

Health Consultation

Review of Activity-Based Sampling on the Hancock/Ripley Trail

FORMER QUINCY SMELTER SITE

TOWN OF RIPLEY, HOUGHTON COUNTY, MICHIGAN

(Included in the Torch Lake Superfund Site,
EPA FACILITY ID: MID980901946)

NOVEMBER 27, 2006

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

Health Consultation: A Note of Explanation

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

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

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Under Cooperative Agreement with
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Abbreviations and Acronyms

| | |
|--------------------------|--|
| $\mu\text{g}/\text{m}^3$ | micrograms per cubic meter |
| ACM | asbestos-containing material |
| ATR | alternative trail route |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| ATV | all-terrain vehicle |
| BFRA | Brownfields Redevelopment Assessment |
| cc | cubic centimeter (cm^3) |
| EPA | U.S. Environmental Protection Agency |
| HRT | Hancock/Ripley Trail |
| MDCH | Michigan Department of Community Health |
| MDEQ | Michigan Department of Environmental Quality |
| MDNR | Michigan Department of Natural Resources |
| MDPH | Michigan Department of Public Health |
| mg/kg | milligrams per kilogram |
| NPL | National Priorities List |
| ORV | off-road vehicle |
| OUIII | Operable Unit III |
| ppm | parts per million |
| QDC | Quincy Development Company |
| QSS | Quincy Smelter site |
| RI/FS | Remedial Investigation/Feasibility Study |
| ROD | Record of Decision |
| TEM | transmission electron microscopy |

Summary

Activity-based sampling was performed at the Quincy Smelter Site (Houghton County, upper peninsula of Michigan) to characterize the breathing zone concentrations of asbestos fibers and various metals associated with historic use of the site. Several intrusive and non-intrusive types of activities were performed to determine airborne concentrations that result from aggressive disruption of the soil. While there is a complete exposure pathway and certain airborne concentrations may exceed some exposure standards, the exposure duration and frequency are insufficient to reasonably expect adverse health outcomes from this exposure. Therefore, both winter and non-winter recreational use of the trails at the site pose no apparent public health hazard from inhalation of airborne asbestos fibers and metals.

Background and Statement of Issues

In July 2004, upon discovery of friable asbestos along the Hancock/Ripley trail (HRT), Houghton County, Michigan, the Michigan Department of Natural Resources (MDNR) indefinitely closed the Franklin Township section of the trail near the Quincy Smelter site (QSS) to ensure public safety. Fencing was placed to block access to the trail and warning signs were posted. MDNR requested that the Agency for Toxic Substances and Disease Registry (ATSDR) and the Michigan Department of Community Health (MDCH) evaluate the health risks from recreational use of the HRT, for both winter and non-winter use. As part of the investigation of site contamination, the U.S. Environmental Protection Agency (EPA) also requested ATSDR and MDCH assistance in responding to any health concerns, the design of a sampling plan and interpretation of sampling data related to the HRT.

The HRT is a two-mile stretch of recreational trail owned and operated by the MDNR, located on the Keweenaw Peninsula portion of Michigan's upper peninsula. The HRT parallels the Quincy Smelter Works buildings for about a quarter-mile of the trail (this is approximately the length of the HRT as it traverses the QSS) and follows the former Copper Range Railroad grade. About 20 feet to the north of the trail is a large slag pile and approximately 100 feet south is the main QSS buildings. A trestle bridge between the slag pile and the former cupola furnace building crosses the trail. The former smelter site is located at 48991 Maple Street in Ripley, Franklin Township, Houghton County, Michigan (See Figures 1 and 2 for maps of the general area and the smelter site, respectively). QSS is one part of Operable Unit III (OUIII) of the Torch Lake Superfund site (CERCLIS # MID980901946) that was listed on the National Priorities List (NPL) in 1986.

Site History

The Quincy Mining Company, formally incorporated in 1848, owned and operated QSS until 1971 (EPA 2004a). The Quincy smelter was one of five copper smelters that operated on the Keweenaw Peninsula during the late 1800s and early 1900s. The main construction of buildings began in 1898 and continued through 1919. Production at QSS peaked between 1909 and 1911. Mining and smelting operations were suspended in 1931 and were reinstated on a small scale in 1937. A reclamation plant for the copper-rich stamp sand tailings operated from 1943 until

1967. From 1968 until the facility closed in 1971, scrap copper was smelted. Since the closing of the smelter, five of the buildings have been used for storage and as offices (Martin 2002).

