

# **HEALTH CONSULTATION**

**Former W.R. Grace & Company**

**Vermiculite Exfoliation Plant**

**3401 N. 3<sup>rd</sup> Ave.**

**Tampa, Florida**

April 1, 2005



**Prepared by**

**The Florida Department of Health**

**Bureau of Community Environmental Health**

**Under Cooperative Agreement with**

**U. S. Department of Health and Human Services**

**Agency for Toxic Substances and Disease Registry**

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## **Foreword: ATSDR's National Asbestos Exposure Review**

Vermiculite mines and processing plants operated in Libby, Montana, from the early 1920s until 1990. We now know that this vermiculite, which was also shipped to locations around the U.S. for processing, contained asbestos.

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

The NAER 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.

ATSDR expects that exfoliation, a processing method in which ore is heated and “popped,” releases more asbestos than other processing methods. The sites that exfoliated Libby vermiculite are being evaluated by (1) identifying ways people could have been exposed to asbestos in the past and if they 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 I: ATSDR has selected 28 sites for the first phase (Phase I) of reviews on the basis of the following criteria:

- The U.S. Environmental Protection Agency (EPA) recommended further action at the site based upon contamination in place; or
- This site was initially thought to be an exfoliation facility that processed more than 100,000 tons of vermiculite mined in Libby according to EPA's database of W.R. Grace Libby invoices. That is why it was chosen as one of the Phase I sites. Further analysis of the shipping records reveals some invoices may have been entered more than once into the database. The following document is one of the site-specific health consultations ATSDR and its state health partners are developing for each of the Phase I sites. A future report will summarize findings at the Phase I sites and include recommendations for evaluating the more than 200 remaining sites nationwide that received Libby vermiculite.

Phase II: 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.

## Florida Department of Health—Health Consultation Process

This health consultation evaluates exposure pathways and public health concerns for the former W.R. Grace & Company vermiculite exfoliation plant at 3401 N 3<sup>rd</sup> Street, Tampa Florida. It is based on a site evaluation prepared by the Florida Department of Health (Florida DOH). Florida DOH undertakes a site evaluation through a four-step process:

- *Evaluating exposure:* Florida DOH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much (or whether) contamination is present, where (and in this case when) it was found on the site, and how people might have been exposed to it. Usually, Florida DOH does not collect its own environmental sampling data. Rather, it relies on information provided by the Florida Department of Environmental Protection (DEP), the U.S. Environmental Protection Agency (EPA) and other government agencies, private businesses, and the general public.
- *Evaluating health effects:* If evidence indicates that people are being exposed—or may have been exposed—to hazardous substances, Florida DOH scientists will determine whether that exposure could be harmful to human health. The report focuses on public health—that is, the health impact on the community as a whole—and it is based on existing scientific information.
- *Developing recommendations:* In the evaluation report, Florida DOH outlines its conclusions regarding any potential health threat posed by a site.. The role of Florida DOH 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 the EPA and Florida DEP. If, however, a health threat exists or is imminent, Florida DOH 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. Florida DOH solicits and evaluates information from various government agencies, individuals, or organizations responsible for cleaning up the site, as well as from those living in nearby communities. Similarly, Florida DOH shares any conclusions about the site with the groups and organizations providing the information. Once an evaluation report is complete, Florida DOH then seeks feedback from the public. *If you have questions or comments about this report, Florida DOH encourages you to contact us.*

*Please write to:* Connie Garrett  
Health Assessment Team  
Bureau of Community Environmental Health/Florida Department of Health  
4052 Bald Cypress Way, Bin #A-08  
Tallahassee, FL 32399-1712

*Or call us:* (850) 245-4299, or toll-free during business hours: 1-877-798-8473

## **I. Summary of Background and History**

The former W.R. Grace & Company vermiculite exfoliation facility occupied 1.5 acres southeast of the intersection of 34<sup>th</sup> Street and North 3<sup>rd</sup> Avenue (at 3401 N. 3<sup>rd</sup> Avenue) in Tampa, Florida (Figure 1, Appendix A). Under an agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), the Florida Department of Health (DOH) evaluated available site information and exposure pathways for operations at site. This health consultation contains Florida DOH's conclusions and recommendations.

Vermiculite has been exfoliated at this location from the 1950s to the present. The Zonolite Company operated a facility at this site from the early 1950s until 1974. Monokote-3<sup>®</sup> was produced in the Zonolite plant for approximately 10 years, from the early 1960s until 1972. In addition to vermiculite, Monokote-3<sup>®</sup> had chrysotile asbestos added to it. In 1974, the W.R. Grace Company built a new plant at this site, which included a fabric air filter or "bag house" to reduce air emissions. W.R. Grace shipping records and internal company memos from before 1990 indicate that their facility received vermiculite from Libby, Montana, and from Enoree, South Carolina. According to these records, expansion of Libby vermiculite ore began in early 1976.

While the Libby vermiculite mine closed in 1990, W.R. Grace continued to operate the facility until 1991. The current owner leased the site in late 1991, bought it in 1993, and still operates the vermiculite expansion (exfoliation) plant. The current owner reports that he did not process vermiculite ore from Libby. The plant now receives vermiculite from South Carolina, Virginia, and South Africa.

Vermiculite's primary usefulness comes from its ability, when heated, to expand (exfoliate) up to 20 times its original size (EPA 1991). The density of raw vermiculite concentrate is approximately 55 pounds per cubic foot, while the density of finished vermiculite is six to eight pounds per cubic foot. Vermiculite's mineral structure also makes it useful for absorbing liquids or chemicals (URS 2000a). Vermiculite serves a variety of purposes: insulation, fireproofing, lightweight aggregate in construction materials, soil additive, and filter medium (The Vermiculite Association website, 2004).

