Health Consultation

W.R. Grace Exfoliation Facility

4220 W Glenrosa Ave

Phoenix, Maricopa County, Arizona

EPA Facility ID: AZD051452563

Prepared by:

Arizona Department of Health Services

Under Cooperative Agreement with the

Agency for Toxic Substances and Disease Registry

Foreword: ATSDR's National Asbestos Exposure Review

From the early 1920s until 1990, mining operations in Libby, Montana, produced and processed vermiculite. This vermiculite, which mining companies shipped to many locations around the United States for processing, contained asbestos.

The National Asbestos Exposure Review (NAER) is a project of the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is working with other federal, state, and local environmental and public health agencies to evaluate public health impacts at sites that processed Libby vermiculite.

The evaluations focus on the processing sites and on the human health effects that might be associated with possible past or current exposures. They do not consider how the products of these facilities were used by businesses or by consumers.

The sites that processed Libby vermiculite will be evaluated by 1) identifying the ways in which people could have been exposed to asbestos in the past and the ways in which people could be exposed currently, and 2) determining whether any such 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. Site evaluations are progressing in two phases:

Phase 1: ATSDR has selected 28 sites for the first phase of reviews on the basis of the following criteria:

- The U.S. Environmental Protection Agency (EPA) mandated further action at the site because of contamination in place, 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 is one of the site-specific health consultations ATSDR and its state health partners are developing for each of the 28 Phase 1 sites. A future report will summarize findings at the Phase 1sites and include recommendations for evaluating the more than 200 remaining sites nationwide that received Libby vermiculite.

Phase 2: ATSDR will continue to evaluate former Libby vermiculite processing sites in accordance with the findings and recommendations contained in the summary report. ATSDR will also identify further actions as necessary to protect public health.

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Arizona Health Consultation Process

This health consultation is based on a formal site evaluation prepared by the Arizona Department of Health Services (ADHS) and summarizes an evaluation of exposure pathways and potential health impacts at a site in Arizona. To conduct a health consultation, a number of steps are necessary.

Evaluating exposure. ADHS scientists begin by reviewing available information about environmental conditions at the site. The first task is to determine the extent of the contamination, where it is found on the site, and how people might be exposed to it. Usually, ADHS does not collect its own environmental sampling data. We rely on information provided by the Arizona Department of Environmental Quality (ADEQ), the U.S. Environmental Protection Agency (EPA), and by other government agencies, businesses, and the general public.

Evaluating health effects. If the evidence shows that people are currently exposed, or could in the future be exposed, to hazardous substances, ADHS scientists will take steps to determine whether such exposure is at levels that could endanger human health. The health consultation focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

Developing recommendations. In the health consultation, ADHS outlines its conclusions regarding any potential health threat posed by a site and offers recommendations for reducing or eliminating human exposure to contaminants. The role of ADHS in dealing with hazardous waste sites is primarily advisory. For that reason, the health consultation will typically make recommendations to other agencies such as EPA and ADEQ. If, however, a health threat is immanent, ADHS will issue a public health advisory warning people of the danger and will work to resolve the problem.

Soliciting community input. The health consultation process is interactive. ADHS starts by soliciting and evaluating information from various government agencies, from the organizations responsible for cleaning up the site, and from the communities near the site. Any conclusions about the site are shared with the individuals, the groups, and the organizations that provided information. Once a health consultation has been prepared, ADHS seeks feedback from the public. If you have questions or comments about this health consultation, we encourage you to contact us**.**

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Introduction

In Libby, Montana, from the 1920s through the early 1990s, W.R. Grace and other entities related to W.R. Grace or preceding it in interest ("the mining companies") mined, processed, and shipped millions of tons of vermiculite ore to approximately 244 sites across the United States. Expanded and unexpanded vermiculite from Libby had many commercial applications. Expanded (exfoliated) vermiculite included loose fill insulation, fertilizer carrier, and concrete aggregate. Unexpanded Libby vermiculite concentrate was found in gypsum wallboard, joint compound, cinder blocks, and many other building products.

Raw vermiculite ore from Libby, Montana, is estimated to contain up to 21–26% fibrous asbestos (MRI 1982). During mining and processing operations, asbestos fibers released into the ambient air, that is, the air in and around the mining companies' facilities. Consequently, many workers were exposed to high levels of asbestos-fiber concentrations. ATSDR health screening activities and other investigations within the Libby community have detected elevated levels of diseases related to asbestos exposure, such as asbestosis, mesothelioma, and lung cancer.

The W.R. Grace facility at 4220 W. Glenrosa Avenue in Phoenix, Arizona, received vermiculite concentrate from the Libby, Montana, vermiculite mine. W.R. Grace Company has owned and operated the Arizona site since 1964. The facility is located within an industrial use area, which is approximately ½-mile square. This area is in turn surrounded by a larger mixed use area consisting of commercial and residential districts. The nearest residential areas are approximately ½-mile northeast and southwest of the facility. In 1964 W.R. Grace purchased the company that had previously occupied the site and, following the relocation of its vermiculite exfoliation furnace from 6960 N 52nd Street, Glendale, Arizona, began processing vermiculite concentrate and marketing it under the Zonolite® brand.

The objective of this health consultation is to evaluate exposure pathways and potential health effects in those persons who, between 1964 and 2002, may have been exposed to Libby asbestos as a result of

1. vermiculite concentrate processing activities,
2. waste materials from the W.R. Grace exfoliation facility in Phoenix.

Background

Vermiculite is a nonfibrous silicate mineral with many commercial and consumer applications. Its usefulness comes from its ability at high temperatures to expand (i.e., exfoliate) up to 20 times its original size (EPA 1991). Additionally, vermiculite has a high-ion exchange capacity, making it useful for absorbing liquids or chemicals. The density of raw vermiculite ore is approximately 55 pounds per cubic foot, while the density of finished vermiculite is in the range of 6 to 8 pounds per cubic foot.

The raw vermiculite ore mined in Libby, Montana, is estimated to have contained up to approximately 21–26% fibrous amphibole asbestos of the tremolite series (MRI 1982). Mining companies extracted the raw ore by open-pit mining methods and transferred it to a milling operation to remove waste rock. Mining facilities in Libby then screened the concentrate into several size ranges (from #0, coarse, to #5, fine) for processing into finished vermiculite for shipment, usually by rail, to a number of exfoliation (expansion) plants across the United States and Canada. Some studies suggest that the different ore grades may have had varying asbestos contents, with finer grades being the more contaminated (EPA 1991). Other data suggest that in the various grades of ore the tremolite content was typically 0.3%–7% (MRI 1982). A 1977 internal W.R. Grace memorandum estimates that 28% of all workers with over 10 years' service and who had been exposed to ore concentrate from Libby, Montana, had contracted asbestosis (MDH 2000). Former workers at other sites using the ore from the Libby mine have reported cases of asbestos-related disease to the media.

The W.R Grace facility in Phoenix received by rail vermiculite concentrate from the mining operation in Libby, Montana, from 1964 to 1992 (EPA 2001). The facility stopped processing vermiculite from the Libby mine in 1992. The facility currently processes vermiculite from a mine in South Carolina. When amphibole asbestos has been detected in vermiculite from mines other than Libby, the reported amounts have been much lower than those in Libby vermiculite (ATSDR 2001). South African expanded and unexpanded samples showed 0.4% and 0.0% amphibole content, respectively (Moatamed et al. 1986). In another investigation, total asbestiform fibers (i.e., classified as tremolite-actinolite) represented less than 1% of the weight of samples of raw ore and vermiculite concentrate from Enoree and Patterson, South Carolina. This is compared with ~21% to 26% and 0.3% to 7% of the weight of raw ore and vermiculite concentrate samples from Libby, Montana (Atkinson et al. 1982). Expanded and unexpanded percentages of the Virginia ore were 1.3% amphibole by weight; Moatamed (1986) notes, however, that the Virginia and South African amphiboles were predominantly nonasbestiform, while the Montana (Libby) amphibole was predominantly asbestiform.

