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EXHIBIT E - THIRD AFFIDAVIT OF ROGER SULLIVAN AT EXHIBIT 100 (FULL COPY ATTACHED OF DISPOSITION PAPER FOR ASBESTOS-CONTAMINATED VERMICULITE AUGUST 1982)

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DISPOSITION PAPER
FOR
ASBESTOS-CONTAMINATED VERMICULITE

AUGUST 1982

CHEMICAL CONTROL DIVISION
OFFICE OF TOXIC SUBSTANCES

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PURPOSE

The objective of this document is to provide information enabling the Director of the Office of Toxic Substances to decide what course of action to take concerning vermiculite.

I. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. There are significant adverse health effects associated with past occupational exposures to asbestos-contaminated vermiculite, although current levels of workers' exposure are reportedly lower than years ago.

2. It is reasonable to assume that these adverse health effects were mainly caused by inhalation of asbestos, a contaminant in vermiculite.

3. About 350,000 tons of vermiculite are mined and distributed in commerce annually in the U.S. Thus, even at low levels of contamination, the amount of asbestos released to the environment could be significant.

4. The demand for vermiculite may increase significantly, due to the growing need for home-insulating materials to replace urea-formaldehyde resin.

5. Viable substitutes are available for most uses of vermiculite, according to a recent OTS contract study. Also, it appears that the level of asbestos contamination in vermiculite can be significantly reduced from current levels through engineering controls.

6. Although occupational exposures fall under existing Federal regulations affecting asbestos in the workplace, there is no regulatory control of consumer uses.

7. Some consumer uses of vermiculite, particularly the insulation of attics, may pose a significant health hazard, although actual exposure measurements are currently lacking to confirm this.

8. The public is generally unaware that vermiculite is likely to be contaminated with asbestos.

9. The Toxic Substances Control Act provides the only Federal authority to regulate asbestos-contaminated vermiculite throughout its life cycle.

10. Monitoring low levels of asbestos in vermiculite presents some technical problems in sampling, analysis, and reproducibility. There is no scientific consensus on acceptable laboratory protocols for compliance monitoring.

Recommendations

1. Perform a study to measure the level of consumer exposure to asbestos in selected vermiculite products. The Mt. Sinai School of Medicine has proposed such a study, which would

include the analysis of 40-50 samples of various vermiculite products (e.g., loosefill insulation for roofs and walls, soil additives, and packaging materials). Also, the levels of airborne asbestos concentrations to which consumers might be exposed in the use of these 40-50 vermiculite products would be determined (see attached research plan). This proposed study would cost about $102,000 and would be coordinated with the Consumer Product Safety Commission.

2. If the study proposed in Recommendation #1 confirms that there is a health concern to consumers, negotiate a voluntary program of engineering controls with the three domestic vermiculite mining and processing companies to reduce the level of asbestos contamination in vermiculite.

3. Again, if the consumer exposure study confirms that there is a health concern, negotiate voluntary labeling of vermiculite as to level of asbestos content and recommended precautions for product use.

4. Use the newly established Federal Asbestos Task Force to disseminate information on the various Federal agency activities concerning vermiculite.

5. Recommend to ORD that uncontaminated vermiculite be tested for biological activity.

II. BACKGROUND

Introduction

Vermiculite is a naturally occurring hydrated magnesium-iron-aluminum silicate found principally in the United States and in South Africa. Most of the 350,000 tons consumed annually in the United States is processed to an expanded (exfoliated) form for use as thermal insulation, plaster and concrete aggregate, and as a carrier for fertilizer and soil conditioner. A small amount of vermiculite is also used in a wide variety of miscellaneous applications including packaging, kitty litter, etc.