In general, processing the copper-containing ore mined from the area consisted of crushing the ore at a stamp mill to sand-sized particles, separating copper-containing sands from the rock by flotation, and sending the treated ore on for smelting (the process of extracting metals out of ore by melting). Waste mine tailings (referred to as “stamp sands”) from the hydraulic separation were disposed of along the local shoreline. Stamp sands have been used in the area for off-road vehicle trails, recreational beach/sandbox use, road traction sand, and other various construction uses, including use by the Houghton County Road Commission (Weston 2004a, Weston 2004b). Waste material produced by smelting (known as slag) was deposited on-site in various piles, such as the rather large slag pile located just north of the HRT.

The QSS portion of Torch Lake encompasses about 25 acres of land and approximately 1500 feet of shoreline along the northern shore of Portage Lake just east of the town of Hancock. The peninsular portion of the shoreline (see Figure 2) where the QSS buildings are sited was man-made and not part of the original Portage Lake shoreline. It is primarily hard-packed sand deposited in a southward progression over a period of time (roughly 1860 to 1900) prior to Quincy Mining Company taking control of the property (ATC 2004). Surface soils are mixed with a considerable amount of waste and smelting process materials, including finely crushed slag, coal, limestone, iron ore, and structural debris such as wood, mortar, and/or firebrick (ATC 2004). There is vacant undeveloped land adjacent to the shore of the Portage Canal while surrounding land use is predominantly undeveloped woodland, residential parcels, commercial developments, and industrial facilities (MDEQ 2002).

The HRT extends from the US 41 bridge crossing (otherwise known as the Houghton-Hancock lift-bridge located on Route M-26) at Hancock east toward Ripley, alternating between the paths of two former railroad grades - the “Copper Range” and the “Hancock to Calumet” (Neese 2004). As the HRT traverses the QSS, it switches from the Copper Range trail to the Hancock/Calumet Range trail. (Refer to the orange-shaded area of Figure 2 for exact location of this segment of trail.) Throughout most of the 20th century, the HRT was used by the Soo Line Railroad Company as a right-of-way, although during the 1980s, there were several changes in ownership. Sometime during the 1980s/1990s, all the railroad tracks were removed from the area and the site has since been vacant (MDEQ 2002). Currently, MDNR holds several easements on the land and has given permission for snowmobile use, but have yet to extend this permission to all off-road vehicle (ORV) use (Neese 2004).¹ The rest of the QSS property is currently owned by Franklin Township, procured from the Quincy Development Company (QDC) in 1999, which procured the property from the Quincy Mining Company in 1986.

As early as September 1987, Quincy Mining Company Historic District was proposed as part of a new National Park Service project, the Keweenaw National Historical Park (EPA 2003). Boundaries of this park/visitor center were first drawn up in the early 1990s and include the smelter area as vital part of the area’s industrial and historical heritage (Nordberg 2004). The

¹ On October 1, 1995, the environmental protection and regulation functions of the Michigan Department of Natural Resources (MDNR) were transferred to the newly formed Michigan Department of Environmental Quality (MDEQ).

“Quincy Unit” of the new park is slated to include the smelter area, Quincy Mine Hoist, and pay office as part of the park’s southern anchor (Nordberg 2004).

As part of the Record of Decision (ROD) for OUIII of this Superfund site, no action was taken on the slag pile located in the Quincy Smelter area because of the proposed development as part of a National Historical Park (EPA 1992). EPA recently announced that clean-up work on the larger Torch Lake Superfund site is now complete but “deed restrictions will ensure the stamp sands [contaminated material] remain covered by any future owners” (EPA 2006).

Recent Site Activity

MDEQ conducted a Brownfields Redevelopment Assessment (BFRA) for the HRT during June 2002, as part of a cooperative agreement with EPA. Soils data collected during the BFRA showed that concentrations of metals and polycyclic aromatic hydrocarbons (PAH) exceeded certain MDEQ exposure standards. They drew the following conclusions:

- soil concentrations presented a “significant direct contact and particulate soil inhalation hazard at the property,”
- groundwater on the property and surrounding areas should be restricted from being used as a source of drinking water, and
- immediate action should be taken to abate the potential threat and to protect against exposure to people entering the property (MDEQ 2002).