EPA's database of shipping records indicates that between February 1966 and January 1991, the Tampa facility received 1,180 shipments (112,005 tons) of vermiculite concentrate from a mine in Libby, Montana (unpublished information from EPA's database of W.R. Grace invoices). A limited manual review of the W.R. Grace document database found tonnage records from 1966, and from 1975-1990. According to these records, at least 48,991.8 tons of vermiculite was shipped from Libby to the Tampa facility. The purpose of this review was not to account for every ton shipped from Libby, but to confirm that Libby vermiculite was historically processed at this facility and to ascertain the relative time periods when it was processed. According to both the invoice database and a manual review of W.R. Grace documents, the majority of the Libby ore processed at the plant was processed between 1980 and 1985.

Before shipment to Tampa, the vermiculite ore was processed in Libby to remove a percentage of the non-ore materials. ATSDR refers to the shipped material alternately as *vermiculite*

*concentrate* or simply *vermiculite*. This concentrate contained fibrous amphibole asbestos of the tremolite-actinolite-richterite-winchite series (referred to subsequently as *Libby asbestos*) (EPA 1991). The asbestos content of the vermiculite concentrate from Libby was typically 2%–6% (EPA 2000). Libby asbestos is a contaminant of the vermiculite; the shape of its fibers are different from mined chrysotile asbestos, which is a form of asbestos used in many commercial products, such as building materials, brake linings, and gaskets (EPA 1991).

The plant currently includes a large metal building with loading bays, three storage silos, an asphalt parking lot, and an abandoned railroad spur. Commercial and light industrial properties surround the site, which is secured by a perimeter chain-link/barbed wire fence. According to the owner, the fence dates at least to 1993, when he bought the site. He does not know, however, how old the fence is.

The residences in the area are small, wooden, 1950s-style houses. One home is 0.1 mile east of the site (Figure 2; Photograph 7), and three homes are 0.1 mile west of the site. No other homes are within a quarter mile of the site. Neighborhood homes of the same vintage stand 0.25 mile north of the site, and they extend northward from 7<sup>th</sup> Avenue for several miles (Appendix A, Photograph 8). McKay Bay, an arm of greater Tampa Bay, lies within 0.25 mile southeast and 0.5 mile south of the site. The proximity of railroad tracks and port facilities suggests that the surrounding industrial facilities are also likely to have been present since at least the 1950s.

### **Past Facility Operations**

Past procedures for processing vermiculite concentrate at this site were reportedly similar to current procedures (Reed Wright, former W.R. Grace employee, 2002 personal communication). Occasionally, the plant operated 24 hours a day, seven days a week. The number of workers varied from two to ten. Vermiculite from the Libby mine was available in five different size ranges, designated grade 1 (coarse) through grade 5 (fine). The facility used mostly grades 3 and 4 of vermiculite concentrate. The facility also occasionally used grade 2 vermiculite concentrate.

Reed Wright (2002 personal communication) indicated that during the 1970s and 1980s railcars moved the material. Closed rail cars transported the vermiculite concentrate to the facility, which has a belly-dump pit and conveyor system. In the 1970s and 1980s, the final product was packaged in large bags. Trucks transported product for roofing and other uses (Reed Wright, personal communication).

Unpublished information from EPA's database of W.R. Grace documents shows that W.R. Grace & Company replaced a former Zonolite plant at this 3401 N. 3<sup>rd</sup> Ave, Tampa address in early 1974. These documents also report that South Carolina #3 and #4 ore were expanded in a Model A furnace in the old plant, from the time of the plant's opening in the early 1950s until it was torn down in 1974.

ATSDR has found that during the 1950s rail cars at some sites were sometimes unloaded manually; however, Florida DOH has no specific information on operational procedures at this location, during that time. Records indicate that between the early 1960s and 1972 this facility produced the fireproofing material Monokote-3<sup>®</sup>, some of which had chrysotile asbestos added

(unpublished information from EPA's database of W.R. Grace documents).

### **Current Operations**

The current facility owner receives vermiculite concentrate from Virginia, South Carolina, and South Africa. The concentrate is either unloaded from tractor-trailer trucks via an under-cab gravity hopper, or it is dumped into the below-ground box. From there, a bracket elevator feeds the concentrate into the storage silos (Photograph 10). From the storage silos, the vermiculite concentrate is gravity-fed to the main holding tank inside the building. A vibrating feeder and bracket elevator feeds it "on demand" into the expanding furnace (the furnace type is D-18). The furnace heats the vermiculite concentrate to a temperature of about 2,000 degrees Fahrenheit. The water trapped inside the vermiculite boils, causing the concentrate to expand. From the furnace, another bracketed elevator takes the expanded vermiculite to a Triple-S Dynamic Stoner, which separates expanded and unexpanded minerals. The unexpanded minerals are stored for off-site disposal (Photograph 11).

A fabric filter (bag house) traps dust created by handling and heating the vermiculite concentrate. The Hillsborough County Environmental Quality Commission (EQC) regulates air emissions from this facility. Diana Lee of the EQC Air Section indicates that the company currently operating on the site has been in compliance with its emissions permit.

Depending on its intended use, the expanded (exfoliated) vermiculite concentrate may then be screened. Two employees package the expanded vermiculite concentrate in 45-cubic-yard, tote-sized bags, stack the bags on pallets, wrap the loaded pallets in plastic, and store the pallets for shipment. The owner indicated that these two employees generally work eight-hour days, five days a week, but when product demand is high, they may work overtime—five days a week, 12—16-hour days.

The facility uses Waste Management, Inc., to dispose of the waste rock, bag house fines, and trash. Surface water runoff flows into an underground drainage system (Photographs 12 and 13).

### **Environmental Data**

W.R. Grace took 12 samples at the former W.R. Grace & Company facility on April 29, 1976, during the exfoliation of Libby #2 ore. Fiber levels on personal samples (n = 8) ranged from non-detect (detection limit = 0.11 f/cc) to 0.48 f/cc. Engineering area samples (n = 4) ranged from non-detect (detection limit = 0.06 f/cc) to 0.76 f/cc (unpublished information from EPA's database of W.R. Grace documents).

