Health Consultation

Borit Asbestos Air Sampling Results from 2006 – 2007
Response to Public Comments

BORIT SITE

AMBLER, MONTGOMERY COUNTY, PENNSYLVANIA

EPA FACILITY ID: PAD981034887

MARCH 17, 2009

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

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

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Executive Summary

At the request of the U.S. Environmental Protection Agency (EPA) and to address community concerns, the Pennsylvania Department of Health (PADOH) and the Agency for Toxic Substances and Disease Registry (ATSDR) prepared this health consultation to determine if levels of asbestos detected in EPA's 2006-2007 on-site and off-site ambient air sampling at the Borit site in Ambler, Pennsylvania were at levels of public health concern. The Borit site consists of a waste pile, a bordering reservoir, the adjacent Whitpain Wissahickon Park, and the adjacent banks of the Wissahickon Creek, Rose Valley Creek and Tannery Run. PADOH conducted this evaluation under a cooperative agreement with ATSDR. In communities where hazardous chemicals exist, PADOH top priority is to ensure that the community is not being exposed to levels of hazardous chemicals that may cause adverse public health effects, as well as to ensure that the community has the best information possible to safeguard its health.

In April 2006, EPA's Superfund site assessment program conducted an environmental sampling event at the Borit Site. The results showed the presence of asbestos in the air, soil, surface water and sediments. In addition, asbestos and asbestos containing materials (ACM) were easily visible on the surface throughout the site area. In an effort to further characterize potential on-site and off-site levels of airborne asbestos fibers during different seasonal conditions and activities, EPA's Superfund removal program conducted ambient air sampling at the site in October 2006 through September 2007. At this time, EPA continues to evaluate the Borit Site under both its Removal and Site Assessment programs. The Site Assessment evaluation is being used in part to prepare a Borit Site scoring package for EPA's National Priorities List (NPL).

All of the EPA air sampling analyses conducted in 2006-2007 at this site were performed by Transmission Electron Microscopy (TEM), which allows "binning" or counting of fibers according to size criteria. To address concerns from community members and to allow for a review of the broadest inclusion of fibers, PADOH and ATSDR evaluated four counting categories for the 2006-2007 air sampling data: (1) Asbestos Hazard Emergency Response Act (AHERA) structures, (2) Berman-Crump structures, (3) total TEM-EPA Superfund Method (EPA-SM) structures and (4) Phase Contrast Microscopy equivalents (PCMe) structures. PADOH and ATSDR particularly focused on the PCMe and AHERA counting results. The PCMe category includes all asbestos fibers greater than 5 μm in length (>5 μm) and greater than 0.25 μm in width (>0.25 μm); currently, PCMe counting results are those which regulatory and health agencies use to determine airborne health risks for cancer effects. Both narrower and shorter fiber lengths are included in the AHERA binning category.

Based on the PADOH and ATSDR review of the 2006-2007 air sampling data, ***current*** exposures to the reported on-site and off-site airborne asbestos levels ***(when site soils are <u>not</u> being aggressively disturbed)*** from the 2006-2007 air sampling results (both AHERA and PCMe fibers) have been classified by PADOH and ATSDR as a ***no apparent public health hazard*** to the community for cancer effects and/or non-cancer effects.

Based on the PADOH and ATSDR review of EPA's 2006-2007 air sampling results, ***both PCMe fibers and AHERA type fibers show significant increases in airborne levels when soils and asbestos-containing material are disturbed through activity-based sampling (ABS) at the Borit***

site. PADOH and ATSDR conclude that ***on-site exposures*** to asbestos fibers ***when onsite soils and asbestos-containing material are disturbed*** are a ***public health hazard*** to area residents. PADOH and ATSDR made this determination after consideration of several important factors, including (1) significant increases in airborne PCMe asbestos (although at an estimated cancer risk level lower than 1 E-4 or 1 in 10,000 persons) during activity; (2) the presence of exposed friable ACM and the quantity of buried asbestos and ACM at the site; (4) the current proximity of a residential community, and (5) the potential for re-development/re-use of this site in the future.

The current consensus in the scientific community, based on epidemiological and animal studies, is that exposures from short fibers overall do not contribute to lung cancer and mesothelioma. However, short fibers might play a role in asbestosis when exposure duration is long and fiber concentration high. However, further scientific research is needed in this area to draw a definitive conclusion. At this site, the majority of the fibers detected during activity-based sampling were short AHERA fibers which, at the levels observed during the 2006-2007 sampling, would not be expected to increase asbestos-related disease. Furthermore, the general public and the Ambler community are not expected to be exposed to the levels of AHERA fibers detected during the ABS events at this site, since they were detected within the site boundary during aggressive soil manipulation.

Across the 2006-2007 sampling events, seasonality appeared to have limited effect on airborne asbestos levels. However, under dryer conditions (e.g., September 2007), increases in airborne asbestos were seen relative to wetter conditions in the rest of the sampling events. Therefore, ***drought or severely dry conditions could exacerbate the problem of re-entrainment of airborne asbestos and migration from the site***.

PADOH and ATSDR make the following recommendations for this site:

- PADOH and ATSDR recommend that EPA implement activities proposed under the removal program to mitigate potential releases and hazards that may cause health effects as a result of exposure to airborne asbestos;
- PADOH and ATSDR recommend that EPA continue site assessment activities for remedial plans;
- PADOH and ATSDR recommend that, during any future removal and remediation activities at this site, air sampling be conducted on-site, off-site, and with personal air monitors, and that the results of these monitoring activities be shared with the community and other interested stakeholders in an timely manner:
- PADOH and ATSDR will consider evaluation of future environmental sampling results for the site, and preparation of an appropriate response which could include an updated health consultation. This recommendation will be implemented at the discretion of the PADOH/ATSDR following the receipt of future environmental sampling results;
- As a precautionary measure, PADOH and ATSDR recommend that any direct soil activity be avoided by visitors or trespassers at this site based on the AHERA and PCMe sampling results; and

- In response to community concerns, PADOH and ATSDR will update PADOH's 2007 evaluation of cancer/mesothelioma health outcome data for the Ambler community, and PADOH and ATSDR will continue working with the community to answer questions and address ongoing health concerns.

Background and Statement of Issues

Site Description and History

The Borit site consists of a waste pile, a bordering reservoir, the adjacent Whitpain Wissahickon Park, and the adjacent banks of the Wissahickon Creek, Rose Valley Creek and Tannery Run totaling approximately 32 acres. The Borit Site consists of three distinct asbestos-contaminated areas along Maple Street just west of Butler Pike in Ambler, PA (See Figure 1). The areas were commonly referred to as the East Maple Street Pile (now called the Borit Asbestos Pile), the West Maple Street Pile (now a closed park known as the Whitpain Wissahickon Park), and a reservoir. These areas are located a few hundred yards northwest of the asbestos piles that became the Ambler Asbestos Piles NPL Site, which was remediated by EPA in 1993. Although the same companies disposed of asbestos-containing waste at both the Borit Site piles and the Ambler Asbestos Site piles across Butler Pike (a local major road) the Borit Site piles were not included as part of the NPL Site. A decision was made that the Borit Site piles would be monitored by the PADER (now PADEP – Pennsylvania Department of Environmental Protection), as the site had been covered with soil in the mid 1960s.

The Borit Asbestos Site exists as a result of waste disposal operations by the former Keasby and Mattison Company, Certainteed Corporation, and Nicolet Industries. Keasby and Mattison Company (K&M), Certainteed Corporation and Nicolet Industries produced asbestos products including: paper, millboard, electrical insulation, brake linings, piping, conveyor belts, high pressure packings, roofing shingles, cement siding, asbestos cement pipe, automobile parts, laboratory table tops and other products. Asbestos manufacturing operations occurred on or near the site from 1897 to the late 1980s.

The former East Maple Street Pile (now Borit Asbestos Pile) rises approximately 35 feet above the natural ground surface and is approximately 6 acres in size. The pile appears on a 1938 aerial photograph (earliest available), and K&M reportedly began disposing of waste there during the 1930s. Asbestos waste disposal appears to have continued until the 1960s. This area primarily received slurry of spent magnesium and calcium carbonate as well as waste products from the manufacturing of asbestos pipe, insulation, sound dampeners, and ceiling/roof tile. The berms around the pile appear to have been constructed of asbestos shingles and soil. Based on aerial photographs, by 1965 the pile appears to be covered and vegetated. The property reportedly was first fenced in approximately 1986 and is currently partially fenced. For short periods of time in the 1980s and 1990s, portions of the pile area were used as a trash transfer station or trash storage location and for fire department training (Gilmore & Associates, 2001). Currently, the pile is naturally vegetated although asbestos containing material (ACM) is visible on the surface in various locations.

The former West Maple Street pile (now the closed and fenced Whitpain Wissahickon Park) reportedly received out-of-spec asbestos manufacturing products and other solid wastes. It is not clear when disposal first took place but, based on historic aerial photos, it was occurring as early as 1937 (EPA Aerial Photo Collection, 1937-1985). Two rows of what appear to be factory worker homes are on the property from 1938 to 1959 but are removed by 1964. Aerial photos indicate that the pile was covered after the homes were removed, sometime during the 1965 to 1970 period. The current park is triangular and rises a few feet above the surrounding street level and is roughly 500 feet at its widest point and approximately 1500 feet from end to end. A 1973 aerial photo shows a baseball diamond in the park. The park also is currently vegetated and has been officially closed for approximately twenty years. However, localized areas of asbestos waste appear at the ground surface. The local community and other interested parties would like to see the park reopened for resident use.

The reservoir between the East Maple Street Pile and Whitpain Wissahickon Park was used to provide process water for facility operations. The reservoir appears in the 1937 aerial photo and likely was in place prior to this date. It is approximately 14 acres in size. The berm around the reservoir was made of asbestos shingles, millboard, and soil. Asbestos product waste, particularly water pipe and tiles, are suspected to lie on portions of the reservoir bottom. Currently, the Wissahickon Valley Watershed Association (WVWA), a local conservation group, has plans to convert the reservoir to a waterfowl preserve with a bird watching platform on the northern side (EPA 2008a and EPA 2008b).

Public Health Involvement

The Pennsylvania Department of Health (PADOH) and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) and its predecessor group at the Centers for Disease Control and Prevention (CDC) have provided health opinions and/or health outcome data reviews at various times for the Ambler Asbestos NPL and Borit sites, including a Public Health Advisory focusing on the Ambler Asbestos NPL Site area in 1983 (CDC 1983, ATSDR 1988, ATSDR 1989, ATSDR/PADOH 1993, ATSDR 2006a).

The following provides a historical summary of language specific to Wissahickon Park. In an October 29, 1984 memorandum, CDC reviewed two asbestos samples collected by the EPA from Wissahickon Park. CDC recommended that (1) every effort should be made to prevent human exposure to the asbestos identified on site, and that it was particularly desirable to prevent the possible re-suspension of the fibers as a result of play activities at the park; (2) a series of samples for asbestos should be collected from the yards abutting the site; and (3) consideration should be given to providing temporary covering for the obvious asbestos outcroppings observed at the site (CDC 1984b).

In a November 8, 1984 memorandum, CDC reviewed information for the Borit tailings pile and the Wissahickon Park/Whitpain Township Park. CDC concluded that the presence of exposed friable asbestos-containing material was a public health risk and a potential chronic public health hazard to persons near the site. The memo notes that the suspension of asbestos fibers would be partially restricted by vegetative ground cover, but complete prevention could not be expected (CDC 1984a).

In January 18, 1985 and February 5, 1985 memoranda, CDC reviewed bulk soil sampling results from the Wissahickon/Whitpain Township Park taken after the park was closed to the public. CDC stated that any sampling strategy also needed to include soil samples from adjacent residential yards, and that the site required sufficient containment of asbestos materials to prevent resuspension of fibers and to prevent offsite migration. CDC recommended that a plan be developed and implemented to ensure against further disturbance of the ground cover at this site (CDC 1985a and CDC 1985b).

A June 26, 1985 CDC memo reiterated the need to sufficiently contain waste materials at Wissahickon Park before reopening of the park could be reconsidered. CDC recommended that the fence be maintained and that the area remains closed to the public until adequate containment could be achieved (CDC 1985c).

In December 2006, ATSDR Region 3 prepared an ATSDR Record of Activity (AROA) Health Consultation (HC) which detailed the extensive investigation and mitigation activities that have occurred on both the Ambler Asbestos and Borit sites since the early 1970's. The air sampling data collected prior to the 2006/2007 sampling event provides a confusing picture of the health implications of asbestos contamination at the Borit site. This is due to confounding factors such as the lack of detailed sampling information and data inconsistencies resulting from the several types of air sampling techniques and analytical methods used over the years. Furthermore, the historical information does not distinguish mineralogy of the fibers, and does not show if total TEM fibers were counted or if PCMe data could be calculated from the counts, which makes drawing any health conclusions from the data extremely difficult. Samples were collected in April 2006, over one 24 hour period within the site perimeter, a time duration insufficient to make projections about continuing airborne asbestos levels given the numerous factors that might affect the release of fibers to the air; e.g. vegetative cover, onsite activities and ground surface disturbance, wind speed and direction, precipitation and ground moisture. Finally, four of the six air samples were found to be overloaded with dust and particles making the analytical data, as presented, unreliable for a determination of health risks or comparison to health-based standards or guidelines. The AROA HC concluded, due to the large piles of on-site ACM and air sampling data that under certain conditions local levels of airborne asbestos may be of concern and further investigation and examination is warranted (ATSDR 2006a).

2006-2007 Site Visits

In November 2006, representatives of the PADOH Health Assessment Program viewed the Borit site with the EPA On-scene Coordinator (OSC). During this visit, PADOH staff took notes, photographs, and discussed site background information with the EPA OSC.
ATSDR and PADOH staffs have accompanied EPA on multiple site visits during the 2006-2008 time frames.

Exposure Pathway Analysis

An exposure pathway is how a person comes in contact with chemicals originating from a source of contamination. Every exposure pathway consists of the following five elements: 1) a *source* of contamination; 2) a *media* such as air or soil through which the contaminant is transported; 3) a *point of exposure* where people can contact the contaminant; 4) a *route of exposure* by which the contaminant enters or contacts the body; and 5) a *receptor population*. A pathway is considered complete if all five elements are present and connected. A pathway is considered potential if the pathway elements are (or were) likely present, but insufficient information is available to confirm or characterize the pathway elements. A pathway may also be considered potential if it is currently missing one or more of the pathway elements, but the element(s) could easily be present at some point in time. An incomplete pathway is missing one or more of the pathway elements and it is likely that the elements were never present and not likely to be present at a later point in time. An eliminated pathway was a potential or completed pathway in the past, but has had one or more of the pathway elements removed to prevent present and future exposures. The presence of a complete exposure pathway, does not, however, necessarily mean that adverse health effects will occur or have occurred in the past as a result of such exposure.

PADOH/ATSDR considers the air pathway or inhalation route of exposure to be the most significant in the current evaluation of this site. PADOH/ATSDR considers the air exposure pathway complete at this site. In addition, PADOH and ATSDR also consider inhalation route of exposure from ACM materials possibly present in residential yards, from the site as a potential exposure pathway. However, currently PADOH and ATSDR do not have any evidence to confirm that exposure via this pathway is occurring. Please see the public comments section of this document (question #7) for further details on potential residential exposure.

Analytical Considerations and Estimation of Health Risk from Asbestos Exposure

Many researchers, risk assessors, and health professionals in the asbestos field believe that asbestos toxicity is a function of both fiber length and mineralogy, with fibers that are longer being the most carcinogenic and fibers from the amphibole class of minerals being the more toxic of the two asbestos mineral classes. Health assessors currently evaluate asbestos health effects by examining the risk of developing two specific cancers - lung cancer and mesothelioma. Although asbestos is associated with other cancers, these other types of cancer tend to occur at exposures higher than lung cancer and mesothelioma. Therefore, protecting the public from the most sensitive cancer health effects (lung cancer and mesothelioma) will protect them from other asbestos- related cancers. Regarding non-cancer effects, there is debate that exposure to asbestos may cause pleural changes at levels below those that cause lung cancer and mesothelioma. However this evaluation is not complete, and there is no scientific consensus (ATSDR 2001, ATSDR 2003b). Therefore this consultation evaluates the human health impact of the Borit site based on exposure data collected during recent sampling events and using risk models to predict the total cancer risk (lung cancer and mesothelioma) to exposed populations.

Risk models – Risk models are mathematical relationships that, in the case of asbestos, are developed from the epidemiological data. Typically a number of studies are used in an analysis that allows the health assessor to develop a dose-response relationship of exposure to asbestos and health outcome. With asbestos these models allow the health assessor to predict cancer risk based upon both the length of time of exposure and the level of asbestos exposure. Only a few models exist for asbestos. Five of the most used models include: 1) the EPA's model based upon the 1986 Nicholson model that is known as the IRIS model; 2) the Berman and Crump model that underwent peer consultation in 2001 and was revised in 2003; 3) the Hodgson and Darton model; 4) California EPA's model; 5) the OSHA risk assessment for asbestos.

One critical element is that the data being applied to a model must be collected in a manner similar to the data upon which the model is developed. In other words, apples must be compared to apples, and oranges compared to oranges (i.e. the same length fibers must be compared to the same length fibers and the same mineral type to the same mineral type). All five of these models require that fiber size be determined. Two of the models require mineralogy to be known (see Table 1). Because the evidence at Borit suggests the predominate mineral type found was chrysotile and that this was commercial grade chrysotile (meaning it may contain longer fibers), PADOH and ATSDR utilized both the IRIS model and the Berman/Crump model to evaluate cancer effects for this health assessment. The IRIS model has been developed based upon studies that were mostly chrysotile epidemiology studies, and the model has been shown to reasonably predict chrysotile risk at a number of sites. The Berman Crump model also allows for differences in mineralogy.

