Health Consultation

ARI-ZONOLITE
(a/k/a BUSTER'S SCHOOL OF STREET RODS FACILITY)

GLENDALE, MARICOPA COUNTY, ARIZONA

EPA FACILITY ID: AZN000905636

SEPTEMBER 26, 2006

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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Prepared by:

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

Foreword: ATSDR's National Asbestos Exposure Review

Vermiculite was mined and processed in Libby, Montana, from the early 1920s until 1990. We now know that this vermiculite, which was 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 human health effects that might be associated with possible past or current exposures. They do not consider commercial or consumer use of the products of these facilities.

The sites that processed Libby vermiculite will be evaluated by (1) identifying ways people could have been exposed to asbestos in the past and 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. 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 based upon contamination in place

- or -

- The site was an exfoliation facility that processed more than 100,000 tons of vermiculite ore from Libby mine. Exfoliation, a processing method in which vermiculite is heated and expanded, is expected to have released more asbestos than other processing methods.

The Ari-Zonolite health consultation is one of the site-specific documents 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

The Ari-Zonolite health consultation summarizes an evaluation of exposure pathways and potential health effects at a site in Glendale, Arizona. It is based on a formal site evaluation prepared by the Arizona Department of Health Services (ADHS). A number of steps are necessary to do such an evaluation:

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

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

Developing recommendations: In the evaluation report, ADHS outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating the threat to public health from contaminants. The role of ADHS in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies, including EPA and ADEQ. However, if there is an immediate health threat, ADHS will issue a public health advisory warning people of the danger, and will work to resolve the problem.

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

Please write to: **Arizona Department of Health Services**

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Introduction

This report evaluates the potential exposure pathways associated with vermiculite concentrate processing activities at the Ari-Zonolite facility. The site is located in the near downtown area of Glendale, approximately ½ mile from the city hall, downtown shops, and other buildings. The areas to the north, east, and south are primarily residential, with neighborhood businesses located at the intersections of the major streets, 59th Avenue and Glendale Avenue. Commercial properties abut all sides of the site. Large vacant lots are on the south and east sides. Figure 1, Appendix A, shows a site map and basic demographic statistics for the area.

The former Ari-Zonolite facility at 6960 North 52nd Avenue in Glendale, Arizona, received vermiculite from the Libby, Montana, mine. From 1951 to 1964, the site was leased the site to the Ari-Zonolite Company. Following the removal of the vermiculite concentrate processing equipment in 1964, several businesses have occupied the site. None of these businesses were involved in vermiculite processing activities. The last occupant of the former vermiculite processing building was an automotive restoration business, which vacated the site in 2002.

The site consists of several brick structures, with the largest being an abandoned 3-story sugar beet factory. The vermiculite concentrate processing took place within the 1-story building that formerly housed the boilers for the sugar beet processing factory. Most of the site is paved; a small portion of unpaved area is covered with gravel. A railroad siding connects to the main rail lines to the west of the site.

Residential properties in the area consist of both single family and multi-family dwellings. U.S. Census data indicate that most of those dwellings were built in the 1950s and 1970s (Figure 2). There are some homes north of the site that were built from the 1930s to the 1950s. U.S. Census data indicate that most of the population currently present was probably not present during the operational period of the Ari-Zonolite facility (Figure 3).

Site Visit

The Agency for Toxic Substances and Disease Registry (ATSDR) and the Arizona Department of Health Services (ADHS) conducted a joint inspection of the facility in August 2002. The boiler building was inspected to determine the locations of previous sampling by the U.S. Environmental Protection Agency (EPA) and to determine if any other areas of the facility may have been used for the vermiculite concentrate processing.

Background

Vermiculite ore is a nonfibrous silicate mineral used for insulation, as a lightweight aggregate in construction materials, and as a soil additive for gardening. Vermiculite is also used as a fireproofing material, as an absorbent, and as a filter medium (Vermiculite Association 2000). Its primary usefulness comes from its ability to expand (exfoliate) at high temperatures from 6 to as much as 30 times its original volume (Van Gosen et al.

2002). The expanded vermiculite has fire- and sound-insulating properties (Van Gosen et al. 2002). In addition, vermiculite ore is useful for absorbing liquids or chemicals. The density of raw vermiculite ore is approximately 55 pounds per cubic foot; the density of expanded 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 21%–26% fibrous amphibole asbestos of the tremolite solid solution series (MRI 1982). The mined ore was screened into several size ranges (from #0 [coarse] to #5 [fine]) for processing into finished vermiculite in Libby or for shipment, usually by rail, to a number of exfoliation plants across the United States and Canada. Some studies have suggested that the different ore grades may have had varying asbestos contents, with finer grades being more contaminated (EPA 1991). Samples of the various grades of unexpanded vermiculite shipped from the Libby mine contained 0.3%–7% fibrous tremolite-actinolite (by mass) (MRI 1982).

In 1951, the Ari-Zonolite facility began receiving vermiculite concentrate from the mining operation in Libby, Montana, to make insulation products (HRO 2000). The concentrate was transported in railroad freight cars with an approximate capacity of 50 tons per car. Information from W.R. Grace documents regarding dust control efforts at the facility suggest that front-end loaders, or similar equipment, were used to unload the railroad cars (unpublished information from EPA's database of W. R. Grace documents). Ore was stored in bins inside the facility. It is unknown what type of conveyance was used to move ore to the furnace, although typical methods would have been screw, auger, or conveyor belt. Waste rock was separated from the finished product, but the manner in which the waste rock was disposed is unknown. The furnace was apparently located within an existing heat-resistant enclosure at the base of the former exhaust stack in the boiler room of the former sugar factory.