Processing Methods

Mining companies shipped the concentrate in railroad cars with an approximate capacity of 45–50 tons per car. Ore was stored in bins outside the facility prior to being fed into an exfoliation furnace. Prior to 1977, vermiculite ore was unloaded using an open conveyor to an enclosed elevator (Grace 1977a). A front end loader took the vermiculite concentrate from the bin to the expanding furnace loading hopper (Grace 1977a).

In 1977, new material handling equipment, consisting of a railroad hopper car unloading pit, enclosed conveyors, and feed elevator were installed. The new system consisted of a belly dump sump, into which the raw ore was gravity fed from the ore car, after which it was transported to a holding bin. From the holding bin, the ore traveled to the furnace on a conveyor type system.

The facility used a furnace, designated as a Model A type, specifically designed to expand the vermiculite concentrate and to facilitate packaging of the finished product. W.R. Grace installed this furnace in 1964 and added another Model D-18 exfoliation furnace during the 1970s.

Waste rock is currently separated from the finished product and placed in 52-cubic foot bags. In the past the bags containing waste rock were stored on site in a holding container until removed for disposal at a local landfill. Employees may have taken home some of the waste rock (EPA 2001).

From 1964 to 1992, the W.R. Grace Phoenix facility used Vermiculite ore from the Libby, Montana, mine to make commercial products. From 1971 to 1992, W.R. Grace processed approximately 204,000 tons of Libby ore at the site (EPA 2001).

Vermiculite is generally used for insulation, as a lightweight aggregate in construction materials, and as a soil additive for gardening. Vermiculite also has many other industrial uses, including as a fireproofing material, as an absorbent, and as a filter medium (Vermiculite Association 2000).

Air Pollution Control Equipment

Dust inside the facility became a significant problem in 1971 when a concrete aggregate bulk system was installed. The system consisted of an overhead conveyor, which allowed dust to fall over the warehouse. A further change to “Number 4 Concrete” created additional dust problems. Because of the increased dust levels, W.R. Grace enclosed the conveyor system, and in 1976 installed a wet dust collector system. These changes resulted in a 99% reduction in dust levels (Grace 1977b). In addition, in 1975 and 1976 dust collection baghouses were installed on the furnaces.

Removal Action

Pursuant to an Administrative Order on Consent (AOC) (EPA 2002d), W.R. Grace as the site owner and operator performed all removal work. EPA provided oversight of the removal action. In the railroad loading area, soil containing asbestos concentrations greater than 1% wasremoved to a depth of 1 foot below the surface, the excavation was backfilled with clean soil, and was capped with concrete or asphalt (EPA 2002d). Upward-facing horizontal surfaces where microvacuum samples showed greater than 10,000 TA asbestos structures/cm^2 (Silo Area and Maintenance Building) were microvacuumed (using HEPA filter vacuum) and wet wiped to remove any asbestos-containing dust (EPA 2002d). All asbestos was transported offsite to an approved disposal facility (EPA 2002d). All work was completed by December 2001.

Environmental Data

In February 2001 the. Environmental Protection Agency, as part of a national evaluation of facilities that received ore from the mine in Libby, Montana, collected surface soil, air, and surface dust samples from this. W.R. Grace Phoenix facility in Phoenix. EPA collected 14 soil samples (including one duplicate), 6 microvacuum dust samples (plus two blanks), and 4 ambient air samples (plus two blanks). Four bulk samples of suspect vermiculite-containing materials were also collected (EPA 2001). The results of the 2001 investigation are contained in Tables 1–4.

Table 1 shows six composite microvacuum dust samples that were collected from horizontal surfaces within the on-site buildings. Appendix A, Figure 2 shows the sample locations. Samples were collected in the Office Building, Production Building, and Warehouse. Microvacuum dust samples were collected by drawing air through a mixed cellulose ester (MCE) filter (0.45 micrometer (µm) pore size) at a flow rate of 2.0 liters per minute (L/min.) for 2 minutes at each sampling location. The sampling was performed using battery-operated sampling pumps. To obtain a more representative dust sample, personnel vacuumed three separate 100-square centimeter (cm^2) sampling areas per sampling cassette. Samples were analyzed by transmission electron microscopy (TEM) by the International Standards Organization (ISO) Method 10312. Two of the samples were rejected by the laboratory because of damage to the cassettes during shipping (e.g., the plastic seal caps fell off the ends of each cassette). Three of the remaining microvacuum samples were found to contain asbestos.

Fourteen samples were collected at 13 locations at unpaved portions of the site (Table 2). Sample locations are shown in Appendix A, Figure 3. All of the soil samples were grab samples and were collected from approximately the top 3 inches of soil using a stainless steel scoop. Soil samples were analyzed using polarized light microscopy (PLM) in accordance with National Institute for Occupational Safety and Health (NIOSH) Method 9002. Sample results are reported as tremolite-actinolite to indicate the presence of Libby asbestos. Of the 14 soil samples, a maximum of 2 percent tremolite/actinolite asbestos was detected in a sample taken along the railroad tracks at the site's western perimeter. In addition, 1 percent chrysotile and a trace amount of tremolite/actinolite asbestos were detected in a sample that was also collected at the railroad tracks. For the remaining 12 soil samples, a trace amount (i.e., less than 1 percent by visual estimate) of tremolite/actinolite asbestos was detected in each sample. A trace amount of chrysotile asbestos was also detected in 3 of the 12 soil samples. The three samples containing trace amounts of chrysotile were collected from unpaved areas along the eastern perimeters of the site and near the railroad tracks adjacent to the western perimeter.

Tables 3 and 4 show the analytic results of the four air samples. These samples were collected in the office building, the production building, and the warehouse. These samples were collected while routine operations were occurring at the site. No deliberate attempt was made to stir up residual contamination;, therefore, these were not aggressive samples. Air samples were analyzed by ISO Method 10312: a TEM method that determines the types of asbestos fibers present, as well as the lengths, widths, and aspect ratios of the asbestos structures. Asbestos structures were detected in one of the four ambient air samples. This sample was collected between the exfoliation ovens and was found to contain 0.0107 s/cc of amphibole asbestos (tremolite-actinolite). [a]

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[a] All microvacuum dust samples were analyzed by ISO Method 10312 (TEM). Results reported as "Number of Asbestos Structures Detected" correspond to the actual number of structures observed during analysis of a portion of the microvacuum filter. The "Total Asbestos Concentration" values are estimated for the surface area sampled.

Table 1. Results of Microvacuum Surface Dust Sample Analysis

Sample	*Sample Type*	*Sample Location*	*Area Sampled*	*Number of Asbestos Structures Detected (on the filter sample)*	*Total Asbestos Concentration (s/cm^2)* (estimated for the surface area sampled)
PA2-00005 PA2-00006	Composite	Three areas west of exfoliation ovens and east of storage silos on the floor adjacent to the auger.	300 cm^{2*}	7 Tremolite – Actinolite	44,667
				1 Chrysotile	6,381
PA2-00007	Composite	Three horizontal surfaces on bag house lids.	300 cm^{2*}	ND	< 2,552
PA2-00008	Composite	Three horizontal areas in the Warehouse	300 cm^{2*}	Invalid Sample	N/A
PA2-00009 PA2-00010	Composite	Three horizontal surfaces in the maintenance shop	300 cm^{2*}	11 Tremolite – Actinolite	350,952
				1 Chrysotile	31,905
PA2-00030	Composite	Three horizontal surfaces of Office Building	300 cm^{2*}	Invalid Sample	N/A
PA2-00031	Composite	Three horizontal surfaces and wall beams in the Warehouse	300 cm^{2*}	1 Chrysotile	4,254
PA2-00005	Blank	Blank		ND	
PA2-00006	Blank	Blank		ND	