Analysis and binning of air samples – Binning is simply a term used by microscopists and health assessors to describe dividing the sample according to certain criteria. At Borit the collected air data were analyzed using Transmission Electron Microscopy (TEM) and fibers were counted according to the rules set by the International Standards Organization (ISO) in their rule ISO10312. This technique captures both the mineralogy of the fibers and the fibers' dimensions allowing "binning" of the fibers in a number of different ways (ASTM 2007). Four size bins were selected for this health assessment and are summarized in the Table 2.

Fiber mineralogy was also determined for each size bin, including 8 amphibole bins, 1 chrysotile bin, and summary bins for total amphibole, total chrysotile, and total asbestos. This resulted in 52 separate bins for each sample collected. Since different models use different binning strategies, several bins were combined to be used in the IRIS and Berman Crump models. IRIS used 1 bin: PCMe fibers of either chrysotile or amphibole. Berman Crump required 2 bins: protocol structures of chrysotile, and protocol structures of amphibole (EPA 1998).

Exposure estimation – The above discussion shows how asbestos environmental sampling data are collected and how they are analyzed (binning) so that they may be used in various risk models as an estimate of "levels of exposure" to individuals and communities. The other part of the exposure equation is at what age and for how long were individuals exposed. For models such as the IRIS model, a unit risk has been calculated that is based upon constant exposure levels over a constant length of time. For IRIS, this length of time is a lifetime or 70 years (EPA 2007b).[1] Technically, estimating less than life-time exposures requires the calculation of a new unit risk for that particular length of exposure. This is a very difficult process and in many cases the data simply do not exist to support calculating new unit risks. So, in practice, quite often the exposure is adjusted as percentage of life-time exposure with a time correction. This type of correction was used in the World Trade Center asbestos calculations (ATSDR 2007). While not technically the most accurate method in situations when the corrections to a new unit risk are small, the calculations nonetheless provide a good estimate of the risk. For models such as the Berman Crump model, less than lifetime exposures are adjusted by statistical means using life table analyses. While it is beyond the scope of this document to describe this process, this

1 EPA defines the unit risk as a quantitative estimate in terms of risk per ug/m^3 air breathed. For asbestos, EPA calculated an inhalation unit risk estimate of 2.3 × 10-1 (fibers/cc)$^{-1}$. EPA estimates that, if an individual were to continuously breathe air containing asbestos at an average of 0.000004 fibers/cc over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing 0.00004 fibers/cc would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 0.0004 fibers/cc would result in not greater than a one-in-ten-thousand increased chance of developing cancer. Or, looking at this in another way, the unit risk estimates that there is a 23 in 100 risk of developing cancer if you are exposed to 1 f/cc for 24 hours, 365 days a year for a lifetime.

process has the advantage of being able to provide risk estimates for intermittent exposures and exposures beginning at different ages.

Because of the levels of airborne asbestos detected at Borit in 2006-2007 in both the stationary samplers and the activity-based samplers, a decision was made to assume a "worst case" exposure scenario and screen the samples to determine if risks were acceptable under these "worst case" assumptions. Performing the analysis in this manner tends to overestimate or conservatively estimate the risk to an individual, but allows determination as to if a more involved risk analysis needs to be performed. The assumptions made were:

24 hour exposure

350 days per year

30 years

Only the air inhalation pathway was evaluated because it is the pathway of greatest exposure/risk for asbestos. We acknowledge that soil, surface water and sediment at the site contains asbestos but unless that asbestos becomes airborne we do not expect dermal or ingestion exposures to result in adverse effects.

Sampling Events

This section summarizes the air sampling data that have been collected for this site. Information on the public health significance of the results is provided in the following 'Public Health Implications' section.

Historical Air Sampling Results (prior to 2006)

A number of environmental investigations have been conducted over the years principally to address the nearby Ambler Asbestos NPL Site. However, due to the proximity of the two sites, the history of disposal operations in Ambler, and the selection of sampling points during these studies, air sampling data from these investigations may provide useful information regarding the past air quality status not only in the neighborhood surrounding the Ambler Asbestos Site but also the community near the Borit Asbestos Site.

The air sampling data collected prior to the 2006-2007 sampling presents a complicated picture in terms of determining the health implications of asbestos exposure from the Borit site. Much of these data is confounded by collection technique, analytical methods, and collection locations where other asbestos sources may have been prevalent. The extent of large piles of asbestos-contaminated material, combined with historical air data, indicates that under certain conditions local levels of air borne asbestos may have been a concern in the past. As detailed in a December 2006 ATSDR Record of Activity (AROA) Health Consultation, air samples were taken in the Ambler area from 1971 through 1987 (when Nicolet discontinued operations), but from 1987 until 2006, the air sampling data are very limited. The historic data show air levels ranging from quantitatively non-detect to as high as ~2 fibers/cubic centimeter (f/cc). The maximum onsite data do not appear to reflect or correlate with the maximum offsite levels. Information gaps in the historical record make drawing any health conclusions regarding past exposures extremely difficult (ATSDR 2006a).

2006-2007 Air Sampling Results

The October 2006 thru September 2007 sampling program was conducted by the U.S. EPA Region III, the U.S. EPA Environmental Response Team (ERT), and its contractors, under authority of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) program, also known as Superfund. Asbestos air samples were collected from locations at and around the Site, in different seasons, and under different weather conditions (Figures 2-3). During each round of sampling, on-site sampling locations were based on wind direction. Seasonal sampling was performed to study the impact of seasonality on the ability of asbestos to become airborne. Once placed, community-based air sampling stations were permanent or fixed locations but weighted toward the prevailing wind direction. The type and amount of groundcover, such as leaves, snow, vegetation, and condition of the soil (e.g., rain saturated or frozen) can affect the likelihood of fibers becoming airborne.

In October 2006, November 2006, March 2007, June 2007, July 2007, August and September 2007, the EPA, in contract with Response Engineering and Analytical Contract (REAC) sampled eight locations within the site boundary, five fixed off-site locations in the community, and a remote location in the nearby town which is used as a background or reference sample. In addition, activity-based sampling (ABS) was conducted at the site three separate times (October 2006; November 2006; September 2007) to represent or simulate a worst-case scenario (i.e. activities disturbing the soil would increase concentration of asbestos fibers in air). During the ABS sampling, field personnel wore personal air sampling pumps while conducting physical tasks, including clearing vegetation using brush cutters, raking the ground surface, and hiking at the park. REAC staff used a Met One meteorological station to collect local meteorological data (e.g., wind direction and speed) during the sampling events (EPA 2008b).

Air sampling for asbestos was conducted using the ERT Standard Operating Procedure (SOP) #2015. The sampler consists of a 0.45-micron (µm), 25-millimeter (mm) mixed cellulose ester (MCE) filter connected to a sampling pump. The air samples were collected at breathing height, approximately 4 to 5 feet above the ground surface. Laboratory analysis was performed at the International Asbestos Testing Laboratories (IATL) in Mount Laurel, New Jersey (EPA 2008b).

To evaluate potential risks associated with inhalation of asbestos under site-specific activities, EPA incorporated simulations of potential future use scenarios where individuals engaged in activities that cause asbestos on the surface and in soil to become airborne. These activities included raking, grass cutting and hiking, to simulate activities by maintenance workers and individuals for recreational purposes. Samples collected during these activities are referred to as "Activity Based Samples" or ABS.

The air sampling data for both the PCMe and AHERA binning methods are summarized in Tables 4 and 5 for the stationary monitors. A total of approximately 382 samples were collected from October 2006 through September 2007. In all of the 2006-2007 EPA air samples, asbestos fibers were detected, above laboratory detection limits, in 10 PCMe method samples and 82 AHERA method samples (Table 4). For the on-site ABS results, 3 PCMe and 11 AHERA samples had detectable levels of fibers. Off-site sampling generated only 1 elevated sample for the PCMe counting method and 20 for the AHERA counting method. Of the 75 samples (74 AHERA with or without concurrent PCMe results, and one PCMe without a concurrent AHERA result) with reportable quantitative results from the October 2006-September 2007 sampling events, 67 of 75 (89.3%) were chrysotile, 6 of 75 (8%) were actinolite, and 2 of 75 (2.6%) were crocidolite mineralogy.

The following describes the evaluation that PADOH and ATSDR performed on the data collected (see Table 2 for Binning criteria). The stationary monitoring data were "binned" in three separate size categories and analyzed for the presence of asbestos and, where applicable, risk of developing mesothelioma and lung cancer. These include:

1. AHERA structures. The Asbestos Hazard Emergency Response Act (AHERA) provided guidance for analyzing asbestos fibers by TEM. This "bin" includes all structures seen by TEM. AHERA does not provide a method for determining asbestos risk, but rather only is able to indicate if there are elevated asbestos levels. AHERA structures include both short structures and long structures greater than or equal to 0.5 µm in length and fibers of any width.

2. PCMe fibers. PCM structures are those that can be seen with a phase contrast microscope (PCM). PCM cannot distinguish mineralogy and therefore can only provide total number of structures. At Borit EPA used TEM and calculated the PCM equivalents (PCMe). Therefore all fibers reported are asbestos. PCMe fibers include all fibers greater than 5 µm in length (>5 µm) and greater than 0.25 µm in width (>0.25 µm), which are the size limitations of phase contrast microscopy.

3. Berman – Crump "protocol" structures. Several researchers and asbestos experts suspect that long fibers are the primary structures responsible for disease. Berman in particular has found a very strong correlation with fiber length and mineralogy but not with other fiber parameters. In 2001, Berman developed a protocol and risk assessment for analyzing the risk of exposure to long fibers, which was included as one of the binning methods for the 2006-2007 data from this site. PADOH and ATSDR used the Berman Crump binned data to see if long fibers could be a contributor to lung cancer and mesothelioma in Borit (i.e., are long, thin fibers present and if so what risks are associated with exposure). Berman-Crump includes fibers greater than 10 µm in length and less than or equal to 0.4 µm in width.

Quality Assurance and Quality Control

In preparing this health consultation, ATSDR and PADOH reviewed the quality assurance and quality control measures that were followed regarding sample collection, sample preparation, sample analysis, data gathering, chain-of-custody, laboratory procedures, and data reporting. ATSDR and PADOH expected and presumed that to ensure the accuracy of the data, extreme care was taken during all aspects of sample collection. ATSDR and PADOH also assumed that the samplers only used certified, clean-sample collection devices. Once samples were collected, ATSDR and PADOH expected they were stored according to the method protocol and were delivered to the analytical laboratory as soon as possible. Finally, ATSDR and PADOH presumed that laboratory Standard Operating Procedures and other procedures and guidance for sample analysis, reporting, and chains of custody were followed. The analyses, conclusions, and recommendations in this health consultation are valid only if the referenced documents are complete and reliable.

To further ensure quality objectives were met, EPA has developed a reporting tool called the National Asbestos Data Entry Spreadsheet (NADES). NADES is a compilation of validated results by individual samples. In addition, NADES standardizes data entry and provides an electronic quality control check.

Results and Discussion

PADOH and ATSDR evaluated the sampling data by looking at six questions the data were designed to answer:

1. Is asbestos present and does activity increase airborne asbestos levels? This was examined by analyzing the AHERA fiber data;
2. What are the cancer risks in the Borit community and at the site during periods when the site is not being disturbed (no-activity)? This question is addressed using PCMe counting and stationary monitors on-site and off-site;
3. What are increased cancer risks from activity in contaminated areas? This question is addressed using several different activity-based exposure scenarios and the resulting PCMe data;
4. How do long fibers contribute to risk at Borit? The contribution to risk from Berman-Crump fibers was evaluated to help answer this question;
5. How do short fibers (total fibers) contribute to risk at Borit? This was examined by analyzing the AHERA fiber data;
6. Do different weather patterns affect the levels of airborne asbestos? This was accomplished by evaluating the sampling from several different times of the year against rainfall information.

The following subsections discuss PADOH and ATSDR's evaluation of the sampling results for these six questions.

1) Is asbestos present and does activity increase airborne asbestos levels? This was examined by analyzing the AHERA fiber data.

The Asbestos Hazard Emergency Response Act is promulgated by EPA under the Toxic Substances Control Act, Subpart E, Asbestos-Containing Materials in Schools. This rule outlines counting methods and rules for determining levels of asbestos in air using transmission electron microscopy (TEM). The rule is a statistical method for determining if indoor air (in schools) has significantly higher levels of asbestos than the corresponding outdoor air. The rule is not risk based. Since the rule uses TEM, all asbestos fibers are seen (short, long, thin, and wide) and the mineralogy can be determined so that non-asbestos fibers are not counted. ATSDR and EPA typically use AHERA counting for a number of reasons, including:

- AHERA is a well known method. Many asbestos labs in the country can perform AHERA counting.
- AHERA yields a good estimate of the fiber size distribution.
- For environmental sampling, TEM can distinguish non-asbestos fibers from asbestos fibers.

AHERA counting cannot be used to determine risk because binning is not possible without individual fiber dimensions (although several labs will divide AHERA into less than and greater than 5 μm). For the Borit analysis, risk was determined using fibers greater than 5 μm (> 5 μm) via the PCMe method.

AHERA fibers were detected in 82 of the Borit samples, indicating that asbestos was present. Some of the activities tested greatly increased the amount of AHERA fibers in the air (see Table 3). The majority of samples were chrysotile (77 of 82). Also the vast majority of fibers were less than 5 μm (<5 μm) in length. Fibers shorter than 5 μm in length do not add significantly to the risk of developing lung cancer or mesothelioma. At very high levels, these shorter fibers likely contribute to asbestosis and can cause overloading of lung clearance mechanisms, which may lead to increased toxicity of longer fibers. Short fibers at very high levels may also act as dust/particulate matter and thus may contribute to adverse health effects on the lung similar to those associated with exposures to dust. Based on the data evaluated, levels of asbestos exposure at Borit are far below any level at which short fibers would be suspected of causing these non-cancer effects. For more discussion on short fiber effects see “Public Health Implications” below.

Conclusions: The AHERA data indicate the presence of asbestos, primarily chrysotile asbestos. Soil disturbing activities appear to significantly increase the amount of airborne AHERA fibers at this site. However, it is not possible to make conclusions about the cancer risk that might be related to exposures to these AHERA fibers at this site. Non-cancer risk will be discussed later in this document (see pages 14-16).

Questions 2 & 3) What are the cancer risks in the Borit community and at the site during periods when the site is not being disturbed (no-activity)? What are increased cancer risks from activity in contaminated areas? These questions were addressed using several different activity-based exposure scenarios and the resulting PCMe data and estimating cancer risks from this information.

Stationary monitors - Phase contrast microscopy (PCM) in the past was the method of choice for counting asbestos fibers on air filters. It has been used in most epidemiology studies (those where it has not been used have been converted to PCM counts) and in all risk methodologies except for Berman-Crump. It is therefore vital that 'apples be compared to apples' and all risks calculated using PCM counts. In environmental samples many of the fibers are non-asbestos fibers, thus TEM is most often used so that mineralogy can be determined and so that only asbestos fibers are counted. TEM, however, can see fibers that are much shorter and thinner than PCM fibers. Therefore a conversion must be made from TEM fibers to PCM equivalent (PCMe) fibers. This method was employed by EPA for the air sampling data from this site.

For the 2006-2007 EPA sampling, the results indicate that 10 out of 376 samples (on-site, off-site) had detectable PCMe levels of airborne asbestos (11, if sample 41304 from October 2006 with a result of <0.005 f/cc is included). Non-activity based sample results ranged from 0.00048 f/cc to 0.00098 f/cc, including both on and off site locations. Calculating a risk for the highest concentration for a person exposed continuously for 30 years can be done as follows:

Risk = Unit Risk (from EPA IRIS) $*$ concentration $*$ correction for less than continuous lifetime exposure

Risk = 0.23 $(f/cc)^{-1}$ $*$ 0.00098f/cc $*$ (24 hours/day / 24 hours/day) $*$ (365 days/year / 365 days/year) $*$ (30 years/lifetime / 70 years/lifetime)

Risk = 9.7 E-5 (or 9.7 excess cancers per 100,000 persons, or conservatively rounded up to 1 in 10,000)

EPA has determined acceptable ranges of risk to be from 1.0 E-4 to 1.0 E-6 (or 1 in 10,000 to 1 in a million). The risk at Borit, when the asbestos containing material or waste is not disturbed, falls within EPA's defined acceptable risk.

Conclusions: At this time the risks from the Borit site for both on-site and off-site do not pose a substantial cancer risk when the waste material is left undisturbed. Under these conditions a public health hazard does not exist and the cancer risk for the site is classified as no apparent increase to low increased risk. Any changes to the site could alter this classification due to the presence of ACM, the findings of the AHERA fibers, and the activity-based results presented and discussed below.

Activity based results

On-site activity-based sampling was performed for four different scenarios: raking, walking, grass cutting, and soil sampling. Personal monitoring was also performed during sediment sampling but these results are not used for the public health evaluation in this document because AHERA fibers were detected at levels less than the levels detected during other ground disturbing activities (i.e., less than 0.076 AHERA f/cc and no PCMe fibers).

