# REMEDIAL ACTION CONTRACT (RAC) II LITE
# IN EPA REGION 4

# FINAL
# HUMAN HEALTH RISK ASSESSMENT
# FOR
# VERMICULITE EXFOLIATION PLANT GAO 144
# ATLANTA, GEORGIA

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## Acronyms and Abbreviations

| | |
|---|---|
| ABS | activity-base sampling |
| bgs | below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CTE | central tendency exposure |
| ELCR | excess lifetime cancer risk |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| f/cc | fibers per cubic centimeter |
| HHRA | Human Health Risk Assessment |
| IRIS | Integrated Risk Information System |
| ISO | International Standards Organization |
| IUR | Inhalation Unit Risk |
| L | liter |
| NCP | National Contingency Plan |
| PCM | phase contrast microscopy |
| PCME | phase contrast microscopy equivalent |
| PEL | permissible exposure limit |
| PLM | polarized light microscopy |
| REAC | EPA's Response Engineering and Analytical Contract |
| RME | reasonable maximum exposure |
| s/cc | structures per cubic centimeter |
| sq. ft. | squared foot |

## Acronyms and Abbreviations

| | |
|---|---|
| TEM | transmission electron microscopy |
| TWF | time-weighting factor |
| μm | micrometer |
| VAI | vermiculite attic insulation |

# 1. INTRODUCTION AND SITE BACKGROUND

The United States Environmental Protection Agency, Region 4 (EPA) is investigating vermiculite exfoliation sites which have documented shipments of vermiculite ore from Libby, Montana. The GAO 144 site is located at 1167 Zonolite Place, NE, Atlanta, Dekalb County, Georgia, 30306 as shown in Figure 1-1. The GAO 144 site is located about 4.8 miles northwest of downtown Atlanta, Georgia, in a mainly industrial area with residences and residential communities located beyond the industrial areas. Several businesses border the GAO 144 site to the north, west and south. The Atlanta Soto Zen Center is located within the site boundaries of the GAO 144 site. Dekalb County uses the site as an unofficial open recreational area. Limited mixed commercial use is also present within the former site area.

The site occupies about 16 acres and was the former location of a vermiculite expansion plant. Twelve acres of the former site area are currently owned by Dekalb County with the additional four acres owned by two separate private parties. According to W.R. Grace, the expansion plant operated until 1970, at which time all equipment and buildings, except for the office building and the worker locker room/change room building, were removed and demolished.

The former vermiculite expansion plant was first constructed at the site by Southern Zonolite Company in 1950; this company reportedly owned the property at that time. In 1957, Zonolite Company merged with the Southern Zonolite Company. In 1963, W. R. Grace and Company acquired the assets of the Zonolite Company, and continued to operate the expansion plant until 1970.

According to various sources, between 499 and 1,225 tons of vermiculite from the W.R. Grace vermiculite mine in Libby, Montana were shipped to the GAO 144 site. Sampling at the site has been conducted in the past, including on December 5, 2000. Based on information gathered regarding the GAO 144 site, EPA has concluded that further investigation is required at the site.

## 1.1 PROJECT OBJECTIVE

The primary objective of this human health risk assessment (HHRA) report is to evaluate the potential human health risks from exposure to asbestos at the Site based on activity-based sampling (ABS) activities performed in March 2010. This HHRA is the culmination of the reevaluation begun by EPA in early 2010.

## 1.2 HHRA FORMAT

This HHRA has been organized as follows:

- Section 1 – Introduction and Site Background
- Section 2 – Goal of the Human Health Risk Assessment
- Section 3 – Data Evaluation and Exposure Assessment
- Section 4 – Toxicity Assessment
- Section 5 – Risk Characterization
- Section 6 – Uncertainty Analysis
- Section 7 – Summary
- Section 8 – References

# 2. GOAL OF THE HUMAN HEALTH RISK ASSESSMENT

The goal of the human health risk assessment is to use current best practice asbestos sampling and analytical techniques to estimate the potential excess lifetime cancer risks associated with those exposures that could occur at the site. This assessment was conducted in accordance with EPA policy and guidance (EPA, 2008). The assessment consists of four parts:

- Exposure Assessment (Section 3) – describes the methods by which the asbestos data used in the HHRA were collected; presents the analytical results of the sampling in tabular format; and presents the manner in which the available asbestos data were used to estimate excess lifetime cancer risks.
- Toxicity Assessment (Section 4) – describes the cancer potency for asbestos and presents a table that summarizes the various cancer potency values based on age of onset and duration of exposure.
- Risk Characterization (Section 5) – presents the equation that was used to estimate the excess lifetime cancer risks and summarizes the exposure scenario-specific parameters that were used. Presents excess lifetime cancer risks for each of the scenarios, with results and conclusions.
- Uncertainty Analysis (Section 6) – discusses the various sources of uncertainty associated with the HHRA process and indicates the potential impact to the estimate of risks (under- or overestimate).

# 3. DATA EVALUATION AND EXPOSURE ASSESSMENT

The objectives of the data evaluation and exposure assessment are to:

- Describe the methods that were followed to collect asbestos data for use in the HHRA (Subsection 3.1).
- Present the sampling results for each of the sample collection methods (Subsections 3.2 – 3.4).
- Present the manner in which the data were evaluated in the HHRA (Subsection 3.5).
- Perform Exposure Assessment (Subsection 3.6).

## 3.1 SAMPLING METHODS

In March and April of 2010, a sampling effort was conducted to further investigate the presence of asbestos at the Site and to determine the possible mechanism of exposure.

The collected samples included:

- Air Samples – activity-based and stationary samples collected during activities (e.g., sweeping paved areas and raking the soil) that could result in exposure.
- Background Air Samples – stationary samples to determine if measurable levels of asbestos existed in background concentrations not associated with the Site.
- Bulk Samples – a method designed to determine the presence of asbestos in soil.