Source: EPA 2001
*Three 100 cm^2 were vacuumed

Table 2. Results of Surface Soil Sample Analysis

Sample	*Sample Type*	*Sample Location*	*Asbestos Concentration (% by Volume)*	*Type of Asbestos*
PA2-00011	Grab	Along Glenrosa Ave from the vegetated buffer strips	Trace	Tremolite-Actinolite
PA2-00012	Grab	Along Glenrosa Ave from the vegetated buffer strips	Trace	Tremolite-Actinolite
PA2-00013	Grab	Along N. 42nd Ave from the vegetated buffer strips	Trace	Tremolite-Actinolite
PA2-00014	Grab	Near exit of facility	Trace	Tremolite-Actinolite
PA2-00015	Grab	Inside gate along warehouse	Trace	Tremolite-Actinolite
PA2-00016	Grab	Along railroad tracks	2 %	Tremolite-Actinolite
PA2-00017	Grab	Along railroad tracks	Trace	Tremolite-Actinolite
PA2-00018	Grab	Near railroad switch along railroad tracks	Trace	Tremolite-Actinolite
PA2-00019	Grab	Along railroad tracks	Trace	Tremolite-Actinolite
PA2-00020	Grab	Along railroad tracks	Trace	Tremolite-Actinolite
PA2-00021	Grab	Duplicate of sample, PA2-00020	Trace	Tremolite-Actinolite
PA2-00022	Grab	Along railroad tracks	Trace	Chrysotile
			Trace	Tremolite-Actinolite
PA2-00023	Grab	Along railroad tracks	1 %	Chrysotile,
			Trace	Tremolite-Actinolite
PA2-00024	Grab	Along railroad tracks	Trace	Chrysotile,
			Trace	Tremolite-Actinolite

Note: All soil samples were analyzed by Polarized Light Microscopy (PLM)

Source: EPA 2001

Table 3 Air Sample Analysis Results

Sample	*Sample Type*	*Sample Location*	*Asbestos Result (asbestos structure count)*	*Type*	*Concentration s/cc*
PA2-00001	Air	Office Building (Reception)	ND*	ND	<0.0008
PA2-00002	Air	Production bldg. near exfoliation ovens (furnaces)	3	Trem-Act	0.0107
PA2-00003	Air	East edge of Warehouse	ND	ND	<0.0009
PA2-00004	Air	Same as PA2-00002	ND	ND	<0.0137
PA2-00028	Blank	Blank	ND	ND	NA
PA2-00029	Blank	Blank	ND	ND	NA

* ND = Nondetect

Source: EPA 2001

Table 4. Air Filter Analytic Data

Sample	*Asbestos Mineral*	*Asbestos Structure Types*				*Structures >5 microns in length*	*Excluded Structures*	*Asbestos Structures for Concentration*
		Fibers	*Bundles*	*Clusters*	*Matrices*			
PA2-00001	ND*	0	0	0	0	0	0	0
PA2-00002	Actinolite	3	0	0	0	1	0	3
PA2-00003	ND	0	0	0	0	0	0	0
PA2-00004	ND	0	0	0	0	0	0	0
PA2-00028	ND	0	0	0	0	0	0	0
PA2-00029	ND	0	0	0	0	0	0	0

* ND = Nondetect

Source: EPA 2001

Discussion

The site investigation at the W.R. Grace Phoenix plant is part of ATSDR's national effort to identify and evaluate potential asbestos exposures that may have occurred at sites where vermiculite mined in Libby, Montana was processed. This effort is known as the National Asbestos Exposure Review (NAER). The findings of studies conducted at Libby linked asbestos exposure with several health effects (ATSDR 2002; Peipins et al. 2003) and led to the current investigation of Libby-vermiculite processing sites, including the W.R. Grace Phoenix facility. Significantly, however, the asbestos exposures documented in the Libby community are in many ways unique to that community. Exposures in Libby include factors that will not be present as a group at other sites where Libby vermiculite was processed or handled.

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 or chrysotile asbestos has relatively long and flexible crystalline fibers; it is the predominant type of asbestos used commercially. Amphibole asbestos minerals are brittle and have a rod- or needle-like shape. Amphibole minerals regulated as asbestos by EPA and OSHA include five classes:

- fibrous tremolite,
- actinolite,
- anthophyllite,
- crocidolite, and
- amosite.

Other amphibole minerals such as winchite and richterite can, however, exhibit fibrous asbestiform properties (ATSDR 2001).

Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water or evaporate, and they are resistant to heat, fire, and chemical and biological degradation.

The vermiculite mined at Libby 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 (MRI 1982). For most of the mine’s operation, Libby asbestos was considered a byproduct 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) (MRI 1982).

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 µm) 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) µm in diameter and shorter than 5µm in length, and the inability to distinguish between asbestos and nonasbestos fibers (ATSDR 2001).

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 ~1 µm, widths greater than ~0.25 µm, 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 (ATSDR 2001).

Historically, the majority of epidemiological studies performed on asbestos exposure used phase contrast microscopy (PCM) to determine fiber levels in air (f/cc). Advances in technology (e.g., transmission electron microscopy, or TEM) allows measurement of fibers many times smaller than those that would have been detected by PCM and thus typically results in counts much higher than those generated using PCM. Therefore, for risk assessment purposes, TEM data needs to be converted to an equivalent PCM value, referred to as PCM equivalents (PCMe). Two ways to make this conversion are 1) count (or bin) fibers with sizes equal to those that would be counted with PCM (diameter >0.4 µm and length >5 µm) or, 2) make simultaneous measures of TEM counts and PCM counts and compute a conversion factor. 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 (EPA 1993).

In limited situations PCM fiber levels can be higher than TEM levels. Because PCM cannot determine fiber types, environments that may have high nonasbestos fiber loads will show higher PCM fiber counts than TEM, which distinguishes asbestos fibers from nonasbestos fibers. In general, the epidemiological literature is based on predominantly asbestos fiber environments in which PCM did not significantly overestimate fiber loads. This limitation may be, however, important in environments that contain nonasbestos fibers and are measured by PCM.

EPA is currently working with several contract laboratories and other organizations to develop, refine, and test a number of methods for screening bulk soil samples. The methods under investigation include PLM, infrared (IR), and SEM (Jim Christiansen EPA, personal communication, November 2002).

Asbestos Health Effects and Toxicity

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

- *Malignant mesothelioma*—is a 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 all mesothelioma cases are attributable to asbestos exposure (ATSDR 2001).
- *Lung cancer*—is a 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 (ATSDR 2001).
- *Noncancer effects*—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 that may restrict breathing; *pleural calcification*, calcium deposits 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 (ATSDR 2001).

Not enough evidence is available to determine whether inhalation of asbestos increases the risk of cancer at sites other than the lungs, pleura, and the abdominal cavity (ATSDR 2001).

Ingestion of asbestos causes little or no risk of noncancerous effects. Some evidence indicates, however, 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 (ATSDR 2001).

ATSDR considers the inhalation route of exposure to be the most significant in the current evaluation of sites that received Libby vermiculite. Exposure scenarios 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 limiting clearance of 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 (ATSDR 2003a). The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths <5 μm are essentially nontoxic in terms of association with mesothelioma or lung cancer promotion. Fibers with lengths <5 μm may, however, play a role in asbestosis when exposure duration is long and fiber concentrations are high. More information is needed to reach this conclusion definitively.

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 clear from the lung, whereas amphibole is not removed and builds up to high levels in lung tissue (Churg 1993). 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 (Churg 1993). OSHA continues, however, to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease (OSHA 1994). EPA's Integrated Risk Information System (IRIS) assessment of asbestos also treats mineralogy (and fiber length) as equipotent (EPA 2002a).

Evidence suggesting that the different types of asbestos fibers vary in carcinogenic potency and site specificity is to some degree limited by the lack of epidemiological information on exposure to pure mineral types. 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 (Berman and Crump 1999a, 1999b).