Activity-based sampling is a method adopted from the industrial hygiene field in which personal monitors are placed on employees as they perform their physical job functions. It has the advantage of showing levels of exposure under conditions similar to real world environments. Onsite sample results under the various activity scenarios described above showed a range of asbestos in the air from none detected (ND) to 0.021 f/cc using the PCMe counting method and ND to 0.076 f/cc using the AHERA counting method. The raking activity produced the highest air levels. Raking is used to simulate aggressive disturbance of surface soil. Assuming someone performed an aggressive soil disturbing activity (like raking) 2 days per month for 8 hours per day for 30 years on-site, a calculated risk using the maximum PCMe result would be estimated at:

> Risk = Unit Risk (from EPA IRIS) $*$ concentration $*$ correction for less than continuous lifetime exposure
>
> Risk = 0.23 $(f/cc)^{-1}$ $*$ 0.021f/cc $*$ (8 hours/day / 24 hours/day) $*$ (24 days/year / 365 days/year) $*$ (30 years/lifetime / 70 years/lifetime)
>
> Risk = 4.5 E-5 (or 4.5 excess cancers per 100,000 persons)

Table 3 indicates that substantial increases in exposure can occur on-site when activities are disturbing the soil. "At the pile" (ATP) raking results in a 116 fold increase in average asbestos exposure levels for AHERA type fibers and a 34 fold increase for PCMe fibers, when compared to comparable onsite results with no activities occurring. Both fiber counting methods show a statistically significant increase in asbestos air levels with raking when compared to levels seen on-site when no activity is taking place (Z = 2.92 and 1.89 respectively; when a Z-value is less than 1.65, it is estimated that there is no statistical difference between the numbers being compared). The soil sampling activity also showed a statistically significant increase in AHERA fibers (although not in PCMe fibers) when compared to levels when no activity is taking place (Z = 2.84 and 1.62 respectively). Other activities do not show the same statistically significant increases in air levels over non-activity air levels although several show elevated air levels.

Uncertainty. It should be noted that these values represent reasonable estimates of activity-based increases in air concentration when compared to non-activity based or stationary values but also contain significant uncertainty. The 6 fold increase seen in the walking activity is interpreted as an artifact of the sample detection limits and technical limitations. Because less air is filtered with personal pumps than with stationary filters, the analytical sensitivities are higher. Since no PCMe (see above comment) fibers were detected in the walking scenario, the ratio of activity-based/stationary is a function of the analytical sensitivity and not the actual fibers counted. In this case the walking activity over-estimates the increase in airborne fibers. The same type of error can be introduced in the comparison data (on-site stationary samples) when non-detects are found. This would result in an underestimation of the increase due to activity. How to treat non-detects has been discussed elsewhere (2007a). The general conclusion is that non-detects should be treated as zero. Since the Z test cannot be performed on samples with zero fibers, ATSDR elected to use a measure that approaches zero and used the analytical sensitivity divided by 2 for analyzing samples where no fibers were detected. It is believed by PADOH and ATSDR that this is a reasonable approach and provides airborne asbestos level estimates close to the true value since an "asbestos type" was identified in every air sample.

Activity-based Sampling Conclusions. The raking activity significantly increased the amount of asbestos fibers in the air (range 54 fold to 240 fold increase; average 116 fold). The soil sampling activity significantly increased airborne AHERA fibers. Both raking and soil sampling involve direct disturbance of soils. ***Therefore any direct soil disrupting activity should be avoided by visitors or trespassers.*** The majority of the raking fibers were short AHERA fibers that would not be expected to increase asbestos-related disease at these levels (see short fiber discussion). However, there were also significant increases in PCMe fibers that can be associated with and may cause lung cancer and mesothelioma at these levels given long enough exposure. Although the example risk calculation shows for a conservative exposure estimate where the calculated risk falls within EPA's acceptable range of risks, PADOH and ATSDR believes significant increases in exposure are not acceptable and pose a *possible public health hazard*. At present the community has restricted access to the on-site sampling locations, off-site data do not indicate air transport of fibers, and on-site construction and soil disturbing activities are not occurring on a regular basis. The data strongly suggest that air-borne asbestos could pose a threat to public health, should any of these conditions change.

Question 4) How do long fibers (fibers longer than 10 um in length) contribute to risk at Borit? The contribution to risk from Berman-Crump fibers was evaluated to help answer this question.

Some recent studies (e.g, Berman 1995) have shown a high correlation of fiber length with cancer risk. Specifically, fibers less than 10 µm in length have been shown to have little or no cancer risk. The latest science for measuring the risk posed by asbestos is the Berman-Crump Asbestos Risk Assessment Protocol (Berman-Crump Protocol). This protocol is the result of an EPA funded, multi-year study (revised in 2003) that demonstrates airborne amphibole asbestos fibers that are long and thin (longer than 10 micrometers (µm) and having widths that are less than 0.5 micrometers) are understood to be of most concern with respect to cancer risk.

Based on a review of the 2006-2007 data for this site, only 1 of the reported fibers was longer than 10 micrometers and less than 0.5 micrometers in width.

Question 5) How do short fibers (total fibers) contribute to risk at Borit? This was examined by analyzing the AHERA fiber data.

In 2002, ATSDR held an expert panel meeting to review fiber size and toxicity in response to asbestos concerns from the World Trade Center disaster(ATSDR 2003b). The panel concluded that fiber length plays an important role in toxicity. The short fibers can be cleared from the lung by various mechanisms, depending on where the fibers deposit. Fibers depositing on the surface of the tracheobronchial region are efficiently cleared generally within 24 hours. Many of the short fibers that reach the gas exchange region of the lung are cleared by alveolar macrophages, and the rate of clearance by phagocytosis has been found to vary with fiber length and to differ across mammalian species. Deposition and retention patterns may differ in people with impaired capacities to clear foreign material from their lungs. The extent to which short fibers preferentially translocate from the gas exchange region to the pleura is not well known.

The health effects from asbestos is a function of fiber dose, fiber dimension (length and diameter), and fiber persistence in the lung (as determined by the mineral type, structure, and the surface chemistry). For short fibers with diameters between 0.1 and 1.6 µm, total lung deposition in healthy people is between 10% and 20% of what is inhaled, with most of that deposition occurring in the deep lung; and the remainder of the fibers not deposited are exhaled. For short fibers with diameters less than 0.1 µm, a greater proportion will deposit and there will be a somewhat greater proportion of deposition in the proximal airways. The asbestos expert panel made the following conclusions on the cancer and noncancer effects of short fibers:

Cancer effects of short fibers - Results from epidemiologic studies, laboratory animal studies, and *in vitro* genotoxicity studies, combined with the lung's ability to clear short fibers, the expert panel believes that there is a strong weight of evidence that asbestos fibers shorter than 5 µm are unlikely to cause cancer in humans.

Noncancer effects of short fibers - Findings from the laboratory animal, epidemiologic, and *in vitro* studies suggest that short fibers, less than 5*um* may be pathogenic for pulmonary fibrosis. Fibers of this size *might* play a role in asbestosis when exposure duration is long and fiber concentration high. However, further scientific research is needed in this area to draw a definitive conclusion (Mossman 2007).

In addition, other animal studies have noted that exposure at chrysotile fibers at sub-chronic levels (3413 f/cc) does not present a detectable risk to health. Since cumulative dose over time decides the likelihood of disease occurrence and progression. Studies also suggest that the risk of an adverse outcome may be low even if exposed to high concentrations over a short duration (Bernstein 2006).

Data from epidemiologic and animal studies of fibers indicate that the health risk posed by fiber exposures are largely determined by the fibers', mineralogy, dimensional characteristics (i.e. length and diameter), the fiber's ability to resist removal from the lung (biopresistence) and dose.

NIOSH and OSHA define that only asbestos fibers greater than 5 µm in length and have an aspect ratio of at least 3:1 be counted towards exposure limits. However, beyond the roles of length and diameter, limited data exist to demonstrate that a fibers' aspect ratio plays a role in the pathogenicity of fibers (ATSDR 2003b).

A few studies have linked short fiber exposure to an increase in fibrosis. A study of tissues from chrysotile asbestos miners and millers reported an inverse relationship between fibrosis grade and length of tremolite fibers retained in the lung. In other words, the most severe fibrosis was observed among those with smaller (on average) tremolite fibers in their lungs. Another study and a study recently submitted for publication examined fibrosis grades for different length intervals of tremolite fibers: 0–5 µm, 5–10 µm, and 10–20 µm. Both studies found the highest average fibrosis grade occurred among those with the lowest tremolite fiber length interval, or for those with average tremolite fiber length less than 5 µm.

Due to these and other observations, scientists might overlook other important factors that influence toxicity if fiber length is exclusively evaluated. For asbestosis, on the other hand, the role of fibers shorter than 5 µm is not as clear and requires further study.

Fiber length alone might not adequately predict fiber toxicity. There are other potential influences on asbestos fiber toxicity. First, cancers observed in a study of rats exposed to erionite could not be explained by fiber length alone; they suggested that the unique findings of this study might be best explained by unique surface chemistry or the mineral's relatively large internal surface area. Second, fiber durability likely explains why asbestos fibers and non-asbestos fibers of the same length are not equally toxic.

Overall, there is limited evidence of noncancer toxicity being associated with fibers less than 5 µm in length, with two exceptions. First, very high doses to short fibers, especially those that are durable in intracellular fluids, may have the propensity to cause interstitial fibrosis. Second, exposure to short, thin durable fibers may play a role in development of pleural plaques or diffuse pleural fibrosis if the dose is high enough. For asbestos fibers, no studies have examined the effects of exposures exclusively to short fibers. Given data collected in Libby, Montana, however, some scientists questioned whether short fibers might play a role in the observed cases of pleural plaques and diffuse pleural fibrosis; but others cautioned against inferring that the risk results from exposure to short fibers, given that the Libby samples contained significant numbers of long fibers as well (Mohr et al 2005).

One study of tissues from chrysotile asbestos miners and millers reported an inverse relationship between fibrosis grade and length of tremolite fibers retained in the lung (Churg et al. 1989). In other words, the most severe fibrosis was observed among those with smaller (on average) tremolite fibers in their lungs. Two studies (Nayebzadeh et al. 2001 and Nayebzadeh et al. 2006) examined fibrosis grades for different length intervals of tremolite fibers: 0–5 µm, 5–10 µm, and 10–20 µm. Both studies found the highest average fibrosis grade occurred among those with the lowest tremolite fiber length interval, or for those with average tremolite fiber length less than 5 µm.

Although are a range of studies in this area, there is not scientific consensus on the interpretation of the literature regarding the potential health effects (for lung cancer, mesothelioma and asbestosis) from exposure to short AHERA fibers. The majority of the raking fibers detected at this site were short AHERA fibers that would not be expected to increase asbestos-related disease at these levels. In addition, the general public and the Ambler community are not expected to be exposed to these levels of AHERA fibers detected during ABS, since they were detected within the site boundary during aggressive soil manipulation. However, **as a precautionary measure, any direct soil activity should be avoided by visitors or trespassers at this site based on the AHERA and PCMe sampling results.**

Question 6) Do different weather patterns/soil moisture levels affect the levels of airborne asbestos? This was accomplished by evaluating the sampling from several different times of the year against rainfall information.

The EPA collected samples at Borit in October and November of 2006 and March, May, June, and September of 2007. Direct soil moisture measurements were included as part of EPA's sampling events in May, July, August, and September 2007. Samples were collected over several seasons to help determine if soil moisture played a crucial role in exposure. Although average rainfall in the Ambler area is fairly constant from month to month (monthly average of 2.75 to 4.39 inches – see average line in Figure 4), sampling was attempted to be performed during a dry season so that a 'worse case scenario' could be evaluated and the differences between wet periods and dry periods noted. Figure 4 shows that the period from October 2006 through Sept 2007 exhibited approximately average rainfall for the region, with notable exceptions of a very wet April and very dry September (Weather Underground 2007). The soil moisture measurements summary included as part of Figure 4 indicates that available soil moisture levels ranged from a maximum average of approximately 30.5% in May 2007 to a minimum average of approximately 17.3% in September 2007.

Conclusion: The asbestos airborne levels do not appear to vary as a function of rainfall with the exception of high airborne asbestos levels in the extremely dry month of September, as seen in Figure 4. This suggests that during long periods of drought or shorter periods of extreme drying, levels of airborne asbestos may increase.

Public Health Implications

Asbestos

Asbestos is a group of six different fibrous minerals (amosite, chrysotile, crocidolite, and the fibrous varieties of tremolite, actinolite, and anthophyllite) that occur naturally in the environment. Chrysotile, also known as white asbestos, is the predominant commercial form of asbestos; amphiboles are of minor commercial importance. Asbestos minerals have separable long fibers that are strong and flexible enough to be spun and woven and are heat resistant. Because of these characteristics, asbestos has been long used (mainly chrysotile) for a wide range of manufactured goods, mostly in building materials, heat-resistant fabrics, packaging, brakes, building materials, and coatings. Currently only the long fibers are considered a health threat, but the risk from shorter fibers is being investigated. Asbestos fibers may break into shorter pieces or separate into a larger number of individual fibers as a result of physical processes (ATSDR 2001).

Asbestos containing material (ACM) is considered "friable" when it can be easily crushed by hand. Friable asbestos can release fibers into the air, creating a potential health hazard. When asbestos fibers are intact, such as in an asbestos-containing cement pipe, they are considered "non-friable." This means that the individual fibers are contained and are not readily released into the surrounding air. From a public health and regulatory standpoint, "friable" asbestos is the greatest health concern.

People can be exposed to asbestos by swallowing contaminated water containing ACM, or by breathing fibers in the air. Asbestos fibers are poorly absorbed through the skin (ATSDR 2007). Exposure to asbestos usually occurs by breathing contaminated air in workplaces that make or use asbestos. Asbestos exposure can cause serious lung problems and cancer. Low level concentrations of asbestos are present in the ambient air. These levels range from 0.00001 to 0.0001 f/cc of air and are usually highest in cities and industrial areas. People working in industries that make or use asbestos products or who are involved in asbestos mining may be exposed to high levels of asbestos (EPA 1998).

Asbestos fibers can enter the air or water from the breakdown of natural deposits and manufactured asbestos products. Asbestos fibers are generally not broken down to other compounds and will remain virtually unchanged over long periods. People living near these industries may be exposed to asbestos in air. Asbestos fibers may be released into the air by the disturbance of asbestos-containing material during product use, demolition work, building or home maintenance, repair, and remodeling. In general, exposure may occur only when the asbestos-containing material is disturbed in some way to release particles and fibers into the air.

The mammalian lung responds to exposures from inert materials whether fibrous or particulate. Once an inert material deposits in the lung beyond the conductive airways, it will either dissolve or be engulfed and cleared by alveolar macrophages; if the dose exceeds the lungs' capacity to clear the material (exposures of approximately 5-10 mg/m^3 of chrysotile (Bernstein 2005)), natural defense mechanisms may act, leading to fibrosis (ATSDR 2003b). Chrysotile fibers were predominantly detected in the 2006-2007 samples. In studies, long chrysotile fibers were observed to break apart into small particles and smaller fibers in the lung. Toxicologically, chrysotile which rapidly falls apart in the lung behaves more like non-fibrous mineral dusts while response to amphibole asbestos reflects its insoluble fibrous structure (Bernstein 2005).

Measuring asbestos content in air samples and in bulk materials that could become airborne involves both quantification of fibers and determination of mineral content of the fibers to identify whether they are asbestiform. Fiber quantification was historically done through phase contrast microscopy (PCM), by counting fibers longer than 5 µm (>5 µm) and with an aspect ratio (length: width) greater than 3:1. This was the standard method by which regulatory limits were developed. Disadvantages of this method include the inability to detect fibers smaller than 0.25 µm in diameter and the inability to distinguish between asbestos and nonasbestos fibers (ATSDR 2001).

Transmission electron microscopy (TEM) is a more sensitive method and can detect smaller and narrower fibers than PCM techniques can detect. TEM allows the use of electron diffraction and energy-dispersive x-ray methods, which give information on crystal structure and elemental composition, respectively (Middendorf et al 2007). This information can be used to determine the elemental composition of the visualized fibers. One disadvantage of electron microscopic methods is that it is difficult to determine bulk asbestos concentrations. The TEM counting method is not currently utilized in the public health assessments, or in the regulatory capacity, due to the lack of evidence in the scientific community on the role of short fibers.

Current Standards and Regulations for Asbestos

Friable asbestos (asbestos which is crumbly and can be broken down to suspendable fibers) is listed as a Hazardous Air Pollutant under Section 112 of the Clean Air Act. Companies releasing friable asbestos at concentrations greater than a 0.1% *de minimus* limit are required to report the release under Section 313 of the Emergency Planning and Community Right-to Know Act.

In 1989, EPA banned all new uses of asbestos; uses established before this date are still allowed. EPA regulates the release of asbestos from factories and during building demolition or renovation to limit and prevent asbestos from being released into the environment. OSHA (Occupational Safety and Health Administration) has set limits of 100,000 fibers with lengths greater than or equal to 5 µm per cubic meter of workplace air for 8-hour shifts and 40-hour work weeks (i.e., 0.1 f/cc). OSHA has set a permissible exposure limit (PEL) of 0.1 f/cc for asbestos fibers greater than 5 µm in length and with an aspect ratio (length: width) greater than 3:1, as determined by PCM. 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.

The National Institute of Occupational Safety and Health (NIOSH) set a Recommended Exposure Limit (REL) of 0.1 f/cc for asbestos fibers greater than 5 µm in length. This REL is a TWA for up to a 10-hour workday in a 40-hour work week. The American Conference of Government Industrial Hygienists (ACGIH) has also adopted a TWA of 0.1 f/cc as its threshold limit value (ATSDR 2001).

EPA has calculated an inhalation unit risk (IUR) of 0.23 per f/cc of asbestos, or 2.3 × 10-1 $(\text{fibers/cc})^{-1}$, as is discussed earlier in this document. EPA's Cancer Slope Factor (CSF) for asbestos is used in the calculation of the IUR. The IUR value estimates additive risk of lung cancer and mesothelioma using a relative risk model for lung cancer and an absolute risk model for mesothelioma. Using this value, one can calculate average lifetime asbestos fiber air concentrations corresponding to specified risk levels. The unit risk value is based on risks calculated using U.S. general population cancer rates and mortality patterns without consideration of smoking habits. The concentration that would result in an increased excess risk of 1 in 10,000 is 0.0004 f/cc. The concentration resulting in an increased excess risk of 1 in 1,000,000 is 0.000004 f/cc. The unit risks were based on measurements with phase contract microscopy (PCM) and should not be applied directly to measurements made with other analytical techniques. Also, the unit risk should not be used if the air concentration exceeds 0.04

f/cc, because above this concentration the slope factor can differ from that stated (EPA 1998). Nationwide studies have shown that background rural air levels of asbestos are about 0.00001 f/cc. Typical levels of asbestos found in cities are typically 10-fold higher, at 0.0001 f/cc (ATSDR 2001).