The facility used a "Model A" furnace specifically designed to handle the vermiculite concentrate and to facilitate packaging of the finished product. This furnace was installed in 1951 and remained in operation until 1964, after which it was dismantled and moved to another facility. The Model A furnace was manufactured by Zonolite to expand vermiculite concentrate (unpublished information from EPA's database of W. R. Grace documents). Vermiculite concentrate was fed to the furnace at approximately 2,000 lbs/hour through one feed pipe at the top of the furnace (unpublished information from EPA's database of W. R. Grace documents).

Environmental Data

In 2001, as part of a national evaluation of facilities that received vermiculite from the mine in Libby, Montana, EPA collected

- seven soil samples,
- one duplicate sample from locations on the property grounds,
- one composite residual dust sample from three locations inside the former vermiculite processing building, and
- two air samples inside the building.

Tables 1–3 present the results of the 2001 investigation (EPA 2001).

One composite microvacuum dust sample was collected from three separate horizontal surfaces within the former Ari-Zonolite building. Approximately 100 square centimeters (roughly the area covered by a beverage coaster) per surface were sampled by use of microvacuum dust sampling. This technique sampled settled dust and fibers by drawing air through a 0.45-micrometer (µm) pore-size, mixed cellulose esterase (MCE) filter at a flow rate of 2.0 liter per minute. Sampling was performed for 2 minutes at each location. Locations sampled were inside the room where the vermiculite furnace was believed to have been housed.

Samples (i.e., the MCE filters) were analyzed by use of International Standards Organization (ISO) Method 10312. This is a transmission electron microscopy (TEM) method that determines the type of asbestos fibers present, as well as the lengths, widths, and aspect ratios of asbestos structures. (The Code of Federal Regulations defines a structure as "a microscopic bundle, cluster, fiber, or matrix which may contain asbestos [Asbestos, 40 CFR Appendix A to Subpart E of Part 763, 2003].) Table 1 presents the results of the microvacuum sampling.

Table 1. Microvacuum Dust Sampling of the Former Ari-Zonolite Facility in Glendale, Arizona, 2001

Sample Type	Sample Location	Number of Asbestos Structures* Detected	Asbestos Concentration (s/cm^2)
Composite	Three separate horizontal surfaces in the original furnace room.	16 structures (0.5–10µm)	35,733 (tremolite-actinolite)
		16 structures (0.5–10µm)	43,390 (chrysotile)
Blank	Blank sample	Nondetect	
Blank	Blank sample	Nondetect	

* a microscopic bundle, cluster, fiber, or matrix which may contain asbestos
s/cm^2 = structure per cubic centimeter
Source: EPA 2001

Seven grab soil samples (and one duplicate sample) were collected from unpaved portions of the site. All grab samples were collected from approximately the upper 2 inches of ground surface (soil) using a stainless steel scoop. Soil samples were processed in accordance with procedure ISSI-Libby-01. Analysis was performed by use of polarized light microscopy (PLM), per National Institute of Occupational Safety and Health (NIOSH) method 9002. A trace amount of tremolite-actinolite asbestos was detected in three of the seven soil samples (Table 2). The duplicate sample also detected a trace level of asbestos.

Table 2. Soil Sampling (0–2 inches) of the Outdoor Grounds of the Former Ari-Zonolite Facility, Glendale, Arizona, 2001

Sample Type	Sample Location	Asbestos Concentration (% by Volume)	Type of Asbestos
Grab	25 feet west from NE corner of building	Nondetect	NA
Grab	75 feet west of north side of building	Nondetect	BA
Grab	125 feet west of north side of building	Nondetect	NA
Grab	175 feet from NE corner of building	Nondetect	NA
Grab	225 feet from NE corner of building	Trace	Tremolite-actinolite
Grab (duplicate)	225 feet from NE corner of building	Trace	Tremolite-actinolite
Grab	25 feet west from NW corner of building	Trace	Tremolite-actinolite
Grab	25 north from NW corner of building	Trace	Tremolite-actinolite

Indoor air samples were collected by drawing air through an MCE filter (0.45 µm pore size) over a 7- to 8-hour period. The samples were collected while employees of Buster's School of Street Rods (the occupant at the time) were working in the room where the samples were collected. Samples were collected 5 feet above the floor. Two ambient air samples were collected in the production building where vermiculite processing previously occurred. Two field blanks were also collected. Samples were analyzed by use of ISO Method 10312. Results are shown in Table 3.

Table 3. Air Sampling Inside the Former Ari-Zonolite Facility, Glendale, Arizona, 2001

Sample Type	Sample Location	Asbestos Result	Type of Asbestos
Air	West end (center of building and 40 feet from west wall)	Nondetect	NA
Air	15 feet north of south wall and 150 feet west of east wall	Nondetect	NA
Blank	Blank sample	Nondetect	NA
Blank	Blank sample	Nondetect	NA

* detection limit = 0.0035 structures per cubic centimeter (s/cc)
Source EPA 2001

The 2001 dust vacuum and indoor air data demonstrate that asbestos-containing ore was used and processed in the facility and that residual contamination was present on the

surfaces of the former furnace room. After the EPA facility investigation, the current owners voluntarily cleaned the facility in 2001 to remove residual asbestos fibers from the former furnace building. No details on the cleaning method have been provided.

Discussion

The site investigation at the former Ari-Zonolite is part of ATSDR's national effort to identify and evaluate potential asbestos exposures that may have occurred at sites that processed vermiculite from Libby, Montana. This project is called the National Asbestos Exposure Review (NAER; see Appendix B). The findings of studies conducted at Libby linked asbestos exposure with several health effects (ATSDR 2002; Peipins et al 2003). These studies led to the current investigation of processing sites that handled Libby vermiculite, including the former Ari-Zonolite facility. The asbestos exposures documented in the Libby community are in many ways unique to that community. They include factors that will not be present at other sites that processed or handled Libby vermiculite.

