ensure it meets the requirements of the Safe Drinking Water Act.
<b>Next Steps</b>	No public health actions are needed regarding drinking water at homes in the vicinity of the site.
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<b>Conclusion 4</b>	ATSDR cannot currently conclude whether chemicals in surface soil could be harmful to people who trespass on the site.
<b>Basis</b>	ATSDR has received reports that trespassers have been known to use four-wheelers at the site. ATSDR does not have the information necessary to determine whether this activity could be harmful to people's health.
<b>Next Steps</b>	ATSDR will work with EPA to acquire information on the chemical levels found in the areas of the site where people have been known to use four-wheelers.

- Conclusion 5** ATSDR cannot currently conclude whether fish species, collected from Tributaries 1, 2, 3, and Hawe Creek, contain levels of metals that are of concern for public health to people who may eat them.
- Basis** ATSDR does not have fish tissue data available to evaluate at this time. However, it may be possible for some of the metals found in the tributaries and Hawe Creek to build up in some fish species over time.
- Next Steps** ATSDR recommends that EPA collect information regarding the fishing activities of the community, such as where people fish and if these areas are impacted, what fish species are consumed and how frequently they are eaten. This may also involve the collection of fish tissue data, if needed.

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Additional site-specific information, including environmental data, will become available from EPA in the future. ATSDR may evaluate this new information in supplemental public health documents, if this information changes the conclusions for the site.

## REFERENCES

1. Tetra Tech for the U.S. Environmental Protection Agency. Final Expanded Site Inspection Report. Barite Hill Nevada Goldfields, McCormick, South Carolina. March 25, 2008.
2. U.S. Environmental Protection Agency (EPA). Hazard Ranking System (HRS) Documentation Record. September 2008.
3. South Carolina Department of Health and Environmental Control (SCDHEC). Preliminary Assessment/Site Inspection. Barite Hill/Nevada Goldfields. December 15, 2006.
4. Oneida Total Integrated Enterprises (OTIE). Surface Water Sampling Letter Report to Leo Francendese, On-Scene Coordinator with the US Environmental Protection Agency. December 16, 2009.
5. U.S. Environmental Protection Agency. Pollution Report #18 (POLREP #18). October 15, 2007. Accessed on-line at:  
[http://www.epaosc.org/site/polrep\\_profile.aspx?site\\_id=2768&counter=9391](http://www.epaosc.org/site/polrep_profile.aspx?site_id=2768&counter=9391)
6. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: US Department of Health and Human Services. January 2005.
7. South Carolina Department of Health and Environmental Control (SCDHEC). Leo Francendese, On-Scene Coordinator with the US Environmental Protection Agency. July 5, 2007.
8. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic. Atlanta: US Department of Health and Human Services; August 2007.
9. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium. Atlanta: US Department of Health and Human Services; September 2008.
10. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Copper. Atlanta: US Department of Health and Human Services; September 2004.

11. U.S. Environmental Protection Agency. Website: Integrated Risk Information System (IRIS). Accessed May 8, 2008 on-line at: <http://www.epa.gov/iris>.

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## APPENDIX A - ATSDR's EVALUATION PROCESS

### Step 1 – Comparison Values and the Screening Process

To evaluate the available data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the chemical concentrations found in a specific media (for example: air, soil, or water) and are used to select chemicals for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, soil, or water that someone may take into their body each day. CVs are generated to be conservative and non-site specific. These values are used only to screen out chemicals that do not need further evaluation; CVs are not intended as environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based comparison values are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factor (CSF) or inhalation risk unit. CVs based on cancerous effects account for a lifetime exposure (70 years) with a theoretical excess lifetime cancer risk of 1 extra case per 1 million exposed people. Non-cancer values are calculated from ATSDR's Minimal Risk Levels (MRLs), EPA's Reference Doses (RfDs), or EPA's Reference Concentrations (RfCs). When a cancer and non-cancer CV exists for the same chemical, the lower of these values is used in the comparison for health protectiveness. The chemical and media-specific CVs utilized during the preparation of this public health assessment are listed below:

An **Environmental Media Evaluation Guide (EMEG)** is an estimated comparison concentration for which exposure is unlikely to cause adverse health effects, as determined by ATSDR from its toxicological profiles for a specific chemical.

A **Reference Dose Media Evaluation Guide (RMEG)** is an estimated comparison concentration that represents concentrations of chemicals (in water, soil, and air) to which humans may be exposed without experiencing adverse health effects.