The commercial utility of the mineral results from its ability to exfoliate or expand to a low-density material when heated under carefully controlled conditions. Exfoliated vermiculite may be 20 times the volume of the crude ore. It contains many small cavities of air, making it a good insulating material. It is also lightweight, noncombustible, chemically inert, resilient, and nonabrasive.[1]

More than 90% of the vermiculite consumed domestically is used in its exfoliated form. About 7% is used in its crude or unexfoliated form. The largest uses of crude vermiculite are in the production of fire-resistant wallboard and as insulation for molten steel where it exfoliates on contact.[2]

Approximately 88% of the vermiculite consumed domestically comes from the world's largest vermiculite deposit at Libby, Montana. W.R. Grace and Co. (Grace), the owner of the Libby mine, also produces vermiculite from mines near Enoree, South Carolina. Virginia Vermiculite in Louisa County, Virginia, and Patterson Vermiculite near Enoree, South Carolina, produce relatively small quantities. Virtually all vermiculite deposits in the U.S. are believed to be contaminated with asbestos.[3] Specifically, the vermiculite deposits at Libby contain sizable veins of tremolite asbestos,[4] yielding an ore that contains 21 to 26% asbestos (although the samples analyzed were not necessarily representative).[5] About 9% of vermiculite consumed domestically is imported from South Africa by American Vermiculite Co. The vermiculite deposits at Palabora in South Africa, one of the world's largest, are presumed to be approximately 75 million tons. These deposits appear to be essentially free of asbestos fibers.

A draft regulatory options analysis completed by the Chemical Control Division in December 1980[6] concluded that the quantity of asbestos in crude vermiculite may be significantly reduced from the average level of 0.5% reported at Grace's Libby mine[14] through more effective processing of the ore. For example, two beneficiation processes were estimated to be capable of maintaining asbestos levels at 0.1 and 0.25%, respectively. These estimates were based on projected capability of existing technology. Such technology is already widely used in reducing the asbestos contamination in talc.

Vermiculite is only one of a number of minerals contaminated with asbestos, but it raises a concern because it is commercially mined in large quantities. One EPA report[7] estimates that rock types in which asbestos might be found cover 30-40% of the continental United States; however, most of these minerals are not disturbed and therefore do not create a potential for the release of asbestos fibers to the environment. A recent Mine Safety and Health Administration publication[8] lists many domestic mining operations and localities where asbestiform minerals may possibly be found. The primary sources of human exposure to asbestos-contaminated vermiculite result from mining and milling operations, processing, transportation, and commercial and consumer uses.

Basis for Concern

In December 1978, O.M. Scott and Sons (Scott) submitted information to EPA regarding serious health problems experienced by workers who had been processing asbestos-contaminated vermiculite at its Marysville, Ohio, chemical fertilizer plant.[9] The initial submission stated that bloody pleural effusions had been observed in 4 of 350 employees; symptoms and clinical findings in the employees were similar to those observed in individuals with known asbestos-related diseases. Subsequent follow-up studies initiated by OSHA revealed that the prevalence of health problems among employees at Scott was greater than initially expected.[10] Thirty-two additional cases of pleural and/or interstitial abnormalities were detected by chest X-rays and/or spirometric measurements (X-rays were taken for 125 of 221 workers).

Monitoring data revealed that prior to the installation of more stringent safety controls in 1976, Scott plant employees were occasionally exposed to high levels of airborne asbestos. One air sample taken in the unloading area contained 245 fibers/cm^3. Similar high fiber levels have been reported in a plant in St. Paul, Minnesota, which also processes asbestos-contaminated vermiculite; peak levels as high as 163 fibers/cm^3 were found.[11]

The major source of asbestos at the Scott plant probably was the use of vermiculite from the Grace mine in Libby, Montana. Grace acknowledged the presence of asbestos in vermiculite from that mine in 1971.[12] In 1977, an EPA study reported the presence of substantial amounts of asbestiform amphibole fibers in the tailings (residues) from mining and milling operations at Libby.[13] During the beneficiation process, impurities in raw vermiculite ore are physically separated by a "wet" method in which adhering clay and other impurities are removed by washing. However, attempts to remove all impurities have been unsuccessful, and some tremolite asbestos remains as a contaminant in the vermiculite. The current asbestos concentration in crude vermiculite leaving the Libby mines has been reportedly reduced from an estimated 10% to about 0.5%.[14] It should be noted, however, that even at these relatively low weight percent levels the number of respirable asbestos fibers may be extremely high, because the size ratio of vermiculite particles to asbestos fibers is very high.

