

# Health Consultation

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FORMER W.R. GRACE/ZONOLITE CO. FACILITY

12<sup>TH</sup> AND FACTORY STREET

ELLWOOD CITY, LAWRENCE COUNTY, PENNSYLVANIA

SEPTEMBER 22, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation  
Atlanta, Georgia 30333

## **Health Consultation: A Note of Explanation**

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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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HEALTH CONSULTATION

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U.S. Department of Health and Human Services  
Agency for Toxic Substances and Disease Registry  
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# **Foreword**

## **ATSDR National Asbestos Exposure Review**

Vermiculite, a mineral with many commercial and industrial uses, was mined in Libby, Montana, from the early 1920s until 1990. During those years, vermiculite from Libby was shipped to hundreds of locations throughout the United States. We now know that the vermiculite from Libby contained asbestos.

The Agency for Toxic Substances and Disease Registry (ATSDR) is working with local, state, and other federal environmental and public health agencies to evaluate sites that received vermiculite from Libby. The evaluations are focused on human health effects that might be associated with possible past or current exposure at the processing sites and in communities near the sites.

The sites that processed Libby vermiculite will be evaluated by (1) identifying ways that people could have been exposed to asbestos in the past or ways that people could be exposed now and (2) determining whether the exposures represent a public health hazard. ATSDR will use the information gained from the site-specific investigations to recommend further public health actions as needed. Evaluations of the sites are being conducted in two phases.

Phase 1 is an evaluation of 28 priority sites that ATSDR selected for review on the basis of the following criteria:

- The US Environmental Protection Agency (EPA) required further action at the site on the basis of current contamination or
- The site was an exfoliation facility that processed more than 100,000 tons of vermiculite ore from the Libby mine. (Exfoliation processing of vermiculite involves heating vermiculite at high temperatures to expand it; higher quantities of asbestos are released during exfoliation processing than in other processing methods.)

The following document is one of the site-specific health consultations that ATSDR and state health partners are developing for each of the priority sites. In a future report, ATSDR will provide a summary of the results of the evaluations of the priority sites selected for initial review and present recommendations for evaluating the remaining sites that received vermiculite from Libby (more than 200 sites nationwide).

In Phase 2, ATSDR and state partners will utilize the findings and recommendations of the summary report to continue to evaluate sites that received Libby vermiculite and identify appropriate public health actions.

# Background

## Site Information

Zonolite and subsequently W.R. Grace operated an exfoliation facility at 12<sup>th</sup> and Factory Streets in Ellwood City, Lawrence County, Pennsylvania, from 1954–1969. The property was purchased by Zonolite in 1954. W.R. Grace acquired the plant in 1963 when they acquired the assets of the Zonolite Company. The property was sold to Beaver-Advance corporation in 1969. A new plant was built by W.R. Grace in New Castle, Pennsylvania, to replace the one in Ellwood City. Over time, it became known that vermiculite that came from a mine in Libby, Montana, was contaminated with naturally occurring asbestos fibers. Libby vermiculite was found to contain several types of asbestos fibers including the amphibole asbestos varieties tremolite and actinolite and the related fibrous asbestiform minerals winchite, richterite, and ferro-edenite [1]. In this report we will use the term “Libby asbestos” to refer to the characteristic composition of asbestos contaminating the Libby vermiculite. It is difficult to measure all the different mineral fibers in Libby asbestos specifically. In this document, soil sample results reported as “tremolite-actinolite” asbestos indicate the presence of Libby asbestos. Scientific studies throughout the 1980s and in 1999 indicated that Libby mine workers had high rates of asbestos-related respiratory diseases [2-6].

ATSDR evaluated this site because EPA had flagged the site as requiring further evaluation\* when Phase I of the National Asbestos Exposure Review (NAER) project was scoped. Also, the process used here—exfoliation—can release more asbestos fibers than other types of processing [7]. Since the majority of the plant’s operations preceded the period for which we have records of vermiculite shipments, we do not know how much vermiculite was actually shipped to this facility.

The site is outside the downtown area of Ellwood City in a mixed residential, commercial, and industrial area. Demographic information is provided in Figure 1, Appendix A. The site encompasses approximately 2 acres and includes a brick building that has been modified several times, making it difficult to determine where the vermiculite expansion operations occurred. The buildings on the site were built in 1913 and predate W.R. Grace’s operations at the site. The site is bordered to the north by the B & O Railroad, to the east by a power company’s service office, to the south by a residential area and to the west by a gravel parking lot and a Moose lodge. A fence separates the residential area from Factory Street and the site. According to U.S. Census data, houses near the site were built in the 1930s (see Appendix A, Figure 2). However, only about 20% of the current residents near the site have lived in their homes since 1969, the year the plant stopped vermiculite exfoliation (see Appendix A, Figure 3). The Connoquenessing Creek is located approximately 2,000 feet to the west of the property and 1,000 feet north of the property. A trucking company currently uses the site to operate a machine shop and for short-term storage.

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\* At the time NAER was scoped, EPA was planning to collect additional samples to evaluate for contamination on the site. This sampling was completed in 2002.

## **EPA Sampling**

EPA collected two bulk samples\* at this site in 2000 [8]. Analysis of these bulk samples was by polarized light microscopy (NIOSH method 9002) [9]. A single sample (a pile of unexpanded vermiculite) contained 2% tremolite. Results are shown in Appendix B, Table 1. EPA returned to the site and collected both surface soil and indoor air samples 2002 [10]. Surface soil samples (ranging from 0”– 6”in depth) and subsurface soil (12” – 18” in depth) were collected on site and analyzed using NIOSH method 9002 and the EPA Superfund elutriator method (per EPA EPA-540-R97-028) [11]. Results of these samples are shown in Appendix B, Tables 2 and 3. Four samples detected <1% asbestos by PLM. The Superfund Elutriator method detected Libby asbestos fibers in the elutriator air samples, up to  $1.9 \times 10^9$  structures/gram of  $PM_{10}^\dagger$ . Two air samples were collected from 10:30 AM until 4:30 PM. Sample collection filters were placed on stands at an approximate height of 5 feet. Samples were analyzed by transmission electron microscopy per NIOSH method 7402 [12]. As shown in Appendix B, Table 4, results were non-detect (<0.0013 f/cc‡ PCMe§).

## **ATSDR Site Visit**

ATSDR staff members visited the site on August 29, 2002. They met with the EPA On Scene Coordinator, a representative from the Pennsylvania Department of Health, and the site owner.

## **Vermiculite Processing**

Vermiculite is a nonfibrous, platy mineral similar in form to mica and used in many commercial and consumer applications. Vermiculite that has not been exfoliated is used in gypsum wallboard, cinder blocks, and many other products; exfoliated vermiculite is used as loose fill insulation, as a fertilizer carrier, and as an aggregate for concrete. Exfoliated vermiculite is formed by heating the ore to approximately 2,000 degrees Fahrenheit (°F), which explosively vaporizes the water in the mineral structure and causes the vermiculite to expand by a factor of 10 to 15 [7]. The Ellwood City facility produced exfoliated vermiculite.

Detailed process information was not available for the site. Vermiculite was apparently delivered to the facility on a railroad spur leading to the back of the processing building where exfoliation took place. Workers may have used shovels or mechanical equipment to unload ore from the railcars to the furnace. No documentation was found describing how the stoner rock (waste material) exiting the furnace was stored or disposed of. Stoner rock from other exfoliation facilities has been shown to contain between 2–10% Libby asbestos [13].

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\* Bulk sample: a sample taken from a larger quantity (lot) for analysis or recording purposes.

†  $PM_{10}$ : Particulate matter in air less than 10 micrometers ( $\mu m$ ) in diameter.