On August 9, 1984, W.R. Grace collected an 8-hour time-weighted average (TWA) personnel fiber sampling from an employee who bagged product and loaded trailers. The ore type was L-4 (presumably Libby # 4). The TWA was 0.014 fibers/cc.

On July 31, 1985, W.R. Grace collected TWA air samples at the site. The ore type again was L-4, and the measurements were 0.332 and 0.036 f/cc. Little information is available on collection of the fiber samples.

In 1993, W.R. Grace cleaned the entire facility before they sold it to the current owner. Florida

DOH has no information on what the cleaning entailed or how it was carried out.

In January 2001, the U.S. Environmental Protection Agency (EPA) collected one surface soil sample and one raw ore sample at the site. EPA did not take any off-site soil samples. The samples taken were analyzed by polarized light microscopy (PLM) methods, and results indicated <1% asbestos (EPA 2002). At the time these measurements were taken, this level may have been the practical quantitative level<sup>†</sup>. The Asbestos Overview section in this document contains a discussion of analytical methods for asbestos.

The National Institute for Safety and Health (NIOSH) visited and sampled a number of horticultural operations and exfoliation facilities to evaluate the potential for workplace asbestos exposures from various vermiculite sources other than Libby. In August 2002, NIOSH collected 48 indoor air samples and two high-volume outdoor air samples at this site to determine baseline dust and/or asbestos exposure levels. The indoor air samples were a mixture of area and personal air samples (Dan Hewett, NIOSH, personal communication). NIOSH also collected bulk samples of the vermiculite (Jen Mosser, NIOSH, personal communication).

### **Site Visit**

On September 11, 2002, Connie Garrett of Florida DOH and Jill Dyken, Dr. Luly Rosales-Guevara, Bob Safay, and James Durant, all with ATSDR, visited the neighborhood around the site. The next day, Connie Garrett and James Durant toured the site (Photographs 1–13). They observed the following:

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<sup>†</sup> **Practical quantitation limits** (PQLs) are the lowest levels which can be routinely quantified and reported by a laboratory. For certain compounds the risk-based values are less than the PQLs. Consequently, the EPA director of the Office of Superfund Remediation and Technology Innovation recently clarified the EPA position on the <1% asbestos level (EPA 2004). He states staff should not assume that materials containing < 1% asbestos do not pose an unreasonable risk to human health. He instructs Regional Office staff to develop risk-based, site specific action levels to determine if response actions should be taken when materials containing < 1% asbestos are found on a site.



- Most of the site is covered with asphalt. (Photographs 1, 3, 10, and 12).
- Surface water runoff flows to grated storm water drains on and near the site (Photographs 12 and 13).
- The railroad spur land south of the site is fenced and covered with vegetation. Gravel in this area appeared to be railroad-bed grading material, not vermiculite expansion waste material (Photograph 9).
- The gravel on the site below the railroad spur, above soil, is crushed limestone and dolomite, not vermiculite expansion waste material (Photographs 10 and 13). The parking areas are covered by asphalt.
- The large building and storage silos are metal (Photographs 1, 2, 3, 6, and 10). These buildings were constructed by W.R. Grace in 1974. Florida DOH did not see any old buildings or foundations on the site.
- Much of the equipment had been in use before 1993. Some equipment used earlier than 1993 was stored. Florida DOH has no information about whether the old equipment had been decontaminated.
- Bag house fines, unexpanded vermiculite, and trash are currently stored in a waste “rolloff” box (Photograph 11). No other material consistent with vermiculite or vermiculite waste rock was observed on the site or on surrounding properties. However, a small amount of vermiculite could be present in the gravel near the rolloff box.
- The storage silos stand on a cement pad (Photograph 10). Florida DOH did not see any vermiculite ore or waste material in this area.

The plant manager stated that most of the current equipment has been there since 1991 (Photographs 1–3, 6, 10, 11).

## **II. Discussion**

The site investigation at the former W.R. Grace & Company plant in Tampa is part of ATSDR’s national effort to identify and evaluate potential asbestos exposures that may have occurred at sites that processed vermiculite mined in Libby, Montana. This project is called 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). These studies led to the current investigation of processing sites that handled Libby-vermiculite, including the one in Tampa. The Tampa site processed Libby vermiculite for only a limited period. The most significant period of Libby vermiculite processing at the Tampa site was from 1980 through 1985, when the W.R. Grace Company operated the site.

Significantly, the asbestos exposures documented in the Libby community are in many ways unique to that community. They include factors that will not be present as a group at other sites that processed or handled Libby vermiculite. Also important to note is that this vermiculite exfoliation facility currently processes South Africa, Virginia, and South Carolina vermiculite.

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 2001a). South African unexpanded and expanded samples showed 0.4% and 0.0% amphibole content, respectively (Moatamed et al. 1986). In another investigation, 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). Expanded and unexpanded percentages of the Virginia ore were 1.3% amphibole by weight; however, Moatamed (1986) notes the Virginia and South African amphiboles were predominantly nonasbestiform, while the Montana (Libby) amphibole was predominantly asbestiform.

### **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 and amphibole. Serpentine asbestos has relatively long and flexible crystalline fibers; this class includes chrysotile, the predominant type of asbestos used commercially. Amphibole asbestos minerals are brittle and have a rod- or needle-like shape. Amphibole minerals regulated as asbestos by 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 2001a).

Asbestos fibers do not have any detectable 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 in the remainder of the document. 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 byproduct 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).

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 can be 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 longer than 5  $\mu\text{m}$  and with an aspect ratio (length: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 thinner than 0.25  $\mu\text{m}$  in diameter and the inability to distinguish between asbestos and nonasbestos fibers (ATSDR 2001a).

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  $\sim 1 \mu\text{m}$  and widths greater than  $\sim 0.25 \mu\text{m}$ . 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 and 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 2001a).