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 (ATSDR 2001; Berman and Crump 1999a, 1999b). 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 µm–5 µm are considered above the upper limit of respirability (i.e., too large to inhale), and thus do not contribute significantly to risk. Methods to assess the risks posed by varying types of asbestos are being developed and are currently awaiting peer review (Berman and Crump 1999a,1999b).

Current Standards, Regulations, and Recommendations for Asbestos

In industrial applications, an asbestos-containing material (ACM) is defined as any material with >1% bulk concentration of asbestos (EPA 1989). It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when EPA regulations were created. Studies have shown that disturbing soil containing <1% amphibole asbestos can, however, suspend fibers at levels of health concern (Weis 2001).

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 (EPA 2002b). 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 µm and with an aspect ratio (length: width) >3:1, as determined by PCM (OSHA 1994). 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 (OSHA 1994). 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 is based on an unacceptable health risk level for this population.

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 of Occupational Safety and Health (NIOSH), the New York City Department of Health and Mental Hygiene, the New York State Department of Health, and OSHA. The work group set a short-term reoccupation level of 0.01 f/cc (ATSDR 2003). 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 is predicated 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 (EPA 2003).

NIOSH set a recommended exposure limit of 0.1 f/cc for asbestos fibers longer than 5 µm. This limit is a TWA for up to a 10-hour workday in a 40-hour work week (NIOSH 2002). The American Conference of Government Industrial Hygienists has also adopted a TWA of 0.1 f/cc as its threshold limit value (ACGIH 2000).

EPA has set a maximum contaminant level (MCL) for asbestos fibers in water of 7,000,000 fibers longer than 10 µm per liter, based on an increased risk of developing benign intestinal polyps (EPA 2002c). 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 has calculated an inhalation unit risk for cancer (cancer slope factor) of 0.23 per f/cc of asbestos (EPA 2002a). 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—the slope factor above this concentration might differ from that stated (EPA 2002a). Perhaps the most significant limitation is that the model does not consider mineralogy, fiber-size distribution, or other physical aspects of asbestos toxicity. Given the limitations of the method currently used and the knowledge gained since it was implemented in 1986, EPA is in the process of updating its asbestos quantitative risk methodology.

Exposure Assessment and Toxicological Evaluation

Evaluating the health effects of exposure to Libby asbestos requires both extensive knowledge of exposure pathways and access to toxicity data. But the toxicological information currently available is limited, so the exact level of health concern for different sizes and types of asbestos remains uncertain. Similarly, exposure pathway information for Phoenix is limited or unavailable. Specific data limitations include

- Limited information on past concentrations of Libby asbestos in air in and around the Phoenix plant.
- Significant uncertainties and conflicts about analysis methods used. These problems limit our ability to estimate the levels of Libby asbestos to which people may have been exposed.
- Unclear data on how and how often people came in contact with Libby asbestos from the plant—most exposures happened long ago. This information is necessary to estimate accurate exposure doses.
- Insufficient information about how some vermiculite materials, such as waste rock, were handled or disposed. As a result, identifying and assessing potential current exposures is difficult.

Given these limitations, we cannot quantitatively evaluate the public health implications of past operations at this site. The following sections are instead a qualitative assessment of potential public health implications. The sections describe the various types of evidence we used to evaluate exposure pathways and to 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; it is likely that the elements were never present and not likely they will ever 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 and from facilities that processed vermiculite from Libby, the NAER team has identified *potential* exposure pathways that apply, in general, to all of the vermiculite processing facilities. All of these pathways have a common source—vermiculite from Libby—and a common route of exposure—inhalation (see Summary Table 4 on the following page). Although asbestos ingestion and dermal (skin) exposure pathways could exist, health risks from these pathways are minor in comparison to those resulting from inhalation exposure to asbestos. Therefore, this health consultation does not evaluate these pathways.

Table 5. Completed and Potentially Completed Exposure Pathways

Pathway Name	*Exposure Scenario(s)*	*Past Pathway Status*	*Present Pathway Status*	*Future Pathway Status*
Occupational	Former workers exposed to airborne Libby asbestos during handling and processing of contaminated vermiculite, or workers exposed to airborne chrysotile fibers during manufacture of Monokote ® -3.	Complete	Not applicable	Not applicable
	Workers exposed to airborne Libby asbestos from residual contamination inside former processing buildings	Complete	Incomplete	Incomplete
Household Contact	Household contacts exposed to airborne Libby asbestos brought home on former W.R. Grace workers' clothing	Complete	Incomplete	Incomplete
On-site Waste Piles	Community members (particularly children) playing in or otherwise disturbing on-site piles of contaminated vermiculite or waste rock	Potential	Eliminated	Eliminated
On-site Soils	Current on-site workers, contractors, or community members disturbing contaminated on-site soils (residual contamination, buried waste)	Not applicable	Potential	Potential
Ambient Air	Community members or nearby workers exposed to airborne fibers from plant emissions during handling and processing of contaminated vermiculite	Potential	Eliminated	Eliminated
Residential Outdoor	Community members using contaminated vermiculite or waste material at home (for gardening, paving driveways, fill material)	Potential	Potential	Potential
Residential Indoor	Community members disturbing household dust containing Libby asbestos from plant emissions or waste rock brought home for personal use	Potential	Potential	Potential
Consumer Products	Community members, contractors, and repairmen disturbing consumer products containing contaminated vermiculite	Potential	Potential	Potential

Occupational

1968–1992

The occupational exposure pathway for people who worked at the Phoenix plant prior to 1992 is considered complete. There are several occupational exposure scenarios resulting from the operation of this facility including

- Transferring materials from the rail cars to the storage area, and loading of raw material into the conveyor system,

- Bagging process materials,
- Removing waste rock from the furnace area prior to removal off site, and
- Inhaling ambient dust inside the facility.

Without question, former W.R. Grace workers were exposed to airborne levels of asbestos that posed a public health hazard. W.R. Grace & Co records indicate that workers were exposed to high indoor levels of Libby asbestos in the air. Employee air sample results for the years 1972 to 1988 (Unpublished information from EPA's database of W.R. Grace Documents) [b] are contained in Appendix A, Figure 4. Personal sampling results were up to 4.56 f/cc. When a sampling time was provided, personal samples collected were approximately 15 to 70 minutes in duration. Because of the short sample periods, W.R. Grace industrial hygienists did not always calculate 8-hour time weighted averages (8 hr. TWA). The 8-hour TWA shows the average concentration, weighed according to time of exposure, of asbestos that the worker was exposed to during the 8-hour work day. The highest W.R. Grace calculated 8-hour TWA's was 0.43 f/cc[c].

According to available information obtained from W.R. Grace records, in 1976 efforts were underway to control fiber levels inside the plant through local exhaust ventilation systems. W.R. Grace began installing enclosed ore handling and dust control equipment in 1977. Area samples collected by W.R. Grace show that concentrations (up to 13.96 f/cc) of fibers were generated by plant operations (see Appendix A, Figure 5).

An internal W.R. Grace memorandum estimates that 28% of workers with over 10 years service exposed to ore concentrate from Libby, Montana, had contracted asbestosis (MDH 2000). Cases of asbestos-related disease among former workers at other sites using the ore from the Libby mine have been reported in the media. The frequency and duration of former worker exposures varied depending on their job assignment, facility operation schedule, and period of employment. Worker exposure to asbestos may have been reduced if respiratory protection was used. Information is not available to evaluate the use or overall effectiveness of respiratory equipment in reducing worker exposures to asbestos at this facility. Depending on the severity of their exposures, former workers at the facility could develop health effects that include increased incidence of fatal lung diseases, pulmonary fibrosis, mesothelioma, and lung cancer as a result of their exposure. Workplace exposures at the facility from 1964 to 1978 were higher, and therefore likely posed a more severe health threat to employees than later periods. According to internal

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[b] Unpublished data from a database of W.R. Grace documents that EPA Region 8 obtained through legal means during the Libby mine investigation. This document database contains confidential business information as well as private information that is not available to the public.