‡ f/cc: fibers per cubic centimeter

§ PCMe: phase contrast microscopy equivalent fibers

## **Asbestos Overview**

Asbestos is a general name applied to a group of silicate minerals consisting of thin, separable fibers in a parallel arrangement. Asbestos minerals fall into two classes, serpentine and amphibole. Serpentine asbestos has relatively long and flexible crystalline fibers; this class includes chrysotile, the predominant type of asbestos used commercially. Amphibole asbestos minerals are brittle and have a rod- or needle-like shape. Fibrous amphibole minerals are brittle and have a rod- or needle-like shape. Amphibole minerals regulated as asbestos by OSHA include five classes: crocidolite, amosite, and the fibrous forms of tremolite, actinolite, and anthophyllite. Other unregulated amphibole minerals, including winchite, richterite, and others, can also exhibit fibrous asbestiform properties [14].

Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water or evaporate into the air, although individual asbestos fibers can easily be suspended in the air. Asbestos fibers do not move through soil. They are resistant to heat, fire, and chemical and biological degradation. As such, they can remain virtually unchanged in the environment over long periods of time.

Vermiculite that was mined in Libby, Montana, contains amphibole asbestos, with a characteristic composition including tremolite, actinolite, richterite, and winchite; this material will be referred to as Libby asbestos. The raw vermiculite ore was estimated to contain up to 26% Libby asbestos as it was mined [15]. For most of the mine's operation, Libby asbestos was considered a by-product of little value and was not used commercially. The mined vermiculite ore was processed to remove unwanted materials and then sorted into various grades or sizes of vermiculite that were then shipped to sites across the nation for expansion (exfoliation) or use as a raw material in manufactured products. Samples of the various grades of unexpanded vermiculite shipped from the Libby mine contained 0.3%–7% fibrous tremolite-actinolite (by mass) [15].

The following sections provide an overview of several concepts relevant to the evaluation of asbestos exposure, including analytical techniques, toxicity and health effects, and the current regulations concerning asbestos in the environment. A more detailed discussion of these topics will also be provided in ATSDR's upcoming summary report for the national review of vermiculite sites.

### ***Methods for Measuring Asbestos Content***

A number of different analytical methods are used to evaluate asbestos content in air, soil, and other bulk materials. Each method varies in its ability to measure fiber characteristics such as length, width, and mineral type. For air samples, fiber quantification is traditionally done through phase contrast microscopy (PCM) by counting fibers with lengths greater than 5 micrometers ( $>5 \mu\text{m}$ ) and with an aspect ratio (length to width) greater than 3:1. This is the standard method by which regulatory limits were developed. Disadvantages of this method include the inability to detect fibers less



than 0.25 (<0.25)  $\mu\text{m}$  in diameter and the inability to distinguish between asbestos and nonasbestos fibers [14].

Asbestos content in soil and bulk material samples is commonly determined using polarized light microscopy (PLM), a method which uses polarized light to compare refractive indices of minerals and can distinguish between asbestos and nonasbestos fibers and between different types of asbestos. The PLM method can detect fibers with lengths greater than approximately 1  $\mu\text{m}$  ( $\sim 1 \mu\text{m}$ ), widths greater than  $\sim 0.25 \mu\text{m}$ , and aspect ratios (length-to-width ratios) greater than 3. Detection limits for PLM methods are typically 0.25%–1% asbestos.

Scanning electron microscopy (SEM) and, more commonly, transmission electron microscopy (TEM) are more sensitive methods that can detect smaller fibers than light microscopic techniques. TEM allows the use of electron diffraction and energy-dispersive x-ray methods, which give information on crystal structure and elemental composition, respectively. This information can be used to determine the elemental composition of the visualized fibers. SEM does not allow measurement of electron diffraction patterns. One disadvantage of electron microscopic methods is that determining asbestos concentration in soil and other bulk material is difficult [14].

For risk assessment purposes, TEM measurements are sometimes multiplied by conversion factors to give PCM equivalent fiber concentrations. The correlation between PCM fiber counts and TEM mass measurements is very poor. A conversion between TEM mass and PCM fiber count of 30 micrograms per cubic meter per fiber per cubic centimeter ( $\mu\text{g}/\text{m}^3/(\text{f}/\text{cc})$ ) was adopted as a conversion factor, but this value is highly uncertain because it represents an average of conversions ranging from 5 to 150 ( $\mu\text{g}/\text{m}^3/(\text{f}/\text{cc})$ ) [16]. The correlation between PCM fiber counts and TEM fiber counts is also very uncertain, and no generally applicable conversion factor exists for these two measurements [16]. Generally, a combination of PCM and TEM is used to describe the fiber population in a particular air sample.

### ***Asbestos Health Effects and Toxicity***

Breathing any type of asbestos increases the risk of the following health effects.

*Malignant mesothelioma*—cancer of the membrane (pleura) that encases the lungs and lines the chest cavity. This cancer can spread to tissues surrounding the lungs or other organs. The great majority of mesothelioma cases are attributable to asbestos exposure [14].

*Lung cancer* – cancer of the lung tissue, also known as bronchogenic carcinoma. The exact mechanism relating asbestos exposure with lung cancer is not completely understood. The combination of tobacco smoking and asbestos exposure greatly increases the risk of developing lung cancer [14].

*Noncancer effects* – these include asbestosis, scarring, and reduced lung function caused by asbestos fibers lodged in the lung; pleural plaques, localized or diffuse areas of thickening of the pleura; pleural thickening, extensive thickening of the pleura which may restrict breathing; pleural calcification, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and pleural effusions, fluid buildup in the pleural space between the lungs and the chest cavity [14].

Not enough evidence is available to determine whether inhalation of asbestos increases the risk of cancer at sites other than the lungs, pleura, and abdominal cavity [14].

Ingestion of asbestos causes little or no risk of noncancer effects. However, some evidence indicates that acute oral exposure might induce precursor lesions of colon cancer and that chronic oral exposure might lead to an increased risk of gastrointestinal tumors [14].

ATSDR considers the inhalation route of exposure to be the most significant in the current evaluation of sites that received vermiculite from Libby. Exposure scenarios that are protective of the inhalation route of exposure should be protective of dermal and oral exposures.

The scientific community generally accepts the correlations of asbestos toxicity with fiber length as well as fiber mineralogy. Fiber length may play an important role in clearing the materials from the body, and mineralogy may affect both biopersistence and surface chemistry.

ATSDR, responding to concerns about asbestos fiber toxicity from the World Trade Center disaster, held an expert panel meeting to review fiber size and its role in fiber toxicity in December 2002 [17]. The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths  $<5 \mu\text{m}$  are essentially nontoxic in terms of association with mesothelioma or lung cancer promotion. However, fibers with lengths  $<5 \mu\text{m}$  may play a role in asbestosis when exposure duration is long and fiber concentrations are high. More information is needed to definitively reach this conclusion.

In accordance with these concepts, it has been suggested that amphibole asbestos is more toxic than chrysotile asbestos, mainly because physical differences allow chrysotile to break down and to be cleared from the lung, whereas amphibole is not removed and builds up to high levels in lung tissue [18]. Some researchers believe the resulting increased duration of exposure to amphibole asbestos significantly increases the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer [18]. However, OSHA continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease [19]. EPA's Integrated Risk Information System (IRIS) assessment of asbestos also currently treats mineralogy (and fiber length) as equipotent [20].

Evidence suggesting that the different types of asbestos fibers vary in carcinogenic potency and site specificity is limited by the lack of information on fiber exposure by mineral type. Other data indicate that differences in fiber size distribution and other process differences can contribute at least as much as fiber type to the observed variation in risk [21].