Toxicological Evaluation

Asbestos fibers mainly affect the lungs and the membrane that surrounds the lungs, known as the mesothelium. Breathing asbestos fibers increases the risk of developing the following cancer and non-cancer health effects:

Malignant mesothelioma- Cancer of the membrane lining the chest cavity and covering the lungs (pleura) or lining the abdominal cavity (peritoneum). This cancer can spread to tissue surround the lungs or other organs. Many scientists believe that amphibole asbestos fibers have a potency for causing mesothelioma at rates 100 times greater than exposure to chrysotile fibers, mainly because of increased persistence of amphiboles in the lungs.

Lung Cancer – cancer of the lung tissue, also known as bronchogenic carcinoma. The exact mechanism relating asbestos exposure with lung cancer in not completely understood. The combination of tobacco use (smoking) and asbestos exposure greatly increases the risk of developing lung cancer.

Laryngeal cancer – cancer of the larynx (voice box). In 2006, the Institute of Medicine found sufficient evidence of an association between laryngeal cancer and asbestos exposure (IOM 2006).

Noncancer Effects – These include *asbestosis*, a restrictive lung disease caused by asbestos fibers scarring the lung; *pleural plaques,* localized areas of thickening of the pleura; *diffuse pleural thickening*, generalized thickening of the pleura; *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 chest cavity. Loss of lung function or other clinical signs may or may not be associated with these noncancer effects (ATSDR 2006b).

The Department of Health and Human Services (DHHS), World Health Organization (WHO), and EPA have determined that asbestos is a human carcinogen. The time between diagnosis of mesothelioma and the time of initial exposure to asbestos commonly has been 15-30 years or more (i.e., long latency period). Occupational exposure to asbestos is involved in 70-80% of all malignant pleural mesothelioma cases.

Insufficient evidence exists to conclude whether inhalation of asbestos fibers increases the risk of cancers at sites other than the lungs, pleura, and lining of the abdominal cavity. Ingestion of asbestos causes little or no risk of noncancer effects. However, some evidence suggests that acute oral exposure can induce precursor lesions of colon cancer, and that chronic oral exposure can lead to an increased risk of gastrointestinal tumors. ATSDR's toxicological profile for asbestos reviewed the published literature about possible immunological effects, such as rheumatoid arthritis, lupus, or fibromyalgia, due to asbestos exposure. Not enough evidence exists to say whether asbestos exposure or resulting asbestos-related disease could increase a person's likelihood of experiencing autoimmune disease (ATSDR 2001). But the associations that have been discovered between immunological changes and asbestos exposure indicate that this question deserves further research.

The toxicity of asbestos is dependent on exposure intensity and duration as well as the physical/chemical properties of the asbestos fibers. The scientific community generally accepts the correlations of asbestos toxicity with fiber length as well as fiber mineralogy. Long and thin fibers are expected to reach the lower airways and alveolar regions of the lung, to be retained in the lung longer, and to be more toxic than short and wide fibers or particles. Fiber length plays an important role in clearance and toxicity. In addition, asbestos exposure and cigarette smoking act synergistically to produce dramatic increases in lung cancer compared with those from exposure to either agent alone (ATSDR 2001).

In 2002, ATSDR held an expert panel meeting to review fiber size and toxicity in response to asbestos concerns from the World Trade Center disaster (ATSDR 2003b). The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths less than 5 micrometers (<5 µm) are unlikely to cause cancer in humans. However, fibers of this size *might* play a role in asbestosis when exposure duration is long and fiber concentration high. Cleavage fragments, or short fibers, of respirable dimensions have generally proven nonpathogenic in animal studies, and are less cytotoxic and bioreactive in animal studies (Mossman 2007). More scientific studies are needed to reach a definitive conclusion regarding fiber length.

In addition, other studies have noted that a exposure (>3,000 f/cc) to pure chrysotile does not present a detectable risk to health. Since cumulative dose over time in part determines the likelihood of disease occurrence and progression, studies also suggest that the risk of an adverse outcome may be low even if exposed to high concentrations over a short duration (Bernstein 2006).

Data from epidemiologic and animal studies of fibers indicate that the health risks posed by fiber exposures are largely determined by the fibers' mineralogy, dimensional characteristics (i.e. length and diameter), ability to resist removal from the lung (biopersistence), and dose. NIOSH and OSHA define that only asbestos fibers greater than 5 µm in length and that have an aspect ratio of at least 3:1 be counted towards exposure limits. However, beyond the roles of length and diameter, limited data exist to demonstrate that a fiber's aspect ratio plays a role in the pathogenicity of fibers (ATSDR 2003b).

Cancer Risk Evaluation

Hypothetical cancer risk calculations can be computed for PCMe results. EPA has performed these risk calculations for various predictive exposure scenarios for the maximum PCMe values for this site and these results have been previously presented to the community. PADOH and ATSDR prepared a summary of these results in the sections below.

These risk estimates were generated assuming residents were exposed to the highest measured passive (non activity based) concentrations of airborne asbestos (on-site and off-site) for 24 hours/day, 350 days/year for 30 years. Maintenance workers and recreational receptors were assumed to be exposed to the maximum activity-based asbestos concentrations under similarly conservative conditions, adjusted to correspond to exposure patterns specific to these kinds of receptors. Only two samples approach the upper bound of EPA's acceptable cancer risk range using these standard EPA cancer risk assessment methodologies. The first sample, a passive, non-activity based sample collected in September 2007 (0.00098 f/cc), has a projected risk calculation of 9E-05 (9 in 100,000), for a residential exposure scenario. The second sample, an activity-based sample collected in November 2006 (0.021 f/cc) has a projected risk calculation for maintenance workers and recreational users of 3.1E-05 (3 in 100,000) and 8.1E-05 (8 in 100,000), respectively. Due to the fact that the locations of these samples are from areas onsite with currently restricted public access, *actual current* human exposures, if any, would be expected to be of less frequent and shorter durations than the calculations assume. Overall, the maximum calculated risks for the 2006-2007 sampling data fall within EPA's generally acceptable range of 1E-06 (1 in 1,000,000) to 1E-04 (1 in 10,000) and are categorized by PADOH and ATSDR as 'insignificant to low increased cancer risk.'

It is important to note PADOH/ATSDR and EPA acknowledge that historical exposure to asbestos is not captured by this predictive cancer risk assessment methodology using the recent 2006-2007 air sampling results. Airborne asbestos concentrations were expected to be higher during active operation of the facility (and prior to the remediation of the Ambler Asbestos NPL site) than were measured during 2006-2007. Assuming this to is the case, significant asbestos exposures could have occurred in the past, resulting in pulmonary disease in the impacted community. With an estimated latency period of approximately 20 to 30 years for mesothelioma, recent observations of asbestos-related respiratory illness in facility workers and their immediate families or contacts and in the community surrounding the plant would be expected to be due to historical exposures.

The following paragraphs summarize predictive cancer risk evaluations of the maximum PCMe results from each of the 2006-2007 sampling events.

April 2006:
It was not possible to conduct PCMe counting of the results from this sampling event due to the indirect method of analysis that was needed to analyze the overloaded filters. Therefore, a cancer risk evaluation was not calculated for this sampling round.

October 2006:
Detectable fiber results using the PCMe counting method were from on-site locations and their concentrations were 0.00048 and 0.00049 f/cc. Note, these levels are considered representative of background asbestos air values (areas with no known readily identified asbestos source). It is estimated that continuous exposure to the maximum on-site concentration (0.00049 f/cc) of these contaminants under a typical residential scenario (i.e., an exposure duration of 30 years), results in a potential additional theoretical cancer risk of 4.6E-05, or 4.6 in 100,000. This is considered and interpreted as a 'low increased risk.'

November 2006:
The highest asbestos concentration was 0.021 f/cc using the PCMe counting method, and this was obtained during ABS (creek-bank raking). This result was used to calculate hypothetical cancer risks for this sampling round. None of the other samples, including the other ABS samples, generated detectable levels of asbestos using the PCMe counting method. The ABS results represent the worst case scenario, and since these results are within the site boundary during vigorous ground disturbance, the general public is not expected to be exposed to these levels. The hypothetical risk calculated (using the 0.021 PCMe f/cc result) for maintenance workers and recreational users was projected to be 3.1E-05 (3 in 100,000) and 8.1E-05 (8 in 100,000), respectively. Risks to both these groups fall within U.S. EPA's generally acceptable range of 1E-06 (1 in 1,000,000) to 1E-04 (1 in 10,000).

March 2007:
No samples generated detectable levels of asbestos by PCMe analysis, and therefore no cancer risk evaluation for this sampling round was calculated.

May 2007:
Results for the May 2007 air sampling event showed that one sample out of 36 samples had measurable airborne asbestos via the PCMe binning/counting method of analysis, the method used for health assessment purposes. A concentration of 0.00049 f/cc was found in an off-site location, near intersection of Mount Pleasant Avenue and Railroad Avenue. It is estimated that continuous exposure to the maximum on-site concentration (0.00049 f/cc) during this sampling round under a typical residential scenario (i.e., an exposure duration of 30 years) results in a potential additional theoretical cancer risk of 4.6E-05, or 4.6 in 100,000. This is considered and interpreted as a 'low increased risk.'

June 2007:
No samples generated detectable levels of asbestos by PCMe analysis, and therefore no cancer risk evaluation for this sampling round was calculated.

July 2007:
Results from July sampling showed that one sample, out of thirty-eight total samples had measurable airborne asbestos via the PCMe binning/counting method of analysis, the method used for health assessment purposes. A concentration of 0.00048 f/cc was detected in a sampler located within site boundaries (i.e., the park). The cancer risk calculation for the PCMe asbestos concentration of 0.00048 f/cc for a continuous, residential-type exposure for 30 years would approximate an excess lifetime cancer risk of approximately 4.6E-05, or 4.6 in 100,000, which as stated previously can be considered and interpreted as a 'low increased risk.'

August and September 2007:

Air sampling results show that 3 samples out of 79 total samples had measurable airborne asbestos, utilizing the PCMe binning/counting method. A concentration of 0.00049 f/cc of air was detected within site boundaries (i.e., the pile). In addition, concentrations of 0.00048 and 0.00098 f/cc were found in samplers located within site boundaries at the pile and park, respectively. A continuous, residential-type exposure to the maximum on-site concentration (0.00098 f/cc) during this sampling round is 9.3E-05, or an estimated increased probability of 9.3 in 100,000. As stated previously, the standard residential scenario (i.e., using the highest exposure assumptions) assumes that inhalation exposure occurs 24 hours per day, 350 days per year, for 30 years. Due to the fact that the location of this sample is in an area currently restricted to public access, any human exposure, if it occurs at all, will be much less frequent and of much shorter duration (i.e., trespasser) than that of the standard residential scenario.

Public Health Implications Summary

The full set of 2006-2007 PCMe sampling data do not show migration of PCMe-counted airborne asbestos fibers off the Borit site. Elevated on-site samples were collected during Activity Based Sampling. Given current site conditions and use patterns, it is unlikely the community would be exposed to the maximum on-site levels achieved during soil disturbance activities. Therefore based on the sampling data evaluated, PADOH and ATSDR find that exposures to the 2006-2007 PCMe-counted airborne asbestos levels are not a current public health hazard.

PAODH and ATSDR acknowledge that AHERA fibers were detected off-site. Six off-site locations detected AHERA fibers (for a total of 20 detectable samples), including the farthest sampling location included in the 2006-2007 sampling events (i.e., the Oreland sampling location, situated 3 miles southeast of the site). These AHERA sampling results indicate the presence of asbestos, primarily chrysotile asbestos. As with the PCMe counted fibers, soil disturbing activities appear to significantly increase the amount of airborne AHERA fibers at this site. However, it is not possible at this time to make conclusions about the public health hazard that might be related to exposures to these AHERA fibers at this site.

Based on significant increases in airborne PCMe asbestos (although at a risk level lower than 1 E-4 or 1 in 10,000 persons) during activity, the presence of exposed friable ACM, the quantity of buried asbestos and ACM, current site conditions, proximity of a residential community, and the potential for re-development/re-use, ATSDR and PADOH conclude that activities that disrupt the surface and subsurface of the site could result in asbestos releases which may pose a potential public health risk to the surrounding community.

Community Health Concerns

The Borit Community Advisory Group (CAG) and other community members have expressed concern regarding the environmental sampling and possible adverse health effects associated with exposure to contaminants from the site. The following is a summary of the CAG's concerns:

Will additional air sampling be performed during removal actions?
ATSDR and PADOH recommend performing additional air sampling, at on-site and offsite locations, during removal and/or remedial actions.

Are there any non-cancer effects from asbestos exposure?
Yes – asbestosis (a restrictive lung disease caused by asbestos fibers scarring the lung) is one non-cancer effect in particular that be associated with asbestos exposure over time. However, scientific evidence regarding non-cancer effects of asbestos is limited, and it is difficult to quantify non-cancer health risk from asbestos exposures. Cancer risk usually outweighs non-cancer risk. Unfortunately, asbestosis is not currently a 'reportable disease' in the available health data base; such a condition cannot be analyzed without designing and performing health surveys and investigations to collect such data. Currently, PADOH does not have plans to conduct surveys or additional investigations regarding non-cancer effects in the community. However, PADOH and ATSDR are interested in learning of any non-occupationally exposed cases of asbestos related disease in the community.

Why aren't the short fibers counted? Are they considered a potential public health threat?
Under the counting rules (binning rules) for the 2006-2007 sampling events the short fibers were counted and reported. Currently only fibers reported under the PCMe binning category are used by regulatory and public health agencies to estimate cancer health threat. PADOH and ATSDR acknowledge there are some scientific uncertainties regarding the role of short fibers and asbestos-related disease. However, the current understanding in the scientific community is that the preponderance of scientific evidence, based on epidemiologic studies, laboratory animal experiments, and in vitro genotoxicity research, combined with the ability of the lung to clear short fibers, shows that short fibers do not play a major role in development of cancer, but contribute possibly to asbestosis. However, the risk from shorter fibers will continue to be investigated by health and regulatory agencies.

How many non-worker related illnesses have been reported in the Ambler community?
PADOH and ATSDR are not able to answer the question of how many non-worker cases of asbestos-related illness are in the community. The Pennsylvania Cancer Registry does not include the detailed information necessary to draw conclusions regarding the source of exposure. Also, the asbestos-related disease information that has been shared by the community to date has not been specific enough to draw conclusions about the type of exposure that led to the asbestos-related disease. ATSDR and PADOH will continue to investigate and review reports from the community of non-occupational asbestos related disease. General information on the health risks associated with asbestos exposure was provided in a January 2007 PADOH/ATSDR fact sheet which was mailed to the Ambler community, distributed to physicians serving the community at two locally held grand rounds, and is currently available on EPA's Borit website (PADOH 2007).

Is there an increased risk of asbestos related disease in our community?
Please note that PADOH and ATSDR are currently updating and revising the information on cancer statistics for this area in cooperation with the Montgomery County Health Department, and this information will be published in a forthcoming Health Consultation document. Based on community concerns, some information from the state cancer registry has already been

provided to the community by PADOH, and this earlier information was as follows: For the period 1996-2003, the cancer incidence, or number of new cancer cases, (for all types of cancer) is less than expected when comparing Ambler to the rest of Pennsylvania. None of the types of cancer are statistically significantly elevated (at the 95% significance level). A 95% significance level means there is a less than a 1 in 20 chance that the results are elevated due to random variation or chance. In this case, none of the cancer rates for the Ambler zip code are higher than what would be expected (allowing for normal variation). The cancer most likely to be associated with asbestos exposure is mesothelioma (cancer of the lining of the lungs or abdominal cavity), and could take 30 years to develop. Mesothelioma was not significantly elevated for the Ambler zip code for 1996 to 2003. There was 1 female case and 8 male cases reported to the Pennsylvania Cancer Registry in the 1996—2003 time period for the area. The incidence in men could be related to men working at the local asbestos manufacturing plants. It is important to note that mesothelioma is not easily diagnosed, and probably underreported for the Ambler zip code but equally underreported throughout the Commonwealth. The number of new cases of lung cancer diagnosed from 1996—2003 is not statistically significantly elevated in the area, compared the overall Commonwealth rates. None of the asbestos-related non-cancer diseases (e.g., asbestosis) are reportable diseases. Therefore, PADOH's ability to evaluate the rate of asbestosis or other asbestos-related diseases in this community is limited (PADOH 2007).

Is it safe for children and adults to have contact with creek waters and their sediments at this site?

ATSDR and PADOH cannot advocate swimming in any unsupervised waterway, since there are no lifeguards to keep swimmers (both child and adult) safe from water levels that can change unexpectedly based on weather conditions. Furthermore, the public health agencies strongly discourage any contact with asbestos-containing material found on the site or in the streams. However, we do understand that members of the public recreate in these areas. The current environmental sampling data for sediments or streams (Wissahickon, Rose Valley, and Tannery) do not indicate that recreational contacts with these streams/sediments would be a problem based on the levels of exposure. Fibers have not been detected in any of EPA's 2006-2007 surface water samples taken from the streams (i.e., Wissahickon, Rose Valley, and Tannery). The only recent surface water sample in which asbestos fibers were detected was one taken from the reservoir in April 2006. The 2006-2007 air sampling data reviewed in this document do not indicate that people are exposed to asbestos at levels of health concern from contacting the surface water and generally playing, walking and fishing in the creeks. Historic sampling events did detect asbestos in surface waters near the Ambler site at higher levels. However, based on the most recent data which are most reflective of the current situation, ATSDR and PADOH do not see a public health asbestos exposure problem for children and adults having occasional recreational contact (e.g., fishing and swimming) in Wissahickon Creek or the other nearby creeks at this time. Therefore, fishing from the western side of the Wissahickon should not present public health concerns regarding asbestos exposure. However, it is the current understanding of ATSDR and PADOH that fishing from the eastern side of the Wissahickon is trespassing and is strongly discouraged.