The air sampling (including activity-based, stationary, and background samples) was conducted using modified International Standards Organization (ISO) Method 10312. A detailed discussion of how this procedure was applied is presented in the Sampling and Analysis Plan (Tetra Tech, 2010).

The subsections below describe each of the sample collection methods and how the data were used in the HHRA.

### 3.2 ACTIVITY-BASED SAMPLING

The primary data for quantifying health risks in this HHRA were collected using ABS techniques. A number of sources indicate that personal monitoring is more representative of actual exposure than samples obtained from a fixed downwind location (McBride, 1999; Rodes, 1991 and 1995; Hildemann, 2005). ABS directly measures the asbestos levels in the breathing zone of an individual, making it a more accurate predictor of exposure than static, stationary monitors. Thus, personal monitoring results are generally most relevant to CERCLA risk characterizations and were used exclusively in the HHRA to estimate the excess lifetime cancer risks.

ABS utilizes personal air monitoring. Personal air monitoring is a well-established approach that has been used for decades by industrial hygienists for exposure assessment in occupational environments. It is well-suited for environmental asbestos exposure measurements because it captures the asbestos structures in the personal dust cloud that is generated by activities that disturb asbestos-containing soils. The breathing zone can be visualized as a hemisphere extending approximately 6 to 9 inches around an individual's face.

EPA has developed ABS to mimic the activities of a potential receptor. EPA or contractor personnel trained in hazard recognition and mitigation serve as surrogates for the potentially exposed populace of interest. Routine activities are simulated to measure personal exposures from disturbance of materials potentially contaminated with asbestos. ABS samples collected during sweeping and raking activities were used to evaluate potential exposure in this HHRA.

The total time of each ABS event was approximately 120 minutes. One high flow-rate air pump and one low flow-rate air pump were carried in a backpack on each of the participant's backs, and the inlets of the air filter cassettes were secured to the participant's shoulder straps so that the inlets were within the participant's breathing zone. At each location, the ABS sample collected using the high flow-rate pump was analyzed first, and if overloaded, the low flow-rate sample was analyzed.

The air sample data were reported as phase contrast microscopy (PCM) equivalent fiber concentrations. The PCM method of quantification was utilized because this is the traditional method for measurement of asbestos fibers in air, and is the basis for current estimates of risk. PCM fibers are equal to or longer than 5 µm, at least 0.25 µm thick, and have an aspect ratio of at least 3:1. Fibers that are observed using transmission electron microscopy (TEM) that have these attributes are referred to as PCM-equivalents (PCMe). In this report, the term fibers per cubic centimeter (f/cc) will be used when referring to IRIS toxicity data and other applicable standards. The air concentrations are reported as structures per cubic centimeter (s/cc) which are intended to mimic the size fraction of fibers that would be detected if the sample was being run under standard PCM. Concentrations reported as s/cc can be directly compared to standards developed as f/cc.

Four rounds of ABS were performed at the Site. The locations of each ABS event are presented in Figures 3-1 and 3-2. The following samples were collected at each ABS location: breathing zone sample collected during simulated activity (ABS), upwind stationary samples (one or two), downwind stationary samples (two or three), and a bulk soil sample.

Upwind and downwind locations, as well as background locations, were determined based on personal observations by the field team and expected wind direction during the upcoming day. An on-site meteorological station was also used during the ABS sampling, but unrecognized equipment problems and the variable local wind conditions experienced during the sampling preclude the use of this information for understanding wind direction variability during the collection period. Given the changing meteorological conditions experienced by the field crew, as well as the influence of local structures, designations of upwind and downwind are ambiguous at best and cannot be used to conclusively establish upwind and downwind conditions.

Table 3-1 presents the results of the samples collected from the four ABS rounds. The table presents the location, the sample number for each sample collected from that location, a brief description of the sample, and the PCME concentration in s/cc.

The subsections that follow discuss the ABS events in greater detail. The site-specific information in the subsections that follow were taken directly from the Draft TTEMI Sampling and Analysis Report (Tetra Tech, 2010).

### 3.2.1 Activity-Based Sampling Round 1: Raking

On March 24, 2010 ABS Round 1 was conducted and involved participants raking a sparsely vegetated, elevated section of the site using a leaf rake. This area was chosen because it was located west of the main structures of the former vermiculite exfoliation operation and may have been used to support exfoliation activities at the GAO 144 site. Furthermore, it was suspected to have possible historical site material because it was elevated relative to the rest of the site.

ABS Round 1 was conducted for 120 minutes. Sample G144-AB1-AH-10 and a field duplicate sample G144-AB1-AH-10-DUP were collected by a high flow-rate air pump using two participants. Four sets (not including field duplicate samples) of collocated ABS perimeter high flow rate and low flow rate air samples were placed around the activity area with one set being described as "upwind" (G144-AB1-PH-02 and its field duplicate sample G144-AB1-PH-02-DUP) and three sets placed "downwind". The three downwind perimeter air samples, G144-AB1-PH-04, G144-AB1-PH-06, and G144-AB1-PH-08 were collected west of the raked area. At the end of ABS event, a five-point composite bulk material sample (G144-AB1-B-22, 0 to 2 inches below ground surface (bgs)) was collected from within the activity area.

Asbestos was detected in the ABS Round 1 sample at a level of 0.00089 s/cc. This was the high flow sample (G144-AB1-AH-10), while its duplicate (G144-AB1-AH-10-DUP) was reported as non-detect. Asbestos was also detected in two of the "downwind" perimeter samples at levels of 0.001 s/cc and 0.00094 s/cc. The "upwind" sample was reported as non-detect. The bulk composite sample (G144-AB1-B-22) associated with Round 1 had a trace level of asbestos, i.e., detected but below the 0.25% analytical detection limit.