Counting fibers using the regulatory definitions (see below) does not adequately describe risk of health effects. Fiber size, shape, and composition contribute collectively to risk in ways that are still being elucidated. For example, shorter fibers appear to deposit preferentially in the deep lung, but longer fibers may disproportionately increase the risk of mesothelioma [14,21]. Some of the unregulated amphibole minerals, such as the winchite present in Libby asbestos, can exhibit asbestiform characteristics and contribute to risk. Fiber diameters greater than 2  $\mu\text{m}$ –5  $\mu\text{m}$  are considered above the upper limit of respirability (that is, too large to inhale), and thus do not contribute significantly to risk. Methods to assess the risk posed by varying types of asbestos are being developed and are currently awaiting peer review [21].

### ***Current Standards, Regulations, and Recommendations for Asbestos***

In industrial applications, asbestos-containing materials are defined as any material with >1% bulk concentration of asbestos [22]. It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when OSHA regulations were created. Studies have shown that disturbing soil containing <1% amphibole asbestos, however, can suspend fibers at levels of health concern [23].

Friable asbestos (asbestos which is crumbly and can be broken down to suspendible fibers) is listed as a hazardous air pollutant on EPA's Toxic Release Inventory [24]. This classification requires companies that release friable asbestos at concentrations >0.1% to report the release under Section 313 of the Emergency Planning and Community Right-to-Know Act.

OSHA's permissible exposure limit (PEL) is 0.1 f/cc for asbestos fibers with lengths >5  $\mu\text{m}$  and with an aspect ratio (length:width) >3:1, as determined by PCM [19]. This value represents a time-weighted average (TWA) exposure level based on 8 hours per day for a 40-hour work week. In addition, OSHA has defined an "excursion limit," which stipulates that no worker should be exposed in excess of 1 f/cc as averaged over a sampling period of 30 minutes [19]. Historically, the OSHA PEL has steadily decreased from an initial standard of 12 f/cc established in 1971. The PEL levels prior to 1983 were determined on the basis of empirical worker health observations, while the levels set from 1983 forward employed some form of quantitative risk assessment. ATSDR has used the current OSHA PEL of 0.1 f/cc as a reference point for evaluating asbestos inhalation exposure for past workers. ATSDR does not, however, support using the PEL for evaluating exposure for community members, because the PEL was developed as an occupational exposure for adult workers.

In response to the World Trade Center disaster in 2001 and an immediate concern about asbestos levels in buildings in the area, the Department of Health and Human Services, EPA, and the Department of Labor formed the Environmental Assessment Working Group. This work group was made up of ATSDR, EPA, CDC's National Center for Environmental Health, the National Institute for Occupational Safety and Health (NIOSH), the New York City Department of Health and Mental Hygiene, the New York State Department of Health, OSHA, and other state, local, and private entities. The work group set a re-occupation level of 0.01 f/cc after cleanup. Continued monitoring was also recommended to limit long-term exposure at this level [25]. In 2002, a multiagency task force headed by EPA was formed specifically to evaluate indoor environments for the presence of contaminants that might pose long-term health risks to residents in Lower Manhattan. The task force, which included staff from ATSDR, developed a health-based benchmark of 0.0009 f/cc for indoor air. This benchmark was developed to be protective under long-term exposure scenarios, and it is based on risk-based criteria that include conservative exposure assumptions and the current EPA cancer slope factor. The 0.0009 f/cc benchmark for indoor air was formulated on the basis of chrysotile fibers and is therefore most appropriately applied to airborne chrysotile fibers [26].

NIOSH set a recommended exposure limit of 0.1 f/cc for asbestos fibers longer than 5  $\mu\text{m}$ . This limit is a TWA for up to a 10-hour workday in a 40-hour work week [27]. The American Conference of Government Industrial Hygienists has also adopted a TWA of 0.1 f/cc as its threshold limit value [28].

EPA has set a maximum contaminant level (MCL) for asbestos fibers in water of 7,000,000 fibers longer than 10  $\mu\text{m}$  per liter, on the basis of an increased risk of developing benign intestinal polyps [29]. Many states use the same value as a human health water quality standard for surface water and groundwater.

Asbestos is a known human carcinogen. Historically, EPA's IRIS model calculated an inhalation unit risk for cancer (cancer slope factor) of 0.23 per f/cc of asbestos [20]. This value estimates additive risk of lung cancer and mesothelioma using a relative risk model for lung cancer and an absolute risk model for mesothelioma.

This quantitative risk model has significant limitations. First, the unit risks were based on measurements with phase contrast microscopy and therefore cannot be applied directly to measurements made with other analytical techniques. Second, the unit risk should not be used if the air concentration exceeds 0.04 f/cc because the slope factor above this concentration might differ from that stated [20]. Perhaps the most significant limitation is that the model does not consider mineralogy, fiber-size distribution, or other physical aspects of asbestos toxicity. EPA is in the process of updating their asbestos quantitative risk methodology given the limitations of the IRIS model currently used and the knowledge gained since this model was implemented in 1986.

## Discussion

The vermiculite processed at the plant in Ellwood City originated from the mine in Libby, Montana known to be contaminated with asbestos. Studies conducted in the Libby community indicate health impacts that are associated with asbestos exposure [30, 31]. The findings at Libby provided the impetus for investigating this site, as well as other sites across the nation that received asbestos-contaminated vermiculite from the Libby mine. It is important to recognize, however, that the asbestos exposures documented in the Libby community are in many ways unique and will not collectively be present at other sites that processed or handled Libby vermiculite. The investigation at the Former W.R. Grace/Zonolite plant in Ellwood City is part of a national effort to identify and evaluate potential asbestos exposures at these other sites.

### Exposure Assessment and Toxicological Evaluation

Evaluating the health effects of exposure to Libby asbestos requires extensive knowledge of both exposure pathways and toxicity data. The toxicological information currently available is limited and therefore prevents definitive determination of the health effects potentially associated with different sizes and types of asbestos. Site-specific exposure pathway information is also limited or unavailable.

- Limited information is available about past concentrations of Libby asbestos in air in and around the Ellwood City plant. Also, as described in the preceding section, significant uncertainties and conflicts in the methods used to analyze asbestos exist. This makes it hard to estimate the levels of Libby asbestos people may have been exposed to.
- Because most exposures happened so long ago, not enough information is known about how and how often people came into contact with Libby asbestos from the plant. This information is needed to estimate exposure doses accurately.
- Not enough information is available about how some vermiculite materials, such as waste rock, were handled or disposed of at this site. This makes it difficult to identify and assess potential current exposures.

Given these difficulties, the public health implications of past operations at this site can only be evaluated qualitatively. The following sections describe the various types of evidence we used to evaluate exposure pathways and reach conclusions about the site.

## Exposure Pathway Analysis

An exposure pathway is the way in which an individual is exposed to contaminants originating from a contamination source. Every exposure pathway consists of the following five elements: (1) a *source* of contamination; (2) a *media* such as air or soil through which the contaminant is transported; (3) a *point of exposure* where people can contact the contaminant; (4) a *route of exposure* by which the contaminant enters or contacts the body; and (5) a *receptor population*. A pathway is considered **complete** if all five elements are present and connected. **Potential** exposure pathways indicate that exposure to a contaminant *could* have occurred in the past, *could* be occurring currently, or *could* occur in the future. A potential exposure exists when information about one or more of the five elements of an exposure pathway is missing or uncertain. An **incomplete** pathway is missing one or more of the pathway elements, and it is likely that the elements were never present and not likely to be present at a later point in time. An **eliminated** pathway was a potential or completed pathway in the past, but has had one or more of the pathway elements removed to prevent present and future exposures.