III. HEALTH EFFECTS

Asbestos

Asbestos is a general term for any of several naturally occurring fibrous minerals composed of silica, oxygen, hydrogen, and other elements such as sodium, calcium, iron, or magnesium. There are six basic varieties of asbestos minerals that are found in fiber form; they are chrysotile (the most common variety, in about 95% of asbestos-containing products in the United States), amosite, crocidolite, actinolite asbestos, tremolite asbestos, and anthophyllite asbestos.

A large body of scientific evidence indicates that all major types of asbestos are carcinogenic. Animal data and human epidemiologic studies support this conclusion. Dose-response studies are supported by evidence of adverse health effects resulting from relatively low levels of asbestos exposure. Workers exposed to asbestos for the equivalent of 5 years at the current workplace standard of 2 fibers per cubic centimeter (f/cm^3) are subject to increased lung cancer risk. Mesothelioma, a "marker disease" (disease that is always, or nearly always, caused by a particular agent) for asbestos exposure, has occurred in persons with exposures as brief as one or two days and in persons with frequent to constant exposures at levels found in the homes of asbestos workers and in the neighborhoods around asbestos mines, asbestos products factories, and shipyards. Occupational studies consistent with the linear nonthreshold dose-response model, and the studies showing risks at exposure levels lower than those found in the workplace, support the conclusion that asbestos exposure in the environment is expected to produce known adverse health effects.[15]

Vermiculite

Vermiculite is a micaceous, hydrated, magnesium-iron-aluminum silicate with a lamellar (plate-like) structure. This mineral, which is related to and often associated with asbestos, exists in fibrous and nonfibrous forms.[15]

There is a dearth of information on the health effects of either vermiculite alone (fibrous or nonfibrous) or vermiculite contaminated with asbestos. In a study conducted by Hunter and Thompson (1973), Rhodesian chrysotile asbestos or vermiculite was injected into the pleural cavity of rats.[16] Mesotheliomata developed in 48% of the rats treated with asbestos. No tumors occurred which could be associated with vermiculite injections. Hunter and Thompson concluded that although the concept of intrapleural injection is unrealistic when compared to the human situation, these findings demonstrate that the use of vermiculite is unlikely to be associated with the degree of hazard imposed by asbestos. The adverse effects of exposure to asbestos-contaminated vermiculite reported by Scott in 1978 showed that pleural changes among the company's employees were similar to those observed among persons chronically exposed to asbestos minerals (chrysotile, amphiboles) or to geologically related fibers (mica, talc). The symptomatology and clinical findings in the four employees are also similar to those found in individuals with known asbestos-related diseases.

To obtain additional data, in January 1979, OSHA took X-rays and spirometric measurements of 108 of the 221 Scott workers employed in the trionizing, packaging, and maintenance departments, areas where the four affected workers had been employed. The most recent X-rays of 17 additional trionizing workers were obtained from the company's medical files and similarly reviewed and classified; thus, a total of 125 employee X-rays were reviewed. Thirty-two of the 125 X-rays were abnormal. The overall prevalence of pleural and/or interstitial abnormalities were found in 16 of the 41 trionizing workers that were examined; 7 of the 32 maintenance workers; and 9 of the 52 packaging workers. The proportion of these abnormalities increased with duration of employment for all departments. The proportion of abnormalities also increased with age.[17]

The incidence of these pleural and interstitial abnormalities is extraordinarily high. This suggests that the problem may even be worse than exposure to asbestos alone. Little data exist for health effects from pure vermiculite (fibrous or nonfibrous); it is possible, however, that cleavage fragments or fibers of vermiculite itself may have contributed to the disease. Free silica present in the dust is another possible toxicant, although silica by itself is not known to cause the adverse health effects observed. The possibility also exists that fertilizer and pesticide chemicals, which are coated onto the vermiculite surface in the process, may have adhered onto the fibers that were inhaled and could have contributed to the adverse health effects. Studies would have to be conducted to resolve these possibilities. For purposes of this document, it is assumed that inhaled asbestos dust was most probably the cause of the disease.