A **Cancer Risk Evaluation Guide (CREG)** is a comparison concentration that is based on an excess cancer rate of one in a million persons and is calculated using EPA's cancer slope factor (CSF).

An **EPA Maximum Contaminant Level (or EPA MCL)** is the highest concentration of a chemical that is allowed in a public drinking water supply to ensure that long-term and short-term health effects are not posed from exposure. EPA also considered factors should as economical and technological feasible when setting these values.

An **EPA Action Level** is the level of a chemical which, if exceeded, triggers water system treatment or other requirements.

## Step 2 – Evaluation of Public Health Implications

The next step in the evaluation process is to take those chemicals that are detected at concentrations above their respective CVs and further identify the site-specific exposure situations and the likelihood that these exposures could pose a health hazard. Therefore, calculations are performed to estimate the possibility of cancer and non-cancer health problems. The calculations consider the activities of people living in the community.

In this public health assessment, ATSDR has estimated potential exposure (via ingestion) of trespassers to chemicals in surface water in the Main Pit by calculating exposure doses and cancer risk estimates. The same equations have been used for the non-cancer and cancer calculations with the indicated modifications. Note that cancer risk calculated are expressed as the risk of an individual developing cancer over his or her lifetime. The equations and the assumptions are based on the EPA Risk Assessment Guidance for Superfund, Part A<sup>1</sup>, EPA Risk Assessment Guidance for Superfund, Part E<sup>2</sup>, and the EPA Exposure Factors Handbook<sup>3</sup>, unless otherwise specified. The assumptions and details on the non-cancer and cancer evaluations of exposure are presented in the following equations and text.

### Trespassers: Accidental Ingestion of Chemicals Present in Main Pit Surface Water During Swimming

The following equation was used to evaluate surface water exposures:

$$Dose(mg/kg/day) = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

Where:

C = maximum detected concentration of a chemical; See Table 1; milligrams per liter (mg/L)

IR = ingestion rate; 0.0125 liters per hour (L/hour)

EF = exposure frequency; 10 days per year (days/year) equal to exposure 2 days per month for 5 months of warm weather

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<sup>1</sup> U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part A. December 1989.

<sup>2</sup> U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Exposure. July 2004.

<sup>3</sup> U.S. Environmental Protection Agency. Exposure Factors Handbook. August 1997.

ED = exposure duration; 10 years

BW = body weight; 63 kilograms (kg) equal to approximately 140 pounds

AT = averaging time; 3,650 days for non-cancer and 25,550 days for cancer evaluation

### **Non-Cancer Health Effects**

The doses calculated for exposure to each individual chemical are then compared to established health guidelines, such as ATSDR's Minimal Risk Levels (MRLs) or EPA's Reference Doses (RfDs), in order to assess whether adverse non-cancer health impacts from exposure are expected. These health guidelines, described in more detail in the following text, are chemical-specific values that are based on the available scientific literature and are considered protective of human health.

#### ***Minimal Risk Levels (MRLs)***

ATSDR has developed MRLs for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. MRLs are developed for different routes of exposure, such as inhalation and ingestion, and for lengths of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (365 days or greater). At this time, ATSDR has not developed MRLs for dermal exposure. A complete list of the available MRLs can be found at <http://www.atsdr.cdc.gov/mrls.html>.

#### ***References Doses (RfDs)***

An estimate of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. RfDs consider exposures to sensitive sub-populations, such as the elderly, children, and the developing fetus. EPA's RfDs have been developed using information from the available scientific literature and have been calculated for oral and inhalation exposures. A complete list of the available RfDs can be found at <http://www.epa.gov/iris>.

Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice for deriving health guidelines is to identify, usually from animal toxicology experiments, a No Observed Adverse Effect Level (or NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The NOAEL is then modified with an uncertainty (or safety) factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated (or applied) to the general human population. The magnitude of the uncertainty factor considers various

factors such as sensitive subpopulations (for example; children, pregnant women, and the elderly), extrapolation from animals to humans, and the completeness of available data. Thus, exposure doses at or below the established health guideline are not expected to result in adverse non-cancer health effects.

When site-specific exposure doses exceed health guidelines, it does not necessarily indicate that health effects will occur. Rather, it indicates that a more thorough look at the known toxicological values for the chemical and the site-related exposures are needed. The known toxicological values are doses derived from human and animal studies that are presented in the ATSDR Toxicological Profiles and EPA's Integrated Risk Information System (IRIS). A direct comparison of site-specific exposure doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur. This in-depth evaluation is performed by comparing calculated exposure doses with known toxicological values, such as the no-observed adverse-effect-level (NOAEL) and the lowest-observed-adverse-effect-level (LOAEL) from studies used to derive the MRL or RfD for a chemical.