[e] Unpublished data from a database of W.R. Grace documents that EPA Region 8 obtained through legal means during the Libby mine investigation. This document database contains confidential business information as well as private information that is not available to the public.

[c] 8-hour Time weighted averages are average levels calculated with the following formula:

$$\frac{\sum_{i=1}^{j} C_i T_i}{480 \text{ min}}$$ Where C = Concentration, T= Time (minutes).

W.R. Grace documents, between 8 and 25 employees worked at this site (Unpublished information from EPA's database of W.R. Grace Documents).

1992-Present

Workplace exposures at the facility after 1992 were probably much lower than exposures that occurred prior to 1992 because Libby ore was no longer used at the facility after 1992. In 2000, EPA measured 0.0107 structures/cc in air next to the exfoliation ovens (EPA 2001). The tremolite-actinolite fibers detected could not, however, be associated with residual exposure to Libby asbestos[d]. A recently published NIOSH study of an exfoliation facility processing vermiculite from South Carolina detected low levels of airborne tremolite-actinolite asbestos as well (NIOSH 2004).

Further exposure to residual Libby asbestos is unlikely at this site, given that EPA required cleanup via HEPA vacuuming and wet wiping of residual, asbestos-contaminated dust sampled on vertical surfaces EPA also ordered removal of asbestos-contaminated soils on site, which was completed in winter, 2001 (Moxley 2002). ATSDR has not received any clearance or confirmatory sampling from this cleanup; however, as previously noted, there is a low level of tremolite-actinolite series fibers in South Carolina ore, which would have likely interfered with any clearance sampling taken.

Household contact

During the period when Libby ore was processed, the families of past workers may have been exposed to asbestos-containing dusts from the plant that were carried home on workers' hair and clothing. Exposures to household contacts cannot be quantified but would have been influenced by the levels of Libby asbestos on worker clothing and certain behavior factors (e.g., worker hygiene practices or household laundering practices). It is reasonable to assume, based on the high levels of exposure at the plant, that fibers made it home on workers' clothing.

Research has documented the link between asbestos-industry workers' exposure to asbestos and asbestos-related disease in the workers' family members (Anderson et al. 1976; Kilburn et al. 1985). ATSDR's 2001 Libby study also observed a prevalence of pleural abnormalities in the household contacts of workers employed at the mine and at associated vermiculite-processing facilities.

Waste Rock

Currently the facility places its waste rock (which is derived from vermiculite from the South Carolina mine) into 52ft^3 storage bags, which are stored in containers prior to disposal in a landfill. Records documenting disposal practices during the period when Libby Vermiculite was processed at this facility were not found. At other exfoliation sites, waste rock was a significant exposure pathway to the community. For instance, at the Western Minerals plant in Minneapolis, children were playing in the waste piles, and the waste rock was given to the surrounding community for fill material and other uses (MDH 2001). At some point in 1985 Grace began

[d] Total asbestiform fibers (classified as tremolite-actinolite) represented less than 1% of the weight of samples of raw ore and vermiculite concentrate from Enoree and Patterson, South Carolina, compared with ~21% to 26% and 0.3% to 7% of the weight of raw ore and vermiculite concentrate samples, from Libby, Montana respectively (Atkinson et al. 1982).

wetting and storing its waste in containers at all exfoliation plants, but the exact date is unknown (Unpublished information from EPA's database of W.R. Grace Documents). Because records to obtain information on the disposal of the waste rock do not exist, alternative methods to determine if people in the surrounding area were exposed were undertaken. Aerial photographs of the facility and the surrounding area were examined to determine if the waste rock piles was stored on the site (EDR 2004). No evidence of on-site storage was observed from the photographs, which clearly show the rail cars on the site during the period the facility was in operation. W.R. Grace also reported that the public has had no access to the site since the perimeter fence was added in the late 1970s. Prior to that time, W.R. Grace had personnel on site for approximately 16 hours each day, which would have possibly discouraged younger children trespassing and disturbing on-site materials (EPA 2001).

If piles of waste rock from the exfoliation of Libby vermiculite were accessible, they may have been a source of asbestos exposure to children who might have played in them. The piles might also have been an exposure source for people removing, handling, or using the stoner rock or waste vermiculite for fill or other uses. The stoner rock was estimated to contain between 2% and 10% friable asbestos (Unpublished information from EPA's database of W.R. Grace Documents). A past study of asbestos-related disease from exposure to tremolite asbestos cited a case of asbestosis and lung cancer in a man who lived near a vermiculite processing plant for the first 20 years of his life and who reportedly sometimes played in the piles of vermiculite tailings (Srebro and Roggli 1994).

Ambient Air

No known data identify the quantities of asbestos emitted from the facility between 1964 and 1992, the time when it was processing Libby concentrate. Nevertheless, using information provided by W.R. Grace for similar facilities, air emissions appear to indicate that tremolite asbestos fibers were present in the particulate emissions from similar exfoliating furnaces. Friable tremolite asbestos at similar facilities was present in the fine particulate matter from the process vent system at concentrations ranging from 1% to 3% (Unpublished information from EPA's database of W.R. Grace Documents). Wind patterns in the Phoenix area are variable; in general, however, winds are out of the east in the evenings and out of the west in the daytime. Assuming operations were generally conducted during the daytime, any downwind asbestos exposures would be primarily east of the facility. Because the facility no longer processes Libby vermiculite, this ambient air pathway is currently incomplete.

Residential outdoor

According to interviews conducted by EPA, workers may have occasionally taken product (e.g., Redi Earth™) off site for home use (EPA 2001). ATSDR does not know if this created a potential hazard to these workers. In any event, these employee's occupational exposures likely exceed any exposure resulting from this practice.

Whether the general public ever hauled away contaminated materials such as waste rock for personal use is unknown. A neighborhood visual survey attempted to determine if the waste material was used in the surrounding residential areas. For instance, ATSDR and ADHS staff looked for gravel driveways containing stoner rock, as occurred in and near the Western Minerals site in Minneapolis (MDH 2001). Although staff members found no indication the material was used within approximately 4 square miles of nearby residential developments, this survey was not comprehensive.

Residential indoor

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 brought home for personal use. No information on past levels of contamination in ambient air exist but past ambient air emissions would have been high enough to infiltrate significantly into houses about a quarter of a mile away appears unlikely. No information has been gathered about community members using waste materials in their yards, and information to evaluate whether this exposure pathway is likely to be significant for the site is insufficient.

On site

Soil containing asbestos concentrations greater than 1% was removed to a depth of 1 foot below the surface, the excavation was back-filled with clean soil, and capped with concrete or asphalt. (EPA 2002d). Trace amounts of Libby asbestos have been detected in the soil remaining around the plant. Disturbing soils with even trace amounts of Libby asbestos can result in airborne Libby asbestos at levels of potential concern (Weis 2001). That said, however, the contaminated soils on site were not presently being disturbed, given that these soils are on a railroad spur or in vegetated areas. Given current site conditions, ATSDR considers on-site soils to be an incomplete exposure pathway at the present time.

Finished Consumer Products

People who purchase vermiculite products and use those products in and around their homes may be exposed to asbestos fibers. At this time, determining the public health implication of commercial or consumer use of vermiculite products (e.g., home insulation or gardening products) is beyond the scope of this evaluation. Studies have shown, however, that disturbing or using these products can result in airborne asbestos fiber levels higher than occupational safety limits (Weis 2001). 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).

Health Outcome Data

As a separate project, ATSDR's Division of Health Studies is obtaining data to perform health statistics reviews related to sites that have received vermiculite ore. When complete, ATSDR will publish results of the health statistics review for this site.

Summary of Removal and Remedial Actions Completed

EPA has overseen a removal action at this site that included

- removal of dusts the horizontal surfaces inside buildings (>10,000 s/cm2), and
- removal of highly contaminated soils (>1% asbestos) on site.