Risk Evaluation

In June 1980, the Assessment Division of OTS completed a Priority Review Level-1 (PRL-1) report entitled "Asbestos-Contaminated Vermiculite," which included a risk evaluation based on exposure data submitted by Grace and Scott on their employees who mine and/or process asbestos-contaminated vermiculite. Risk estimates were derived, using the linear nonthreshold model, for workers handling asbestos-contaminated vermiculite.[15] According to the PRL-1, the estimates are applicable only to the approximately 600 workers in the two plants and are not representative of the general risk of persons handling asbestos-contaminated vermiculite. A detailed risk assessment would require quantitative data and size distribution of the fibers in the asbestos-contaminated vermiculite to which workers are exposed.

The PRL-1 risk estimates, using the Grace/Scott data, project that 1 of every 10 workers exposed to levels as high as the OSHA workplace standard of 2 f/cm^3 for 50 years will die prematurely from an asbestos-related disease. In the mining and screening of asbestos-contaminated vermiculite, the workers are exposed to at least 0.1 f/cm^3. For a 50-year exposure at this level, 1 in 200 workers will die prematurely of an asbestos-related disease. Thus, regardless whether the workers handling asbestos-contaminated vermiculite are exposed to 0.1 f/cm^3 or 2 f/cm^3 (the OSHA workplace standard), there is potential for significant risk.[15] The degree of risk for other exposed populations cannot be determined with the limited information currently available.

IV. FEDERAL AND STATE AGENCY AUTHORITIES AND ACTIVITIES

In a February 1981 decision paper prepared by OTS concerning vermiculite, a review of the authorities and actions of Federal agencies revealed that existing regulations have not been successful in minimizing exposure of workers and the general public to asbestos-contaminated vermiculite.[18] A number of Federal agencies have issued regulations to control exposure to asbestos; two agencies, the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA), have occupational standards in place which cover worker exposures during mining, processing, and distribution of asbestos, including asbestos-contaminated vermiculite. The Department of Transportation has a regulation to control the transportation of commercial asbestos; however, that regulation is not applicable when the asbestos is present as a contaminant, as in vermiculite. Consumer uses of asbestos-contaminated vermiculite are free of any regulatory control. Although the Consumer Product Safety Commission (CPSC) has the authority to ban or to require labeling of asbestos-contaminated vermiculite when used as consumer products, only EPA, under the Toxic Substances Control Act (TSCA), has regulatory authority throughout the life-cycle of vermiculite.

The National Institute for Occupational Safety and Health (NIOSH) has begun a comprehensive study of employees at the Grace mine in Libby, Montana. This effort includes a mortality study of a cohort of workers employed at the mine between 1940 and 1969. In addition, NIOSH is surveying the industrial hygiene and health records maintained by Grace since the 1960's for its employees. The study is focusing primarily on spirometry (a measure of pulmonary function), including lung capacity, morbidity, and the mortality findings. The findings of these NIOSH investigations will not be available before the summer of 1983.

As far as the States' regulatory authorities are concerned, the Occupational Safety and Health Act allows States to submit plans for developing safety and health standards to OSHA. If these plans are approved, States are authorized to issue and enforce the standards, which must be at least as stringent as Federal standards. A number of States have used these provisions of the Act to develop standards for workplace exposure to asbestos. To our knowledge, only one State, Minnesota, has used its authority to enforce a workplace standard for asbestos at a vermiculite plant.