### 3.2.2 Activity-Based Sampling Round 2: Raking/Sweeping

On March 24, 2010 ABS Round 2 was conducted and involved raking and sweeping an area located west of and adjacent to the former offices of the exfoliation facility, currently located on the eastern side of the GAO 144 site. The Atlanta Soto Zen Center currently occupies this area. The raking/sweeping activity was focused on a concrete pad that is being used as a driveway for the Atlanta Soto Zen Center and a grassy area adjacent to that driveway. The activity combined the use of a push broom and a leaf rake. The push broom was used on the concrete section of the activity area and the leaf rake was used on the grassy section of the activity area.

ABS Round 2 was conducted for 120 minutes. One set of collocated ABS backpack high flow rate and low flow rate air samples were collected. The high flow sample was overloaded so the low flow sample (G144-AB2-AL-21) was analyzed and was non-detect for asbestos. Four sets of collocated ABS perimeter high flow rate and low flow rate air samples were placed around the activity area with two sets described as "upwind" (G144-AB2-PL-13 and G144-AB2-PH-14) and two sets placed "downwind" (G144-AB2- PH-16 and G144-AB2-PH-18). The two upwind samples had detected concentrations of asbestos and the two downwind samples were non-detect. At the end of ABS Round 2, a six-point composite bulk material sample (G144-AB2-B-23) was collected from within the activity area, which was non-detect for asbestos.

### 3.2.3 Activity-Based Sampling Round 3: Raking

On March 25, 2010 ABS Round 3 was conducted and involved participants raking in a mostly wooded area at the convergence of three pedestrian trails on the western portion of the site. This area was identified as an activity area because it was considered to be a higher than usual traffic area for this site. Furthermore, the location was west and down gradient from the former vermiculite exfoliation main structures.

ABS Round 3 was conducted for 120 minutes. One set of collocated ABS backpack high flow rate and low flow rate air samples were collected. Sample G144-AB3-AH-33 was collected by a high flow-rate air pump and was non-detect. Four sets of collocated ABS perimeter high flow rate and low flow rate air samples were placed around the activity area with one set being labeled "upwind" (G144-AB3-PH-25) and three sets placed "downwind" (G144-AB3-PH-27, G-144-AB3-PH-29, and G144-AB3-PH-31). All of the perimeter samples were non-detect for asbestos. At the end of ABS air sampling Round 3, a five-point composite bulk material sample (G144-AB3-B-45) was collected from within the activity area. The bulk composite sample had a trace level of asbestos, i.e., detected but below the 0.25% analytical detection limit.

### 3.2.4 Activity-Based Sampling Round 4: Raking

On March 25, 2010, ABS Round 4 was conducted and involved participants raking in an area located along the northern boundary of the GAO 144 site. This area was used as an activity area because it was located down gradient from the elevated area in which ABS Round 1 was conducted and is adjacent to a drainage ditch that runs along the northern property boundary. Furthermore, the location was northwest and down gradient of the former vermiculite exfoliation main structures.

ABS Round 4 was conducted for 120 minutes. One set of collocated ABS backpack high flow rate and low flow rate air samples were used collected. Sample G144-AB4-AH-43 was collected by a high flow-rate air pump and was non-detect. Four sets of collocated ABS perimeter high flow rate and low flow rate air samples were placed around the activity area with two sets described as "upwind" (G144-AB4-PH-35 and G144-AB4-PH-37) and two sets placed "downwind" (G144-AB4-PH-39 and G144-AB4-PH-41). All of the perimeter samples were non-detect for asbestos. At the end of ABS Round 4, a five-point composite bulk material sample (G144-AB4-B-46) was collected from within the activity area, which was non-detect for asbestos.

## 3.3 BACKGROUND SAMPLING

Background air samples are typically collected off site or at the site perimeter and upwind at a distance sufficient to prevent real-time influence by ABS sampling activities at the site. Although the location for the background air samples was chosen to be upwind, the wind direction and speed were variable at times during both days of the two-day sampling event at the GAO 144 site due to changes in weather conditions and the influence on wind patterns caused by obstacles on and in the vicinity of the site. This variability is likely to have significantly influenced the background air samples, making the results ambiguous at best.

Background air samples were collected on the two days (March 24 and 25, 2010) of the ABS events. Background air sample, G144-BKA-01 and its field duplicate sample, G144-BKA-01-DUP, were collected on March 24, 2010 and both samples were non-detect. Background air sample G144-BKA-24, and its field duplicate sample, G144-BKA-24-DUP were collected on March 25, 2010. G144-BKA-24 had a detected concentration of asbestos (0.0001 s/cc), however given the variability of the placement and the lack of supporting meteorological data, it is unlikely that this value represents true background and the detected concentration will not be used to modify or reduce any of ABS sample concentrations.

## 3.4 BULK SAMPLING

The bulk samples were analyzed using the CARB 435 Method, which achieves a low level of detection (0.25%). As discussed in the previous sections, bulk samples were collected at each ABS location. Trace level asbestos was detected in the bulk samples associated with ABS Rounds 1 and 3. Asbestos was not detected in the bulk samples associated with ABS Rounds 2 and 4.

Additional bulk sampling was performed for a number of other areas around the site, not associated with a specific ABS sample as shown in Table 3-1. Bulk material samples may consist of debris, soil, vermiculite attic insulation (VAI), starting or finished product associated with historical or current site operations, or a combination of these matrices. Additional bulk material samples, which consisted of both soil and VAI, were collected at the GAO 144 site.

On March 25, 2010, two additional bulk samples were collected from the GAO 144 site. Sample G144-BS-47 was collected from the former offices of the facility, which is currently occupied by the Atlanta Soto Zen Center, and was non-detect for asbestos. The sample was a 2-point aliquot of VAI material from the open attic space inside of the building. Sample G144-BS-48 was collected from several locations around the former offices of the facility, which is currently occupied by the Atlanta Soto Zen Center. The sample was a 9-point aliquot, eight of which included soil surrounding the building and one from a small garden located near the building. All of the aliquots for sample G144-BS-48 were collected at 0-2 inches below ground surface (bgs) and were homogenized prior to being placed into the sample jar. Sample G144-BS-48 had a trace level of asbestos detected.