A recent study from Italy found residents living near an asbestos factory had significantly higher levels of mesothelioma. Is this site comparable to Borit?

Epidemiological studies have been conducted in Casale Monferrato, Italy area to evaluate the rate of mesothelioma from environmental exposures to asbestos in a residential community. For example, one of the Casale studies concluded that exposure to environmental asbestos (non-occupational) in the residential communities surrounding the asbestos factory source greatly increases mesothelioma risk (Maule, 2007). Studies of other sites can provide relevant information and advance the overall scientific understanding of these types of exposures, but studies of other locations cannot substitute for actual site conditions and exposure levels, since every site is unique.

There are several key differences between conditions at Casale, Monferrato and those at the Borit site. The levels of airborne asbestos detected in residential areas in the Casale, Monferrato, Italy study were considerably higher than those detected in residential or offsite areas near the Borit site. The range of asbestos concentrations with lengths > 5 um and diameter > 0.3 um reported in this study were from 1-11 AF/L (asbestos fibers per liter), with 2.2-7.4 AF/L reported in the residential areas of Casale. The study also refers to an average concentration of total (any length) asbestos fibers of 48.4 AF/L and of total amphiboles of 1.5 AF/L in Casale. Converting these measurements to f/cc (fibers per cubic centimeter) reflects a range of 0.001-0.011 f/cc, 0.0022-0.0074 f/cc, and 0.0484 f/cc (keep in mind this maximum result was for all fiber sizes). The April 2006 Borit sample analysis was conducted via indirect methods and results ranged from 0.00061-0.039 f/cc. These were on-site samples in close proximity to areas of known asbestos disposal.

EPA detected asbestos in the air offsite at the Borit site under current conditions only once using the PCME binning method, and this result was 0.00049 f/cc during the May 2007 sampling event, which is lower than the Casale results. Some of the onsite activity-based sampling results from the Borit site employed to simulate potential exposures if people were onsite disturbing soils are in the range of the Casale results (e.g., 0.0058-0.021 f/cc), but these results do not indicate actual current exposures in the community. Besides this exposure difference, there are other important differences between the Casale Italy and the Borit sites: including (1) the form of asbestos predominantly found in Casale was amphibole versus chrysotile at Borit; (2) the Casale site has documented cases of non-occupational disease, which health agencies have not been able to document at Borit; and (3) the Casale sampling analyses were based on indirect sample preparation (similar to the April 2006 Borit sampling event); while direct analysis is recommended for risk assessment and health assessment purposes.

Why are the agencies less confident using results from indirect methods of fiber counting/analysis? Specifically, four of the six samples from April 2006 were counted using an indirect measuring technique?

The method to analyze for asbestos is an approved EPA method using Transmission Electron Microscopy (TEM), widely considered the most sensitive method for analyzing asbestos air samples. All six of the air samples were analyzed by TEM. Counting fibers directly from the filter is the preferred technique. Of the six air samples collected, four had too much dust/particulates/fibers to count directly so an indirect measuring technique had to be used for analysis of those four samples. Indirect and direct techniques define how the sample filters are transferred to a grid for fiber counting in the laboratory. When a sample is overloaded, it must be broken down to remove excess material on the filter to measure the asbestos sample. The direct technique is preferred when conducting human health evaluations for asbestos. However, in cases where the sample is overloaded, the indirect method can be used to interpret the sample results. Scientists have less confidence interpreting positive indirect results for health exposure purposes because it can produce higher results than what is actually present. Nevertheless, the procedures used to collect and analyze the samples were followed correctly and were EPA-approved methods.

What is the difference between the asbestos contamination/disease occurrence at the Libby, Montana site and Borit?

The site conditions and extent of contamination at the Libby site vary considerably from those at the Borit site. The Libby site is contaminated mostly with amphibole asbestos fibers. Fibers from the amphibole class of asbestos are considered the more toxic of the two asbestos mineral classes. The serpentine class (specifically chrysotile) is the predominant species present at the Borit site, and is generally considered to be the less toxic form of asbestos.

Mining and processing operations, as well as home use of Libby vermiculite products, resulted in the spreading of Libby asbestos throughout the town and not in one isolated area. In additional, there were several exposure pathways at the Libby site, the predominant ones being both indoor inhalation (from insulation) and outdoor inhalation (from mining and transport activities). The pathway of concern at Borit is outdoor inhalation.

An epidemiological cohort study was conducted to follow Libby vermiculite mine workers as a group (including workers who moved away from the Libby area). The review of health outcome data for the Libby communities showed significantly higher levels of lung cancer and mesothelioma (ATSDR 2003a). For the Borit site, PADOH and ATSDR reviewed health outcome data for 1996 through 2003 for the Ambler community and found no significant increase in lung cancer or mesothelioma rates. PADOH and ATSDR are currently reviewing additional health outcome data, from subsequent reporting years and surrounding ZIP codes. Due to the high number of people diagnosed with asbestos-related respiratory diseases in the Libby community from both occupational and non-occupational exposures, ATSDR developed a community-based medical testing program, which provided detailed information on non-occupational exposure. Currently the Cancer registry for the Commonwealth of PA does not provide detailed occupational information. However, PADOH and ATSDR plan to review community-collected reports of non-occupational asbestos related disease in the Ambler community.

Child Health Considerations

PADOH and ATSDR recognize that infants and children might be more vulnerable than adults to exposure in communities faced with environmental contamination. Because children depend on adults for risk identification and management decisions, PADOH and ATSDR are committed to evaluating their special interests at the site. The effects of asbestos on children are thought to be similar to the effects on adults. However, children could be especially vulnerable to asbestos exposures because they are more likely to disturb asbestos fiber-laden soil or indoor dust while playing, and they are closer to the ground and thus more likely to inhale contaminated soil or dust. In addition, children have a higher risk of developing disease after asbestos exposure because they have a longer life expectancy and thus more time to develop asbestos-related respiratory diseases, which have long latency periods between exposure and onset of disease.

Differences between Children and Adults

An important body of scientific literature is available describing the significant anatomic and physiological differences between the developing lungs of children and those of mature adults. PADOH and ATSDR incorporated the analysis of this information contained in the California Environmental Protection Agency Air Resources Board's review of the "Health Effects of Particulate Matter" (CA EPA 2004) in the following paragraphs, to assist in the understanding of these differences as they relate to children's exposures at the Borit site.

Specifically, the anatomic and physiological differences between children and adults include the size and shape of the conducting airways, the number and orientation of physiologically active gas exchange regions, and ventilation rates. Though the basic structure of the airways is established in utero, most of the alveoli (> 85%) develop in infancy and early childhood (Snodgrass 1992). Alveolar multiplication coincides with incorporation of elastin and collagen in the lung, which are responsible for the mature lung's mechanical properties (Lipsett 1995). During growth and development other patterns of anatomical differences emerge i.e., tracheobronchial airways increase in diameter and length until adulthood. Lung volume expands disproportionately in relation to the increasing number of alveoli during somatic growth, indicating enlargement of individual alveoli (Murray 1986). Repeated episodes of injury and inflammation may therefore have long-term consequences on the lung's functional abilities.

Due to these differences in anatomy, activity, and ventilation patterns, children are likely to inhale and retain larger quantities of pollutants per unit body weight than adults (Adams, 1993). Phalen et al. (1985) developed a model incorporating airway dimensions measured in lung casts of people (aged 11 days to 21 years) to predict that particle deposition efficiency would be inversely related to body size, which would tend to accentuate differences in exposure related to activity and ventilation patterns. Corroborative evidence for this was provided by Oldham et al. (1997), who found that in models of the proximal TB airways (i.e., the trachea and the first two bronchial bifurcations) of 4- and 7-year-old children and an adult, deposition efficiencies for radiolabelled particles 1.2, 4.5, 9.7 and 15.4 mm in median aerodynamic diameter were greater in the child models in almost all cases. As expected, particle deposition efficiency increased markedly with increasing particle size in this model system. For instance, in the model of the four-year-old child, the deposition efficiency increased from 0.3% to 10.7% when the smallest and largest particle sizes were used, respectively.

Inhalation experiments comparing particle deposition patterns in children and adults have produced somewhat inconsistent results. Schiller-Scotland et al. (1994) reported greater fractional deposition in healthy children, aged 3 - 14 years, compared with adults, when breathing 1, 2 or 3 mm particles spontaneously through a mouthpiece. The differences were greater with the larger particles. However, as noted by the authors, these children were breathing more deeply than expected, which is a common tendency when breathing through a mouthpiece. This propensity may result in greater time-dependent deposition of fine particles (by sedimentation and diffusion). Schiller-Scotland et al. (1994) also noted that, among the older children (mean age = 10.9 years) who were capable of controlled breathing in time with a metronome, particle deposition was inversely related to body height, so that the shorter children demonstrated greater fractional deposition (for 1 and 2 mm particles, the only categories analyzed in this manner). In contrast, Bennett and Zeman (1998) found no significant differences between children (7 - 14 yr), adolescents (14 to 18 yr), and young adults (19 - 35 yr) in deposition (measured as deposition fraction or rate) of 2 mm particles during spontaneous breathing at rest. Unlike the study by Schiller-Scotland et al. (1994), this investigation tailored the participants' mouthpiece breathing patterns to those measured during unencumbered breathing, in order to control for the tendency to breathe more deeply through a mouthpiece. Another difference between the study by Bennett and Zeman (1998) and that by Schiller-Scotland et al. (1994) is that the former did not include very young children, who would have had difficulty in mimicking their normal breathing patterns while using a mouthpiece. However, Schiller Scotland et al. (1994) found that older children (mean age = 10.9 years) as well as the younger ones (mean age = 5.3 years) also showed increased fractional particle deposition relative to adults.

Children demonstrate lower absolute minute ventilation at rest than adults, despite having higher breathing rates. Relative to lung volume, however, children demonstrate higher minute ventilation than adults. Thus, Bennett and Zeman (1998) noted that children tended to have a somewhat greater normalized deposition rate (by about 35%) than the combined group of adolescents and adults, suggesting that children at rest would receive higher doses of particles per unit of lung surface area than adults. This tendency might be additionally enhanced by activity patterns, as children spend more time than adults in activities requiring elevated ventilation rates. However, it is unknown whether flow-dependent deposition mechanisms operative at higher ventilation rates in children would offset the decreases that would occur in time-dependent mechanisms (sedimentation and diffusion). If this offset does occur, then particle deposition would likely be shifted more towards the larger, more central airways, which would tend to increase the dose per surface area in children versus adults (Bennett and Zeman, 1998).

The above studies suggest that children may experience proportionately greater particle deposition than adults. It is also possible that, especially in very young children, immature respiratory defenses may result in lower clearance rates in relation to those observed in adults. For instance, Sherman et al. (1977) reported that alveolar macrophages of neonatal rabbits (1 day old) ingested significantly fewer bacteria than older animals (7 days). To the extent that this phenomenon may also apply across species and to nonbiological particles, the immaturity of the neonatal human lung may result in slower and less complete particle clearance (CA EPA 2004).

Cancer Risk and Early Life Exposures

In addition to the physiological differences discussed above, children are also of special concern because their exposures occur earlier in their lives. The cancer risk models for mesothelioma include a time function, so early-lifetime exposures contribute more to lifetime risk than exposures later in life. Therefore, a 30-year exposure beginning at age 6 is expected to have greater risk than the same exposure (concentration, frequency, and duration) occurring later in life. There is a delay of 10 to 50 years or longer from first exposure to disease effect. Therefore, the longer one lives after asbestos exposure, the greater the probability of contracting mesothelioma or lung cancer. The mesothelioma probability is dependent on the cube of the elapsed time since first exposure. Separate cancer risk calculations accounting for early life exposures were not conducted in this document. Making an adjustment in this direction would result in an estimate of a higher cancer risk for this sensitive population (EPA 2005).

Public Comments

PADOH and ATSDR received the following comments during the public comment period for the 2006 to 2007 EPA-sponsored air sampling data collected at the Borit site. The public comment period was from July 15 2008 till August 30 2008. PADOH and ATSDR made the public comment version of the HC available for public review and comment and were distributed on the EPA Borit website, at the EPA command post in Ambler, PA, at several local libraries, and at the EPA public meeting in August 2008. Public comments were received from concerned community members and the Borit Community Advisory Group (CAG) (Appendix 1). After reviewing the comments and incorporating any changes or revisions, this version of the HC now reflects PADOH and ATSDR's final conclusions and recommendations for the 2006-2007 air sampling data for the Borit site.

1. It is mentioned in the HC that the Borit site received a soil covering in the 1960's. Could you please describe the details of this action (i.e. when, where etc.)

This information is based on historical and anecdotal reports. Aerial photos, and documents, reviewed by ATSDR and PADOH document that topsoil was placed on the park in the mid 1960's. The health agencies defer to the environmental agencies for the specifics of this action.

2. Would different air test results change the health risk calculation described in the HC document? For instance, if higher test results were obtained during drier times when testing was implemented, would this change the respective health calculations?

Yes, different air results would affect the risk calculation. Increases or decreases in sampled asbestos levels would change the corresponding exposure and risk estimates. PADOH and ATSDR attempted to acknowledge this uncertainty throughout this Health Consultation document, along with other limitations of our evaluation. A mitigating factor is that our assessment of soil moisture and average rainfall information for the site area does indicate that a range of wet to dry conditions were experienced during the 2006-2007 sampling period, even though it is not possible to demonstrate that the maximally driest conditions existed.

3. Were the higher air tests for the site, which were captured in past sampling, considered or factored in the health risk calculations?

No, the health consultation only evaluated the 2006-2007 air sampling results collected by EPA. These air sampling results reflect the current site conditions, and thus the most relevant to any potential current community-level exposures. Because this site was proposed to the National Priority List, PADOH and ATSDR are now required to complete a full Public Health Assessment document for this site. This assessment will consider past historical exposures in this community.

4. If asbestos air sampling results are obtained in the future, would a new health risk study be performed?

PADOH and ATSDR will review any new data and issue an appropriate response. In addition, it is the understanding of PADOH and ATSDR that concerned community members collected additional asbestos air samples in Ambler within the last few months. PADOH and ATSDR would like to review this additional data and, if appropriate, include it in future evaluations and/or documents.

5. In the Libby, Montana site were there any case reports of individuals with asbestos-related disease that did not fall into one of the following categories: 1) occupational exposures, 2) home-related exposures of family members to material that migrated home with workers, and 3) home-related exposures among people who used the amphibole-containing products at their homes?

Yes, in Libby there were reports of non-occupationally exposed individuals with asbestos-related diseases. In addition to each site having unique characteristics and exposure pathways, there are many significant differences between the Libby site and Borit. Perhaps one of the most critical differences were the estimated much higher levels of asbestos in ambient air in Libby as compared to Ambler. Historical asbestos levels in ambient air in downtown Libby were much higher than those seen in Ambler, and at times higher than the current OSHA occupational standard of 0.1 f/cc (in 1975, and into the mid-1980s).

The likely past exposure pathways in Libby (some of which overlap with Ambler, and some of which do not) included: (1) Occupational exposures during the transport and handling operations at the mine and processing operations such as exfoliation; (2) Household contact from relatives of workers via dirty clothing (‘paraoccupational’ exposure) and cars of workers returning from the mine; (3) Children playing in open piles of vermiculite piles; (4) Residential outdoor exposure during other outdoor activities, such as gardening or playing in soil with vermiculite, and inhalation of Libby asbestos used as fill at local schools; and (5) Residential indoor exposure from household dust, Libby asbestos-contaminated insulation, or deteriorating Libby asbestos-contaminated building materials.

A mortality review for Libby was conducted by ATSDR and included a comparison of death certificate data with employment data obtained from employee records at the mining/milling facilities in Libby. This analysis showed that 92% of the asbestosis deaths, 17% of the lung cancer deaths, and two out of three mesothelioma deaths were former employees of the vermiculite facility. PADOH and ATSDR are currently evaluating the health outcome data for the Ambler area and these data will be presented in an additional Health Consultation Document.

6. Do the lung and air passageways of a child differ from that of an adult? Is a differentiation made in health risk assessments between inhaled asbestos fibers in child population vs. adult population? What is the population breakdown for the local residents?

As noted in the HC, based on anatomy, activity, and ventilation rates, children are more likely to inhale and retain larger quantities of pollutants per body weight than adults. A 30-year exposure beginning in early childhood is expected to have a greater risk than same exposure occurring later in life. However, separate cancer risk calculations for early-life exposures were not included in this Health Consultation. However, PADOH and ATSDR would consider, if feasible, researching early-life cancer risks in a future Public Health Assessment (PHA) document.

According to the 2000 Census for Ambler (as summarized below), children under the age of 5 comprised 6.8% of the population, which is the same as for national figures for the same timeframe. Ambler had a slightly lower number of individuals in the 5 to 17 age category with 16.7%, compared to the nationwide number of 18.9%.

	Median Age	Persons under 5	Persons 5 to 17	Persons over 18
Ambler	37.3	434 (6.8%)	1073 (16.7%)	4919 (76.5%)
United States	35.3	6.80%	18.90%	74.30%

7. I have heard stories from some citizens that ACM was given to employees at the factory for home use, possibly for use in driveways and yards. Was any type of investigation conducted? Is ATSDR concerned this is a potential exposure pathway?