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 groups:

- **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. Amphibole minerals regulated as asbestos by the Occupational Safety and Health Administration (OSHA) include five asbestiform varieties: fibrous tremolite, actinolite, anthophyllite, crocidolite, and amosite. However, other amphibole minerals, including winchite, richterite, and others, can exhibit fibrous asbestiform properties (ATSDR 2001).

Asbestos fibers have no odor or taste. They do not dissolve in water or evaporate and are resistant to heat, fire, and chemical and biological degradation. The vermiculite mined at Libby contains amphibole asbestos, with a characteristic composition that includes tremolite, actinolite, richterite, and winchite. This characteristic material is referred to as Libby asbestos. The raw ore was estimated to contain up to 26% Libby asbestos (MRI 1982).

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 sorted into various grades or sizes. The ore was 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).

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 conclude whether inhalation of asbestos increases the risk of cancers at sites other than the lungs, pleura, and abdominal cavity (ATSDR 2001).

Ingestion (swallowing) of asbestos causes little or no risk of noncancer effects. However, acute (short-term, high level) oral exposure may induce precursor lesions of colon cancer and chronic (long-term) oral exposure might lead to an increased risk of gastrointestinal tumors (ATSDR 2001).

ATSDR considers inhalation to be the most significant route of exposure in the current evaluation of sites that received Libby vermiculite. Actions taken to limit inhalation exposures will also minimize risk from skin and oral exposures.

Exposure Assessment and Toxicological Evaluation

Evaluating the health effects of exposure to Libby asbestos requires extensive knowledge of exposure pathways and toxicity data. The toxicological information currently available is limited, however, so the exact level of health concern for different sizes and types of asbestos remains uncertain. Exposure pathway information for Ari-Zonolite, in particular, is also limited, and some is unavailable. Specific data limitations include the following:

- Only limited information is available on past concentrations of Libby asbestos in

air in and around the Ari-Zonolite plant.

- Significant uncertainties and conflicts exist about the analytical methodology. These problems limit our ability to estimate the levels of Libby asbestos to which people may have been exposed.
- How and how often people came in contact with Libby asbestos from the plant remains unclear because most exposures happened long ago. This information is necessary to estimate accurate exposure doses.
- Not enough information is available 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 evaluate the public health implications of past operations at this site quantitatively. 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 may be exposed to contaminants from a given source. Every exposure pathway consists of the following five elements:

1. a *source* of contamination;
2. a *medium*, such as air or soil, through which the contaminant can be transported;
3. a *point of exposure* where people can contact the contaminant;
4. a *route of exposure* by which the contaminant can enter or contact the body; and
5. a *receptor population*—the people who are exposed to the contaminant.

For each pathway, we determine the status of those elements to decide which of the following four categories describe it:

- ***Completed***—all five elements are present *and* connected.
- ***Potential***—the pathway elements likely are (or were) present, but not enough information is available to be certain. A pathway can also be *potential* if it is now missing one or more of the pathway elements, but the element(s) could easily have existed in the past or become present in the future.
- ***Eliminated***— this pathway at one time was a completed or potential pathway, but now has had at least one of the pathway elements permanently removed.
- ***Incomplete***—this pathway has never been, is not, and probably never will be complete. At least one pathway element is missing, and the elements probably *never* were present and *are not likely* to become present in the future.

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 Table 4). 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 4. Completed and Potentially Completed Exposure Pathways for the Ari-Zonolite Site, Glendale, Arizona

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.	Complete*	Not applicable	Not applicable
	Workers exposed to airborne Libby asbestos from residual contamination inside former processing buildings	Complete	Potential	Potential
Household contact	Household contacts exposed to airborne Libby asbestos brought home on former Ari-Zonolite 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

* The pathway is complete for periods when the Glendale facility received Libby vermiculite, principally 1951-1964

Occupational (Past and Present)
Workers were exposed to asbestos in Libby vermiculite concentrate from 1951 to 1964. Former workers inhaled contaminated dusts generated during the exfoliation and handling of Libby vermiculite concentrate. Inhalation of the contaminated dust is the exposure pathway of greatest concern.

Before the early 1970s, workplace air monitoring for asbestos was not required. Consequently, there is no information available on the workers' exposure to airborne asbestos before that time at Ari-Zonolite or similar facilities between 1951 and 1964. While we do not have monitoring results from this specific facility, 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 OSHA's current permissible exposure limit (PEL) of 0.1 fiber per cubic centimeter (f/cc) in an 8-hour time-weighted average (TWA) (see Appendix A, Figure 2; and Appendix B). As ventilation controls in these facilities were installed, exposures progressively dropped throughout the late 1970s and early 1980s. However, since the Ari-Zonolite plant operated before 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.

An internal W.R. Grace memorandum estimated that 28% of workers with more than 10 years service who were 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.

Several occupational scenarios could have resulted in exposure at the Ari-Zonolite facility:

- transferring materials from the rail cars to the storage area, and loading raw material into the conveyor system;
- bagging process materials;
- removing waste rock from the furnace area before removal off-site; or
- inhaling ambient dust inside the facility.

Assuming air levels of asbestos were the same or similar to those at other exfoliation facilities, workers at the former Ari-Zonolite facility might develop lung diseases such as pulmonary fibrosis, mesothelioma, and lung cancer.

1964–Present
People working at the former vermiculite concentrate processing building after 1964 may have been exposed to residual asbestos fibers. Sampling in 2001 found residual asbestos fibers in the former flue from operations before 1964. Asbestos was not found in other areas of the building.