It is important to consider that the methodology used to develop these health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer evaluation is necessary for potentially cancer-causing chemicals detected in samples at this site. A more detailed discussion of the evaluation of cancer risks is presented in the following section.

### **Cancer Risks**

Exposure to a cancer-causing compound, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated excess risk of developing cancer from exposure to chemicals associated with the site was calculated by multiplying the site-specific adult exposure doses, with a slight modification, by EPA's chemical-specific Cancer Slope Factors (CSFs or cancer potency estimates), which are available at <http://www.epa.gov/iris>, with the exception of dioxins.

CSFs are only available for ingestion and inhalation exposures and no specific CSFs exist for exposures occurring as a result of dermal contact. As part of this public health assessment, cancer health effects from dermal exposure were evaluated using oral CSFs. This approach conservatively assumed 100% absorption to adjust from administered dose (oral) to absorbed dose (dermal). This approach is likely to overestimate exposure.

Note that cancer risk calculated for exposures occurring during adulthood and childhood are combined and expressed as the risk of an individual developing cancer over his or her lifetime. An increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may

develop cancer sometime during his or her lifetime following exposure to a particular chemical. Therefore, the cancer risk calculation incorporates the equations and parameters (including the exposure duration and frequency) used to calculate the dose estimates, but the estimated value is divided by 25,550 days (or the averaging time), which is equal to a lifetime of exposure (70 years) for 365 days/year.

There are varying suggestions among the scientific community regarding an acceptable excess lifetime cancer risk, due to the uncertainties regarding the mechanism of cancer. The recommendations of many scientists, as well as ATSDR and EPA, have been in the risk range of 1 in 1 million to 1 in 10,000 (as referred to as  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ ) excess cancer cases. An increased lifetime cancer risk of one in one million or less is generally considered an insignificant increase in cancer risk. Cancer risk less than 1 in 10,000 (or  $1 \times 10^{-4}$ ) is not typically considered a health concern. An important consideration when determining cancer risk estimates is that the risk calculations incorporate several very conservative assumptions that are expected to overestimate actual exposure scenarios. For example, the method used to calculate EPA's CSFs assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. As previously stated, the method also assumes that there is no safe level for exposure. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, suggesting that the cancer risk is actually lower, perhaps by several orders of magnitude.

Because of the uncertainties involved with estimating cancer risk, ATSDR also employs a qualitative approach in evaluating all relevant data. The actual environmental exposures have been given careful and thorough consideration in evaluating the assumptions and variables relating to both toxicity and exposure. A complete review of the toxicological data regarding the doses associated with the production of cancer and the site-specific doses is an important element in determining the likelihood of exposed individuals being at a greater risk for cancer.

## ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines some of the words used by ATSDR in communications with the public.

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

**Acute exposure** - Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

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

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

**Biologic uptake** - The transfer of substances from the environment to plants, animals, and humans.

**Biota** - Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

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

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

**Carcinogen** - A substance that causes cancer.

**Chronic exposure** - Contact with a substance that occurs over a long time (more than 1 year).

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

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

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

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

**Dermal contact** - Contact with (touching) the skin.

**Dose** - The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An exposure dose is how much of a substance is encountered in the environment. An absorbed dose is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

**Dose-response relationship** - The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

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

**Environmental media and transport mechanism** - Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

**EPA** - United States Environmental Protection Agency

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

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

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

**Groundwater** - Water beneath the earth's surface in the spaces between soil particles and between rock surfaces.

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

**Hazardous waste** - Potentially harmful substances that have been released or discarded into the environment.

**Ingestion** - The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way.

**Inhalation** - The act of breathing. A hazardous substance can enter the body this way.

**Intermediate duration exposure** - Contact with a substance that occurs for more than 14 days and less than a year.

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

**Migration** - Moving from one location to another.

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

**National Priorities List (or NPL)** – EPA’s list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

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

**Point of exposure** - The place where someone can come into contact with a substance present in the environment.

**Prevention** - Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

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

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

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

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

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

**Remedial investigation** - The CERCLA process of determining the type and extent of hazardous material contamination at a site.

**Sample** - A portion or piece of a whole. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

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

**Substance** - A chemical.

**Surface water** - Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

**Survey** - A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment.

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

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

**Uncertainty factor** - Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk

level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. They are also sometimes called a safety factor.