In December 1984, EPA collected soil core, surface soil and vacuum dust samples from seven residential yards and/or roads adjacent to the site. For a comparison background samples, two locations in Fort Washington State Park were also sampled. In total, four core soil samples (two from residential yards and two from the State Park) were analyzed by Polarized Light Microscopy (PLM) and did not detect asbestos fibers. Ten surface soil composite samples (eight from the residential properties and two from the State park) also were analyzed by PLM and also did not detect asbestos fibers. In addition, eighteen vacuum samples were collected, fourteen from the residential properties and four from the State Park. Thirteen of the residential samples were analyzed by PCM and one by TEM. Two of the background samples were analyzed by PCM and two by TEM. EPA and public health officials concluded from these studies that asbestos levels in the residential yards and homes adjacent to the site were comparable to background levels in Fort Washington State Park.

In addition, in September 1984, EPA collected a total of 135 dust vacuum samples from four adjacent homes and five homes located within 2400 and 4500 feet of the Ambler Asbestos NPL site. Background samples were collected from homes in the Ambler community, located northeast of the NPL site. Results did not show asbestos levels in homes adjacent to the site above levels in the background homes and corrective action was not recommended for these homes.

At this point, PADOH and ATSDR have considered this as a potential pathway but have no evidence to confirm that exposure is actually occurring via this pathway. In 2008, EPA issued a fact sheet to residents offering to conduct visual inspections if the resident believes friable offsite material was present in home yards/driveways . If residents believe their yard/driveway contains ACM, PADOH and ATSDR encourage residents to notify EPA for a visual inspection. PADOH and ATSDR will review such data, as appropriate. Currently EPA is not investigating ACM related to consumer products and building materials (i.e. interior insulation, floor insulation, roof shingles…), since it is beyond EPA's regulatory purview and not related to the site. However, PADOH and ATSDR recommend residents follow EPA's general recommendation regarding ACM in homes;

- If asbestos is in good condition and does not show signs of damage (such as tears, abrasions, or water damage), do not touch or disturb the material

- If asbestos material is more than slightly damaged, or if you are going to make changes in your home that might disturb it, material should only be repaired or removed by a professional. Check with local health, environmental, or other appropriate officials to find out proper handling and disposal procedures

- Limit access to areas believed to contain ACM and keep activities to a minimum in any areas having damaged material that may contain asbestos.

8. What is the asbestos mineralogy of the products manufactured in Ambler and potentially disposed of at Borit? Are there other forms of asbestos found at the Borit site, such as crocidolite (blue asbestos), which are generally considered more toxic than chrysotile (white asbestos)?

Clearly the principle asbestos mineralogy detected during historical and current environmental sampling in Ambler has been chyrsotile. There have been sporadic hits of other mineral types over time. For example, during the 2006 to 2007 air sampling events, there were a few samples containing actinolite or crocidolite asbestos, all equal or less than 0.0005 f/cc. In addition, there was a soil sample collected in the park (1983) that was positive for crocidolite (amount not indicated). Based on limited information, a large portion of the asbestos used in the manufacturing process at Ambler was derived from chrysotile mines in Canada.   PADOH and ATSDR will continue to look into the types of asbestos used in manufacturing, and ultimate disposal at the site, as appropriate.

9. I played on the asbestos piles a few times when I was a child, should I be concerned?

Asbestos toxicity is determined by dose and cumulative exposure over time (i.e. the level of asbestos and the number of exposures). Based on epidemiological studies, short-term low dose exposure to asbestos is far less likely to result in asbestos-related illnesses than short-term very high doses or long-term exposures, such as those seen historically in occupational settings.

10. The 2006-2007 air sampling data has serious limitations. Specifically, the samples represent only a snapshot of conditions and not a range of all conditions over the years or potentially in the future. Air sampling did not capture the true 'worst case' scenario (i.e. dry and windy conditions) due to wet conditions during sampling. If more sampling had occurred during drier conditions, high asbestos levels along with higher cancer risk predictions, are likely. How can the cancer risk predictions be based on these levels, without samples collected during very dry and or windy conditions?

Since air sampling events are scheduled in advance at pre-determined intervals, it is difficult to predict 'worst case scenario' conditions prior to sampling. Sampling was attempted to be performed during over several seasons, so that a 'worse case scenario' could be figured and the differences between wet periods and dry periods noted. During the 2006 to 2007 air sampling, the asbestos airborne levels did not appear to vary as a function of rainfall with the exception of slightly high airborne asbestos levels in the extremely dry month of September (Figure 1). This suggests that during long periods of drought or shorter periods of extreme drying, levels of airborne asbestos may increase. As noted in the HC, drought or severely dry conditions could exacerbate the problem of airborne asbestos migrating from the site.

However, the average rainfall in the Ambler area remained fairly constant from month to month (monthly average of 2.75 to 4.39 inches). The sampling took place, overall, during average rainfall levels and therefore represents the average exposure levels expected throughout the year. PADOH and ATSDR do not reasonably anticipate that residents would be exposed to 'worst case scenarios' for extended periods of time. The cancer risk predictions, which are based on average rain fall, reflect the most realistic, and most likely, community exposure scenario during average weather conditions over a certain length of time.

11. Why doesn't ATSDR consider sampling and work completed for the Ambler Asbestos NPL site, due to their close proximity and potentially impacted community? Since the distinction between these two sites is somewhat arbitrary, the prior public health assessment work completed on the Ambler asbestos site seems to apply to the Borit site and the entire community.

The HC did discuss previous public health agency involvement at the Ambler Asbestos piles (see 'Public Health Involvement' Section). However, this HC focuses only on the 2006 to 2007 air sampling data because it is the most reflective of current site conditions, and thus potential current exposures. Since site conditions change and the Ambler Asbestos Pile NPL site was remediated in 1993, historical sampling data collected is not relevant to current site conditions, but is useful for historical purposes. In addition, since alternative sampling methods were employed, it would be difficult to apply those levels into the current risk calculation. The 2006 ATSDR AROA document, which is available on the EPA Borit website, further documents the activities associated with the Ambler Asbestos NPL site and information on past public health evaluations of historical community exposures to asbestos in the area. In addition, because the

Borit site was proposed to the National Priority List in September 2008, PADOH and ATSDR are now required to complete a full Public Health Assessment document for this site. This assessment will also consider past historical exposures in the community.

12. According to the HC:

> **"Substantial increase in exposures can occur on-site when activities are disturbing the pile. At the top of the pile raking results in a 116 fold increase in average asbestos exposure levels for AHERA type fibers and a 34 fold increase for PCMe fibers, when compared to comparable onsite results with no activities occurring. Both fiber counting methods show a statistically significant increase in asbestos air levels with raking when compared to levels seen on-site when no activity is taking place."**

In July 2008, many community members observed significant soil disturbances at the site during EPA remediation activities. How does the ABS sampling results relate to the current site activities and the surrounding community?

PADOH and ATSDR agree, based on the on-site activity based sampling data from 2006 to 2007, that significant disturbance to the soil could potentially increase on-site levels and should be minimized. In July 2008, during the above mentioned site activities, asbestos sampling results around the site perimeter did not show off-site migration of asbestos. During that time period, an asbestos level of 0.0006 f/cc was observed near the McDonalds (W. Maple Street and W. Butler Avenue in Ambler). In addition, soil samples were collected from the pile that was briefly exposed in July 2008 during EPA clearing and grubbing activities. The results showed the sample material contained 0.4% asbestos. Based on the sampling data, PADOH and ATSDR do not believe asbestos migrated off-site at an appreciable level and therefore was not a public health threat to the local community as a result of those activities.

In addition, PADOH and ATSDR reviewed air sampling data, collected by concerned community members, in response to the above-mentioned site activities. The community contracted RT Environmental Services to perform additional independent ambient asbestos air sampling. In August 2008, six air samples were collected in Ambler and neighboring Whitpan Township. The samples were analyzed by PCM and the highest concentration was 0.0041 f/cc. The PCM method counts all fibers within the established size criteria and does not distinguish between asbestos and non-asbestos fibers. Five of the samples were also analyzed by TEM, which is able to determine the presence of asbestos fibers and their mineralogy. Sample analysis by the TEM method did not detect asbestos fibers.

13. Measurements of airborne asbestos are reported in 'fibers per cc' of air. We believe a more balanced overview of the results should include translating the test results into asbestos fibers inhaled in a one day period.

The unit measurement of fiber per cc (f/cc) or fibers per milliliter of air is the standard scientific measurement terminology for asbestos used by both regulatory and health agencies in the environmental and occupational settings. This unit allows for a standard comparison value. In addition, inhalation of asbestos fibers can vary vastly due to respiration rates, length of exposure, age, physical activity, and a host of other factors. Due to this variability, expressing asbestos levels in terms of fibers per day does not provide a standard measurement for comparison of different sampling events over time.

Furthermore, expressing asbestos levels in terms of inhaled fibers does not take into account differential deposition of fibers in the lungs or potential variability in retention patterns amongst individuals. For example, according to the 2003 Asbestos Expert Panel report on asbestos, the lung depositional patterns of fibers less than 5um in length have been well established and depend almost entirely on fiber width. For short fibers with diameters between 0.1 and 1.6um, total lung deposition in healthy people is between 10% and 20% of what is inhaled, with most of that deposition occurring in the deep lungs; the fibers that do not deposit will be exhaled. Therefore, since there is a wide variability in fiber deposition, referencing sampling data in terms of the number of fibers inhaled per day would most likely provide an inaccurate value or range of values.

14. We are unconvinced about the soundness of excluding short asbestos fibers in assessing risk to human health. The following passage summarizes this issue:

> **"According to the parametric data of F. Pott, 2.5 micron fibers are approximately ¼ as carcinogenic as 5 micron fibers, but because of the fiber distribution, there are hundreds of times more fibers at 2.5 microns as 5.9 micron fibers. And as the fibers get smaller toward the mean, around 1 micron, there are thousands times more fibers. The 1 micron fibers are about 1/16 as carcinogenic as 5 micron fibers. Incidentally, fibers above 10 microns are so heavy, they seldom become airborne. The most carcinogenic fibers (about 5 times the risk of 5 micron fibers) are 25 microns, but pose little potential airborne risk, because unless there are very high winds, they would not become airborne. It is the product of the number of fibers at a fiber micron length times the carcinogenicity a that length summed (integrated) over the whole spectrum of fiber lengths and their distributions that determines the total carcinogenic risk"**

In light of this, are fibers greater than 5 microns a good surrogate marker for total asbestos fiber concentrations? Does ATSR consider it important for all asbestos fibers to be included in air sample reports?

PADOH and ATSDR must emphasize again, as EPA has also done in multiple public forums, that <u>all</u> fiber lengths, short and long, were sampled and analyzed in the 2006-2007 EPA sampling for the site Short fiber analyses were not excluded at this site. ATSDR and PADOH affirm that short fiber exposures should be evaluated in the context of overall asbestos fiber exposures at this site. PADOH and ATSDR acknowledge there are some scientific uncertainties regarding the role of short fibers and asbestos-related disease. However, the current understanding in the scientific community is that the preponderance of scientific evidence, based on epidemiologic studies, laboratory animal experiments, and in vitro genotoxicity research, combined with the ability of the lung to clear short fibers, shows that short fibers do not play a major role in development of cancer, but contribute possibly to asbestosis. Currently there are no accepted risk models that exclusively address the health effects related to exposures of only fibers shorter than 5 um.

The commenter's quoted reference to research conducted by F. Pott appears to be based solely on one researcher and one study. In contrast the EPA IRIS model was derived from fourteen major studies; both epidemiology and animal research and provide a greater 'weight-of-evidence' than relying on a single researcher or study. In 2003, EPA reviewed the current research and methodologies related to risk associated with asbestos-related diseases, and complied a technical document. In the EPA review document, F. Pott's hypothesis and research on laboratory animals in regards to fiber length and toxicity were summarized. Work by F. Pott (1982) showed that relative potency is low for short fibers, rises rapidly over an intermediate range of lengths, and approaches a constant for the longest fibers. According to the EPA review and more recent studies conducted by Berman et. al, the current base of scientific research shows short structures do not contribute to overall cancer risk. However, the conclusion on the role of short fibers in the development of asbestosis is not conclusive.

PADOH and ATSDR collaborated with an EPA toxicologist to prepare the following information. EPA's IRIS model of asbestos toxicity is based primarily on an assessment completed in 1986 and considers all mineral forms of asbestos and all asbestos fiber sizes (i.e., all fibers longer than 5 micrometers) to be of equal carcinogenic potency. To incorporate the knowledge gained since the last assessment, EPA is currently re-evaluating the current risk assessment methodologies. If, and when, EPA develops a revised risk assessment model for asbestos, PADOH and ATSDR will consider adopting the updated model to the Borit site, as appropriate.

14. In the HC, cancer risk calculations are performed using the EPA IRIS Unit Risk multiplier for asbestos. This model is based on historical epidemiological studies in occupationally exposed populations, prior to the advent of the TEM method and only assesses fibers greater than 5 um. We are concerned about whether this risk analysis method is the most appropriate for decision-making with regard to environmental and public health interventions in our community. Has the risk model ever validated prospectively by predicting excess cancer incidence within a population?

It is largely beyond the scope of this document to evaluate EPA's methodologies. To the best of the knowledge of PADOH and ATSDR, it is believed that the EPA IRIS model was utilized appropriately in the risk assessment for Borit. PADOH and ATSDR agree there are several limitations to the use of risk models, however, only a few accepted models currently exist for asbestos. In addition, the IRIS model is conservative in nature and assumes a cumulative lifetime exposure for 30-years 24 hours per day, 350 days per year (a 'worst case scenario' for exposure time) resulting in a potential overestimate, rather than underestimate, of risk. As discussed previously, EPA is in the process of updating their asbestos risk methodology.

The IRIS model Inhalation Unit Risk (IUR) for asbestos was based on analytical measurements that only counted fibers greater than 5 um in length. Although shorter fibers were not directly measured in the development of the IUR, their contribution (if any) to the observed incidence of pulmonary carcinoma in occupationally-exposed populations was considered by default. IRIS IUR factor is based on a large number of studies of occupationally-exposed workers that conclusively demonstrated a relationship between asbestos exposure and lung cancer or mesothelioma and further corroborated by animal studies. If shorter fibers contributed to the carcinogenic endpoints observed in the epidemiological studies, then that contribution was indirectly captured in the development of the IUR.

Further, scientific evidence overwhelmingly suggests that longer fibers (rather than shorter ones) are responsible for the observed increased occurrence of bronchogenic cancers following asbestos exposure. Shorter fibers may, in fact, play a role in the development of non-cancer health effects related to asbestos exposure, such as asbestosis or other fibrotic diseases of the lungs. Currently, U.S. EPA does not quantify non-cancer threats associated with asbestos, simply because an accepted methodology for doing so is not available. This represents a significant data gap in the overall evaluation of asbestos-related risks. This having been stated, if asbestos is similar to most chemical carcinogens, mitigating potential cancer risks will also be protective of non-cancer endpoints. Although it is not possible to prospectively predict excess cancer incidence in a population for a host of reasons, the IRIS model has been validated in animal studies.

Since fiber length is not a factor in the IRIS model, the Berman Crump model was also selected as a "check" to see if fiber size was a major contributing factor to asbestos toxicity at Borit. The Berman Crump model considers additional and updated epidemiology data, using TEM-determined sizes. The Berman Crump Model applied animal inhalation studies to determine the fiber sizes most relevant for toxicity and long, thick fibers correlated best with cancer risk.

Lastly, ATSDR and EPA are conducting a 5-year study in Libby, Montana. The study will focus on determining whether exposure to lower levels of Libby asbestos, related to the Libby NPL site, is associated with increased risk of lung disease, cancer, chronic illnesses, auto-immune diseases or other adverse health outcomes. It is currently known that long-term exposure to high levels of asbestos is associated with lung cancer, serious lung disease and upper respiratory health conditions. The findings from this study might assist in expanding the scientific knowledge on low-dose environmental exposures to asbestos.

Conclusions

1. ***Current exposures*** to the reported on-site and off-site airborne asbestos levels ***(when site soils are not being aggressively disturbed)*** from the 2006-2007 air sampling results (both AHERA and PCMe fibers) are classified by PADOH and ATSDR as a ***no apparent public health hazard*** to the community for cancer effects and/or non-cancer effects.

2. Based on the PADOH and ATSDR review of EPA's 2006-2007 air sampling results, both PCMe fibers and AHERA type fibers show significant increases in airborne levels when soils and asbestos-containing material are disturbed through activity-based sampling at the Borit site. Based on significant increases in airborne PCMe asbestos (although at an estimated cancer risk level lower than 1 E-4 or 1 in 10,000 persons) during activity, the presence of exposed friable ACM, the quantity of buried asbestos and ACM, current site conditions, proximity of a residential community, and the potential for re-development/re-use, PADOH and ATSDR conclude that ***on-site exposures*** to PCMe

fibers and increases in AHERA total asbestos structures ***from activity-based events*** are determined by PADOH and ATSDR to be a ***public health hazard*** to area residents.

3. ***The current consensus in the scientific community, based on epidemiological and animal studies, is that exposures from short fibers overall do not contribute to lung cancer and mesothelioma. However, short fibers might*** **play a role in asbestosis when exposure duration is long and fiber concentration high.** At this site, the majority of the fibers detected during activity-based sampling were short AHERA fibers which, at the levels observed during the 2006-2007 sampling, would not be expected to increase asbestos-related disease. Further, the general public and the Ambler community are not expected to be exposed to the levels of AHERA fibers detected during the ABS events at this site, since they were detected within the site boundary during aggressive soil manipulation.

4. The 2006-2007 weather patterns did not appear to severely impact airborne asbestos levels based on the sampling data evaluated. However, ***drought or severely dry conditions could exacerbate the problem of re-entrainment of airborne asbestos and migration from the site***.

Recommendations:

1. PADOH and ATSDR recommend that EPA implement activities proposed under the removal program to mitigate potential releases and hazards that may cause health effects as a result of exposure to airborne asbestos.

2. PADOH and ATSDR recommend that EPA continue site assessment activities for remedial plans.

3. PADOH and ATSDR recommend that, during any future removal and remediation activities at this site, air sampling be conducted on-site, off-site, and with personal air monitors, and that the results of these monitoring activities be shared with the community and other interested stakeholders in a timely manner.