In 2003, MDEQ and Franklin Township requested that EPA Emergency Response Branch provide assistance in the removal of drums of hazardous materials and laboratory equipment stored at the site. A preliminary site visit and associated field screening was conducted from July to September 2003 by EPA, its contractors, and QDC. During the field screening of on-site waste materials, visual inspection identified suspect asbestos-containing materials (ACM) not only inside most site buildings but also in QSS soils, including soils adjacent to the HRT (EPA 2004a). A removal action was initiated at QSS, which also specified that an asbestos survey was to be conducted.

The asbestos survey, completed in June 2004 (ATC 2004), found evidence of friable asbestos fibers in 13 buildings, non-friable asbestos in 3 buildings, and friable asbestos at 9 locations outside of the buildings, including 4 locations near/along the HRT (EPA 2004a). Due to the presence of friable asbestos and structural deterioration of the buildings, it was recommended that access to the site be restricted. In July 2004, EPA temporarily blocked access to the HRT and removed ACM from the trestle bridge crossing the HRT and bulk ACM from along the trail. On completion of the fencing, responsibility for controlling access to the trail was returned to the MDNR. On July 14, 2004, the Director of the MDNR issued an order restricting public access to the 760-foot trail section bordering the QSS, pending an evaluation of health hazards. The subsequent public meeting held in late July 2004 was mainly devoted to answering questions from local residents concerning re-opening the trail as well as addressing concerns over “lost business” from the trail closure. (The HRT is used for recreational snowmobile use and, as such, is an important source of income during the winter months.)

MDNR requested a health consultation to address potential health risks from exposure to airborne asbestos or metals during recreational use of the HRT. ATSDR and MDCH reviewed existing data and determined that additional air sampling should be performed to more accurately determine potential exposures to people using the trail at the QSS. EPA, MDEQ, ATSDR, and MDCH developed a sampling and analysis plan to determine the levels of exposure that could be experienced by individuals using the trail in intrusive recreational activities (bike riding and all-terrain vehicle [ATV] riding), as well as those walking on the trail during these activities. The resultant “activity-based sampling” was conducted during August 2004, along the QSS stretch of the HRT (about 0.25 miles in length) and along a potential alternate trail route, located adjacent to M-26 (see the pink-shaded portion from Figure 2) (ATSDR 2004). After evaluation of available and appropriate environmental sampling data, ATSDR and MDCH issued a letter to MDNR stating that use of the HRT did not pose a public health hazard from exposure to airborne asbestos or metals for winter users of the trail (ATSDR 2004) (Appendix B). MDNR reopened the trail for the start of the Winter 2004-2005 season. More recently, ATSDR and MDCH issued another letter to MDNR stating that the HRT did not pose a public health hazard from exposure to airborne asbestos or metals for non-winter trail use (ATSDR 2006) (Appendix C).

Some additional data were taken by MDEQ following the activity-based sampling done by EPA. Soil samples were taken along the QSS segment of the HRT in late August 2004 by staff of the MDEQ Upper Peninsula District office. See the Discussion section for a more in-depth review of the environmental data.

Past MDCH Involvement

As part of its cooperative agreement with ATSDR, MDCH has prepared three separate health consultation documents on the Torch Lake Superfund Site. Following the Michigan Department of Public Health (MDPH) precautionary fish consumption advisory, MDPH (1988) concluded that the site posed “no potential human health concern because of the possibility of human exposure to an as-yet unidentified etiologic agent.”² This was precautionary in the sense that, although no cause could be identified for “high incidence of tumors found in certain species of game fish,” a fish advisory was still issued for the area. The 1983 MDPH fish advisory for sauger and walleye contributed to the inclusion of the Torch Lake Superfund Site on the NPL in 1986.

MDPH prepared a consultation for ATSDR in April 1990 in which soil, air and tailings data taken by EPA were evaluated and characterized as posing no health threat at the time (MDPH 1995). Additional data were collected from lakeshore tailings, sediment, surface water, groundwater, air, and surface soil in conjunction with the Remedial Investigation/Feasibility Study (RI/FS) for the larger Torch Lake area, including data from the Quincy Smelter area. MDPH (1995) concluded that the presence of metals and PAHs in tailings piles and groundwater from areas including the QSS posed a health risk from chronic exposure to these materials.