EPA has no regulations that apply to asbestos-contaminated vermiculite, although the Agency has issued a number of regulations to control asbestos. In 1973 and 1976, pursuant to the National Emissions Standard for Hazardous Air Pollutants (NESHAP) promulgated under the Clean Air Act, EPA banned the use of all sprayed-on insulating materials containing greater than 1% asbestos. The limit of 1% was set due to knowledge of the presence of asbestos as a contaminant in several commercial insulating materials, especially vermiculite; also, 1% was considered to be the lowest practical limit for detection of asbestos at that time.

V. OTS ACTIVITIES

The following discussion summarizes the activities, completed and ongoing, by OTS concerning asbestos-contaminated vermiculite. Table 1 contains a chronological listing of these activities.

Initial Activities

An investigation of vermiculite was initiated by OTS following the December 1978 letter to EPA, by Scott, concerning the serious health effects observed in some of their workers who had been processing asbestos-contaminated vermiculite. The first report issued by OTS as a result of the initial investigation was a Chemical Hazard Information Profile (CHIP), dated October 1979.[19]

In June 1980, OTS produced a Priority Review Level-1 (PRL-1) report entitled "Asbestos-Contaminated Vermiculite."[15] The report cited asbestos as the probable causative agent in the Scott plant. Recommendations made were focused primarily on the potential risk of asbestos-related diseases among workers who mine and process vermiculite. The PRL-1 report recommended specifically that (1) data be gathered on health effects and human exposure, and (2) a pre-regulatory control options analysis be performed.

In December 1980, OTS completed a draft final report entitled "Vermiculite Regulatory Options Analysis," under contract with GCA Corporation.[6] A profile of the vermiculite industry was completed along with a detailed analysis of eight identified regulatory options. These regulatory options were defined on the basis of a series of engineering assumptions since specific data were not available. The objective was to develop preliminary information to help determine the direction of OTS activities relative to vermiculite. The analysis was considered tentative, pending more definitive data. The eight options varied from a complete ban on the use of vermiculite to the other extreme of doing nothing. Other options included requesting voluntary industry compliance affecting process alterations to reduce asbestos content, and issuing rules for labeling of vermiculite products.

Under another OTS contract, GCA Corporation performed an analysis of vermiculite substitutes, completed in November 1980.[20] Several materials were identified as technically suitable and cost-competitive substitutes, assuming vermiculite becomes unavailable.

A draft final Level-II materials balance was completed in January 1982 by JRB Associates, Inc., under contract to OTS.[21] The materials balance reported environmental releases of asbestos-contaminated vermiculite from mining through each use, and identified specific sources and levels of release.

In February 1981, a decision paper for asbestos-contaminated vermiculite was prepared by the Chemical Control Division.[18] This paper developed and analyzed five major alternative control strategies. These strategies emerged following a review of EPA's authority under TSCA and other acts, the authorities of other agencies, and a number of non-regulatory options. The alternative strategies analyzed were as follows: (1) take no action at this time; (2) gather information; (3) pursue voluntary controls with the vermiculite industry; (4) develop a rule under TSCA, requiring labeling of asbestos-contaminated vermiculite; and (5) take action under section 6 of TSCA to control asbestos-contaminated vermiculite. The advantages and disadvantages of each alternative strategy were examined, and finally the strategies encompassing information gathering, voluntary controls, and labeling of products were recommended.

Recent Activities

A. Monitoring Study

Pursuant to data gaps identified by the PRL-1 review of asbestos-contaminated vermiculite, the Field Studies Branch initiated a contractor study to determine current levels of asbestos fibers in ambient air and bulk vermiculite during mining and milling operations. Details of the study are contained in the September 1981 report issued by Midwest Research Institute (MRI), "Collection, Analysis, and Characterization of Vermiculite Samples for Fiber Content and Asbestos Contamination."[5] A brief discussion of the protocol and subsequent observations are presented in the following section. It should be noted that monitoring low levels of asbestos presents some technical problems in sampling, analysis, and reproducibility. There is no scientific consensus on acceptable laboratory protocols; however, the MRI report is now undergoing peer review to assure that the results reported can withstand scientific scrutiny.