People who worked in the building after 1964 may have entered the enclosed area of the former furnace room. These employees likely would have been exposed to the residual asbestos fibers. The former furnace room has been cleaned to remove the residual asbestos (Brett Moxley, EPA, personal communication September 14, 2005). However,

no details on the extent of the cleaning, the cleaning method, or clearance sampling have been provided. We therefore do not know if asbestos contamination remains inside the building. Exposure would occur if a contaminated area was disturbed and fibers were released to the air.

Household Contact (Past and Present)
From 1951 to 1964, persons living with the Ari-Zonolite workers could have inhaled Libby asbestos coming off of clothing or hair of workers returning home from work. Plant operations were dusty, and the plant did not have facilities for workers to shower before going home. This pathway was therefore likely to be important for the site.

Vermiculite exfoliation ended at this site in 1964. The exposure pathway to residual asbestos for household contacts of workers who worked in the facility after 1964 (and were working at the site before the site was voluntarily cleaned in 2002) is considered complete. However, we expect this exposure to have been minimal because EPA did not detect airborne asbestos.

Waste Rock
It is unknown where the waste rock was deposited following its separation from the finished product. No records of its disposal were found. Records from other sites suggest that the industry standard was to accumulate the waste rock outside the facility until disposal at a later date. No evidence of large piles of waste or ore was seen in aerial photographs of the site (ADOT 1952, USGS 1953). (See Figure 5, a 1953 U.S. Geological Survey [USGS] aerial photograph of the site, and Figure 6, a 2002 USGS aerial photograph of the same area.)

Piles of contaminated waste rock and “stoner” rock (unexpanded vermiculite) may have been a source of asbestos exposure to children who may have played in the piles or to people removing, handling, or using either material for fill or other uses. The stoner rock was estimated to contain between 2% and 11% friable asbestos (Unpublished information from EPA’s database of W.R. Grace Documents). Information from the investigation underway in Libby, Montana, where similar exposures occurred, may help to better qualitatively assess the health risk of such activities. 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).

Waste rock from the facility potentially posed an exposure hazard, but the manner in which the rock was disposed is unknown. At other facilities processing this ore, the waste rock was responsible for exposures to asbestos fibers in concentrations that could result in adverse health effects to persons handling the material.

To compensate for the lack of waste rock disposal records, site assessors used alternative methods to determine if people in the surrounding area may have been exposed to asbestos. Aerial photographs of the facility and the surrounding area were examined to

determine if the waste rock was stored on the site. No evidence of on-site storage was observed from the photographs, which clearly showed the rail cars on the site during the period the facility was in operation.

Ambient Air (Past)
Data are not available to tell how the amounts of asbestos that were emitted from the facility between 1951 and 1964 when it was processing Libby concentrate. Information from W.R. Grace for similar facilities indicates that tremolite asbestos fibers were present in the particulate air emissions from similar exfoliating furnaces. Friable tremolite asbestos at similar facilities was present in the fine particulate matter from process vent systems at concentrations ranging from 1% to 3% (Unpublished information from EPA's database of W.R. Grace Documents). If the annual particulate emission rate was 240 pounds per year from the Ari-Zonolite furnace stack, 2.4–7.2 pounds of friable tremolite asbestos possibly was emitted per year from 1951 to 1964.

Wind patterns in the Glendale area are variable. In general, however, winds are out of the east in the evenings and out of the west in the daytime. For operations that were conducted during the daytime, people living and working east of the facility would more likely have been exposed to asbestos from the stack.

Residential Outdoor (Past, Present, and Future)
Whether people ever hauled contaminated materials away from the Ari-Zonolite site for personal use is unknown. If they did, people could be exposed to asbestos from those materials A neighborhood survey was conducted to determine if the waste material was used in the surrounding residential areas. Responses to the survey indicated no use of the material within approximately 4 square miles of nearby residential developments. However, this survey was not comprehensive.

Residential Indoor (Past, Present, and Future)
Residents could have inhaled Libby asbestos fibers from household dust, either from plant emissions that infiltrated homes or from dust brought inside from waste products brought home for personal use. We found no information on past levels of contamination in the surrounding air. However, it appears unlikely that past air emissions would have been high enough to infiltrate significantly into houses about ¼ mile away. No information has been gathered about community members using waste materials in their yards. Available information is insufficient to evaluate whether this exposure pathway is likely to be significant for the site.

On-Site Soil (Present and Future)
Trace amounts of Libby asbestos have been detected in the soil around the plant. Disturbing soils with even trace amounts of Libby asbestos can result in airborne levels of concern (Weis 2001). The area around the site is not frequently accessed, but anyone disturbing the material could be exposed. This pathway is considered an insignificant exposure pathway at the present time because people rarely contact the contaminated areas, if at all. Potential future exposure could result if the contamination remains accessible and disturbance of on-site soils increases.

Finished Consumer Products
People who bought and used vermiculite products may be exposed to asbestos fibers from using those products in and around their homes. 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 airborne asbestos fiber levels higher than occupational safety limits (Weis 2001). EPA, ATSDR, and the National Institute for Occupational Safety and Health (NIOSH) have developed additional information for consumers of vermiculite products. Links to that information are available at http://www.epa.gov/asbestos/pubs/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.

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 may be at greater risk than 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. They are smaller than most adults; therefore, they breathe dust and soil from close to the ground. The developing body systems of children may sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The long latency period (10–40 years) of asbestos-related diseases places children at greater risk of developing disease earlier in life. Children who lived in the community around the site may have been exposed to asbestos-containing wastes while the plant was operating. Children also may 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 household member who worked at the plant. Ongoing exposure could be occurring in locations where vermiculite wastes were used as fill and remains at the ground surface. Evaluation of the extent of these exposures, and the potential health effects, is not possible at this time.