In 1997, MDCH was asked to evaluate health risks associated with tailings piles near Torch Lake as part of their ongoing “Brownfields Pilot Project,” with part of the area under investigation

² On April 1, 1996, the Michigan Department of Public Health (MDPH) Division of Health Risk Assessment was absorbed into the newly-formed Michigan Department of Community Health (MDCH).

focusing on the “closed copper smelter between Hancock and Ripley (Area F)” (MDCH 1998). At this time, there was evidence that the piles were used for ORV recreation, for residential use, and for winter use on roads to increase tire traction, as well as for walking and bicycle riding. MDCH evaluated soils data provided by MDEQ (analyzed for metals and semi-volatile organic chemicals) and concluded that “several of the [Torch Lake Area Brownfield] properties would pose public health hazards under long-term exposure from metals in the soil” (MDCH 1998). It was also stated that some of these properties (including the Quincy Smelter area) “are also under consideration for future residential development” and that further evaluation of these areas were recommended to “determine the extent and appropriate treatment of the elevated lead and arsenic concentrations in the soil” (MDCH 1998).

In 2004, a large group of stakeholders had been working together to address health risks (among other concerns) from use of the trail, including MDEQ (regional as well as state Superfund and Brownfield staff), MDNR, MDCH, EPA, ATSDR, and several state public offices (including the Governor’s office). Also at the heart of the future land use decision is the standing proposal to establish a National Park Service visitor center at the QSS. According to Franklin Township (2003), the “idea for a shared visitor center between Isle Royale National Park and Keweenaw National Historical Park” was suggested in the early 1990s and, furthermore, the “idea of a shared visitor center at the site of the Quincy Smelting Works” continues to draw local interest and support.

Discussion

Environmental Data - Asbestos

In order to address the possible exposure of recreational users of the HRT to airborne asbestos fibers (either released from building structures at QSS or dispersed from ACM deposited along the trail), EPA conducted activity-based sampling in August 2004. The primary objective of the air sampling was to determine the concentration of asbestos fibers in the “breathing zone” of individuals engaging in intrusive recreational activities (i.e. bike riding and ATV riding) and of individuals walking along the trail concurrent with these intrusive activities. Although this sampling technique is relatively new, it provides distinct advantages over the predominant method of estimating health risk from soils contaminated with asbestos. Both EPA and OSHA define “asbestos-containing material” as a material that contains more than 1% asbestos. It is very important to realize that this threshold was “related to the limit of detection for the analytical methods available at the time and also to EPA’s prioritization of resources on materials containing higher percentages of asbestos” (EPA 2004b)³. Furthermore, EPA data from similar sites “provide evidence that soil/debris containing significantly less than 1 percent asbestos can release unacceptable air concentrations of all types of fibers (i.e. serpentine/chrysotile and amphibole/tremolite)” (EPA 2004b).

The use of activity-based sampling at QSS provides an alternative to:

- comparison of soil sampling for bulk asbestos content for estimation of risk,
- allows for a determination of the level of airborne asbestos from specific degrees of soil disturbance or activity level occurring on site (i.e. low-impact versus high-impact activities), and

³ The 1% threshold for asbestos-containing materials was first used by EPA in the 1973 “National Emissions Standards for Hazardous Air Pollutants” and retained in the 1990 revisions to these standards.

- allows for identification of complete exposure pathways relative to different types of activities.

Activity-based air sampling was conducted along the approximately quarter-mile segment of the existing trail (HRT) adjacent to QSS and along a potential alternate trail route (ATR) adjacent to Highway 26. (See Figure 2 for a map of these areas.) Air samples from 6 “events” were collected from 12 HRT and 3 ATR locations while a variety of activities were performed: walking, pushing a stroller, bicycle use, and ATV use. (See Table 1 for more information.) Each activity was carried out on the same quarter-mile stretch of trail for a three-hour time period while the soil moisture percent was low. Thus, the air samples generated represent a conservative, worst-case exposure. Seventy-one (71) samples were submitted for analysis from the activity-based sampling events, with 116 total samples from all monitors (including background, baseline, and personal monitors) submitted for analysis.