On March 30, 2010, eight additional bulk samples were collected from various locations at the GAO 144 site. Sample G144-BS-49 (non-detect), collected at 0-12 inches bgs, and G144-BS-50 (trace), collected at 12-24 inches bgs, were both collected from the same location, an elevated mixed debris and soil pile located west of the former exfoliation facility.

Sample G144-BS-51 (0.5%), collected at 0-12 inches bgs, and G144-BS-52 (0.75%), collected at 12-15 inches bgs, were both collected from the same location, a plateau located west of the former exfoliation facility. These samples represented the highest percentage of asbestos from any bulk sample at the site. The plateau appears to be an artificially raised area where cleared soil and debris may have been pushed together by heavy equipment. Small amounts of vermiculite have been observed in this area, and it is not known what may be covered at depth in the raised soil area.

Sample G144-BS-53 (trace), collected at 0-12 inches bgs, and G144-BS-54 (trace), collected at 12-24 inches bgs, were both collected from the same location, a mound of dirt with visible debris, located in the woods southwest and down gradient of the former exfoliation facility. As noted above, a trace level of asbestos indicates a detection, but below the 0.25% analytical detection limit.

Sample G144-BS-55 (non-detect), collected at 0-4 inches bgs, was from a creek bank that flows through the western half of the GAO 144 site and is located down gradient from the former exfoliation facility. Sample G144-BS-56 (non-detect), collected at 0-1.5 inches bgs, consisted of soil and debris and was from the crawl space underneath the former offices of the facility, which is currently occupied by the Atlanta Soto Zen Center.

On April 15, 2010 Tetra Tech returned to the GAO 144 site to collect additional bulk material samples at the request of EPA. Two samples were collected from the southern-most portion of the GAO 144 site. Sample G144-BS-57 (non-detect) was a 5-point aliquot collected at 0-2.5 inches bgs in an east to west linear pattern from undisturbed areas of soil. Sample G144-BS-58 (non-detect) was also a 5-point aliquot collected at 0-2.5 inches bgs of current active areas along the southern side of the GAO 144 site.

## 3.5 DATA TREATMENT

The approach to evaluating data for each sampling method described above is presented below:

- ABS Sampling – the recreational exposure scenario described in Section 3.6 was evaluated based on the asbestos results from the four ABS rounds. Asbestos was detected in an ABS sample in a single round. Two concentrations were used in the risk assessment: a site maximum represented by the single detect in ABS Round 1 (0.00089 s/cc), and an average asbestos concentration based on the four rounds of ABS samples (0.00011 s/cc). The average concentration was calculated by averaging the detected concentration in ABS Round 1 with its duplicate to establish a Round 1 average concentration (0.00045 s/cc) and then averaging that value with the 3 non-detects in Rounds 2, 3, and 4.

- Background Air Samples – there was one detected concentration in the four background samples (0.0001 s/cc). However, since the meteorological data is unavailable and the conditions during the day were reported as variable with respect to wind direction, this value is not assumed to be true background and is not used in any calculations of risk.

- Bulk Samples – the bulk sample associated with ABS Rounds 1and 3 had trace levels of asbestos, i.e., detected but below the 0.25% analytical detection limit. The bulk samples for ABS Rounds 2 and 4 were non-detect. Bulk sample data were not used in the calculation of risk. The additional bulk samples collected at the site, which were not part of any ABS activity, ranged from non-detect to 0.75% asbestos. One area of the site had the highest level of asbestos with sample G144-BS-51 (0.5%) and G144-BS-52 (0.75%) located in the same general area, a plateau located west of the former exfoliation facility.

## 3.6 EXPOSURE ASSESSMENT

The exposure assessment consists of several steps including:

- Developing a conceptual site model.
- Determining the potentially exposed population(s).
- Identifying exposure pathways to be quantified in the risk assessment.

A conceptual site model (CSM) describes the contaminant sources, the exposure media, the exposure routes, and the potentially exposed populations. The primary objective of the conceptual site model is to identify complete and incomplete exposure pathways. A complete exposure pathway has all of the above-listed components, whereas an incomplete pathway is missing one or more.

The predominant use of the former site area is recreational. As described previously, Dekalb County owns 12 of the 16 acres of the former site area. Recreational use is expected to continue in the future. Given the current and reasonably anticipated current and future land use, a single exposure scenario was developed for evaluation in this HHRA. A typical recreational scenario was developed to characterize the risks that may be associated with long-term exposure to the levels of asbestos present while engaging in recreational activities at the Site, such as walking, running, or playing for both an adult and a child:

- Adult Recreational Exposure – this scenario was represented by an adult who walks, runs, and plays at the Site and contacts asbestos-contaminated soil. The period of exposure was assumed to begin at age 20.
- Child Recreational Exposure – this scenario was represented by a child (1 to 6 years old) contacting the Site soil while playing. The child was assumed to accompany the adult during recreational activities and/or exercise events.

The recreational scenario was designed to reflect the range of potential activities in which individuals could participate during a typical day, week, or year. To provide a range of exposure and risks, the reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were evaluated (EPA, 1992). The RME, an estimate of the high-end exposure in a population, is based on a combination of average and high-end estimates of exposure parameters typically representing the $90^{th}$ percentile or greater of actual expected exposure. The CTE represents an estimate of the average exposure in a population and is based on central estimates of exposure parameters.

Other scenarios were considered such as future residential and industrial exposure. However, given the current and anticipated future uses of the site, it is unlikely that either scenario would occur at any point in time in the future. If land uses change such that such a scenario was likely, the risks associated with potential exposure would need to be reconsidered.