After reviewing information from Libby, Montana, and from facilities that processed vermiculite ore from Libby, the National Asbestos Exposure Review team has identified possible likely exposure pathways for vermiculite processing facilities. All pathways have a common source—vermiculite from Libby contaminated with Libby asbestos—and a common route of exposure—inhalation. Although asbestos ingestion and dermal exposure pathways could exist, health risks from these pathways are minor in comparison to those resulting from inhalation exposure to asbestos and will not be evaluated.

The pathways that will be considered for each site are listed in Table 1. Not every pathway identified will be an important source of exposure for a particular site. An evaluation of the pathways for this site is presented in the following paragraphs.

**Table 1. Summary of Inhalation Pathways Considered for the Former W.R. Grace/Zonolite Plant in Ellwood City, Pennsylvania**

<i>Pathway Name</i>	<i>Exposure Scenario</i>	<i>Timeframe</i>	<i>Pathway Status</i>	<i>Public Health Hazard Determination</i>
Occupational	Former workers inhaling Libby asbestos in and around the facility during handling and processing of contaminated vermiculite	Past (1954–1969)	Complete	Public health hazard
		Past (1969–Present)	Potential	No apparent public health hazard
	Current on-site workers inhaling Libby asbestos from residual contamination inside former processing buildings or in on-site soil (residual contamination, buried waste)	Present	Potential	No public health hazard
		Future	Potential	No public health hazard
Household Contact	Household contacts inhaling Libby asbestos brought home on workers' clothing, shoes, and hair	Past (1954–1969)	Complete	Public health hazard
		Past (1969–Present)	Potential	No apparent health hazard
		Future	Potential	No apparent health hazard
Community	Facility air emissions: Community members or nearby workers inhaling asbestos fibers from plant air emissions during handling and processing of contaminated vermiculite	Past	Complete	Indeterminate
		Present/ Future	Eliminated	No public health hazard
	Waste piles: Community members (particularly children) inhaling asbestos while playing in or disturbing on-site piles of contaminated vermiculite or waste rock	Past (1954–1969)	Potential	Indeterminate
		Present	Incomplete	No public health hazard
	On-site soil: Community members inhaling Libby asbestos fibers from contaminated on-site soils (residual contamination, buried waste)	Past	Potential	Indeterminate
		Present/ Future	Potential	Indeterminate
	Residential outdoor: Community members inhaling Libby asbestos while using contaminated vermiculite or waste material at home (for gardening, driveways, fill material)	Past	Potential	Indeterminate
		Present/ Future	Potential	Indeterminate
	Residential indoor: Community members disturbing household dust containing Libby asbestos fibers from plant emissions or residential outdoor waste	Past	Potential	Indeterminate
		Present/ Future	Potential	No apparent health hazard

*Occupational (1954–1969)*—ATSDR assumes that individuals who worked at the facility at the time Libby vermiculite was processed were exposed to a public health hazard. While ATSDR has not found records of personal or area air samples in the EPA database of W.R. Grace documents, an internal W.R. Grace document describes the Ellwood City facility as “...quite dusty, and as the plant processes Libby ore which contains asbestos, it presents a potentially serious health problem for employees” (Unpublished information from EPA’s database of W.R. Grace Documents). Historical sampling records from six other exfoliation facilities operated by W.R. Grace showed levels of exposure to asbestos in the early 1970s to be greater than the current OSHA Permissible Exposure Limit of 0.1 f/cc, 8-hour time weighted average (see Appendix A, Figure 4). As ventilation controls in these facilities were installed, exposures progressively dropped throughout the late 1970s and early 1980s. However, since this plant operated prior to W.R. Grace’s installation of ventilation controls, we assume that exposures at this facility would have been at or near levels seen in the early 1970s. We do not have information about the amount of material that was processed at the Ellwood City plant and its operational cycles, or the use of protective equipment; therefore, this assumption has a significant level of uncertainty.

In addition to the asbestos that contaminated the Libby vermiculite, another source of contamination is chrysotile, which was added to Monokote™ 3. Monokote™ 3 was a fireproofing material that was applied to structural steel. According to company documents, Monokote™ 3 was produced at this facility (Unpublished information from EPA’s database of W.R. Grace Documents). Monokote™ 3, was initially developed by Zonolite in 1959. At an exfoliation facility in New Jersey, 100 pounds of chrysotile was added to each batch of Monokote™ 3 produced. We do not know how much Monokote™ 3 was produced at this facility, or how often it was produced. Therefore, we do not know the concentration of chrysotile to which plant workers were exposed.

Information is also limited regarding the number of employees who worked at the Ellwood facility. A single 1960 internal Zonolite memorandum indicated that approximately 12 employees worked at this facility (Unpublished information from EPA’s database of W.R. Grace Documents).

Other workers besides plant employees could have been exposed to Libby asbestos, for instance, waste haulers and equipment operators at landfills that may have received waste exfoliation material from the Ellwood City plant. ATSDR does not have exposure data for workers who may have handled vermiculite waste products from the Ellwood City plant. However, W.R. Grace industrial hygienists monitored exposures of workers involved in hauling waste products from four other exfoliation plants (Unpublished information from EPA’s database of W.R. Grace Documents). All four exfoliation plants processed Libby vermiculite. Analysis was by phase contrast microscopy (PCM). Data from the monitoring is provided in Table 2:



**Table 2 - Levels of personal asbestos exposure (PCM) to waste haulers and handlers**

<i>Plant Location</i>	<i>Date</i>	<i>Duration (minutes)</i>	<i>Concentration (f/cc)</i>	<i>8-hour Time Weighted Average(f/cc) *</i>
Muirkirk, MD	4/12/1979	87	0.08	0.0145
Weedsport, NY	9/18/1980	43	0.11	0.047
		43	0.43	
Weedsport, NY	8/3/1983	69	0.26	0.037
New Castle, PA <sup>†</sup>	6/27/1984	126	<0.002	<0.002
		126	<0.002	
Easthampton, MA <sup>‡</sup>	8/9/1983	24	0.26	0.0014

\* 8 hour Time Weighted Average =  $\sum(\text{concentration} \times \text{duration})/480$  minutes

<sup>†</sup> Waste rock was moistened and placed in cardboard boxes for disposal

<sup>‡</sup> Sample was from grader operator crushing bags at landfill

ATSDR has not found information about how often waste products were picked up from the Ellwood City plant, nor where the waste was disposed of. At other exfoliation plants, waste pickup occurred once or twice a week (Unpublished information from EPA’s database of W.R. Grace Documents). The data in Table 2 indicate that workers who handled vermiculite waste materials were exposed to Libby asbestos. However, their exposure is likely to be much less frequent and of a shorter duration and a lower intensity than the exposure of exfoliation plant workers.

*Occupational (1969–present)*—ATSDR does not know if W.R. Grace cleaned and decontaminated the buildings when they sold the property in 1969. EPA collected two air samples in 2002, and these samples did not detect airborne asbestos. The detection limit for these samples was 0.0013 f/cc (PCMe), well below the current OSHA limit for asbestos of 0.1 f/cc. However, we can not definitively conclude from these data that exposures at the site are not possible because only a limited amount of sampling was conducted (two samples). Furthermore, activities that may generate airborne dust (sweeping or cleaning) may not have occurred on the day EPA took the samples. If these samples do represent typical activities at the site, then any exposures that could occur through occasional cleaning would be minimal and of no apparent public health hazard.

*Household contact (1954-1969)*—Household contacts of former workers could have been exposed to asbestos fibers if workers did not shower and change clothes before leaving work. Family members or other household contacts could have come into contact with Libby asbestos by direct contact with the worker, by laundering clothing, or by the re-suspension of dust during cleaning activities. Exposures to household contacts cannot be estimated without information concerning Libby asbestos levels on worker clothing and behavior-specific factors (for example, worker practices, household laundering practices). ATSDR screenings of Libby residents found a higher rate of pleural abnormalities associated with having been a household contact of a W.R. Grace mine worker [31]. Therefore, we have classified this exposure as a public health hazard.