In addition, data from 15 off-site “baseline” locations and five “background” locations were collected prior and after the activity-based sampling. The “baseline” data were intended to capture “current site conditions without activity on the trail” while the “background” data were intended to capture the influence of site activities on the “fenceline” of the site (Lockheed Martin 2004). One of 10 background samples had an airborne concentration of 0.0005 structures per cubic centimeter (cc).

No asbestos was detected in eight samples from the two scenarios that included only bicyclists and a walker with a stroller (Events 1 and 2). Activities involving ATV riding were more “intrusive” and generated more dust; samples taken from along the HRT and from the breathing zone of both ATV riders and the walker contained some asbestos fibers. Using a Transmission Electron Microscopy (TEM) direct analytical methodology (ISO 10312), low levels of asbestos were detected in nine of 14 samples during ATV events on the HRT. Concentration of asbestos in these samples ranged from non-detect to 0.01 structures per cc. Based on this sampling, most commonly, recreational trail users may experience a lower dose while the ATVs are in use. The results of two samples at stroller level were both non-detect, and the walker experienced approximately one-third of the exposure experienced by the ATV riders (up to approximately 0.003 structures per cc). All of these reported concentrations are at or below the asbestos exposure standard identified for reoccupation of indoor spaces near the World Trade Center (see Toxicological Evaluation section for more information).

Table 1. Description of Activity-based sampling scenarios for EPA sampling (August 2004)

| Event # | Trail | Event Description |
|----------------|--------------|--|
| 1 | HRT | Two bicyclists rode side-by-side while a walker pushing a stroller used the same portion of the trail. |
| 2 | ATR | |
| 3 | HRT | Two ATV riders rode in tandem while a walker pushing a stroller used the same portion of the trail. |
| 4 | ATR | |
| 5 | HRT | |
| 6 | ATR | |

HRT: Hancock/Ripley Trail

ATR: Alternate Trail

Since dust overloading was a problem for some of the HRT samples, which prevented their analysis by the direct TEM method, seven of 10 HRT samples were analyzed by an indirect TEM method (ISO 13794). However, the limitation of the indirect method is that due to the dispersive method used, many of the asbestos structures identified may not have been actually present in the same dimensions in the sampled air (i.e. the sample preparation used for the indirect analysis method may have broken up fibers found on the sampling medium). Therefore, the results are not comparable to the direct method and are only used qualitatively as an indication of the presence or absence of airborne asbestos that may be generated during on-site activities.

The indirect analysis indicated that the area immediately adjacent to the trestle bridge, where previous asbestos abatement activity had occurred, had higher levels of the chrysotile form of asbestos than the remainder of the trail sampled. Concentration of asbestos in these samples ranged from non-detect to 0.07 structures per cubic centimeter. The indirect method uses sonication to suspend the material on the overloaded filters and then reapplication onto new filters. Due to the potential for sonication to disrupt clusters of fibers, there is uncertainty about the quantification of respirable asbestos fibers concentrations using the indirect method. However, the results have value in a qualitative determination of the presence of asbestos in an air sample.

In the letter of October 2004 to MDNR, ATSDR and MDCH concluded that during the snowmobile season, the concentration of airborne asbestos did not pose a public health hazard for individuals using the snowmobile trail (ATSDR Oct 2004). In a second follow-up letter of August 2006 to MDNR, ATSDR and MDCH concluded that recreational use of HRT or ATR during non-snowmobile season does not pose a health hazard from exposure to airborne asbestos or metals. In addition, in part based on the indirect TEM analytical results, it was suggested that consideration be given to paving the stretch of HRT (or some other exposure barrier) near the trestle bridge in order to minimize exposure to the potentially higher levels of asbestos found there.

The results of the activity-based sampling indicate that only the most aggressive disturbances of HRT soils (i.e. ATV riding) during dry soil conditions generate detectable asbestos concentrations in the breathing zone. Exposure should be put into context of the time spent on the trail (i.e. with attention paid to the frequency and duration of exposure). The activity-based sampling used a three-hour time period in which the recreational users traveled back and forth over the same quarter-mile section of trail. This would be considered a worst-case exposure scenario. More realistically, a 10-minute time period for a walker and less for an ATV rider would be anticipated, and that these activities would be infrequently performed. Thus, concentrations of airborne asbestos do not pose a public health hazard for individuals using the trail. To further minimize possible exposure, consideration should be made to pave this stretch of the trail, especially near the trestle bridge.