For risk assessment purposes, TEM measurements are sometimes multiplied by conversion factors to give PCM equivalent fiber concentrations. The correlation between PCM fiber counts and TEM mass measurements is very poor. A conversion between TEM mass and PCM fiber count of 30 micrograms per cubic meter per fiber per cubic centimeter ( $\mu\text{g}/\text{m}^3/(\text{f}/\text{cc})$ ) was adopted as a conversion factor, but this value is highly uncertain since it represents an average of conversions ranging from 5 to 150 ( $\mu\text{g}/\text{m}^3/(\text{f}/\text{cc})$ ) (EPA 2002b). 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 2002b). Generally, a combination of PCM and TEM is used to describe the fiber population in a particular sample.

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 (personal communication, Jim Christiansen, US Environmental Protection Agency, 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 lining of the lung (pleura) and other internal organs. This cancer can spread to tissues surrounding the lungs or other organs. The vast majority of mesothelioma cases are attributable to asbestos exposure (ATSDR 2001b).

*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 2001b).

*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 (lining of the lung); *pleural thickening*, extensive thickening of the pleura which may restrict breathing; *pleural calcification*, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and *pleural effusions*, fluid buildup in the pleural space between the lungs and the chest cavity (ATSDR 2001b).

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 2001b).

Ingestion of asbestos causes little or no risk of noncancer effects. However, some evidence indicates that acute oral exposure may induce precursor lesions of colon cancer and that chronic oral exposure might lead to an increased risk of gastrointestinal tumors (ATSDR 2001b).

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

The scientific community generally accepts correlations of asbestos toxicity with fiber length as well as fiber mineralogy. Fiber length may play an important role in clearance 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 in December 2002 to review fiber size and its role in fiber toxicity (ATSDR 2001b). The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths less than 5  $\mu\text{m}$  are essentially nontoxic when considering a role in mesothelioma or lung cancer promotion. However, fibers less than 5  $\mu\text{m}$  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 has suggested that amphibole asbestos is more toxic than chrysotile asbestos, mainly due to physical characteristics which allow chrysotile to be broken down and cleared 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). However, OSHA continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease (OSHA 2002). EPA's Integrated Risk Information System assessment of asbestos also treats mineralogy and fiber length as equipotent (MRI 1982).

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, Crump 1999a, 1999b).

Counting fibers using the regulatory definitions (see below) does not adequately describe risk of health effects, as fiber size, shape, and composition contribute collectively to risks in ways that are still being elucidated. For example, shorter fibers appear to preferentially deposit in the deep lung, but longer fibers might disproportionately increase the risk of mesothelioma (ATSDR 2001b; Berman, 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 to 5  $\mu\text{m}$  are considered above the upper limit of respirability (that is, too large to inhale) and do not contribute significantly to risk (ATSDR 2001b; Berman, Crump 1999a, 1999b). Methods are being developed to assess the risks posed by varying types of asbestos and are currently awaiting peer review (Berman, Crump 1999a, 1999b).

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

In industrial applications, asbestos-containing materials are defined as any material with greater than 1% bulk concentration of asbestos (EPA 1997). This concentration, however not a health-based level, but instead represents a regulatory and technical limit set in the 1970s when OSHA created the regulations. Studies have shown that disturbing soils containing less than 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 f/cc for asbestos fibers longer than 5  $\mu\text{m}$  and with an aspect ratio (length:width) greater than 3:1, as determined by PCM (OSHA 2000). This value represents a time-weighted average (TWA) exposure level 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 in excess of 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 prior to 1983 were determined based upon 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 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, US Environmental Protection Agency, National Institute for Occupational Safety and Health, CDC National Center for Environmental Health, Occupational Safety and Health Administration, New York City Department of Health and Mental Hygiene,

the New York State Department of Health, and other state, local, and private entities. The workgroup set a re-occupation level of 0.01 f/cc after cleanup. Continued monitoring was also recommended to limit long-term exposure to this level.

NIOSH set a recommended exposure limit of 0.1 f/cc for asbestos fibers longer than 5  $\mu\text{m}$ . This limit is a TWA for up to a 10-hour workday in a 40-hour work week (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 7,000,000 fibers longer than 10  $\mu\text{m}$  per liter, based on an increased risk of developing benign intestinal polyps (EPA 2002). Many states use the same value as a human health water quality standard for surface water and groundwater (CDPHE 2002).

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 2002b). 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, since above this concentration the slope factor might differ from that stated (EPA 2002b). 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 their asbestos quantitative risk methodology given the limitations of the current assessment and the knowledge gained since it was implemented in 1986.

### **Exposure Assessment and Toxicological Evaluation**

Evaluating the health effects of exposure to Libby asbestos requires extensive knowledge of exposure pathways as well as 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 Tampa 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 Tampa plant.
- Significant uncertainties and conflicts about analysis methods used exist. These problems limit ATSDR's 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, ATSDR 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.

After determining whether these conditions exist, ATSDR places pathways in one of four categories:

***Completed:*** In a *completed* pathway, all five elements are present *and* connected.

***Potential:*** In a *potential* pathway, 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(se) element(s) could easily have existed in the past or become present in the future.

***Eliminated:*** An *eliminated* pathway at one time was a completed or potential pathway, but now has had at least one of the pathway elements permanently removed.

***Incomplete:*** An *incomplete* 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 Summary Table 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.

**Summary Table—Inhalation Pathways Considered for W.R. Grace & Company Vermiculite Exfoliation Plant, Tampa, Florida.**

<b>Pathway Name</b>	<b>Exposure Scenario(s)</b>	<b>Past Pathway Status</b>	<b>Present Pathway Status</b>	<b>Future Pathway Status</b>
Occupational	Former (before 1990) 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
	Current workers exposed to airborne Libby asbestos from residual contamination inside former processing buildings	Not applicable	Incomplete	Incomplete
Household Contact	Household contacts exposed to airborne Libby asbestos brought home on former (before 1990) 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	Incomplete	Incomplete
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	Incomplete
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

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\* The pathway is complete for periods when the Tampa facility received Libby vermiculite, principally 1980–1985. The facility used chrysotile from approximately 1962-1972. The pathway is incomplete for other periods.