*Household contact (1969–present)*—Household contacts of current workers may be exposed to asbestos if current workers are exposed to residual asbestos fibers. However, EPA’s air sampling data indicates that current occupational exposure to Libby asbestos is not occurring on a frequent basis or at a level that would pose an apparent public health hazard.

*Facility air emissions (past)*—In the past, while the plant was operating, community members could have been exposed to Libby asbestos fibers released into the ambient air from the furnace stack or from fugitive dust. However, no reliable estimate of community exposure to past air emissions of asbestos from the Ellwood City plant can be made. It is unlikely that sufficiently detailed plant-specific emission information will ever be available, and if it were, it would still not be possible to reconstruct past exposures, given the lack of knowledge of such factors as past weather patterns or people’s activity patterns. The wind direction pattern (wind rose) for this site is difficult to determine, because the nearest weather station is 32 miles from the site. In view of the lack of concrete information, the past ambient air pathway is being characterized as an indeterminate public health hazard. However, due to dispersion and changing wind patterns, the level of exposure from the ambient air would be much lower than the high-level exposure experienced by former plant workers.

*Facility air emissions (present and future)*—The present and future ambient air pathways are eliminated from further consideration because the exfoliation plant is no longer operating.

*Waste piles (past)*—No documentation was available on storage and disposal of waste rock (stoner rock) from the process. At some other processing facilities, waste rock was stored in piles on the site before removal and children had played in the waste piles [13].

*Waste piles (present)*—The site is near a residential area, although a fence separates the site from the community (see Appendix A, Figure 8). ATSDR does not know whether the fence was present when the facility was used to expand vermiculite.

*On-site soils (past, present, and future)*—On-site soil presents a possible source of exposure to Libby asbestos. Libby asbestos has been detected in the soil around the plant using PLM and the Superfund TEM Method (EPA-540-R97-028). The results show that when disturbed, the soil that was sampled has the potential to release Libby asbestos fibers. At other sites, disturbing soil with even trace amounts of Libby asbestos can result in airborne Libby asbestos at levels of concern [23]. Furthermore, subsurface soils have not been evaluated to see if there was an on-site landfill of waste rock. A search of documents obtained by EPA through 104(e) data requests has not found any discussion of the disposal of waste rock from the Ellwood City facility. Aerial photography from the past shows an area that may have been used to dispose of waste rock onsite (Figure 5, Appendix A). Thick vegetation covers this area of the site. During a site visit in 2002, ATSDR representatives saw what appeared to be tremolite bundles and vermiculite in the soil near the facility.

Currently, the potential for people in the community to be exposed to contaminated on-site soils or possibly buried stoner rock is low: the vegetative cover would reduce the airborne dispersal of any asbestos fibers from the soil (Figures 6 and 7, Appendix A). Also, a chain link fence surrounding the facility deters access to the site (Appendix A, Figure 8). Libby asbestos fibers could be released if excavation were to occur on the site and areas of previously undetected waste rock were disturbed. Therefore, ATSDR has recommended to EPA that a deed notice be filed to alert the owner and future owners of this potential hazard. This pathway is considered a potential exposure pathway at the present time.

*Residential outdoor (past)*—Whether people ever hauled contaminated materials away for personal use is unknown; if they did, people could be exposed to asbestos from those materials.

*Residential outdoor (present and future)*—Not enough information is available to determine whether individuals are being exposed to Libby asbestos through direct contact with waste rock brought home for personal use (for example, as fill material, driveway surfacing, or as a soil additive in gardening). If vermiculite or waste rock was brought home from the facility in the past, it could still be a source of exposure today. If the material containing asbestos is covered (e.g., with soil, grass, other vegetation) and is not disturbed, the asbestos fibers will not become airborne and will not be a public health hazard.

*Residential indoor (past, present, and future)*—Residents could have inhaled Libby asbestos fibers from household dust, either from plant emissions that infiltrated into homes or from dust brought inside from waste products that were brought home for personal use. However, not enough information is available to evaluate whether this exposure pathway is likely to be significant for the site.

*Consumer products*—People who purchased and used products containing contaminated vermiculite may be exposed to asbestos fibers from the use of the products. At this time, determining the public health implication of commercial or consumer use of vermiculite products (such as home insulation or gardening products) is beyond the scope of this evaluation. However, studies have shown that disturbing or using these products can result in release of asbestos fibers to the air [23, 32]. Additional information for consumers of vermiculite products has been developed by EPA, ATSDR, and NIOSH and provided to the public (see [www.epa.gov/asbestos/insulation.html](http://www.epa.gov/asbestos/insulation.html)).

## **Health Outcome Data**

Health outcome data can be used to give a more thorough evaluation of the public health implications of a given exposure. Health outcome data can include mortality information (for example, the number of people who have died from a certain disease) or morbidity information (for example, the number of people in an area who have a certain disease or illness). A health statistics review cannot prove a causal relationship between potential exposures and health outcomes, but it may indicate whether additional studies are needed. ATSDR will release annual reports summarizing health statistics review findings for sites where data have been received and evaluated. In Libby, Montana, the number of recorded

deaths associated with asbestos-related diseases was significantly elevated (as compared with the state or the nation as a whole), especially among former workers at the vermiculite mine and their household contacts [30]. Former workers and their household contacts also had higher rates than expected of pleural abnormalities, indicating higher levels of exposure and a higher risk for developing asbestos-related disease [31].

ATSDR's Division of Health Studies, in cooperation with state partners, is conducting an ongoing effort to gather health outcome data from selected former vermiculite facilities. No review of the available health statistics data for this site has been completed at this time. It should be noted that the small number of potentially affected people around the site could make it difficult to detect if there are any community-level health effects. ATSDR will release a report summarizing health statistics review findings for selected sites for which data have been received.

### **Summary of both Completed and Proposed Remedial Actions**

- There has been no clean-up action taken by EPA at the site. ATSDR and EPA are exploring the feasibility of instituting a mechanism of alerting present and future owners of the site to the potential presence of buried on-site soil contamination.

### **Child Health Considerations**

ATSDR recognizes that infants and children may be more vulnerable than adults to exposure in communities faced with environmental contamination. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests.

The effects of asbestos on children are thought to be similar to the effects on adults. However, children could be especially vulnerable to asbestos exposures due to the following factors.

- Children are more likely to disturb fiber-laden soil or indoor dust while playing.
- Children are closer to the ground and thus more likely to breathe contaminated soil or dust.
- Children could be more at risk than people exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease.

The most at-risk children are those who were household contacts of workers at the time the plant was operating. The plant is no longer operating, and children would not likely play around the site. Therefore, it is unlikely that children today are exposed to vermiculite contaminated with Libby asbestos near the Ellwood City plant.

## Conclusions

- From 1954 to 1969, workers at the former W.R. Grace/Zonolite plant in Ellwood City were likely exposed to hazardous levels of Libby asbestos. Household contacts of those workers could also have been exposed to hazardous levels of Libby asbestos in the past. The past occupational and household contacts pathways represent a public health hazard.
- There is not enough information available to determine the extent to which people living in the neighborhood of the plant from 1954 to 1969 were exposed to Libby asbestos from the ambient air pathway, the on-site soil pathway, the residential indoor pathway, the residential outdoor pathway, or the waste piles pathway. These exposures pose an indeterminate public health hazard. However, the risk of adverse health effects from these exposures would be small compared to the past occupational and household contacts exposures.
- ATSDR considers worker exposures since 1969 to be no apparent public health hazard. Based on the limited data available, it is unlikely that people working inside the former exfoliation plant since 1969 were exposed to hazardous levels of Libby asbestos.
- Trace Libby asbestos contamination present around the plant could create an exposure to asbestos if disturbed. Currently, adverse health effects are unlikely because current workers or other people are not frequently in the areas that are contaminated. Future exposure is possible if these areas become used more often and action is not taken to contain the contamination. This exposure pathway is an indeterminate public health hazard.