Conclusions

Definitions of public health hazard categories that ATSDR are provided in Appendix C.

- Occupational exposure to asbestos fibers in indoor air at the former Ari-Zonolite facility between 1951 and 1964 was a **public health hazard** to employees of the facility. Workers' household contacts are likely to have been exposed to hazardous levels of Libby asbestos through household contact in the past. The occupational and household contacts pathways represented a public health hazard.

- Occupational exposure to asbestos fibers in the former Ari-Zonolite facility between 1964 and 2001 was an **indeterminate health hazard** because levels in that area at that time are unknown and the frequency at which employees might have accessed the area is unknown. The former furnace room area was cleaned in an unspecified manner 2001, but remains an **indeterminate health hazard** because we lack information on the cleaning methods and post-cleaning sampling.

- There is not enough information 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**. However, the risk of adverse health effects from these past pathways would be small compared to the past occupational and household contacts pathways.

- From 1964–2002, residual Libby asbestos contamination inside the plant posed an **indeterminate health hazard** in the past. These areas of the site have been cleaned up in an unspecified manner and remain an **indeterminate health hazard** because we lack information on the cleaning methods.

- Given the current land use surrounding the site, trace levels of Libby asbestos contamination in onsite soils pose **no apparent public health hazard**. A potential future exposure exists if the contamination remains accessible and disturbance of on-site soils increases.

Recommendations

- Identify former workers and their families for possible evaluation of health effects associated with Libby asbestos exposure.
- Develop a plan for reducing the possibility of frequent 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.
- Contact former workers and request more detailed information about waste disposal and operating practices at the facility to assist in exposure analysis.

Public Health Action Plan

The Public Health Action Plan for this site describes actions that ATSDR and other government agencies have taken or will take 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 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 include the following:

- ATSDR, 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 findings from other health consultations on sites that processed vermiculite from Libby and develop a national summary report of the overall conclusions and strategy for addressing the public health implications.
- ATSDR and ADHS will provide educational materials and references, upon request, to community members concerned about products containing vermiculite.
- ATSDR and 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 AriZonolite (aka Buster's Street Rods 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.

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

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Appendix A — Figures

Figure 1. Ari-Zonolite Site Introductory Map.

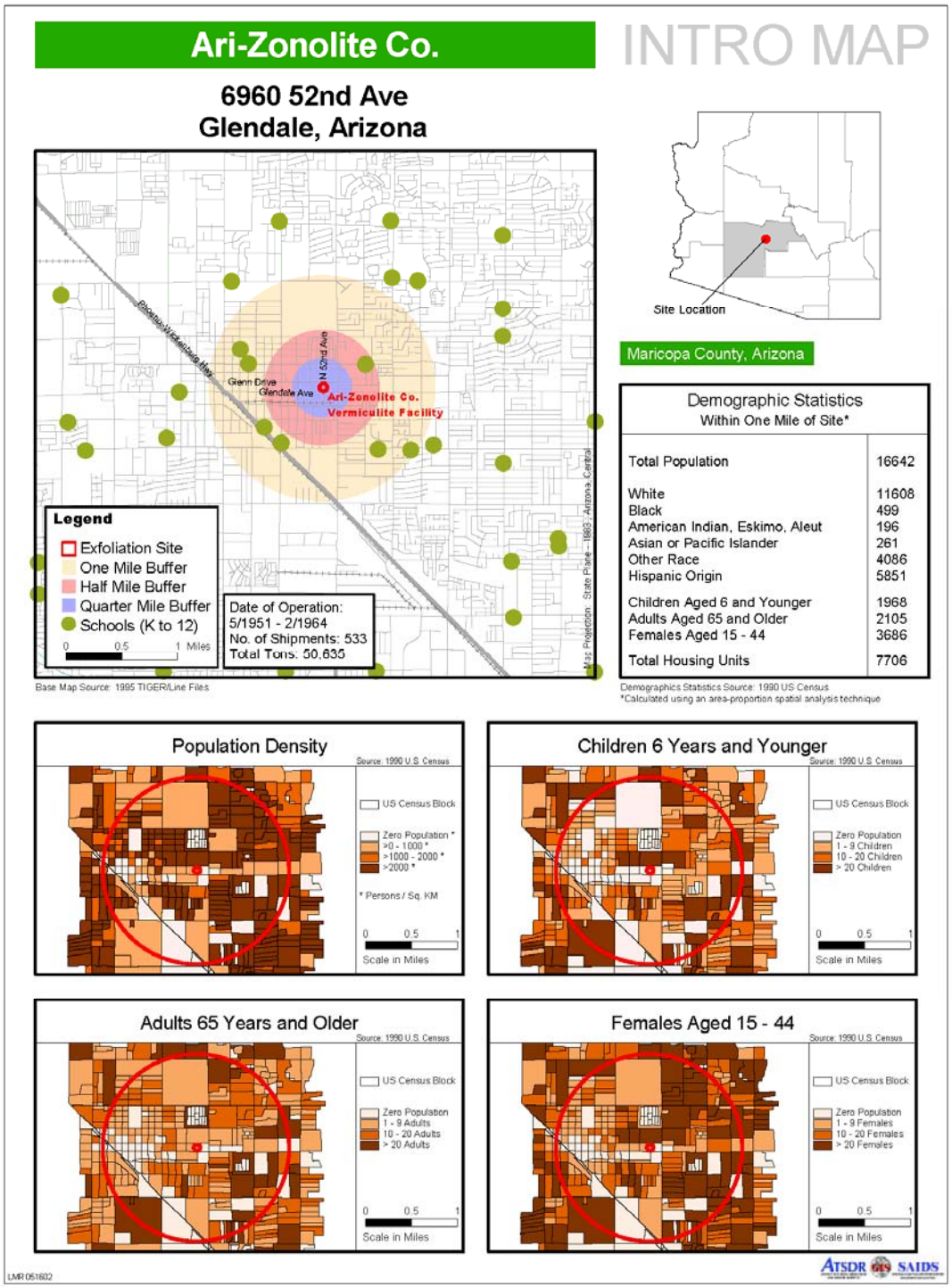

Figure 2. Year Housing Unit Structure Built, by Census Tract.