Child Health Considerations

ATSDR and ADHS recognize that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than are adults from certain kinds of exposures to hazardous substances—including asbestos—at waste disposal sites. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are smaller than are most adults, which means they breathe dust, soil, and heavy vapors close to the ground. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, however, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. The long latency period (between 10 and 40 years) of asbestos-related diseases also places children at greater risk of developing disease earlier in life.

Children who lived near the site may have been exposed to asbestos-containing wastes while the plant was operating. Children may also have been exposed to asbestos in particulate emissions from the plant, in dust carried into homes from air emissions, or from use of the vermiculite wastes as fill at residential properties. Children could have been exposed from dust carried home on the clothing of a parent who worked at the plant. Ongoing exposure could be occurring in locations where vermiculite wastes were used as fill and in homes where it was used for insulation. That said, however, the extent of these exposures, and the potential health effects, remain difficult to determine.

Conclusions

1. Occupational exposure to asbestos fibers in indoor air at the W.R Grace facility in Phoenix between 1964 and 1992 was a **public health hazard**[e] to employees of the facility. In the past, workers' families are likely to have been exposed to Libby asbestos through household contact.
2. Because residual levels of Libby asbestos in the facility were low, occupational exposure from 1992–2002 posed no apparent public health hazard. In 2002, the EPA required cleanup further reduced exposures to Libby asbestos to workers on site.
3. Information is insufficient to determine the extent to which people living in the neighborhood of the plant were exposed to Libby asbestos in the past from the ambient air pathway, the residential indoor pathway, the residential outdoor pathway, or the waste piles pathway. These pathways pose an indeterminate public health hazard. Any risk of adverse health effects from these past pathways would, however, be small compared to the past occupational and household contacts pathways.
4. In the past, Libby asbestos contamination in on-site soils around the plant posed an indeterminate health hazard. Soils containing >1% asbestos on the site have been cleaned up, and given current site conditions (i.e., no disturbance of soils containing trace levels of asbestos), present and future on-site exposure poses no public health hazard.

Recommendations

- Promote awareness of past asbestos exposure among former workers and members of their households.
- Encourage former workers and their household contacts to inform their regular physician about their exposure to asbestos. If former workers or their household contacts are concerned or symptomatic, they should be encouraged to see a physician who specializes in asbestos-related lung diseases.

[e] See Appendix B for ATSDR Health Hazard Category Definitions

- Develop a plan for reducing the possibility of frequent or regular contact with soil containing trace levels of Libby asbestos.
- Promote awareness of potential past asbestos exposure among community members who lived near the facility from 1964 through 2002 and provide easily accessible materials that will assist community members in self-identifying their exposures.
- Provide information to increase awareness of the site owner about potential residual asbestos at the site.

Public Health Action Plan

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by ATSDR and other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this health consultation not only identifies public health hazards, but provides a plan of action designed to mitigate and to prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR is committed to follow up on this plan to ensure its implementation. The public health actions to be implemented follow.

- ATSDR or its state partners, or both, will study the feasibility of conducting worker and household contact follow-up activities.
- ADHS, ATSDR or EPA will notify the current owner of the facility about potential residual asbestos contamination at the site.
- ATSDR will combine the findings from this health consultation with health consultation findings from other sites that processed vermiculite from Libby, and ATSDR will develop a national summary report of the overall conclusions and strategy for addressing the public health implications.
- ATSDR or ADHS will provide educational materials and references, upon request, to community members concerned about products containing vermiculite.
- ATSDR or ADHS will review any new information that becomes available to determine appropriate site-specific public health actions.
- ATSDR will publish annual reports summarizing results of health statistics reviews for the vermiculite processing sites.

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Certification

This W. R. Grace Exfoliation Facility Health Consultation was prepared by the Arizona Department of Health Services under cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

Technical Project Officer, CAPEB, CAT, DHAC NAER Team Member, EISAB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with the findings.

Chief, CAPEB, DHAC

Chief, EISAB, DHAC

Appendix A. Figures

Figure 1 – Site Introductory Map

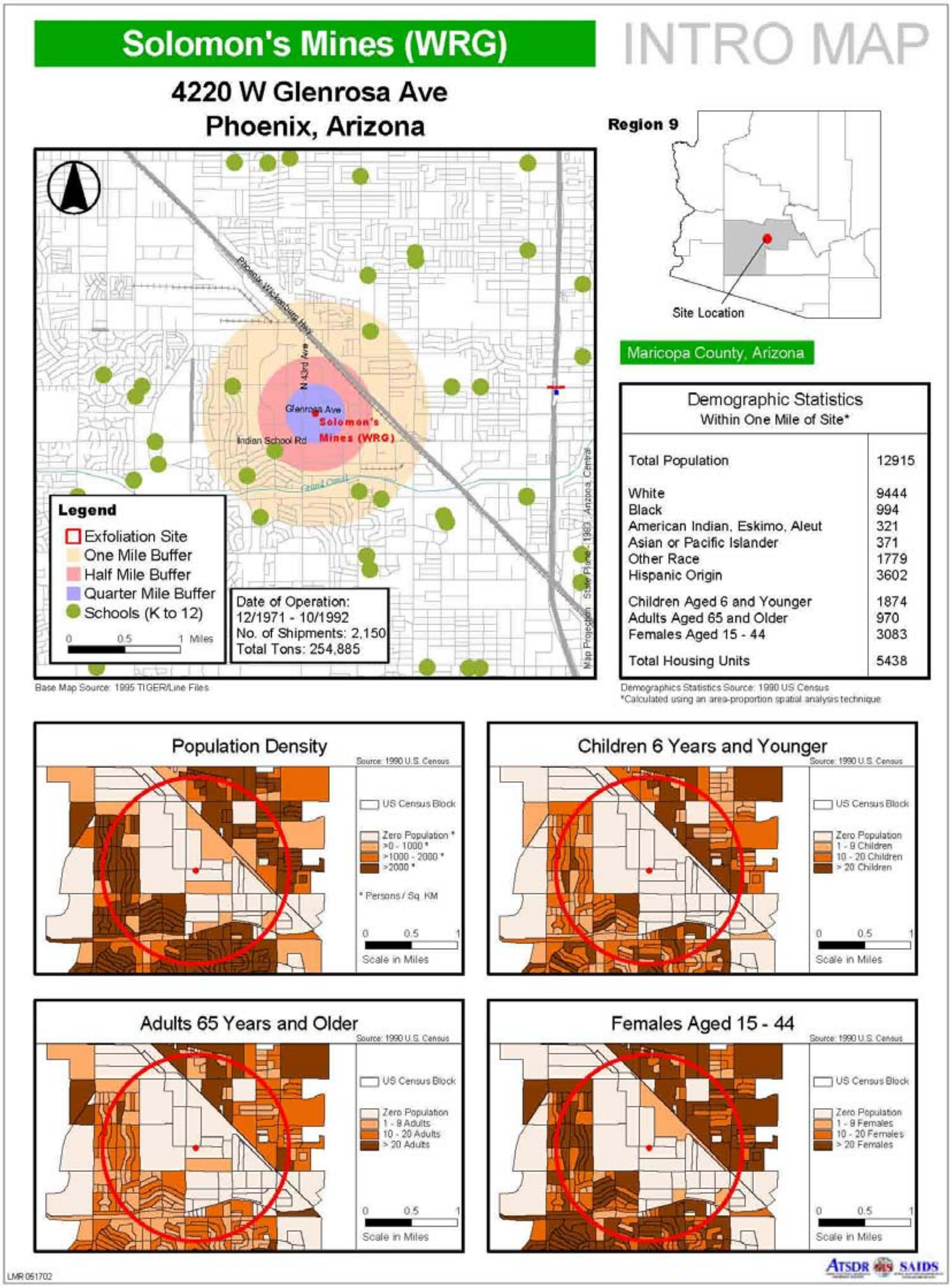


Figure 2 Microvacuum Dust Sampling Locations (image taken from EPA 2001)