*Occupational (past)*—Former workers may have inhaled asbestos fibers generated during processing or bagging of vermiculite from Libby. Past exposure to chrysotile asbestos could have occurred when the facility used chrysotile in its manufacturing of fireproofing material between 1962 and 1972 (unpublished information from EPA’s database of W.R. Grace documents). The majority of shipments of Libby ore occurred from 1980 through 1985.

W.R. Grace took eight personal samples in 1976 during exfoliation of Libby #2 ore. Results of these samples ranged from nondetect [detection limit = 0.11 fibers per cubic centimeters of air (f/cc)] to 0.48 f/cc. Both the detection limit and the measured levels were higher than the current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 0.1 f/cc, although it should be noted that the OSHA PEL was 2.0 f/cc at the time of sampling†. A 1984 personal fiber sampling showed an 8-hour time-weighted average (TWA) of 0.014 f/cc (unpublished information from EPA’s database of W.R. Grace documents).

In 1985, during the exfoliation of ore type L-4 (presumably Libby #4); an 8-hour TWA indoor air concentration was 0.332 f/cc. The 1985 measured asbestos level could have been higher than the 1984 level because almost twice the amount of Libby vermiculite was processed that year. In addition, the 1984 sample may have been low-biased. As the industrial hygienist for the 1984 data collection noted, “Some samples were not evaluated for their fiber content due to a ‘coated membrane’”. A TWA calculation for one of the two employees was not possible due to this problem.” This could mean that the filter membrane had too much material on it for fibers to be discernable under the microscope (Mike Gilley, FDOH Industrial Hygienist, personal communication).

A 1985 engineering sample recorded a high fiber count (e.g., 6.2 f/cc) near the baghouse drop (unpublished information from EPA’s database of W.R. Grace documents). When Florida DOH visited the facility, the baghouse drop was open to a common workroom where the vermiculite was exfoliated, bagged, and stored. Other engineering samples taken in 1985 came from the stoner deck (0.27 f/cc and 0.22 f/cc), where the dense waste was separated from the final product and from the waste rock storage hopper (0.74 f/cc).

These past air sampling data from inside the plant indicate that the occupational exposure pathway was complete. Asbestos levels inside the plant, therefore, represented a *past public health hazard* to persons who worked inside the facility during the period when the plant exfoliated Libby vermiculite.

*Occupational (present)*—Because the facility stopped using asbestos-laden vermiculite concentrate from the Libby mine in 1991 (the highest use levels were from 1980 to 1985) and because W.R. Grace washed down the buildings prior to the current owner’s purchase of the site in 1993, current workers are not likely being exposed to asbestos at pre-1991 levels.

Air samples collected by NIOSH in August 2002 did not indicate that there was a risk of

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† The OSHA PEL for airborne asbestos has been lowered a number of times since it was introduced, moving from 12f/cc (initial level, May 1971), to 5 f/cc (December 1971), to 2 f/cc (July 1976), to 0.2 f/cc (June 1986), and to 0.1 f/cc (August 1994).

asbestos exposure for current workers. ATSDR and Florida DOH received a report of these sample results in 2004. Although these samples did not indicate the presence of airborne asbestos, the current owner indicated that he should require the workers in the bagging part of the operation to wear dust masks.

*Household Contact (past and present)*—During the period when Libby ore was processed, mainly from 1980 until 1985, the families of past workers may have been exposed to asbestos-containing dusts from the plant carried home on workers' hair and clothing. Exposures to household contacts cannot be quantified, however, without information concerning levels of Libby asbestos on worker clothing and certain behavior factors (for example, worker hygiene practices, household laundering practices). Therefore, the past household contact pathway is complete.

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

Because the present occupational pathway is not expected to result in any Libby asbestos-related exposures for current workers, the present household contact pathway is considered *incomplete*.

*Waste piles (past and present)*—Very little factual information exists regarding the past disposal of wastes from this facility. If the current development in the area—primarily industrial facilities close by the site, with only four homes within 0.1 mile of the site (and no other homes within ¼ mile of the site)—was the same in the past, residents' and/or children's exposures are unlikely. However, the possibility remains that waste rock from the Tampa facility could have been stockpiled on-site temporarily and could have been accessible to children or others in the past. Additional information is needed to substantiate past waste handling practices and the potential for community exposures to on-site waste piles.

During recent site visits by EPA and by ATSDR and Florida DOH, personnel found no evidence of waste rock piles on-site; therefore, this pathway is currently incomplete for on-site workers and off-site community members.

*Ambient Air (past)*—Florida DOH has no information or anecdotal evidence concerning past emissions from the facility. Community members could have been exposed in the past to Libby asbestos fibers released into the ambient air from fugitive dusts or the furnace stack while the plant was running. However, specific information concerning emissions from the plant was not available, so no estimate of risk from this exposure is currently possible.

Even with emission data, however, constructing past exposures would be difficult, given limited information on the population in the area. The Minnesota Department of Health developed an air dispersion model that suggested that areas within ¼ mile of a Minneapolis, Minnesota, exfoliation plant could have had elevated fiber levels, but the levels were predicted to drop off rapidly as distance increased (Pratt 2001). In Tampa, currently, only four residences are within ¼

mile of the former W.R. Grace & Company site, and only one of these homes stands in the downwind path of the prevailing wind.† Other current area residences are more than ¼ mile away. Considering the high average rainfall in Tampa and the fact that the vent for the furnace is only 35 ft high, emissions from the site may not have been dispersed over a wide area. Insufficient information exists to permit Florida DOH to evaluate this exposure pathway's health significance.

*On-site (present)*—Very little information is available on soil asbestos content on the site. While disturbing soils with even small amounts of Libby asbestos can result in airborne levels of concern, the site is currently paved with very little exposed soil. Therefore, *current* exposures to the ground surfaces likely pose little or no hazard. Any future excavation at the site, however, would warrant further consideration of this pathway.