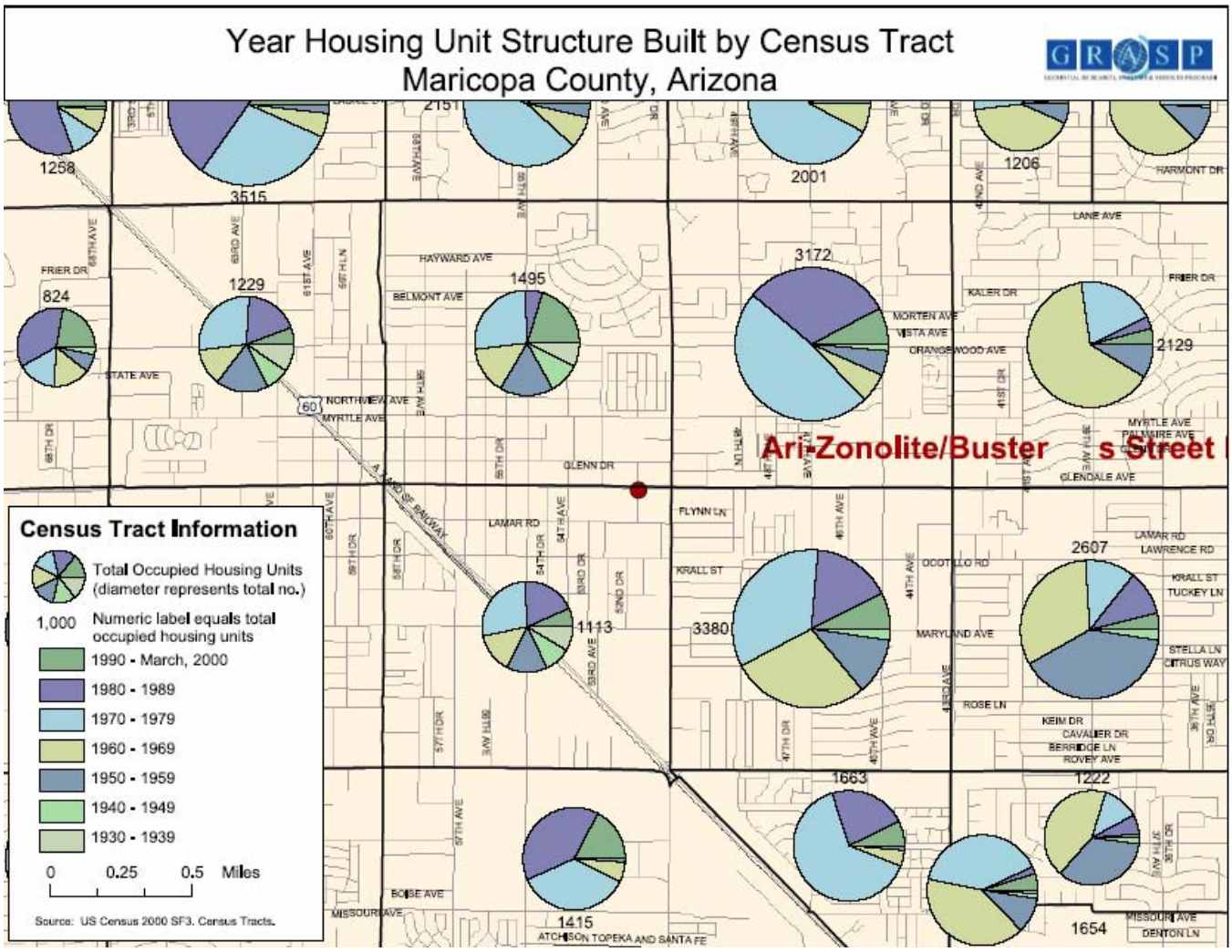

Figure 3. Year Householder Moved Into Current Unit, by Census Tract.