Environmental Data - Metals

Samples for metal analyses were also collected on the activity-based air sampling events from August 2004. A similar protocol was used for the collection of baseline, background, and event-specific data and is described above. Ninety-eight samples were collected and analyzed.

Table 2. Analysis of soil data from the Hancock/Ripley Trail taken in 1997, 2002, and 2004. Selected soil concentrations are presented and compared against the “state background” values as provided by the Michigan Department of Environmental Quality “Part 201 Cleanup Criteria” document.

| Chemical | Soil Concentration (<i>reported in mg/kg, or ppm</i>) | | | |
|-----------|---|----------------|----------------|-------------------------|
| | <i>Maximum</i> | <i>Minimum</i> | <i>Average</i> | <i>State background</i> |
| Aluminum | 22,100 | 7,600 | 12,394 | -- |
| Arsenic | 25.6 | 0.70 | 5.02 | 5.8 |
| Cadmium | 2.0 | 0.1 | 0.40 | 1.2 |
| Chromium | 46.8 | 12.1 | 20.2 | 18 |
| Cobalt | 33 | 10 | 20 | 6.8 |
| Copper | 21,000 | 2,420 | 5,644 | 32 |
| Iron | 34,800 | 13,000 | 22,606 | 12,000 |
| Lead | 120 | 5.2 | 39.6 | 21 |
| Magnesium | 17,600 | 8.68 | 12,891 | N/A |
| Manganese | 1,100 | 330 | 588 | 440 |
| Mercury | 0.5 | 0.05 | 0.13 | 0.13 |
| Nickel | 39 | 19 | 23 | 20 |
| Selenium | 1.2 | 0.46 | 0.68 | 0.41 |
| Silver | 20 | 0.37 | 6.68 | 1 |
| Zinc | 654 | 57.4 | 142 | 47 |

As anticipated from the previous quantification of metals from historic sampling of surface soil, slag material, and stamp sands at the Quincy Smelter site, activity-based air samples revealed that particulate aerosols created during recreational activities contained several metals. Seventy-two (72) of the 98 samples had detectable levels of one or more metals (Lockheed Martin 2004). The most prevalent airborne metals detected were iron (found in 56 out of 72 samples), copper (52), aluminum (48), manganese (38), chromium (30), zinc (30), magnesium (23), and lead (21) while the least prevalent were cadmium (3), nickel (3), cobalt (3), arsenic (2), and silver (2) (Lockheed Martin 2004).

Previously collected data provide a brief overview of the metals concentration in soils from/near HRT – see Table 2 above. Given that iron, aluminum and magnesium are major constituents of the earth’s crust (or lithosphere), it would appear as if copper, chromium, iron, lead, manganese, and zinc may be related to historic smelting at the QSS (Butzer 1976). These latter metals appear to be occurring in concentrations higher than state background, which may or may not constitute a health hazard (which is dependent on a complete exposure pathway as well as sufficient duration and frequency of exposure). No state background data is available from MDEQ for aluminum and magnesium.

Table 3 presents those metals that were measured above the limit of detection for all six events from both trails (HRT and ATR). Thirteen (13) metals were detected across all six events, with the vast majority of maximum air concentrations found in conjunction with ATV use somehow. The air concentrations of copper and most other metals were generally highest for the second of two ATV riders riding in tandem. Walkers, strollers, bikers and the first ATV rider typically were exposed to lower concentrations of all metals.