## Recommendations

- Promote awareness of past asbestos exposures among former workers and members of their households.
- Encourage former workers and their household contacts to inform their regular physician about their asbestos exposures. If they are concerned or symptomatic, they should be encouraged to see a physician that specializes in asbestos-related lung diseases.
- Promote awareness of potential past asbestos exposures among community members that lived near the facility from 1954 to 1969; provide easily accessible materials that assist community members in self-identifying their exposures.
- Encourage past community members to inform their regular physician about their potential asbestos exposures if they feel they were exposed.

- Develop a plan for reducing the possibility of frequent and/or regular contact with soil containing trace levels of Libby asbestos.
- Provide information to increase awareness of the site owner about potential residual asbestos at the site.
- Promote awareness of potential asbestos exposures from direct contact with waste rock brought home from the facility in the past; provide easily accessible materials that assist community members in self-identifying their exposures.

## **Public Health Action Plan**

The public health action plan for the site contains a description of actions that will be taken by ATSDR and/or others at the site. The purpose of the public health action plan is to ensure that public health hazards are not only identified, but that a plan of action is designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR is committed to follow up on the plan to ensure its implementation. Following are the public health actions to be implemented.

- ATSDR will develop and disseminate reliable and easily accessible information concerning asbestos-related health issues for exposed individuals and health care providers.
- ATSDR will publicize the findings of this health consultation within the community around the site; ATSDR will make the report accessible on the internet and in the community.
- ATSDR will notify former workers for whom we have contact information and provide exposure and health information regarding asbestos.
- ATSDR is researching and determining the feasibility of conducting additional worker and household contact follow-up activities.
- ATSDR will develop reliable, easily accessible, and understandable information concerning asbestos-related health issues for exposed individuals and health care providers.
- ATSDR will publicize the findings of this health consultation within the community around the site; ATSDR will make the report accessible on the internet and in the community.
- ATSDR will develop reliable, easily accessible, and understandable information concerning asbestos-related health issues for exposed individuals and health care providers.

- ATSDR will publicize the findings of this health consultation within the community around the site; ATSDR will make the report accessible on the internet and in the community.

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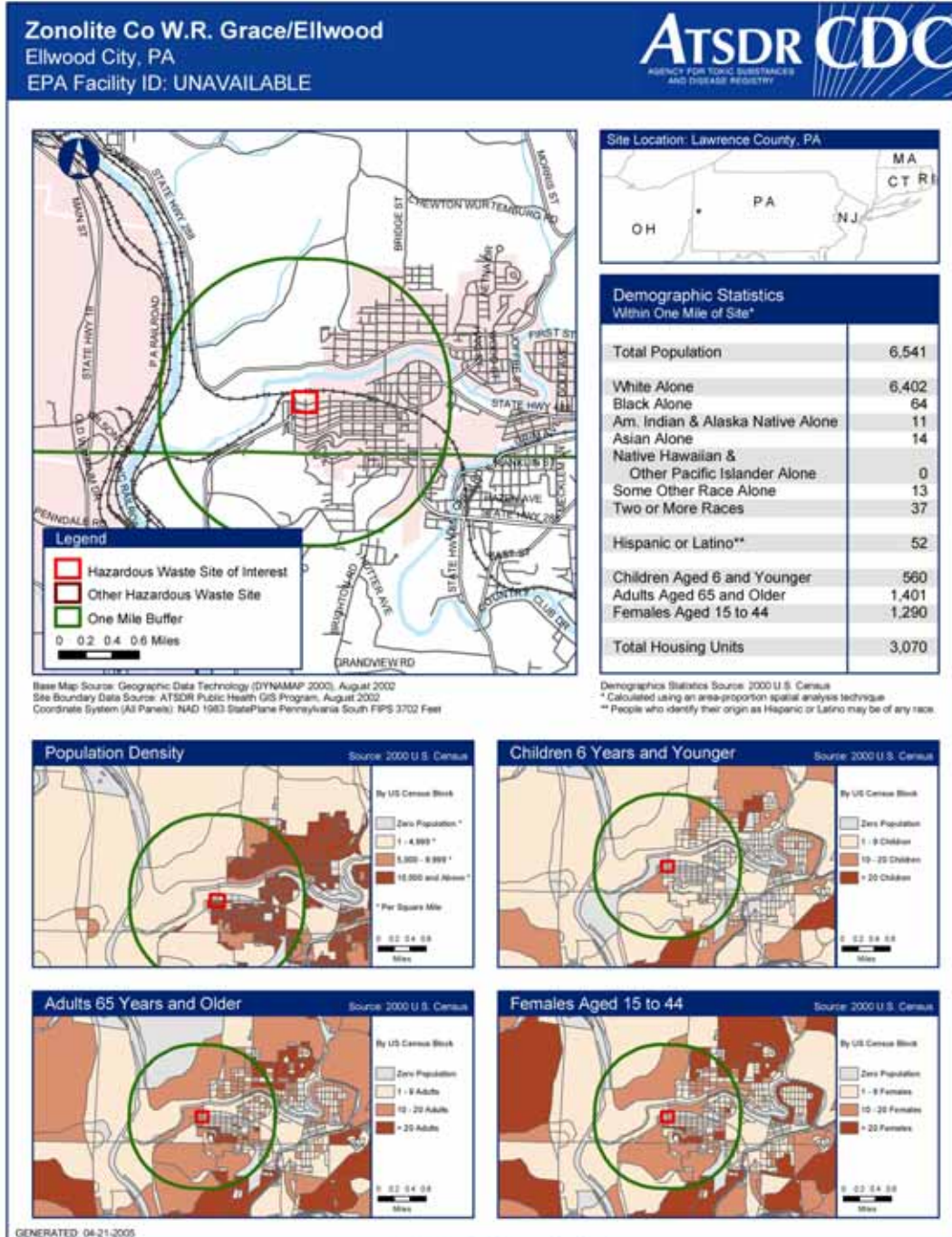
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## Appendix A- Figures