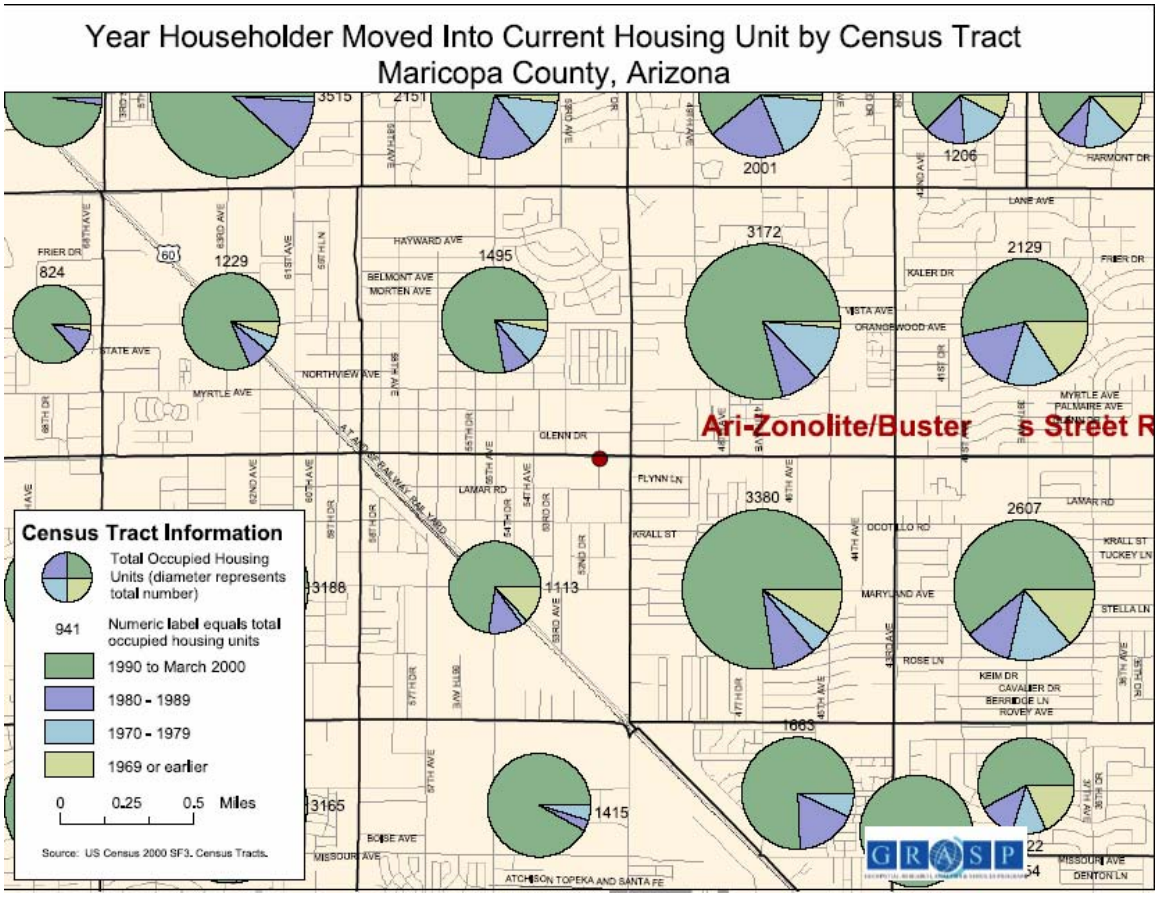

Figure 4. Personal Sampling Data for Six Sites

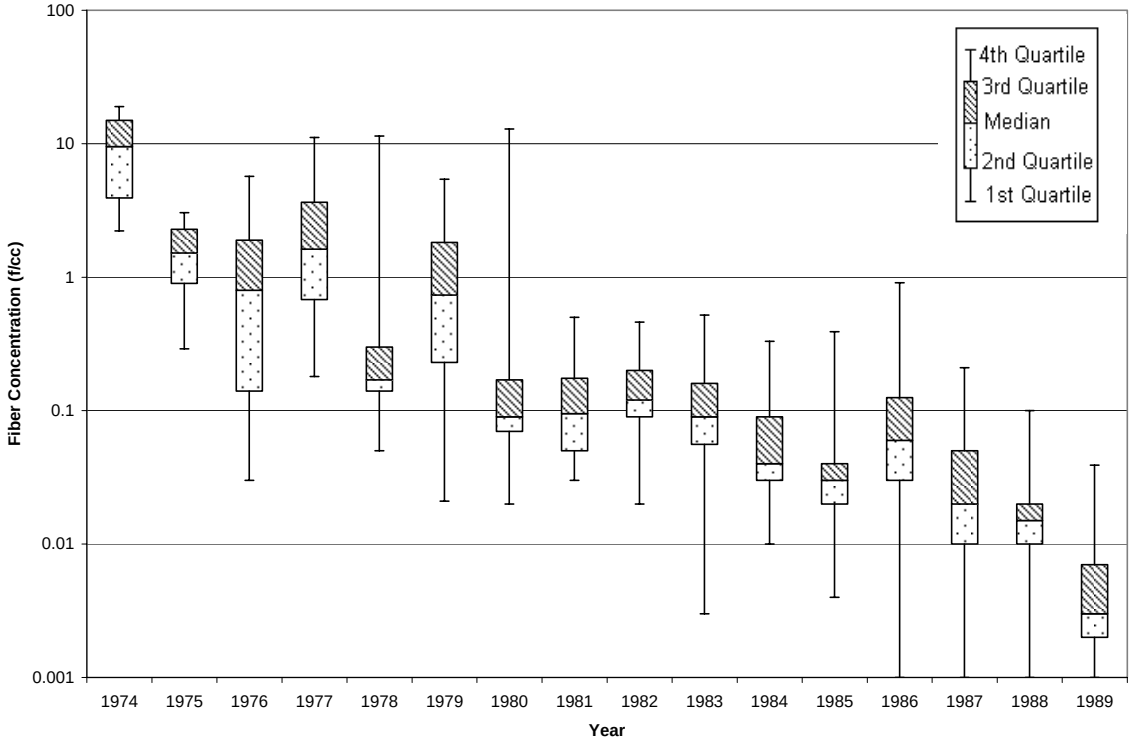

Figure 5. 1953 U.S. Geological Service Aerial Photograph of Ari-Zonolite Site, Glendale, Arizona.

Figure 6. 2002 U.S. Geological Service Aerial Photograph of Ari-Zonolite Site, Glendale, Arizona.

Appendix B — Asbestos Analysis, Toxicity, and Regulation

The following sections provide an overview of several concepts relevant to the evaluation of asbestos exposure, including

- analytical techniques,
- toxicity and health effects, and
- current regulations concerning asbestos in the environment.