Table 3. Maximum airborne metal concentrations, presented by event. All figures are presented in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). The “non-ATV” category includes walkers, strollers, and bicyclists.

| Metal type | Events 1 and 2 | Event 3 (HRT) | | Event 4 (ATR) | | Event 5 (HRT) | | Event 6 (ATR) | |
|------------|----------------|---------------|---------|---------------|---------|---------------|---------|---------------|---------|
| | | ATV | Non-ATV | ATV | Non-ATV | ATV | Non-ATV | ATV | Non-ATV |
| Aluminum | 14 | -- | 65 | -- | -- | 1300 | -- | 100 | 78 |
| Arsenic | -- | -- | -- | -- | -- | 1.3 | -- | -- | -- |
| Cadmium | 0.42 | -- | -- | -- | -- | -- | -- | -- | -- |
| Chromium | 0.54 | -- | 0.57 | 0.37 | -- | 2 | 0.36 | -- | -- |
| Cobalt | -- | -- | -- | -- | -- | 2.4 | -- | -- | -- |
| Copper | 1.9 | 25 | 34 | -- | -- | 620 | -- | -- | -- |
| Iron | 9.3 | -- | 140 | -- | -- | 2500 | -- | 190 | -- |
| Lead | 24 | -- | 0.77 | -- | -- | 9.9 | -- | -- | 0.29 |
| Magnesium | -- | -- | 52 | -- | -- | 1100 | -- | 82 | -- |
| Manganese | 0.2 | -- | 3 | -- | -- | 64 | -- | 3.9 | 2 |
| Nickel | -- | -- | -- | -- | -- | 2.7 | -- | -- | -- |
| Silver | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| Zinc | 1.7 | -- | -- | 8 | 18 | 16 | -- | -- | -- |

During the HRT ATV riding activity (Event 5), the two copper air samples for the second ATV rider were 300 and 620 $\mu\text{g}/\text{m}^3$. The range for all other participants and stations from the HRT event sampling was from below the detection limit (0.35 $\mu\text{g}/\text{m}^3$) to 34 $\mu\text{g}/\text{m}^3$ (29 samples).

Chromium concentrations ranged from below the detection limit (0.14 $\mu\text{g}/\text{m}^3$) to 2.0 $\mu\text{g}/\text{m}^3$ for both trails. The greatest concentration measured was associated with the 2nd HRT ATV rider (Event 5).

Iron concentrations ranged from below the detection limit (0.27 $\mu\text{g}/\text{m}^3$) to 2,500 $\mu\text{g}/\text{m}^3$ for both trails. The greatest concentration measured was associated with the 2nd HRT ATV rider (Event 5).

Lead concentration ranged from below the detection limit (0.21 $\mu\text{g}/\text{m}^3$) to 24 $\mu\text{g}/\text{m}^3$. The greatest concentration measured was associated with ATR walker (Event 2) and, oddly enough, not associated with ATV use.

Manganese concentrations ranged from below the detection limit (0.14 $\mu\text{g}/\text{m}^3$) to 64 $\mu\text{g}/\text{m}^3$ for both trails. The greatest concentration measured was associated with the 2nd HRT ATV rider (Event 5).

Zinc concentrations ranged from below the detection limit ($0.35 \mu\text{g}/\text{m}^3$) to $18 \mu\text{g}/\text{m}^3$ for both trails. The greatest concentration measured was associated with the walker near the ATR ATVs (Event 4).

Exposure of HRT users to metals would be primarily associated with particulate matter via inhalation of metal-bearing dust and soil particles from the trail. Based on activity-based sampling, for the most part, maximal air concentrations were associated with ATV use. The frequency with which a walker, stroller, or bicyclist will “share” the trail with an ATV rider during the drier months is expected to be low. Given the length of time that these users will be using the trail, the recreational use of this stretch of the HRT does not present a public health hazard from exposure to metals.

Exposure Assessment

Human Exposure Pathways

To determine whether nearby residents are, have been, or are likely to be exposed to contaminants associated with a property, ATSDR and MDCH evaluate the environmental and human components that could lead to human exposure. An exposure pathway contains five major elements: (1) a source of contamination, (2) contaminant transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) an receptor population. An exposure pathway is considered a complete pathway if there is evidence that all five of these elements are, have been, or will be present at the property. Alternatively, an exposure pathway is considered complete if there is a high probability of exposure. It is considered either a potential or an incomplete pathway if there is no evidence that at least one of the elements above are, have been, or will be present at the property, or that there is a lower probability of exposure. The exposure pathway analysis for the HRT can be found in Table 4.