4. PADOH and ATSDR will consider evaluation of future environmental sampling results for the site, and preparation of an appropriate response which could include an updated health consultation. This recommendation will be implemented at the discretion of the PADOH/ATSDR following the receipt of future environmental sampling results.

5. As a precautionary measure, any direct soil activity should be avoided by visitors or trespassers at this site based on the AHERA and PCMe sampling results.

6. In response to community concerns, PADOH and ATSDR will update PADOH's 2007 evaluation of cancer/mesothelioma health outcome data for the Ambler community. PADOH and ATSDR will continue working with the community to answer questions and address ongoing health concerns.

Public Health Action Plan

In light of the uncertainties related to quantitative risk estimates and the weight of the evidence regarding health effects associated with asbestos exposures, PADOH and ATSDR recommend several precautionary actions to reduce potential exposures and increase public awareness of potential hazards.

1. Outreach to community and local health professionals
    a. Continue to investigate and evaluate scientific research on short fiber and non-cancer effects of asbestos exposure.
    b. Continue working with the community to answer questions and address ongoing asbestos-related concerns.
    c. Provide information to health professionals.
    d. Provide copies of this Health Consultation to the Borit Community Advisory Group, on EPA's Borit website, and at the EPA Borit command post.

2. Community precautions
    a. Implement mitigation efforts to cover exposed areas of the site that can result in the migration of asbestos fibers into ambient air.
    b. Improve access restrictions at the site.
    c. Do not remove ACM, disturb soil, and/or engage in other activities at the site without controls that serve to mitigate the re-suspension of asbestos fibers from the site.

Certification

This health consultation for the Borit asbestos site was prepared by the PADOH under a cooperative agreement with the ATSDR. It is in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the cooperative agreement partner.

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

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Figures:

Figure 1 – Borit site layout map, courtesy of Tetra Tech EM, Inc.

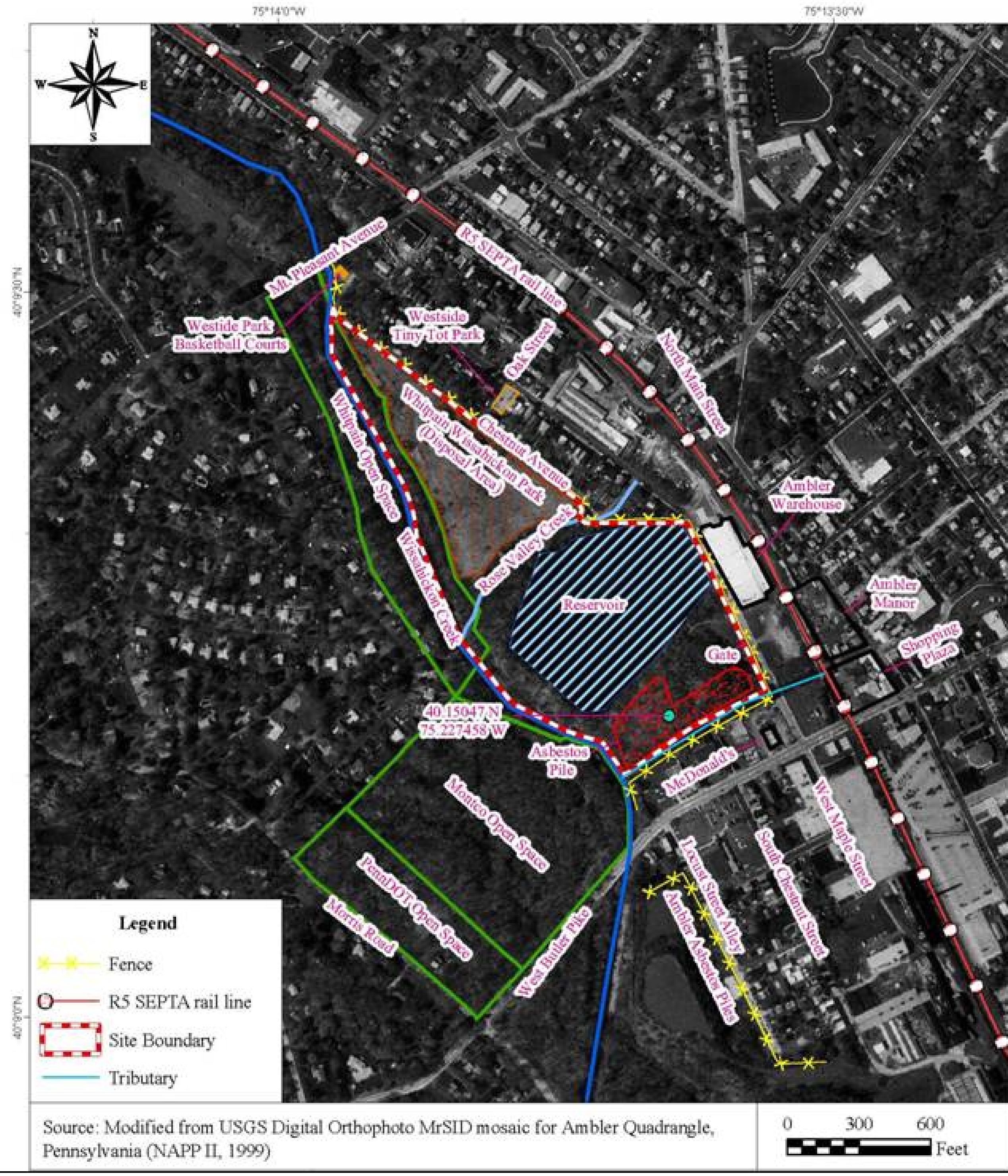


Figure 2 – PCMe air sampling results, courtesy of Tetra Tech EM, Inc.

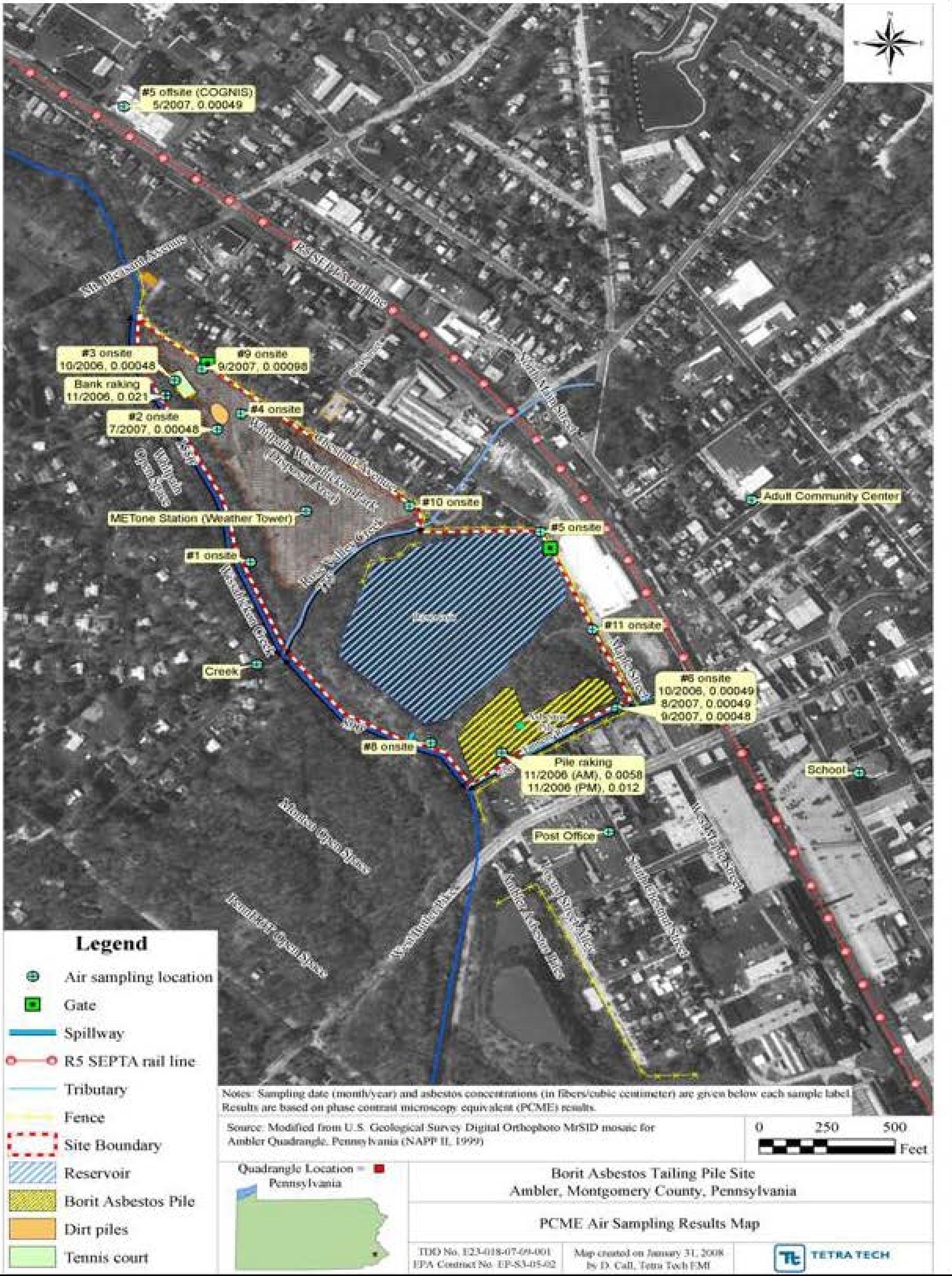


Figure 3 – AHERA air sampling results, courtesy of Tetra Tech EM, Inc.

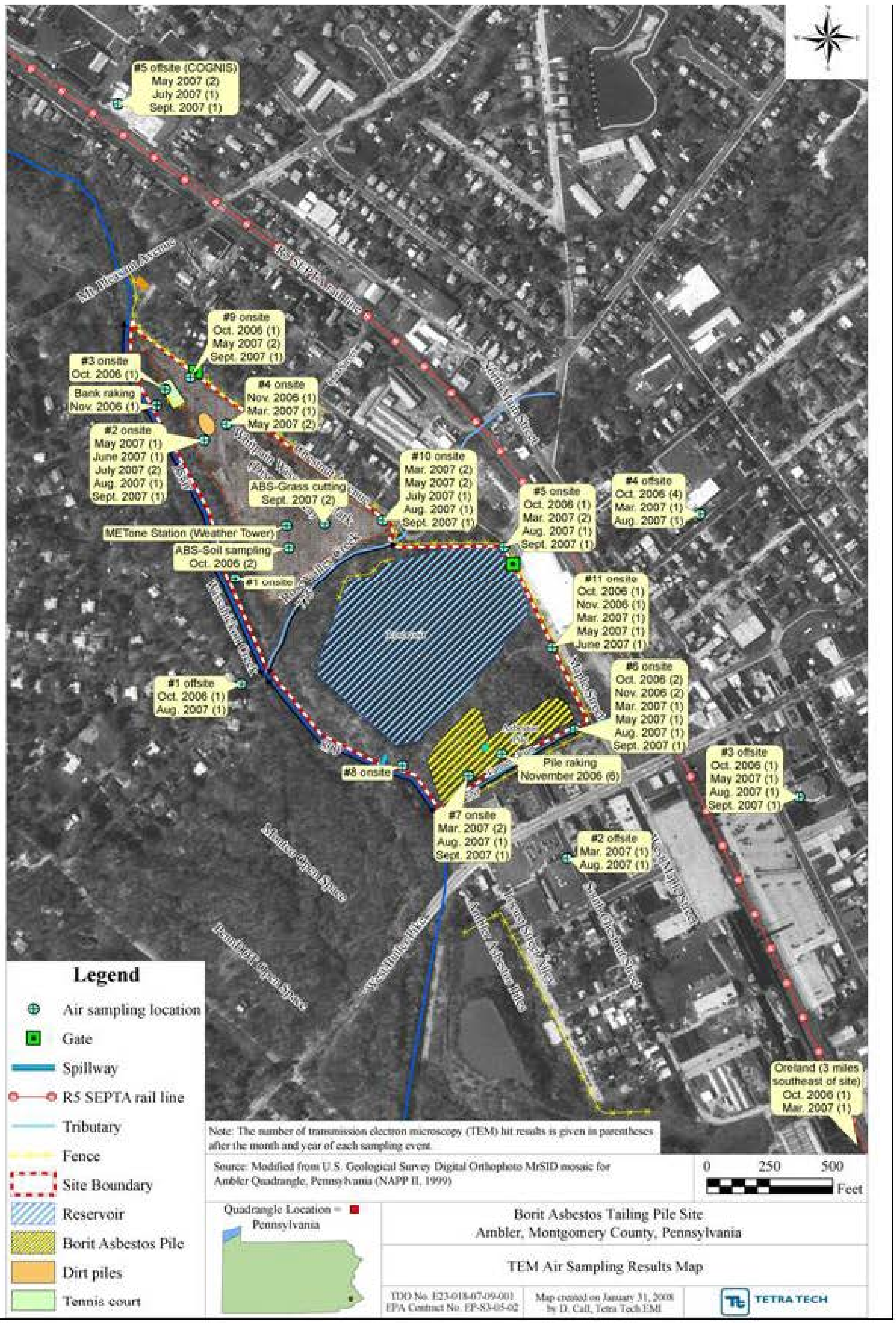
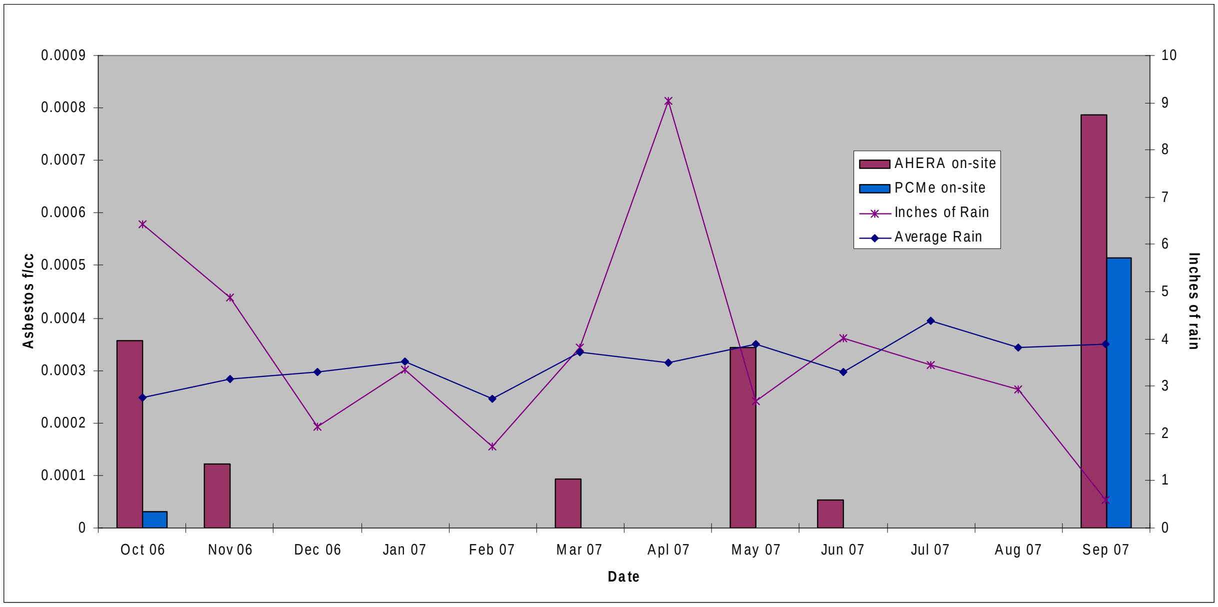


Figure 4 - Average rainfall in Ambler and the on-site PCMe, AHERA sampling results and summary of the 2007 EPA soil moisture data



Sample Date	Sample location	Soil Moisture (%)
May 2007	Onsite 4	21.09
	Onsite 5	32.35
	Onsite 6	49.25
	Onsite 10	19.28
	May 07 Average	*30.49*
July 2007	Onsite 4	11.01
	Onsite 5	4.75
	Onsite 6	48.50
	Onsite 11	12.14
	July 07 Average	*19.10*
August 2007	Onsite 4	15.71
	Onsite 5	34.17
	Onsite 6	23.02
	Onsite 10	10.45
	August 07 Average	*20.84*
September 2007	Not listed	6.25
	Not listed	32.39
	Not listed	22.99
	Not listed	7.71
	September 07 Average	*17.34*

Tables:

Table 1- Models available based upon fiber length

	Length		
	0.5 µm to 5 µm	**>5 µm**	**>10 µm**
Model available	None available	IRIS Hodgson and Darton Cal EPA OSHA	Berman Crump

Table 2 – "Binning" criteria for the Borit sampling data

	BIN name (based upon fiber size)			
	AHERA	**TEM (EPASM)**	**PCMe**	**Berman Crump (Protocol Structures)**
Length	≥0.5 µm	≥0.5 µm	>5 µm	>10 µm
Width	Any width	Any visible width	≥0.25 µm	≤ 0.4 µm
Aspect ratio	5:1	3:1	3:1	Upper width cutoff

Table 3 – Statistical Z-score analysis for on-site ABS events

Activity		Average ratio (Activity-based sample vs. Concurrent onsite sample w/no activity) AHERA	Z-value AHERA	Average ratio (Activity-based sample vs. Concurrent onsite sample w/no activity) PCMe	Z-value PCMe
Raking					
	ATP (at top of the pile)	116	2.92	34	1.89
	Playground	9	1.38	6	1.22
Walking		6	1.25	6	1.38
Grass cutting		15	1.56	13	1.42
Soil Sampling		16	2.84	6	1.62
Note: When the Z-value is less than 1.65 there is no statistical difference between the activity (i.e. ABS) and the concurrent on-site sampling (i.e. non-ABS).					