*Consumer Products*—People who used commercial products containing Libby vermiculite might be exposed to asbestos fibers from using those products in and around their homes. At this time, however, determining the public health implication of commercial or consumer use of company products (such as home insulation or vermiculite gardening products) that contain Libby vermiculite is beyond the scope of this evaluation. Additional information developed by EPA, ATSDR, and NIOSH on vermiculite products for consumers is available at [www.epa.gov/asbestos/insulation.html](http://www.epa.gov/asbestos/insulation.html).

*Residential outdoor (past and present)*—The area immediately around the plant is industrial. Soil sampling around other vermiculite exfoliation sites has shown asbestos contamination to be concentrated in specific locations around the processing buildings and railroad spurs, not widespread throughout neighborhoods (ATSDR 2003). Florida DOH has no information indicating whether people ever hauled materials contaminated with Libby asbestos away from the site for personal use. As a result, Florida DOH is unable to evaluate the potential for current exposures to asbestos in residential soil.

*Residential indoor (past and present)*—Residents could have inhaled Libby asbestos fibers from household dust while the facility processed Libby vermiculite (mainly 1980 through 1985), either from plant emissions that infiltrated into homes or from residue brought indoors on clothing or other items. No information is available on past levels of contamination in ambient air; however, it appears *unlikely* that past ambient air emissions would have been widespread (c.f. *Ambient Air* pathway discussion).

### **III. Child Health Considerations**

ATSDR and Florida DOH recognize that infants and children may be more vulnerable than adults to exposure in communities faced with environmental contamination. Because children

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† On average, area winds blow from the east (1930–1996 National Climate Data Center data). Compilation of historical data shows winds blow from the east-northeast from January to April, from the east from May to October, and from the west in November and December. Average wind speeds have been 7–10 miles per hour, with gusts averaging from 44–61 miles per hour.

depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests.

The effects of asbestos on children are thought to be similar to the effects on adults. However, children could be especially likely to be exposed to asbestos in soils or dust because they are more likely to disturb these media while playing. Children also breathe air that is closer to the ground and may thus be more likely to inhale airborne fibers from contaminated soils or dust.

Furthermore, children who are exposed could be more at risk of actually developing asbestos-related disease than people exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease.

The most at-risk children are those who were household contacts of workers at the time the plant was exfoliating Libby vermiculite (especially 1980–1985). In addition, children who may have played in on-site waste piles, if such piles existed, would be at significant risk. As noted, during the site visit, ATSDR did not observe any waste piles present at the site. Therefore, children today are not exposed to waste piles contaminated with Libby asbestos at the Tampa site.

#### **IV. Conclusions**

- Florida DOH's preliminary calculations show that the highest volume of Libby ores was processed from 1980 through 1985. Former workers employed at the Tampa facility from 1980 through 1985 were probably exposed to Libby asbestos during active exfoliation of Libby vermiculite. From approximately 1962 through 1972, the facility used chrysotile asbestos to manufacture fireproofing material. Household contacts of former workers were also probably exposed to Libby asbestos from contamination brought home on workers' clothing and hair. The past occupational and household contact exposure pathways to asbestos were a public health hazard.
- Current occupational and household contact exposure pathways are no apparent public health hazards because Libby ore is not being processed at the site and has not been processed at the site for over a decade. Analyses of air samples NIOSH collected during normal site operations in 2002 did not indicate a risk of airborne asbestos exposure to current workers.
- Past waste pile, past ambient air, past and present residential outdoor, and past and present residential indoor exposure pathways represent indeterminate public health hazards. Currently, insufficient data exist to evaluate these pathways accurately.
- On-site vermiculite, waste, and waste piles present no apparent public health hazard since onsite soils are not being disturbed. EPA collected one soil sample containing vermiculite ore from the site in 2001, but that sample did not contain asbestos. However, this one sample may not be representative of all areas where the Libby vermiculite was handled and may have been comprised only of non-Libby ore. Florida DOH staff will evaluate the potential for exposure to contaminated soil if they receive any additional soil data.
- Exposure pathway evaluations regarding consumer products were not within the scope of this project.

## **V. Recommendations**

- Florida DOH will coordinate with ATSDR's NAER team to identify former workers and their household contacts for follow-up activities. Former workers may also be a source for additional information on waste disposal practices, industrial hygiene practices, and other facility operations relevant to an exposure pathway analysis.
- Florida DOH will review site-specific information as it becomes available and use emerging information to evaluate potential exposure pathways as applicable.
- Florida Department of Environmental Protection should require the additional testing of soils if onsite activities are planned that result in significant disturbance of soils in areas where Libby vermiculite was handled.
- Florida DOH and ATSDR should provide educational materials and references upon request to community members concerned about products containing vermiculite.

## **VI. Public Health Action Plan**

The following plan for the former W.R. Grace & Company site contains a description of public health actions that have been or will be taken by ATSDR, Florida DOH, and/or other government agencies at the site.

The purpose of the public health action plan is to ensure that health consultations not only identify public health hazards, but also provide a plan designed to mitigate and prevent adverse human health effects from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and Florida DOH to follow up on this plan to ensure its implementation.

**Actions Completed:**

- EPA site visit, May 12, 2000
- NIOSH site visit, August 2002
- ATSDR/Florida DOH site visit, September 12, 2002

**Actions Ongoing:**

- ATSDR will combine the findings from this health consultation with findings from similar sites nationwide to create a summary report. This summary will present ATSDR's overall conclusions and recommend strategies for addressing public health implications for sites that received Libby vermiculite.
- ATSDR staff will continue to research the EPA database of W.R. Grace documents to gather more information about potentially completed pathways. This database contains an estimated 3 million pages related to Libby, Montana, and to vermiculite processing sites nationwide.
- ATSDR's Division of Health Studies has funded Florida DOH to conduct a health statistics review for the area surrounding the Tampa site.