# 4. TOXICITY ASSESSMENT

The primary purpose of the toxicity assessment is to identify the toxicity values for evaluating the impacts of asbestos exposure. The risk estimates used to derive the current inhalation unit risk (IUR) presented in the Integrated Risk Information System (IRIS) were based on a synthesis of published epidemiological studies currently available (EPA, 2010). Risk of lung cancer and mesothelioma from asbestos exposure in different occupational cohorts were considered discreetly and then summed to generate a value used to estimate total lifetime risk. EPA currently uses an IUR value of 0.23 per PCM fibers per cubic centimeter $(f/cc)^{-1}$.

The IRIS program is undertaking a reassessment of risks associated with asbestos exposure to provide an update of the current understanding of asbestos carcinogenicity and to adjust the potency factor (i.e., the IUR value previously described) as needed. There are a number of areas of uncertainty associated with the current unit risk value that may be taken into account in any new IRIS value including the following:

- Mineral present at the site (amphibole forms may have a different potency from chrysotile).
- Size distribution of materials at the site (length, width, aspect ratio) may differ from those used in the IRIS assessment.
- Potential for less than lifetime exposures.

While some of these uncertainties can only be addressed qualitatively at the present time, the potential for increased risk for certain subpopulations based on age at onset of exposure and the duration of exposure(s) can be evaluated through the use of alternative IURs. Table 4-1 presents both the lifetime IUR and the less-than-lifetime IURs that were used in the analysis of carcinogenic risk for each of the exposure scenarios (EPA, 2008).

EPA currently has no methods available for evaluating any of the non-cancer health effects of asbestos despite clear evidence that asbestosis and other non-cancer related health conditions are caused by exposure to asbestos. Non-cancer effects of asbestos are discussed in the Uncertainty Analysis in Section 6.0.

**Table 4-1**

**Lifetime Inhalation Unit Risk (IUR) $(f/cc)^{-1}$ and Less-than-Lifetime Inhalation Unit Risk ($IUR_{LTL}$) $(f/cc)^{-1}$ Values for Various Continuous Exposure Scenarios**

| Age at first exposure (years) | Duration of exposure (years) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 6 | 8 | 10 | 20 | 24 | 25 | 30 | 40 | Life-time |
| 0 | 0.010 | 0.047 | 0.055 | 0.071 | 0.085 | 0.14 | 0.15 | 0.16 | 0.17 | 0.19 | 0.23* |
| 1 | 0.0099 | 0.045 | 0.053 | 0.068 | 0.081 | 0.13 | 0.15 | 0.15 | 0.17 | 0.19 | |
| 5 | 0.0085 | 0.039 | 0.046 | 0.058 | 0.070 | 0.11 | 0.13 | 0.13 | 0.14 | 0.16 | |
| 10 | 0.0070 | 0.032 | 0.038 | 0.048 | 0.057 | 0.092 | 0.10 | 0.10 | 0.11 | 0.13 | |
| 20 | 0.0049 | 0.022 | 0.026 | 0.033 | 0.039 | 0.062 | 0.068 | 0.069 | 0.075 | 0. 083 | |
| 30 | 0.0034 | 0.015 | 0.018 | 0.022 | 0.026 | 0.040 | 0.044 | 0.045 | 0.048 | 0.052 | |

* Lifetime in this table means continuous lifetime exposure beginning at birth and lasting until death of the individual. Continuous means that exposure occurs 24 hours/day, 365 days/year.

Values obtained from EPA, 2008.

All values are shown to two significant figures.

# 5. RISK CHARACTERIZATION

The risk characterization presents the approach to estimating risk, the exposure scenario and exposure factors applied in the risk analysis, and the quantitative risk estimates, as well as a summary of the results and conclusions of the risk assessment.

## 5.1 RISK CALCULATION METHOD

The applicable ABS data were used to develop the exposure point concentration (EPC) that was used to calculate the excess lifetime cancer risk for the future outdoor worker exposure scenario (described in the exposure assessment). The general equation for estimating risks from inhalation to asbestos is:

$$ELCR = EPC \times IUR \times TWF$$

Where:

| | | |
|---|---|---|
| ELCR | = | Excess Lifetime Cancer Risk, the risk of developing cancer as a consequence of the site-related exposure. |
| EPC | = | Exposure Point Concentration (s/cc). |
| IUR | = | Inhalation Unit Risk $(f/cc)^{-1}$. |
| TWF | = | Time Weighting Factor (unitless), this factor accounts for less-than-continuous exposure during a 1-year exposure. |

Each of the input parameters needed to calculate the ELCR is discussed below.

### 5.1.1 Exposure Point Concentration

The concentrations of asbestos fibers in air (s/cc) were determined based on the ABS personal breathing zone sampling results. As described in Section 3, asbestos was detected in only one of the four ABS rounds. A site maximum (0.00089 s/cc) and an overall site average (0.00011 s/cc) were calculated. Both values were used to estimate potential human health risk.

### 5.1.2 Inhalation Unit Risk

Depending on the assumed age when exposure begins (age 20 for the adult and age 1 for the child) and the duration of the exposure (24 years and 5 years), the IUR value presented in Table 4-1 that best represents the exposure scenario was selected and was used to estimate a range of excess lifetime cancer risk. Table 5-1 presents the selected IURs for the RME and CTE scenarios.

## 5.2 EXPOSURE PARAMETERS

As previously discussed, the single scenario evaluated for the site included an adult and child recreational receptor. Table 5-1 summarizes the parameters for the RME and CTE parameters for this scenario. A time weight factor (TWF) was developed to account for the less-than-continuous exposure during a one-year period.