Table 4 – Summary of air sampling results, PCMe and AHERA Counting Methods

Sample collection date	***Total # samples collected***	***# Samples w/ PCMe fibers***	***# Samples w/ AHERA fibers***	***Location/type of sample w/ PCMe result***
Apr-06	6	N/A	6	On-site
Oct-06	80	2 0 0	6 2 7	On-site On-site/ABS Off-site
Nov-06	69	0 3	4 7	On-site On-site/ABS
Mar-07	34	0	9 3	On-site Off-site
May-07	36	0 1	9 3	On-site Off-site
Jun-07	35	0	2	On-site
Jul-07	38	1 0	3 1	On-site Off-site
Aug/Sept-07	78 0	3 0 0	12 2 6	On-site On-site/ABS Off-site
Total	376	10	82	

Table 5 – Detailed air sampling results, PCMe and AHERA counting methods

Sample #	Location	PCMe (f/cc)	AHERA (f/cc)	Asbestos Type
Oct-06				
40497	#4 off-site	0	0.0005	Chrysotile
40511	#4 off-site	0	0.0005	Chrysotile
40517	#1 off-site	0	0.0005	Chrysotile
40523	#4 off-site	0	0.0005	Chrysotile
40537	#4 off-site	0	0.0005	Chrysotile
40547	#3 off-site	0	0.005	Chrysotile
40549	Oreland	0	0.0005	Chrysotile
41281	#3 on-site	0.00048	0.0005	Actinolite
41294	#9 on-site	0	0.001	Chrysotile
41304	#11 on-site	<0.0005	0	Chrysotile
41325	#5 on-site	0	0.0005	Chrysotile
41329	#6 on-site	0.00049	0.0001	Chrysotile
41349	#6 on-site	0	0.0005	Chrysotile
41355	ABS – soil sampling at the park	0	0.003	Chrysotile
41358	ABS – soil sampling at the park	0	0.015	Chrysotile
Nov-06				
41362	ABS – raking at the pile #1 AM	0	0.021	Chrysotile
41364	ABS – raking at the pile #2 AM	0.0058	0.046	Chrysotile
41366	ABS – raking at the pile #1 PM	0.012	0.023	Chrysotile
41368	ABS – raking at the pile #2 PM	0	0.017	Chrysotile
41370	ABS – raking at the park #1 PM	0	0.015	Chrysotile
41372	ABS – raking at the park #2 PM	0	0.0029	Chrysotile
41373	# 4 on-site	0	0.001	Chrysotile
41393	ABS – bank raking	0.021	0.076	Chrysotile
41397	#11 on-site	0	0.0005	Chrysotile
41401	#6 on-site	0	0.0005	Chrysotile
41427	#6 on-site	0	0.0005	Chrysotile
Mar-07				
40625	Oreland	0	0.0005	Chrysotile

Sample #	Location	PCMe (f/cc)	AHERA (f/cc)	Asbestos Type
41221	#10 on-site	0	0.0005	Crocidolite
41223	#4 on-site	0	0.0005	Chrysotile
41229	#11 on-site	0	0.0005	Chrysotile
41231	#6 on-site	0	0.0005	Chrysotile
41233	#7 on-site	0	0.0005	Chrysotile
41235	#5 on-site	0	0.0009	Chrysotile
40617	#4 off-site	0	0.0005	Chrysotile
40621	#2 off-site	0	0.0005	Crocidolite
41203	#7 on-site	0	0.0005	Chrysotile
41207	#5 on-site	0	0.0005	Chrysotile
41215	#10 on-site	0	0.0005	Chrysotile
May-07				
16965	#9 on-site	0	0.0005	Chrysotile
16966	#4 on-site	0	0.0005	Chrysotile
16967	#2 on-site	0	0.0005	Chrysotile
16968	#10 on-site	0	<0.001	Chrysotile
16969	#11 on-site	0	0.0005	Chrysotile
16970	#6 on-site	0	0.0005	Chrysotile
41573	#3 off-site	0	0.0005	Chrysotile
41576	#5 off-site	0.00049	0.0005	Actinolite
41584	#5 off-site	0	0.0005	Actinolite
41593	#9 on-site	0	0.0005	Chrysotile
41594	#4 on-site	0	0.0005	Actinolite
41595	#10 on-site	0	0.002	Chrysotile
Jun-07				
43619	#2 on-site	0	< 0.0005	Chrysotile
41232	#11 on-site	0	0.0005	Actinolite
Jul-07				
43655	#2 on-site	0.00048	< 0.0005	Actinolite
43657	#10 on-site	0	< 0.0015	Chrysotile
41257	# 5 off-site	0	< 0.0005	Chrysotile
43638	#2 on-site	0	< 0.0005	Chrysotile
Aug-07				
43556	#5 on-site	0	0.0015	Chrysotile
43714	#3 off-site	0	0.0005	Chrysotile
43560	#2 on-site	0	0.0005	Chrysotile

Sample #	***Location***	***PCMe (f/cc)***	***AHERA (f/cc)***	***Asbestos Type***
43561	#10 on-site	0	0.0005	Chrysotile
43564	#6 on-site	0.00049	0.0005	Chrysotile
43565	#7 on-site	0	0.0014	Chrysotile
43721	#2 off-site	0	0.0005	Chrysotile
43722	#4 off-site	0	0.0005	Chrysotile
43725	#1 off-site	0	0.0005	Chrysotile
Sep-07				
43571	ABS – grass cutting, park	0	< 0.01	Chrysotile
43572	ABS – grass cutting, park	0	< 0.017	Chrysotile
43732	#3 off-site	0	< 0.0005	Chrysotile
43949	#10 on-site	0	0.0029	Chrysotile
43950	#2 on-site	0	0.0005	Chrysotile
43954	#5 on-site	0	0.0005	Chrysotile
43955	#6 on-site	0.00048	0.0005	Chrysotile
43738	#5 off-site	0	0.0005	Chrysotile
43961	#9 on-site	0.00098	0.0005	Chrysotile
43965	#7 on-site	0	0.0029	Chrysotile

Table 6 - Projected Cancer Risk Calculations

Sample #	**Location**	**Maximum Concentration PCME (f/cc)**	**Sampling Date**	**Exposure Scenario**	**Projected Risk**
43961	Park	0.00098	Aug/Sept 2007	Residential	9.00E-05
41393	ABS- bank raking	0.021	Nov 2006	Recreational	8.10E-05
				Maintenance	3.10 E-5

Appendix A:

Borit CAG Public Comments

U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

In Reference To: **Health Consultation, BoRit Asbestos Air Sampling Results from 2006-2007**
Response Date: September 30, 2008
Submitted To: Lora Werner, MPH
Submitted By: Health, Environment, Risk & Safety (HERS) Working Group of the BoRit Asbestos Area Community Advisory Group (CAG)

Introduction:

The Health, Environment, Risk & Safety (HERS) Working Group of the BoRit Asbestos Area Community Advisory Group, upon review of the ATDSR document, respectfully submits our response to the Health Consultation pertaining to BoRit Asbestos Air Sampling Results from 2006-2007.

Overall, we appreciate the substantial involvement of the ATSDR in our Community Advisory Group, as well as the outreach to the general community. The concern for our community is clearly reflected in the Health Consultation document. In particular, our group takes notice that ATSDR discusses the following risks in the executive summary: 1) airborne asbestos levels were increased with activity-based sampling; 2) on-site exposures with disturbance of soil or asbestos-containing material are a public health hazard; 3) drought or severely dry conditions could cause exacerbated airborne asbestos levels. The precautionary measures recommended by ATSDR seem prudent to our participants given the large-scale nature of this unremediated asbestos waste site in our community.

At present, the main area of conclusion that we cannot accept within the Health Consultation document involves the calculation of cancer risk assessment for individuals exposed to onsite conditions. In particular, we remain circumspect about the potential for increased cancer risk, even when there is no soil disturbance, during commonly encountered conditions at the site. We are actively approaching the topic with a mission to become well-informed community members with a cautious attitude toward making decisions that involve our own health and the health of our community members. Over time, we hope that a clearer and more definitive picture will emerge with regard to the unanswered questions that surround the calculation of cancer risk assessment. The following areas of concern represent certain issues that comprise our reluctance to fully accept the safety analysis.

Areas of Concern:

1. Limitations of sampling conditions

EPA collected air samples in and around the BoRit Asbestos Site from October 2006 until September 2007. These tests were intended to reflect the seasonal variances and associated potential for airborne asbestos that could have adverse effects on human health. The results of these air tests were used to quantify potential asbestos-related cancer risk for this health consultation. However, the obtained samples were just a snapshot of certain conditions not entirely representative of the range of conditions over recent years or likely in the future. Since the initial public release of the test results, the sampling conditions have come under scrutiny by the CAG as expressed in our response document to the EPA dated December 2007 in which we stated the following:

“ while the risk calculations, from a toxicology standpoint, from the latest sample data do seem to have followed the “worst-case scenario” approach; the sampling itself may have underestimated major factors known to community members (e.g. particular locations where soil asbestos content is believed to be high, weather variables such as dry windy conditions, and children and animals physically active in contaminated areas.)” (CAG response to EPA, 12/2007)

The cancer risk prediction based upon these samples cannot be definitively accepted by our working group because the sample collection occasions and locations are a source of ongoing, high-level concern among our participants. The air test data may not have captured a true worst-case scenario due to wet conditions experienced within that year, as substantiated by the soil moisture percentage table presented on page 42 of the Health Consultation document. We notice that the ATSDR shares our concern about the potential range of weather conditions and states in the executive summary that drier conditions could yield a higher level of airborne asbestos:

“ Across the 2006-2007 sampling events, seasonality appeared to have limited effect on the airborne asbestos levels. However, under dryer conditions (e.g. September 2007), increases in airborne asbestos were seen relative to wetter conditions in the rest of the sampling events. Therefore, drought or severely dry conditions could exacerbate the problem of re-entrainment of airborne asbestos and migration from the site.” (page iii, health consultation)

If more sampling had occurred during drier conditions, we presume that higher test results would have been reported, along with a higher cancer risk projection. Within the 80+ years that these BoRit Asbestos piles have existed, inadequately covered and improperly contained, such dry and windy weather conditions have occurred many times. In fact, our participants recall various community drought warnings during extended time periods in the past decade.

2. Relationship between the BoRit Asbestos site, the Ambler Asbestos NPL site, and the impacted community

The Ambler Asbestos site is within 100 yards of the BoRit Asbestos site, and the waste contamination at both sites is from the same manufacturer. The historical air sampling results are briefly discussed in the Health Consultation document to summarize certain highlights from the data on record for both sites. However, it seems implied in the first paragraph of this section (*page 7*) that there are two separate communities: 1) the “neighborhood surrounding the Ambler asbestos site”, and 2) the “community near the BoRit asbestos site”. We observe that the distinction between these two sites is to some extent arbitrary, and we prefer to characterize the impacted community as essentially a single community with salient public health implications arising from both sites over the historical timeline. Our participants are concerned that the focus of this Health Consultation on a narrow window of air sampling results at only one of the sites does not constitute an in-depth approach to study the potential for asbestos-related disease due to combined asbestos contamination from the presence of these two sites within the same community. The prior health assessment work completed for the Ambler Asbestos NPL site would seem to apply to this entire community. Why doesn’t the ATSDR consider this relevant and provide a combined assessment?

3. Implications of activity-based sample results

The health consultation provides important information about disturbances related to activity conducted at the asbestos waste site:

> *"Table 3 indicates that substantial increases in exposure can occur on-site when activities are disturbing the soil. 'At the pile' (ATP) raking results in a 116 fold increase in average asbestos exposure levels for AHERA type fibers and a 34 fold increase for PCMe fibers, when compared to comparable onsite results with no activities occurring. Both fiber counting methods show a statistically significant increase in asbestos air levels with raking when compared to levels seen on-site when no activity is taking place…." (page 13, health consultation)*

This causes some of us to have great unease while the EPA removal action preparation activities are currently underway. During the month of July 2008, many members of our community witnessed significant disturbances of the waste site as the EPA began removal actions. A high level of concern from many of the residents surrounding the site has ensued. We understand that the EPA reports that on-site air testing performed during the removal activities demonstrates that on-site exposures are well within the range protective for worker and resident safety. However, the risk for elevated air levels by virtue of asbestos fiber content at these locations, documented to contain up to 35% chrysotile asbestos fiber with 5% amosite asbestos fiber in the soil, demands that we expect proactive vigilance in project plans and a high level of engagement with the community for all phases of removal work.

4. Translating the air sampling results into an "inhaled asbestos fibers per day" calculation

The test results were communicated to the public with a unit of measurement in "fibers per cc" of air sample. We are concerned that a balanced overview of the results should include translating the test results into a measurement that provides information about the total number of asbestos fibers that would be inhaled in a one day period. The calculation involves considering the air volume in one breath multiplied by the respiratory rate in breaths per day.

The following calculation assumes:
Asbestos air concentration = 0.00098 fibers per cc (highest result for the non-activity based samples)
Tidal Volume = 500 cc (volume of air inhaled during quiet breathing at sleep)
Respiratory Rate = 12 breaths/minute (respiratory rate during quiet breathing at sleep)

Estimated Inhaled Asbestos Fibers per Day in an Adult =
0.00098 fibers/cc x 500 cc/breath x 12 breaths/minute x 60 mins/hr x 24 hrs/day = 8467 fibers per day

We provide this conservative calculation as an example that expresses potential exposure level in an entirely different numerical magnitude than the air sample test reports. The fiber concentration used in this calculation includes only the 5 micron and greater asbestos fibers. The total asbestos fiber exposure is many times greater in value. Furthermore, at increasing activity levels, the inhaled volume per minute increases markedly, as shown in the provided reference table.

Metabolic level for adult males versus minute volumes in liters:

Metabolic Level	Breathing Minute volume (Liters)
Sleep	6.0
Rest	9.3
Light Work	19.7
Medium Work	29.2
Med. Heavy Work	40.0
Heavy Work	59.5
Maximum Work	132.0

(Source: NASA's Bioastronautics Data Book)

5. Potential cancer risk of short fibers

Our working group remains unconvinced about the soundness of excluding short asbestos fibers in assessing risk to human health.

The following passage represents a fundamental disagreement from one of our participants in response to perceived over-simplification, and resultant risk minimization, in the disregard of the short fibers for the final risk calculations in the health consultation.

> *"According to the parametric data of F. Pott, 2.5 micron fibers are approximately 1/4 as carcinogenic as 5 micron fibers, but because of the fiber distribution, there are hundreds of times more fibers at 2.5 micron fibers as 5.9 micron fibers. And as the fibers get smaller toward the mean, around 1 micron, there are thousands times more fibers. The 1 micron fibers are about 1/16 as carcinogenic as 5 micron fibers. Incidentally, fibers above 10 microns are so heavy, they seldom become airborne. The most carcinogenic fibers (about 5 times the risk of 5 micron fibers) are 25 microns, but pose little potential airborne risk, because unless there are very high winds, they would not become airborne. It is the product of the number of fibers at a fiber micron length times the carcinogenicity at that length summed (integrated) over the whole spectrum of fiber lengths and their distributions that determines the total carcinogenic risk." (HERS working group dialogue)*

The executive summary of the health consultation begins to address the topic with emphasis:

> *"There is not scientific consensus on the interpretation of the literature regarding the potential for lung cancer, mesothelioma and asbestos from exposure to short fibers." (in bold font, page iii, health consultation)*

We are at a loss to understand why the document subsequently, in seeming contradiction with itself, states:

> *"Fibers shorter than 5 μm in length do not add significantly to the risk of developing lung cancer or mesotheliomia." (page 11, health consultation)*

As a frame of reference, it is important to iterate that there is no demonstrated safe level of asbestos exposure. There are at least some asbestos experts who question the notion of a "regulatory" fiber that must meet a certain minimum length as an over-simplification of methodology design for risk assessments. Furthermore, the working group is aware that the 2002 expert panel's report after the World Trade Center disaster, cited in the health consultation document, has come under serious scrutiny by individuals at the EPA and within the broader scientific community. With this in mind, we appreciate when test results are conveyed with total counts for all TEM-detected asbestos fibers. Does the ATSDR share our uncertainty about whether the concentration of 5 micron and greater fibers is a good surrogate marker for total asbestos fiber concentration? Does the ATSDR consider it important for the concentration of all asbestos fibers to be included in air sample test reports?

6. Uncertainty about the predictive value of a risk model based upon historical epidemiology research in occupationally exposed populations

Our working group has made a concerted effort to understand the Unit Risk multiplier (from EPA IRIS) that is used in the health consultation (0.23 $(f/cc)^{-1}$). We have been informed that the value of this multiplier is based upon numerous historical epidemiology studies of workers with varying levels of asbestos exposure. Since these studies were performed prior to the advent of TEM technology, the correlation between asbestos fiber exposure and development of asbestos-induced cancer is assessed in terms of exposure to concentrations of 5 micron and greater length fibers. For this reason, according to our knowledge base, the EPA reports concentrations of PCMe fibers to provide a historically relevant measurement for risk analysis. We are uncertain about whether this risk analysis model is indeed appropriate for decision-making with regard to environmental and public health interventions in our community. Has this risk model ever been validated prospectively by successfully predicting excess cancer incidence within any population? We encourage governmental agencies to continue to refine this risk model in response to recent and future research wherever opportunities exist.

Additional Comments:

The HERS working group will continue to gather information about the asbestos-related health issues that affect our community. The area of asbestos toxicology is complex and controversial within the scientific community. With this in mind, it seems appropriate that the ATSDR health consultation document is written with a precautionary tone in several important areas. Our community has been impacted by asbestos hazard for a long period of time, and we are thankful that the EPA and ATSDR are involved with the CAG as we pursue safer conditions for the BoRit Asbestos site. We support all efforts to improve environmental justice and minimize future asbestos exposure within our community.

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