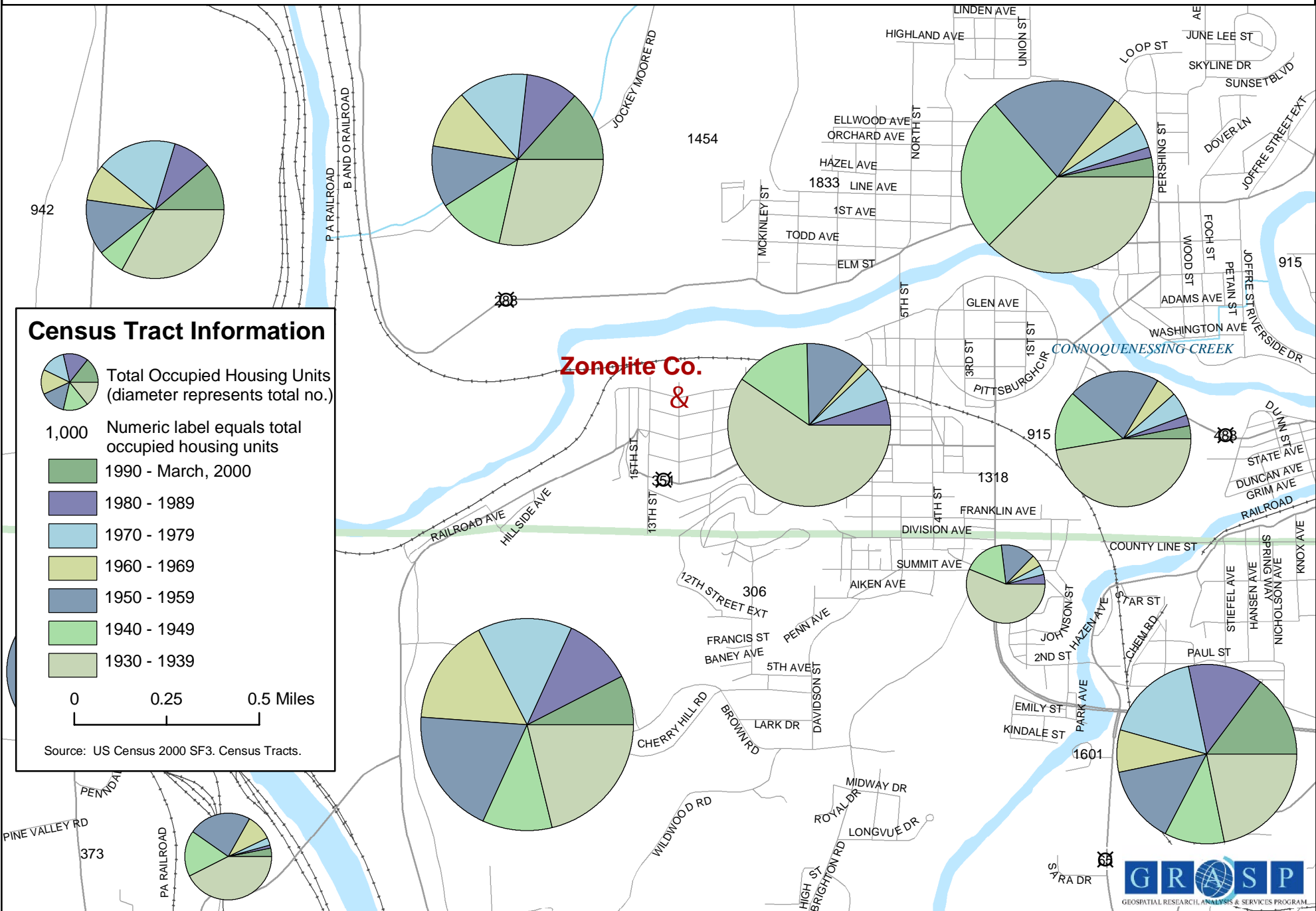
Figure 1. Site Map



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**Figure 2. Year Housing Structure Unit Built by Census Tract**