**Table 5-1**
**Summary of the Exposure Parameters – Recreational**

| Exposure Scenario | Hours per Day | Days per Year | TWF | Age at Onset of Exposure | Exposure Duration (yrs) | IUR $(f/cc)^{-1}$ (EPA , 2008) |
|---|---|---|---|---|---|---|
| **Reasonable Maximum Exposure** | | | | | | |
| Recreational (Adult) | 2 | 156[a] | 0.04 | 20 | 24 | 0.068 |
| Recreational (Child) | 2 | 156[a] | 0.04 | 1 | 5 | 0.045 |
| **Central Tendency Exposure** | | | | | | |
| Recreational (Adult) | 0.5 | 52[b] | 0.003 | 20 | 24 | 0.068 |
| Recreational (Child) | 0.5 | 52[b] | 0.003 | 1 | 5 | 0.045 |

[a] Based on professional judgment, assumes an individual exercises three days per week. The child is assumed to accompany the adult.

[a] Based on professional judgment, assumes an individual exercises one day per week. The child is assumed to accompany the adult.

EPA, 2008 – Framework for Investigating Asbestos-Contaminated Superfund Sites

### 5.2.1 Recreational Exposure

Recreational receptors were assumed to be exposed to asbestos while walking, running, and/or engaging in recreational activities at the site. Under the RME scenario, the adult and child were assumed to be exposed 2 hours per day. The frequency of the RME was three days per week (156 days per year). Under the CTE, the adult and child were assumed to be exposed 30 minutes per day for one day per week (52 days per year). The calculated TWFs were 0.04 (RME) and 0.003 (CTE).

## 5.3 RISK ESTIMATES

The RME and CTE risks were calculated based on EPCs of 0.00089 s/cc (maximum) and 0.00011 s/cc (average). The risks are summarized below and presented on Table 5-2.

| Exposure Scenario | RME ELCR | CTE ELCR |
|---|---|---|
| Recreational Adult | 2E-06 | 2E-08 |
| Recreational Child | 2E-06 | 1E-08 |

## 5.4 RESULTS AND CONCLUSIONS

EPA has established an acceptable ELCR range that is expressed as a probability between 1E-04 and 1E-06. ELCRs calculated to be less than the low end of the range, 1E-06, are said to be *de minimis* (minimal) and generally do not need to be considered further. Risks greater than 1E-06 but less than 1E-04 are within EPA's acceptable risk range. Risks greater than 1E-04 exceed the risk range and may require that an action be taken to reduce the potential risks. The designated risk managers for a site ultimately decide whether an action is necessary based upon a variety of considerations.

The risks to the recreational receptor were within the acceptable risk range for the RME and below the acceptable range for the CTE. This was the only potential exposure pathway quantified because the conditions are likely to preclude residential exposure and any future site worker exposure. Should future actions at the Site result in changes in potential use and exposure, the results and conclusions of the risk assessment would need to be re-evaluated.

The highest detected levels of asbestos in the bulk samples collected were both in an area west of the former exfoliation facility that appears to be an artificially raised plateau. Visible vermiculite residues have been observed in this area, and the only detection in an ABS sample was identified in this area. Additional evaluation of the subsurface of this area may be warranted.

# 6. UNCERTAINTY ANALYSIS

All risk assessments have some level of uncertainty associated with them. The goals of an uncertainty analysis are to provide to the appropriate decision makers (i.e., risk managers) information about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of risk. The uncertainty analysis should show that risks are relative in nature and do not represent an absolute quantification. This is an important point that is vital to the proper interpretation and understanding of the risks presented in this report. Conservative assumptions were used throughout this risk assessment in an attempt to balance some of these uncertainties.

Uncertainties and limitations of this risk assessment include the following:

- The asbestos air data upon which the risk estimates were based are limited. It includes ABS results collected during four sampling rounds. In reality, exposure over a lifetime would be based on a wide variety of physical conditions, some of which may increase or decrease exposure and risk as compared to those at the time of the ABS. Actual conditions over a lifetime could result in either higher or lower exposure concentrations.

- The IRIS Inhalation Unit Risk for asbestos was based on epidemiological data from groups exposed to asbestos fibers that typically did not include amphibole asbestos, which is the predominant type of fiber associated with Libby Mine vermiculite and the predominant type of fiber found on this Site. The toxicity of amphibole asbestos may be different from other forms of asbestos. Furthermore, it is anticipated that the EPA is intending to modify the Inhalation Unit Risk for amphibole asbestos at some point in the future. Risks may need to be revisited when any change to this factor is finalized.

- The metric used to evaluate inhalation exposure was PCMe. There is not a clear consensus in the scientific community as to whether this metric captures the entire range of asbestos fibers that could cause disease, especially in a case like this Site where amphibole fibers predominate. To the degree that some categories of fibers that are currently not counted in the PCMe-based concentration estimates could contribute to adverse health impacts, risks could be underestimated.

- EPA has no methods available for estimating noncancer risks from asbestos exposure. Asbestosis and other non-malignant asbestos-related diseases are known to occur to individuals exposed to asbestos. Evaluating only the cancer risks associated with exposure at the Site underestimates this potential health risk, potentially to a significant degree.

- Activities other than those evaluated at the Site, based on raking and sweeping scenarios, could occur in the future to potentially exposed receptors. This could include activities with a greater or lesser potential for releasing dusts, and therefore asbestos, and a greater or lesser potential for inhalation, based on presumed inhalation rates. This could result in the predicted risks being either over- or underestimated.

# 7. SUMMARY

The HHRA focused on the potential asbestos risks from inhalation exposure estimated from the ABS sampling activities at the site. The ABS-based inhalation risks for the recreational receptors were either below or at the low end of EPA's risk range. As described in the Uncertainty Analysis, there is a considerable degree of uncertainty associated with estimated risks derived from the ABS sampling.