MRI determined asbestos concentrations in bulk vermiculite and air samples from three locations, including W. R. Grace mines in Libby, Montana, and Enoree, South Carolina; and Patterson Vermiculite in Enoree, South Carolina. The study was not carried out in depth as originally planned; nevertheless, some useful conclusions can be drawn regarding fiber characteristics and levels in various media.

Bulk vermiculite samples were taken before and after beneficiation (purification), and after exfoliation (expansion). Several samples of waste (e.g., baghouse dust) were also taken. The bulk vermiculite samples were treated and analyzed in several ways. Selected fractions were separated from the bulk vermiculite by a density separation technique and were analyzed by polarized light microscopy (PLM) and X-ray diffraction (XRD). PLM and XRD measure the total asbestos content of the bulk samples.

Transmission electron microscopy (TEM) was also used for bulk vermiculite samples. The TEM procedure was designed to yield a fiber count which includes only fibers considered to be respirable. Respirable fibers are related to the unit density and spherical diameter of the fibers. Results were reported in terms of chrysotile fibers and asbestiform amphibole fibers; presumably, the amphibole fibers are tremolite-actinolite asbestos fibers. Isopropanol-suspended fractions of vermiculite and some laboratory-expanded vermiculite samples were also analyzed by TEM to determine whether exfoliation of vermiculite releases asbestiform fibers.

The PLM and XRD analyses show that the beneficiated vermiculite from Libby may contain up to 7% tremolite-actinolite asbestos. Baghouse dust from the mill may be up to 12%, and the mill head feed may be up to 26% tremolite-actinolite asbestos.

The results of PLM and XRD analyses for the South Carolina (Grace and Patterson) samples showed that all samples (mill feed, beneficiated vermiculite, and expanded vermiculite) are less than 1% anthophyllite asbestos and tremolite-actinolite asbestos.

The TEM analyses showed concentrations of asbestiform fibers of respirable size (less than 10 um) in the South Carolina samples to be less than the Libby samples. At Libby, the head feed contained between 62.5 x 10^6 and 130 x 10^6 respirable asbestiform amphibole fibers/g (less than 0.1%). The beneficiated vermiculite at libby contained up to 160 x 10^6 respirable asbestiform amphibole fibers/g (0.26%) in the smallest size (grade 5), while the other grades representing larger sizes contained less such respirable fibers (up to 65 x 10^6 fibers/g or 0.05% in grade 4, up to 59 x 10^6 fibers/g or 0.03% in grade 3, etc.). The mill dust and screening dust contained up to 770 x 10^6 (3.5%) and 1,800 x 10^6 (4.1%) respirable asbestiform amphibole fibers/g, respectively, showing that the Libby beneficiation plant removes significant amounts of respirable asbestos.

The TEM analysis of all South Carolina bulk vermiculite samples showed much lower concentrations of respirable asbestiform amphiboles than the Libby samples. Grace's smallest size (grade 5) of beneficiated vermiculite contained up to 31 x 10^6 asbestiform amphibole fibers/g; larger sizes (below grade 5) appeared to contain less. The respirable asbestiform amphibole content of Patterson vermiculite, which may be up to 1.7 x 10^6 fibers/g, appears to be within the range observed in the beneficiated Grace samples.

The TEM analyses before and after laboratory expansion did not show an appreciable change in respirable asbestiform fiber content.

MRI took air samples at various locations to measure occupational exposure. The air samples included "personal samples" taken in the breathing zone of workers, stationary samples taken at worksites, and stationary samples taken downwind, upwind, or crosswind from vermiculite mining, milling, or expansion operations. These air samples were analyzed by phase contrast optical microscopy, yielding data in units of fibers per cubic centimeter. This method does not characterize or distinguish the asbestos fibers from other fibers present in the air samples; however, it has been the standard method for measuring asbestos exposure levels used by NIOSH and OSHA under the assumption that all fibers present are asbestos. This method measures fibers with aspect ratios of 3:1 or greater and lengths greater than 5 micrometers, the fiber size on which the OSHA asbestos standard is based.