Methods for Measuring Asbestos Content

Various 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. However, it can not detect fibers less than 0.25 (<0.25) µm in diameter and shorter than 5 µm It also can not distinguish between asbestos and nonasbestos fibers (ATSDR 2001).

Asbestos content in soil and bulk material samples is commonly determined using polarized light microscopy (PLM). This method uses polarized light to compare refractive indices of minerals and distinguish between asbestos and nonasbestos fibers and between different types of asbestos. The PLM method can detect fibers with lengths greater than about 1 µm and widths greater than about 0.25 µm. Detection limits for PLM methods are typically 0.25%–1% asbestos by area.

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 soils and other bulk materials is difficult, and the small area of the field requires counting many fields when asbestos levels are low (ATSDR 2001).

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 ($\mu g/m^3$)/(f/cc) was adopted as a conversion factor. This value is highly

uncertain, however, because it represents an average of conversions ranging from 5 to 150 ($\mu g/m^3$)/(f/cc) (EPA 2002a). 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 2002a). Generally, a combination of PCM and TEM is used to describe the fiber population in a particular sample.

The scientific community generally believes asbestos toxicity is influenced by fiber length and fiber mineralogy. Fiber length may play an important role in clearance and mineralogy may affect both biopersistence and surface chemistry. The Agency for Toxic Substances and Disease Registry (ATSDR), responding to concerns about asbestos fiber toxicity from the World Trade Center disaster, held an expert panel meeting in December 2002 to review fiber size and its role in fiber toxicity (ATSDR 2003). The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths <5 µm are essentially nontoxic for mesothelioma or lung cancer promotion. However, fibers <5 µm in length may play a role in asbestosis when exposure duration is long and fiber concentrations are high. More information is needed to definitively make this conclusion.

Research suggests that amphibole asbestos is more toxic than chrysotile asbestos, mainly due to physical characteristics. Chrysotile is broken down and cleared from the lungs, 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). However, the Occupational Safety and Health Administration (OSHA) continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease (OSHA 1994). The U.S. Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) assessment of asbestos also treats mineralogy and fiber length as equally potent (EPA 2002a).

An asbestos fiber's mineralogy and fiber size may affect its potency as a carcinogen. In addition, limited evidence suggests that the different sizes of asbestos fibers may also affect site that cancer develops. Other data indicate that differences in fiber size distribution and other process differences may contribute at least as much to the observed variation in risk as does the fiber type itself (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 risks in ways that are still being revealed. For example, shorter fibers appear to preferentially deposit in the deep lung, but longer fibers might 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 >2 µm to 5 µm are considered to be too large to inhale and do not contribute significantly to risk

(ATSDR 2001; Berman and Crump 1999a, 1999b). Methods are being developed to assess the risks posed by varying types of asbestos and fiber size distributions (Berman and Crump 1999a, 1999b).

Current Standards, Regulations, and Recommendations for Asbestos

In industrial applications, asbestos-containing materials are defined as any material with >1% bulk concentration of asbestos (EPA 1997). This concentration, however, is not a health-based level; it represents a regulatory and technical limit set in the 1970s when OSHA created the regulations. Studies have shown that disturbing soils containing <1% amphibole asbestos can resuspend fibers at levels of health concern (Weis 2001).

Friable asbestos (asbestos that is crumbly and can be broken down to suspendable fibers) is listed as a Hazardous Air Pollutant on EPA's Toxic Release Inventory (EPA 2002c). This requires companies that release friable asbestos at concentrations greater than 0.1% to report the release under Section 313 of the Emergency Planning and Community Right-to Know Act.

OSHA has set a permissible exposure limit (PEL) of 0.1 fiber per cubic centimeter (f/cc) for asbestos fibers longer than 5 µm and with an aspect ratio (length-to-width) greater than 3:1, as determined by PCM (OSHA 1994). This value represents a time-weighted average (TWA) exposure level that is based on 8 hours a day for a 40-hour work week. In addition, OSHA has defined an excursion limit in which no worker should be exposed to more than 1 f/cc, as averaged over a sampling period of 30 minutes (OSHA 2002). Historically, the OSHA PEL has steadily decreased from an initial standard of 12 f/cc established in 1971. The PEL levels before 1983 were determined through 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 community member exposure, as the PEL is based on an unacceptable risk level (OSHA 1994).

In response to the World Trade Center disaster in 2001 and an immediate concern about asbestos levels in homes in the area, the U.S. Department of Health and Human Services, EPA, and the U.S. Department of Labor formed the Environmental Assessment Working Group. This work group included representatives from federal health agencies, New York state health departments, and other state, local, and private entities. The workgroup set a short-term reoccupation level of 0.01 f/cc after cleanup. Continued monitoring was also recommended to limit long-term exposure to this level.

In 2002, a multi-agency task force headed by EPA was specifically formed to evaluate indoor environments for the presence of contaminants that might pose long-term health risks to local (Lower Manhattan) residents. The task force developed a health-based

benchmark of 0.0009 f/cc for indoor air. This benchmark, developed to be protective under long-term exposure scenarios, is based on criteria that include conservative exposure assumptions and the current EPA cancer slope factor. The cancer risk factor is an estimate of the likelihood that a person might develop cancer over a lifetime of exposure to an agent. The 0.0009 f/cc benchmark for indoor air is primarily applicable 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 (ACGIH) 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 million fibers longer than 10 µm per liter. Beyond that level, the risk of developing benign intestinal polyps is increased (EPA 2002d).

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 PCM measurements 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; above this concentration the slope factor might differ from that stated (EPA 2002a). Perhaps the most significant limitations are that the model does not consider mineralogy, fiber size distribution, or other physical aspects of asbestos toxicity. EPA is in the process of updating its asbestos quantitative risk methodology.

Appendix C — 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.