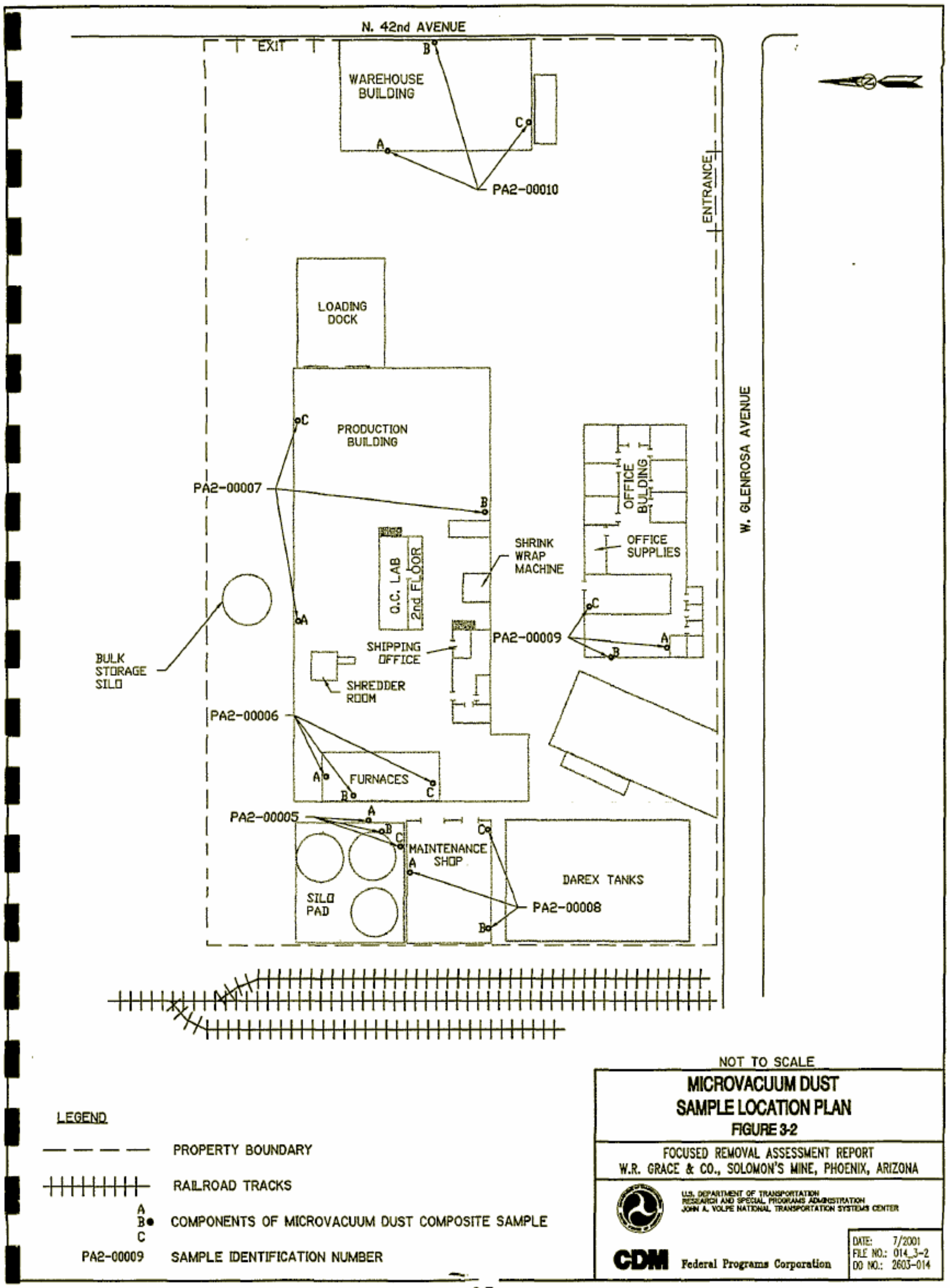


Figure 3 Soil and Product Sampling Locations (image taken from EPA 2001)