Only one of 30 air samples exceeded the OSHA/MSHA occupational standard of 2 fibers/cc, and most samples were 0.1 fiber/cc or less. All samples taken at the South Carolina vermiculite operations were 0.3 fiber/cc or less. However, all three sets of samples were taken following periods of inclement weather. Precipitation has a known scrubbing effect which may have affected the ambient conditions at the time the samples were actually taken.

B. Exposure Assessment

More recently, in February 1982, Versar, Inc., under contract to OTS, prepared an interim final exposure assessment for asbestos-contaminated vermiculite throughout most of its life cycle.[22] Human exposures to vermiculite were estimated during mining and milling, processing, transporting, and during commercial and consumer uses. Sources of information included data found in the vermiculite industry records, information in the PRL-1 report, monitoring data obtained by EPA, and a number of other sources.

Exposure to asbestos in asbestos-contaminated vermiculite occurs primarily through inhalation; ingestion and dermal absorption seem to be insignificant routes, although ingestion of asbestos may follow initial inhalation. The exposure assessment was designed to provide inhalation exposure estimates for use in a risk analysis and subsequent regulatory action, if indicated. The focus was on occupational and consumer exposures. Some high-exposure occupational groups identified included rail workers transporting raw ore, miners, and exfoliators. These three types of occupational exposure were estimated at levels of 4.0×10^{11} fibers per year, 1.7×10^{10} fibers per year, and 8.3×10^{8} fibers per year, respectively. These exposures affect a relatively small population. A much larger number of persons may inhale asbestos during trade or consumer use of vermiculite products, but are expected to receive lower exposures.

Major consumer uses of vermiculite are for home attic insulation, garden and lawn care products, and a variety of other uses including packaging, kitty litter, etc. The Versar report estimated that over 74 million persons use lawn and garden fertilizers and 188,000 persons insulate their own attics with vermiculite. (However, it should be noted that not all lawn and garden fertilizers contain vermiculite and that some vermiculite is imported from South Africa and is essentially uncontaminated with asbestos.) Exposure data were not available for these uses; therefore, Versar made "reasonable worst-case" assumptions to estimate consumer exposure levels during installation of vermiculite for attic insulation and during the use of home garden fertilizers and lawn care products. It should be noted, however, that in the Versar study, "reasonable worst-case" was intended to refer to concentration of asbestos fibers rather than duration or frequency of exposure. These consumer exposure levels to asbestos in vermiculite have been estimated by Versar as follows: (1) lawn treatments (4 hours per year) average 4.4 ug/m^3, (2) gardening (1 hour per year) average 28 ug/m^3, and (3) attic insulation (8 hours single exposure over a lifetime) average 6,800 ug/m^3. These levels represent total exposures of 14.7 ug/year, 23.3 ug/year, and 45,000 ug/lifetime (assuming only one heavy exposure), respectively. By comparison, background levels of asbestos in ambient air in 50 large cities averaged 0.003 ug/m,[23] producing exposures of about 20 ug/year. Brake mechanics are exposed to levels of asbestos[24] which produce exposures up to 110,000 ug/year. It should be noted that although the exposure calculated for home attic insulators may appear to be less severe than for brake mechanics, single heavy exposures of short duration have been shown to induce asbestos-related diseases.

TABLE 1

CHRONOLOGY OF OTS ACTIVITIES ON VERMICULITE

October 1979	Chemical Hazard Information Profile (CHIP)
June 1980	Priority Review Level-1 (PRL-1)
November 1980	Substitutes Analysis (GCA)
November 1980	Regulatory Control Options Analysis (GCA)
February 1981	Decision Paper
September 1981	Monitoring Study (MRI)
January 1982	Materials Balance (JRB)
February 1982	Exposure Analysis (Versar)

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