**Actions Planned:**

- ATSDR and Florida DOH plan to review new data as they become available to determine appropriate site-specific public health actions;
- Florida DOH will review site-specific information as it becomes available and use emerging information to evaluate potential exposure pathways as applicable;
- Florida DOH will coordinate with ATSDR's National Asbestos Exposure Review team to identify former workers and their household contacts for follow-up activities. Florida DOH plans to record any concerns voiced in an asbestos database in TOPHAT, provided by ATSDR. Former workers may also be a source for additional information on waste disposal practices, industrial hygiene practices, and other facility operations relevant to an exposure pathway analysis;
- Florida DOH will provide educational materials and references upon request to community members concerned with products containing vermiculite; and
- Florida DOH will provide information to area physicians on the recognition of asbestos-related lung disease.

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## **VIII. Preparers of the Report**

### **Florida Department of Health Author**

Connie Garrett  
Bureau of Community Environmental Health  
Division of Environmental Health  
(850) 245-4299

### **Florida DOH Designated Reviewer**

Randy Merchant  
Program Manager  
Bureau of Community Environmental Health  
Division of Environmental Health

### **ATSDR Designated Reviewer**

James Durant  
Environmental Health Scientist  
Division of Health Assessment and Consultation  
Agency for Toxic Substances and Disease Registry

Susan Moore  
Section Chief, Consultations Section  
Division of Health Assessment and Consultation  
Agency for Toxic Substances and Disease Registry

### **NAER Project Coordinator**

Barbara A. Anderson  
Environmental Health Scientist  
DHAC, ATSDR

### **Editor**

Joseph Sigalas, PhD  
Writer/Editor  
NCEH/ATSDR

## **CERTIFICATION**

The Florida Department of Health Bureau of Community Environmental Health prepared this Public Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It followed approved methodology and procedures existing at the time it began.

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Jennifer Freed  
Technical Project Officer,  
CAT, SSAB, DHAC

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

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Bobbie Erlwein  
Team Leader, CAT,  
SSAB, DHAC, ATSDR

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

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Susan Moore  
Acting Branch Chief,  
EICB, DHAC, ATSDR

## **IX. APPENDICES**

## **Appendix A**

### **Figures and Photographs**



1995 Aerial Photography

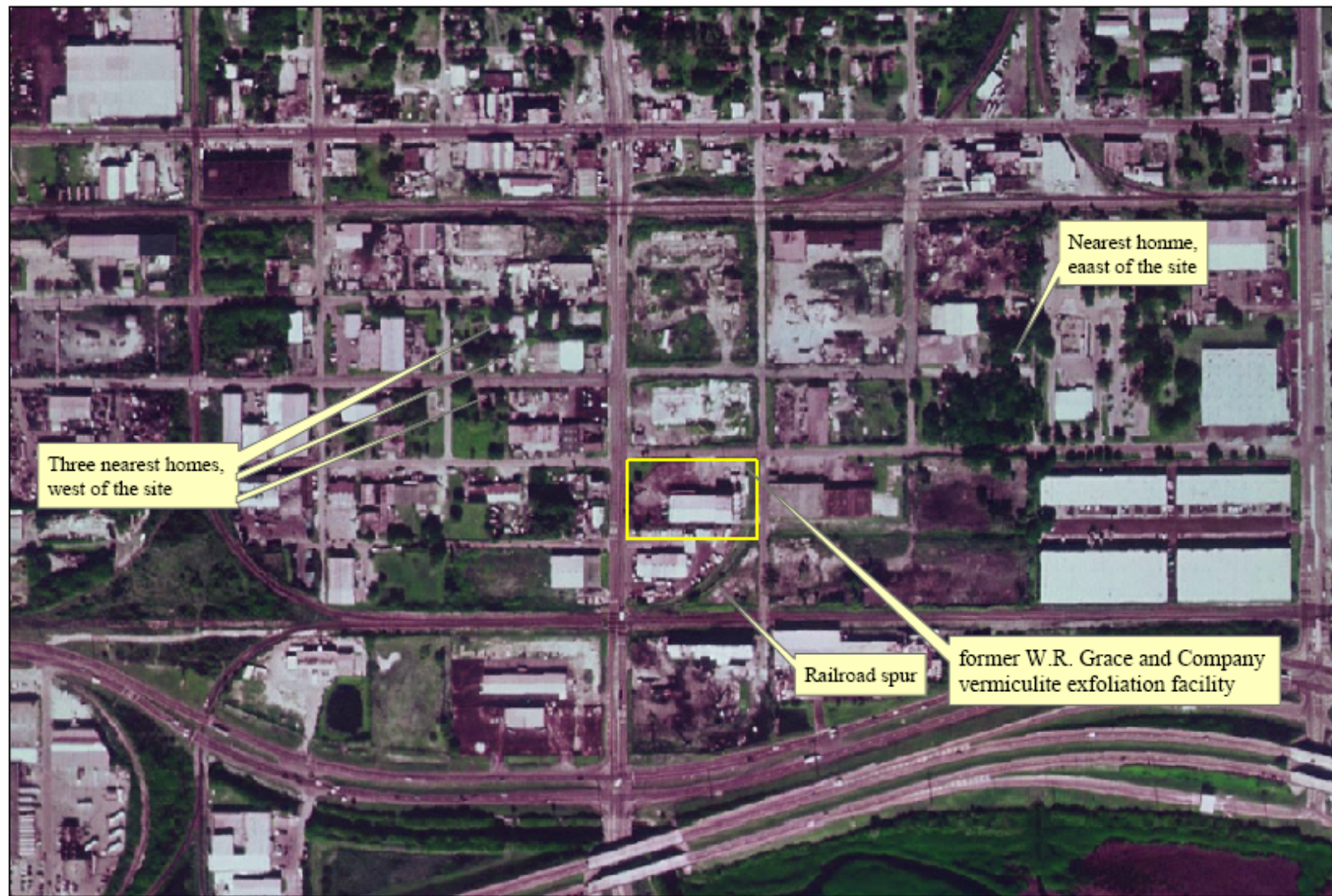


Figure 1: Site location - former W.R/Grace and Company, and former Zonolite vermiculite exfoliation facility