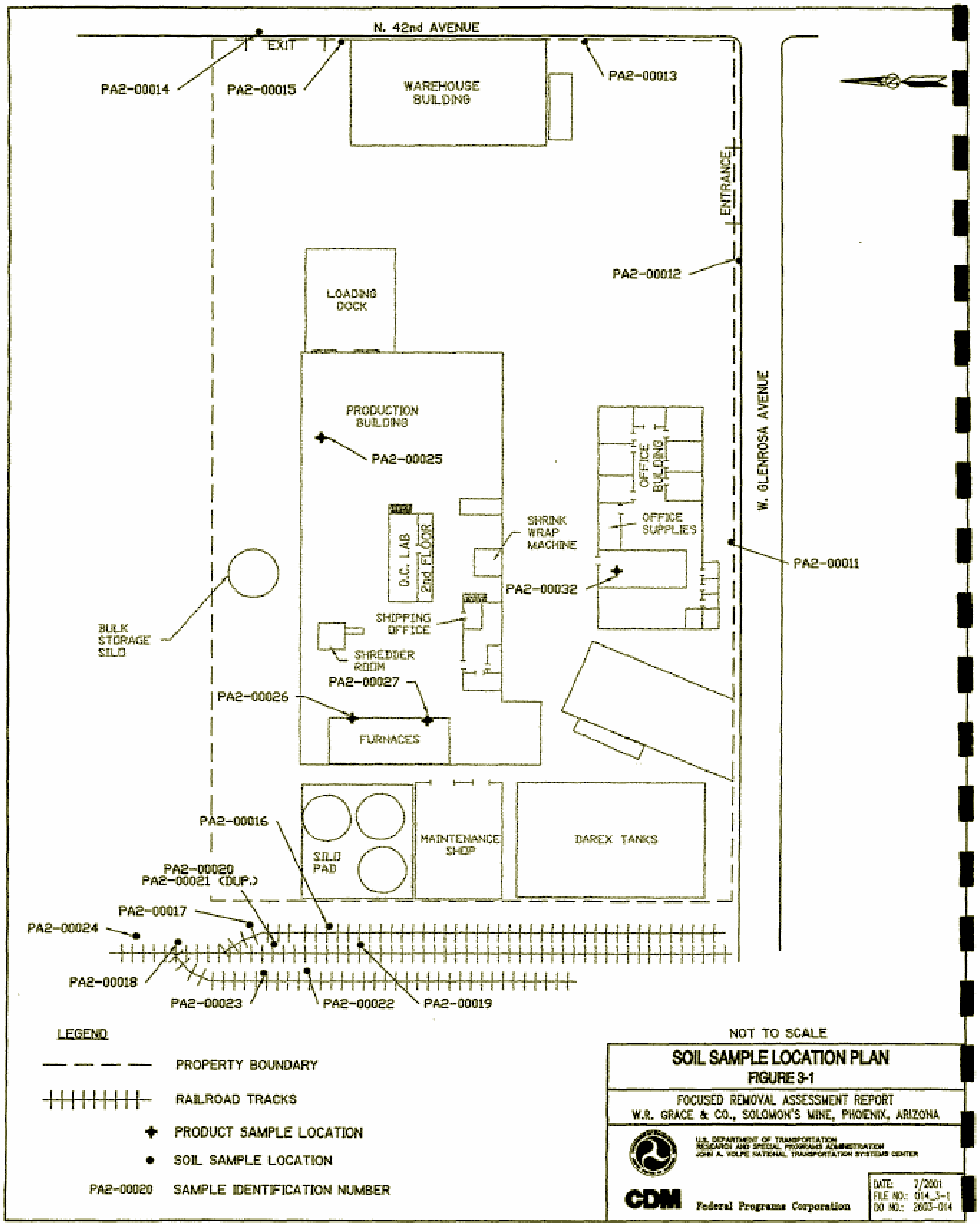
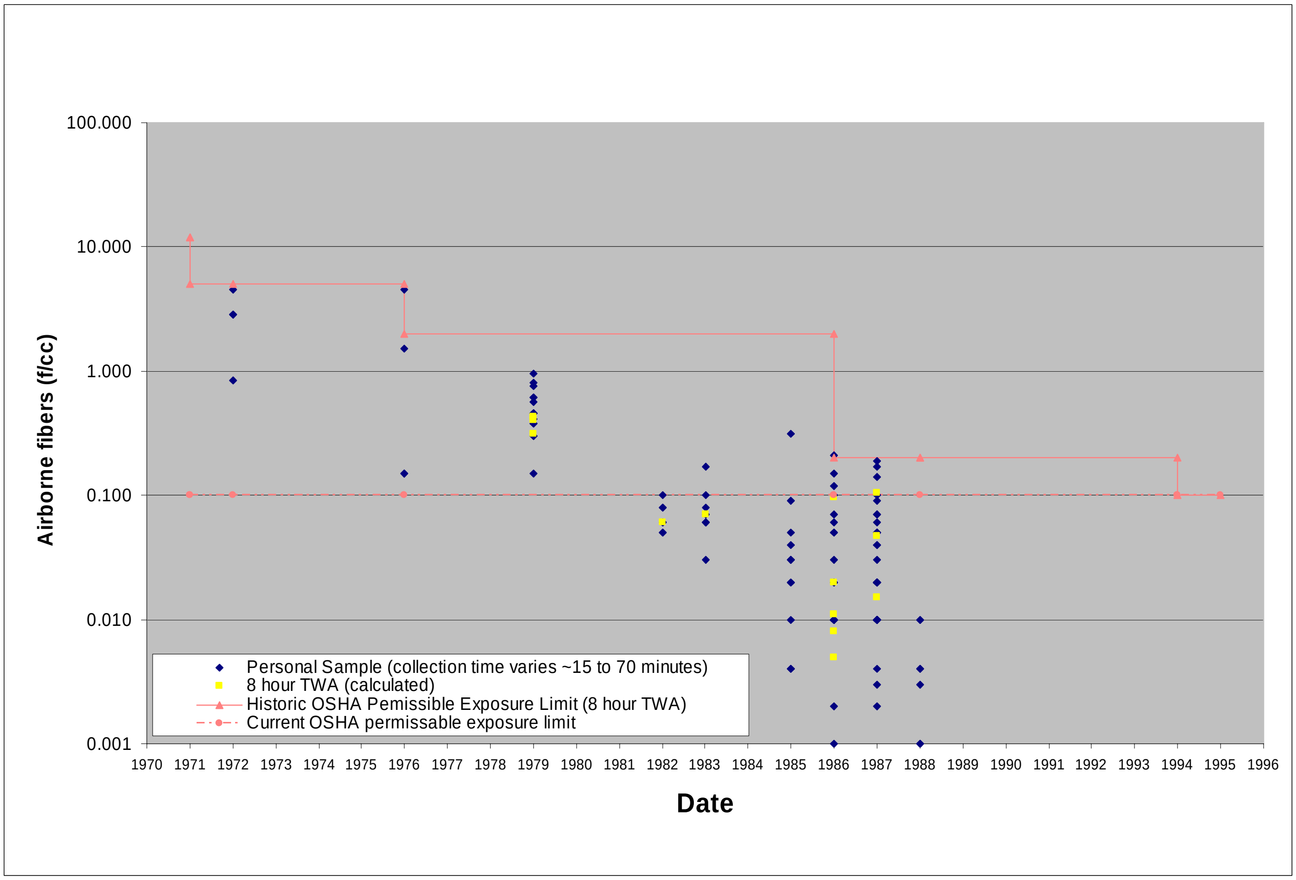


Figure 4 - Personal Sample Data (N=127)[f], W.R. Grace Plant, Phoenix, AZ



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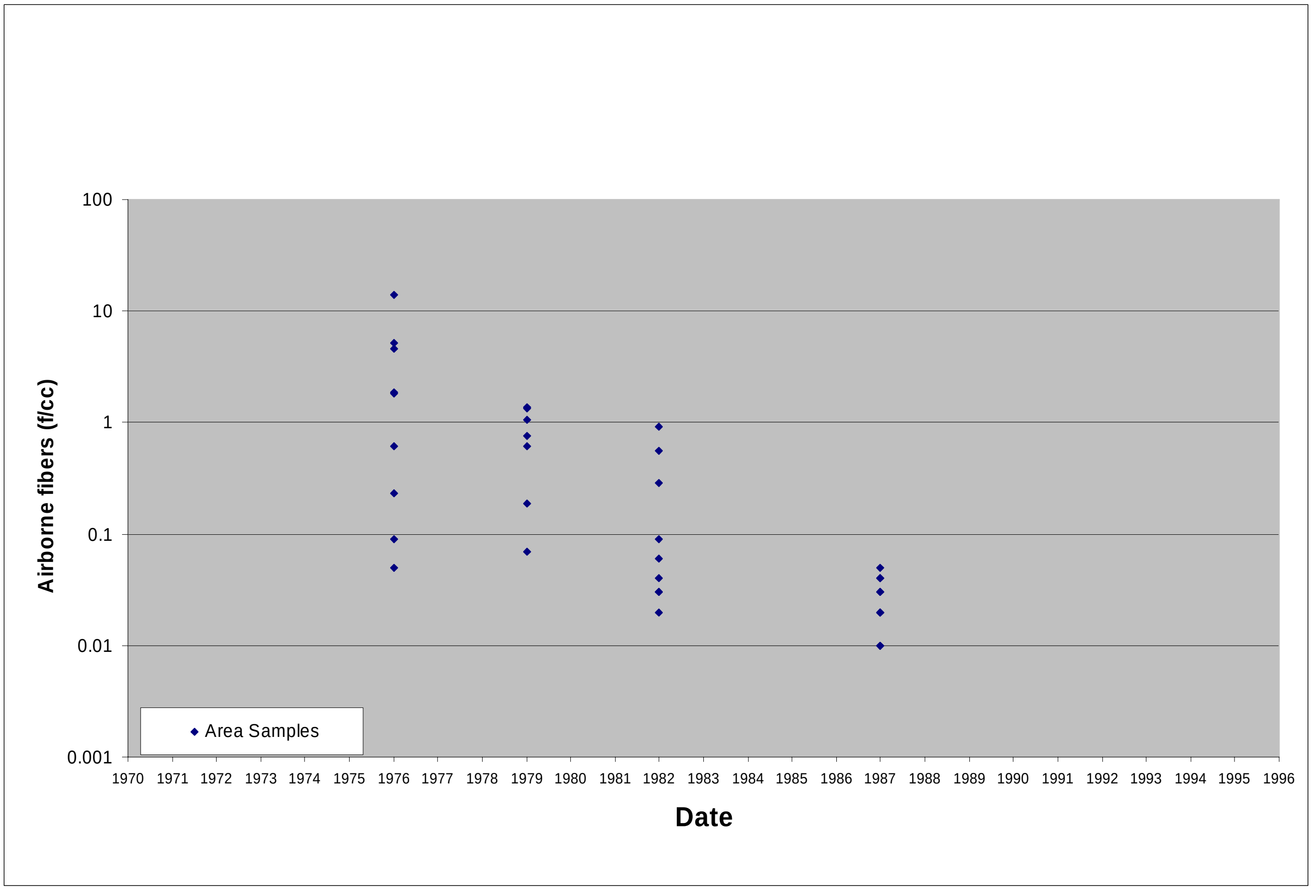
[f] Non detect = Limit of detection

Figure 5 – Area Sampling Data (n=35), W.R. Grace Plant, Phoenix, AZ



Appendix B. Public Health Hazard Category Definitions

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 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.