# Year Housing Unit Structure Built by Census Tract Lawrence County, Pennsylvania

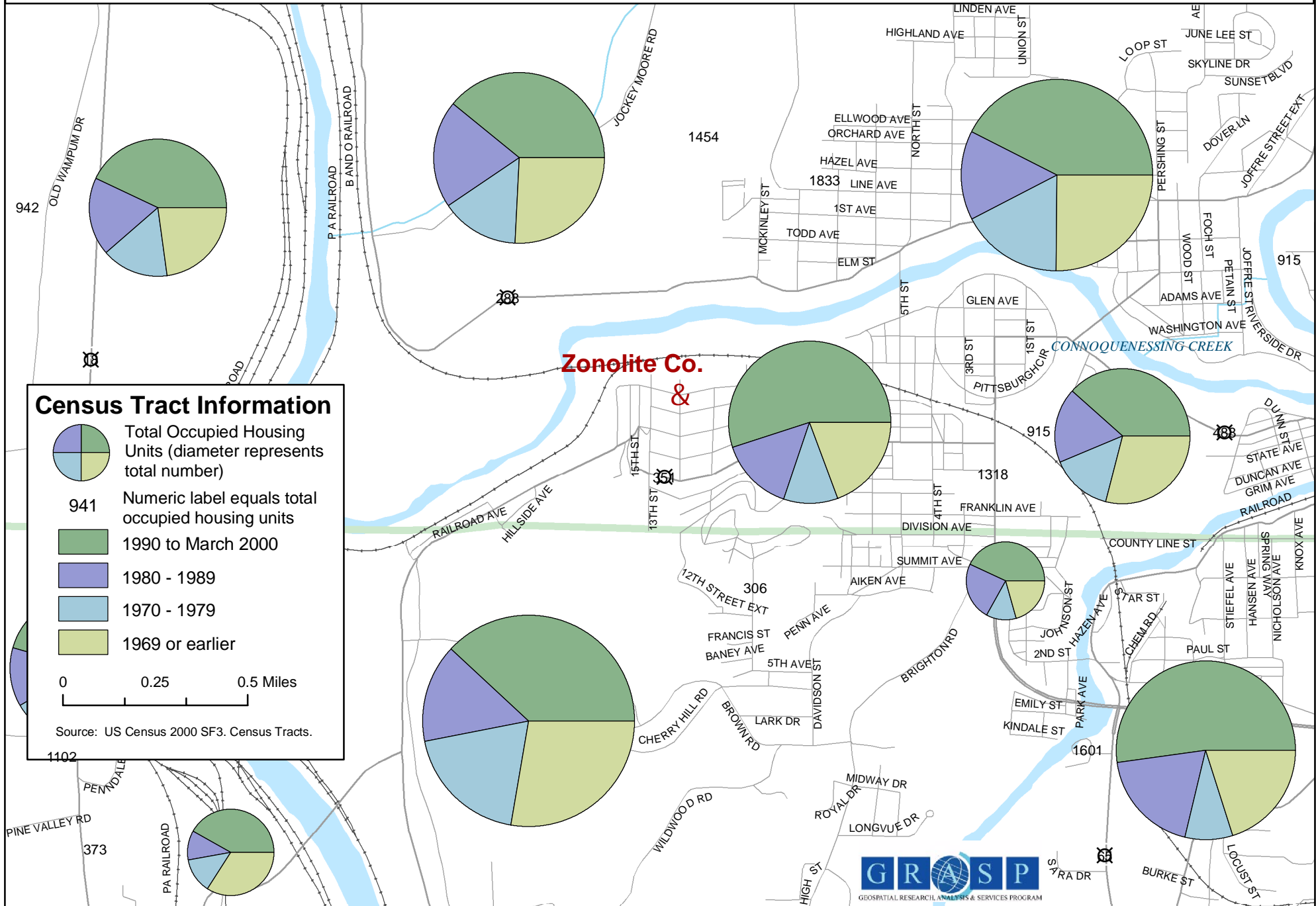


Zonolite Co. &

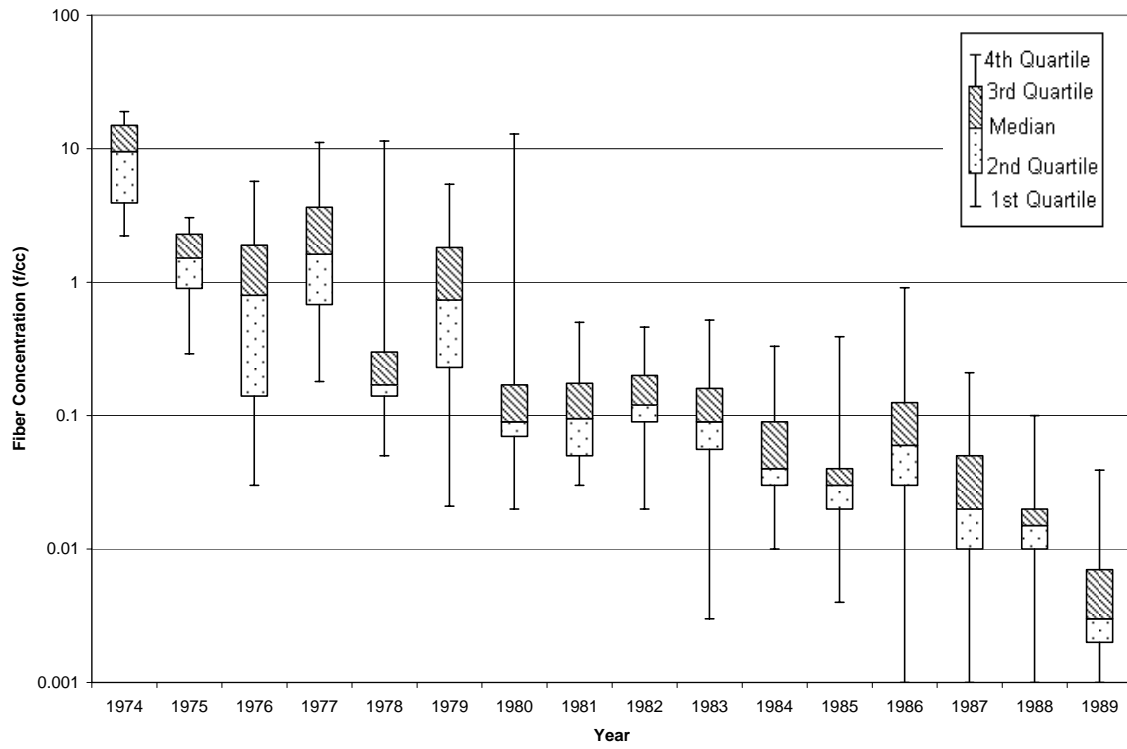


**Figure 3. Year Householder Moved Into Current Housing Unit by Census Tract**

# Year Householder Moved Into Current Housing Unit by Census Tract Lawrence County, Pennsylvania



**Figure 4. Personal Air Sampling Data for Workers at six Exfoliation Plants**



**Figure 5: Historical Aerial Photographs of Ellwood City plant.**

**WR Grace/Zonolite Co. Ellwood City, PA**



**Figure 6: Berm area where possible onsite burial occurred.**





**Figure 7: Embankment where ATSDR team member observed what appeared to be tremolite.**



**Figure 8: Chain Link Fence Surrounding Facility**



## Appendix B - EPA Sampling Data

**Table 1. Bulk Sample Data Analysis (NIOSH 9002) EPA Trip Report TDD#00-08-018**

Sample Location Number	Sample type/ Location Description	PLM Analysis (NIOSH 9002)
103100-03	Various non-fibrous/heterogeneous material. Collected in an alcove for a ventilation fan approximately 5 feet off the ground. The storage room in which the sample was collected appeared to house the old furnace for vermiculite expansion	Non-detect
103100-04	Sample collected from a pile of unexpanded vermiculite. The pile was approximately 75 feet from the building and 30 feet from the railroad tracks.	2% tremolite

**Table 2. Polarized Light Microscopy Analysis of Soil Samples (NIOSH 9002)**

Sample Location Number	Location Description	Depth	Grams PM <sub>10</sub> Collected on Filter
WRG4SS1	Soil berm on the left side of building in rear. Subsurface sample	12"-18"	< 1% actinolite/tremolite
WRG4SS2	Vegetated area on left side of building in front.	0"-6"	< 1% actinolite/tremolite
WRG4SS3	Left side of property near fence line	0"-6"	Non-detect
WRG4SS4	Vegetated area on right side of building in front	0"-6"	Non-detect
WRG4SS5	Right side of property near the fence line	0"-6"	Non-detect
WRG4SS6	Slope behind building on right side of property	0"-6"	< 1% actinolite/tremolite
WRG4DS7	duplicate - SS6	0"-6"	< 1% actinolite/tremolite



**Table 3. Soil Sample Analysis Data (NIOSH 9002 and EPA Superfund Method) EPA Trip Report TDD #SW3-02-07-0025 (Structures per gram of PM<sub>10</sub>\*)**

Sample	Location	Depth	Estimated Analytical Sensitivity	Chrysotile Protocol Structures†	Long Chrysotile Structures‡	Amphibole Protocol Structures	Long Amphibole Structures	Libby Asbestos Structures	Long Libby Asbestos Structures
WRG4SS1	Soil berm on the left side of building in rear. Subsurface sample.	12"-18"	$4.851 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	$6.3 \times 10^8$	$4.85 \times 10^7$
WRG4SS2	Vegetated area on left side of building in front.	0"-6"	$5.3711 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	$1.3 \times 10^9$	$3.22 \times 10^8$
WRG4SS3	Left side property near fence line	0"-6"	$5.324 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	$1.3 \times 10^9$	$4.3 \times 10^8$
WRG4SS4	Vegetated area on right side of building in front	0"-6"	$5.324 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	$1.1 \times 10^8$	$5.32 \times 10^7$
WRG4SS5	Right side property near fence line	0"-6"	$3.906 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect	Non-detect
WRG4SS6	Slope behind building on right side of property	0"-6"	$7.336 \times 10^7$	$2.2 \times 10^8$	$7.336 \times 10^7$	Non-detect	Non-detect	$1.9 \times 10^9$	$2.2 \times 10^8$
WRG4DS7	Duplicate - SS6	0"-6"	$7.615 \times 10^7$	Non-detect	Non-detect	Non-detect	Non-detect	$3.8 \times 10^8$	Non-detect

\* PM<sub>10</sub>: Particulate matter in air less than 10 micrometers (µm) in diameter.

† Protocol structures – asbestos structures that meet the size requirements stated in the EPA Superfund Method and are 5–10 µm in length.

‡ Long structures – all asbestos structures that meet the size requirements stated in the EPA Superfund Method and are >10 µm in length.



**Table 4. Air Sample Analysis Data (NIOSH 7402)**

<b>Sample Number</b>	<b>Sample Volume (liters)</b>	<b>Filter Area Analyzed (mm<sup>2</sup>)</b>	<b>Asbestos Concentration (f/cc, PCMe*)</b>
AS-1	800	0.3606	<0.0013
AS-2	800	0.3606	<0.0013

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\* f/cc, PCMe = fibers per cubic centimeter of air, Phase Contrast Microscopy Equivalents.

## AppendixC: Definitions

### Exposure pathways

An exposure pathway is the way in which an individual comes in contact with a contaminant. An exposure pathway consists of the following five elements: (1) a *source* of contamination; (2) a *media* such as air or soil through which the contaminant is transported; (3) a *point of exposure* where people can contact the contaminant; (4) a *route of exposure* by which the contaminant enters or contacts the body; and (5) a *receptor population*. A pathway is considered **complete** if all five elements are present and connected. A **potential** exposure pathway indicates that exposure to a contaminant could have occurred in the past, could be occurring currently, or could occur in the future. A potential exposure exists when information about one or more of the five elements of an exposure pathway is missing or uncertain. An **incomplete** pathway is missing one or more of the pathway elements and it is likely that the elements were never present and are not likely to be present at a later point in time. An **eliminated** pathway was a potential or completed pathway in the past, but has had one or more of the pathway elements removed to prevent present and future exposure.

### Public health hazard categories

ATSDR uses public health hazard categories to describe whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are defined as follows:

#### *No public health hazard*

A category used in ATSDR's assessments for sites where people have never and will never be exposed to harmful amounts of site-related substances.

#### *No apparent public health hazard*

A category used in ATSDR's assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

#### *Indeterminate public health hazard*

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

#### *Public health hazard*

A category used in ATSDR's assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high

levels of hazardous substances or radionuclides that could result in harmful health effects.

***Urgent public health hazard***

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