0 0.01 0.02 0.03 0.04 Miles

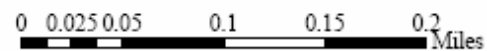




1995 Aerial Photography

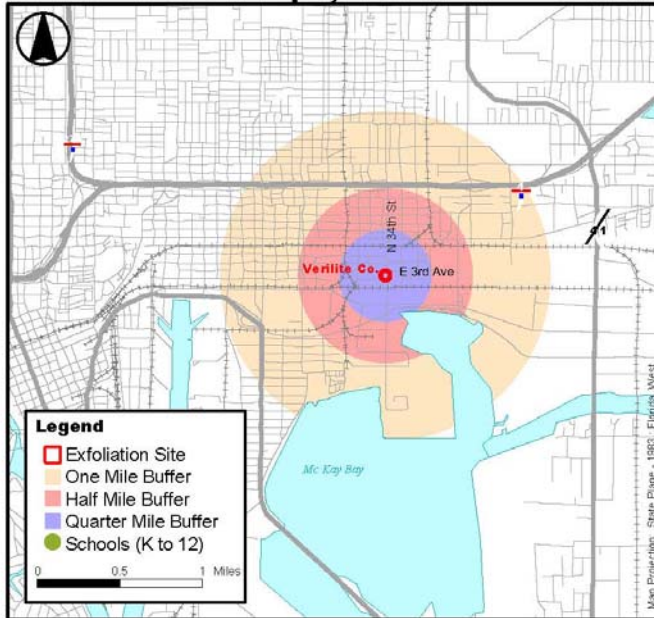


Figure 2: Site location, nearest homes and railroad spur.



# Verlite Co. (Schmelzer Sales)

3401 E 3rd Ave  
Tampa, Florida



Base Map Source: 1995 TIGER/Line Files

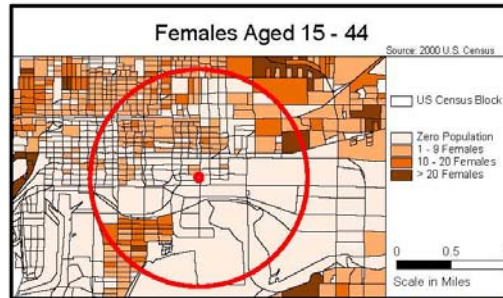
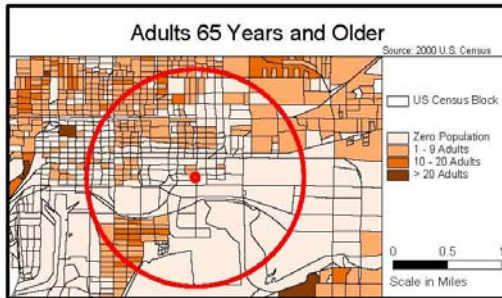
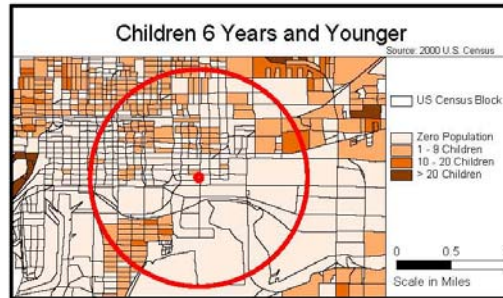
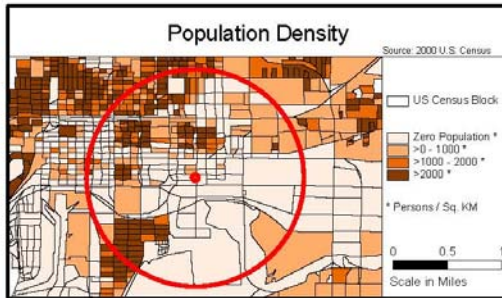
# INTRO MAP



Hillsborough County, Florida

Demographic Statistics Within Area of Concern*	
Total Population	4266
White alone	1482
Black alone	2334
Am. Indian and Alaska Native alone	16
Asian alone	6
Native Hawaiian and Other Pacific Islander alone	0
Some other race alone	284
Two or More races	144
Hispanic or Latino	1201
Children Aged 6 and Younger	428
Adults Aged 65 and Older	602
Females Aged 15 - 44	878
Total Housing Units	1738

Demographics Statistics Source: 2000 US Census  
\*Calculated using an area-proportion spatial analysis technique



LMR 073002





Photograph 1: North side of former W.R. Grace building looking south from 3<sup>rd</sup> Street



Photograph 2: West side of building looking east from 34<sup>th</sup> Avenue



Photograph 3: Silos on east side of building, abandoned train tracks at the base of silos



Photograph 4: North side of building looking east on 3<sup>rd</sup> Street, electrical contractor across 34<sup>th</sup>, Waste Management Inc. on right, during rain, note surface water.



Photograph 5: Electrical contractor across 34<sup>th</sup> (also visible in above photograph).



Photograph 6: North side of building looking southeast from 34<sup>th</sup> Avenue through Waste Management, Inc. property in foreground.





Photograph 7: Nearest residence, a little more than 1/10<sup>th</sup> of a mile east of the site.



Photograph 8: Nearest neighborhood a little more than 1/4<sup>th</sup> of a mile north of the site, across 7<sup>th</sup> Street.



Photograph 9: Property south of site, from where the railroad spur used to service the vermiculite exfoliation facility joins the site.



Photograph 10: Storage silo on the east side of the building, looking north from the loading dock.



Photograph 11: Close-up of the waste sled, this photo was taken from the same location as photo 10, but looking south from the loading dock.





Photograph 12 & 13: Storm water grates leading to surface water drainage system, left photo outside of property, right photo inside of property.