# 8. REFERENCES

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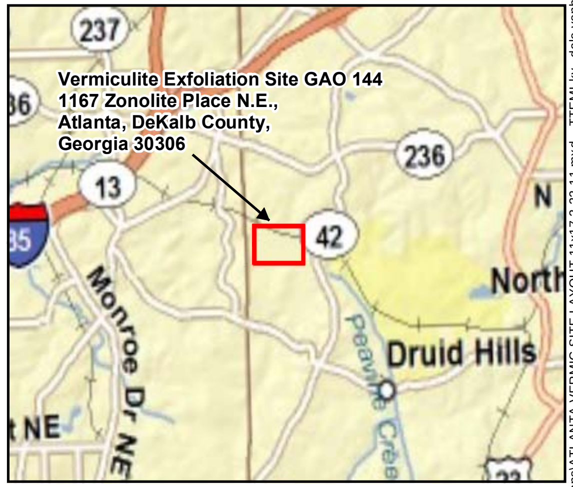
## Legend

- Approximate location of former railroad spur (eastern extent is unknown)
- Approximate location of unnamed drainage
- Approximate location of footpaths
- Approximate location of former vermiculite exfoliation facility buildings

0 75 150 Feet

N W E S

Aerial Photograph:
ImageConnect, 'DigitalGlobe', 2008

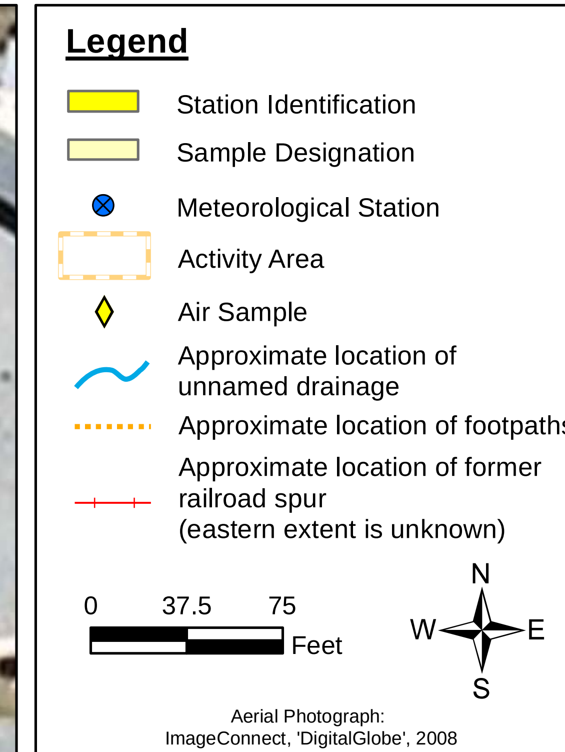


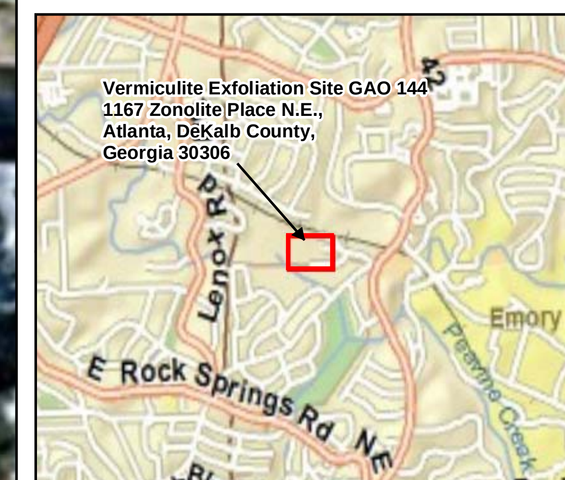

United States
Environmental Protection Agency

VERMICULITE EXFOLIATION SITE
GAO 144
ATLANTA,
DEKALB COUNTY,
GEORGIA
TDD No.TTEMI-05-003-0077

**FIGURE 1-1**
**SITE LAYOUT**

TETRA TECH


United States
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VERMICULITE EXFOLIATION SITE
GAO 144
ATLANTA,
DEKALB COUNTY,
GEORGIA
TDD No.TTEMI-05-003-0077

**FIGURE 3 -1**
**SAMPLE LOCATIONS**
**FOR ACTIVITY-BASED AIR**
**SAMPLING ROUNDS 1 & 2**
**MARCH 24, 2010**

TETRA TECH

2011-3-22 \GIS_Workspace\TTEMI-05-003-0077 Vermiculite Exfo GAO 144\GIS\MXDs\Sampling Activity Maps\ATLANTA GA VERMIC 3-24-10 SAMPLING 11x17 3-22-11.mxd TTEMI-KY dale.vonbusch


## Legend

- Station Identification
- Sample Designation
- Meteorological Station
- Activity Area
- Air Sample
- Approximate location of unnamed drainage
- Approximate location of footpaths
- Approximate location of former railroad spur (eastern extent is unknown)

0 37.5 75 Feet

Aerial Photograph:
ImageConnect, 'DigitalGlobe', 2008

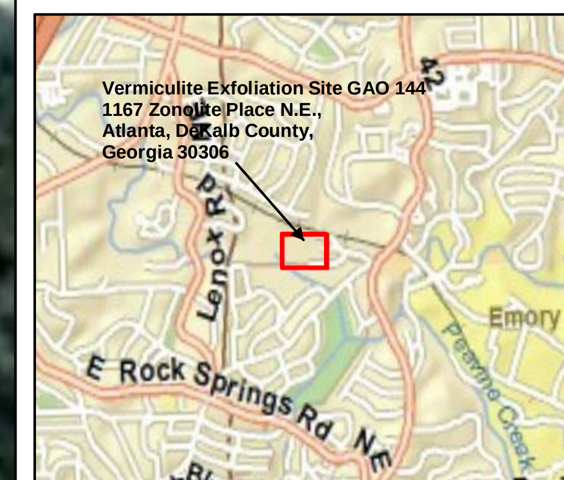


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**FIGURE 3-2**
**SAMPLE LOCATIONS FOR ACTIVITY-BASED AIR SAMPLING ROUNDS 3 & 4**
**MARCH 25, 2010**

TETRA TECH

**Table 3-1**
**Analytical Results Summary**

| Sampling Program | Sample Number | Description | PCMe Concentration (s/cc) |
|---|---|---|---|
| Activity Based Sampling Round 1 Raking | G144-AB1-AH-10 | ABS | 0.00089 |
| | G144-AB1-AH-10-DUP | ABS | 0 |
| | G144-AB1-PH-02 | Upwind Perimeter | 0 |
| | G144-AB1-PH-02-DUP | Upwind Perimeter | 0 |
| | G144-AB1-PH-04 | Downwind Perimeter | 0.001 |
| | G144-AB1-PH-06 | Downwind Perimeter | 0 |
| | G144-AB1-PH-08 | Downwind Perimeter | 0.00094 |
| | G144-AB1-B-22 | Bulk composite | Trace (< 0.25%) |
| Activity Based Sampling Round 2 Raking/Sweeping | G144-AB2-AL-21 | ABS | 0 |
| | G144-AB2-PL-13 | Upwind Perimeter | 0.00099 |
| | G144-AB2-PH-14 | Upwind Perimeter | 0.00094 |
| | G144-AB2-PH-16 | Downwind Perimeter | 0 |
| | G144-AB2-PH-18 | Downwind Perimeter | 0 |
| | G144-AB2-B-23 | Bulk composite | no asbestos detected |
| Activity Based Sampling Round 3 Raking | G144-AB3-AH-33 | ABS | 0 |
| | G144-AB3-PH-25 | Upwind Perimeter | 0 |
| | G144-AB3-PH-27 | Downwind Perimeter | 0 |
| | G144-AB3-PH-29 | Downwind Perimeter | 0 |
| | G144-AB3-PH-31 | Downwind Perimeter | 0 |
| | G144-AB3-B-45 | Bulk composite | Trace (< 0.25%) |
| Activity Based Sampling Round 4 Raking | G144-AB4-AH-43 | ABS | 0 |
| | G144-AB4-PH-35 | Upwind Perimeter | 0 |
| | G144-AB4-PH-37 | Upwind Perimeter | 0 |
| | G144-AB4-PH-39 | Downwind Perimeter | 0 |
| | G144-AB4-PH-41 | Downwind Perimeter | 0 |
| | G144-AB4-B-46 | Bulk Composite | no asbestos detected |
| Reference | G144-BKA-01 | Air | 0 |
| | G144-BKA-01-DUP | Air | 0 |
| | G144-BKA-24 | Air | 0.0001 |
| | G144-BKA-24-DUP | Air | 0 |
| Additional Bulk Sampling | G144-BS-47 | Bulk sample | no asbestos detected |
| | G144-BS-48 | Bulk sample | Trace (< 0.25%) |
| | G144-BS-49 | Bulk sample | no asbestos detected |
| | G144-BS-50 | Bulk sample | Trace (< 0.25%) |
| | G144-BS-51 | Bulk sample | 0.5 % |
| | G144-BS-52 | Bulk sample | 0.75 % |
| | G144-BS-53 | Bulk sample | Trace (< 0.25%) |
| | G144-BS-54 | Bulk sample | Trace (< 0.25%) |
| | G144-BS-55 | Bulk sample | no asbestos detected |
| | G144-BS-56 | Bulk sample | no asbestos detected |
| | G144-BS-57 | Bulk sample | no asbestos detected |
| | G144-BS-58 | Bulk sample | no asbestos detected |

ABS = activity-based sampling

s/cc = structures per cubic centimeter

PCMe = phase contrast microscopy equivalent

## Table 5-2

## Estimated Cancer Risks for Activity Based Sampling - Recreational

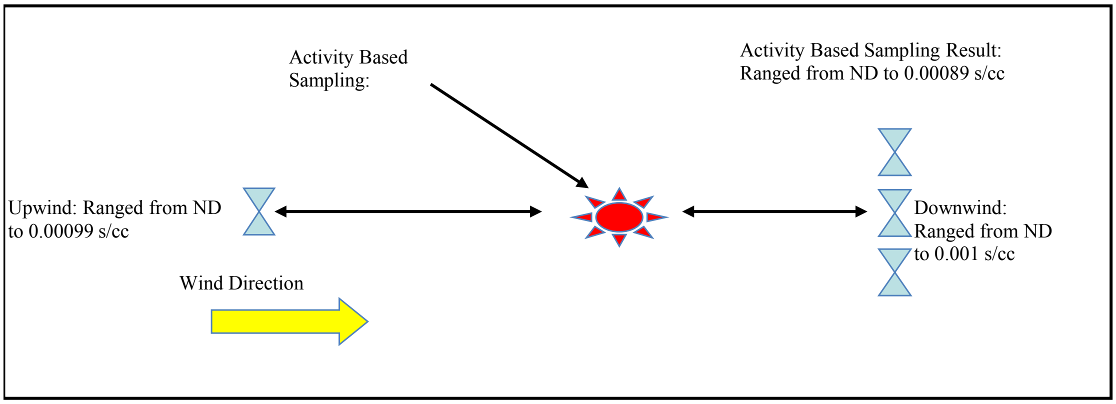
### Reasonable Maximum Exposure

| Exposure Scenario | PCMe Concentration (s/cc) | IUR $(f/cc)^{-1}$ | TWF | Cancer Risk |
|---|---|---|---|---|
| Recreational (Adult) | 0.00089 | 0.068 | 0.04 | 2E-06 |
| Recreational (Child) | 0.00089 | 0.045 | 0.04 | 2E-06 |

### Central Tendency Exposure

| Exposure Scenario | PCMe Concentration (s/cc) | IUR $(f/cc)^{-1}$ | TWF | Cancer Risk |
|---|---|---|---|---|
| Recreational (Adult) | 0.00011 | 0.068 | 0.003 | 2E-08 |
| Recreational (Child) | 0.00011 | 0.045 | 0.003 | 1E-08 |

| | |
|---|---|
| **Bulk Result:** | ND to trace level |




ND = not detected.

* Because of changes in wind direction during the ABS events, the upwind and downwind results do not reflect the true upwind and downwind concentrations.