Asbestos Exposures

While there may be a complete exposure pathway along/near HRT, the nature of any exposure would be episodic and/or intermittent. During the winter months, the trail typically has about 200 inches of snow. Thus during the winter and in spring when the snow is melting, little disturbance of the soil would take place. Fugitive asbestos fibers from the QSS buildings appear to present a minor exposure, if at all. Based on the trail monitors located along the HRT, the trestle bridge area, from which ACM was removed one month prior to the sampling events, was the area with the greatest exposure. Aggressive disturbance of HRT soils will continue to generate asbestos exposures during drier months. An exposure barrier, such as pavement, on the trail may minimize this exposure.

Table 4. Exposure pathway analysis for recreational use of the Hancock/Ripley trail

| Source | Environmental Transport and Media | Chemicals of Concern | Exposure Point | Exposure Route | Exposed Population | Time | Status |
|--|-----------------------------------|----------------------|----------------|---------------------------|--|---------|-----------|
| Hancock Ripley Trail--slag piles, mine tailings, & historic soil contamination | Ambient air | Metals, asbestos | Ambient air | Inhalation | Local residents; Recreational users of HRT | Past | Complete |
| | | | | | | Present | Complete |
| | | | | | | Future | Potential |
| | Surface Soil | | Surface Soil | Ingestion, dermal contact | Recreational users of HRT | Past | Complete |
| | | | | | | Present | Complete |
| | | | | | | Future | Potential |

Metals Exposures

While there may be a complete exposure pathway along/near HRT, the nature of any exposure would be episodic and/or intermittent. The significant snow cover that the region receives would prevent dispersion of any fugitive metal-containing dust from these sources and, therefore, winter use of the trail is not expected to lead to any appreciable exposure.

Toxicological Evaluation

Asbestos⁴

Inhalation of asbestos fibers has been associated with an increased risk of:

- (1) *Malignant mesothelioma*—Cancer of the lining of the lung (pleura) and other internal organs. This cancer can spread to tissues surrounding the lungs or other organs. The great majority of mesothelioma cases are attributable to asbestos exposure.
- (2) *Lung cancer*—Cancer of the lung tissue, also known as bronchogenic carcinoma. The exact mechanism relating asbestos exposure with lung cancer is not completely understood. The combination of tobacco smoking and asbestos exposure greatly increases the risk of developing lung cancer.
- (3) *Non-cancer effects*—These include asbestosis, scarring, and reduced lung function caused by asbestos fibers lodged in the lung; pleural plaques, localized or diffuse areas of thickening of the pleura; pleural thickening, extensive thickening of the pleura which may restrict breathing; pleural calcification, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and pleural effusions, fluid buildup in the pleural space between the lungs and the chest cavity (ATSDR 2001).

The scientific community generally accepts the correlations of asbestos toxicity with fiber length as well as fiber mineralogy (i.e. chemical composition of the asbestos fiber type). Fiber length may play an important role in clearance and mineralogy may affect both *in vivo* persistence and surface chemistry.

⁴ This section was excerpted and modified from an “Asbestos Overview” authored by ATSDR’s National Asbestos Exposure Review Team, including B. Anderson, J. Dyken, and J. Wheeler.

Fiber length plays an important role in toxicity. Fibers with lengths $>5 \mu\text{m}$ (micrometer) have the strongest association with mesothelioma and lung cancer. The toxicity of fibers $<5 \mu\text{m}$ in length is uncertain, but they may play a role in asbestosis with prolonged exposure and high fiber concentrations (ATSDR 2003).

Asbestos fiber toxicity is also influenced by the type of fiber, generally classified as either serpentine (e.g. chrysotile) or amphibole (e.g. amosite, crocidolite, tremolite, actinolite). Epidemiology evidence indicates that amphibole asbestos, including the fibers in Libby vermiculite (known as “Libby amphibole”), is far more toxic than chrysotile asbestos in causing pulmonary disease. There may be a number of factors that explain the differences in toxicity, including physical characteristics of chrysotile fibers that allow it to break down more readily and to be cleared from the lung. However, amphibole fibers are physiologically more stable and cleared at slower rates. As a consequence, fibers levels accumulate in lung tissue (Churg 1993). Some researchers believe the resulting increased duration of exposure to amphibole asbestos significantly increases the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer (Churg 1993).

Inorganic Contaminants

While several different metals have been detected across various sampling efforts at QSS, this consultation is focused on the relevant metals (i.e. those appearing to be elevated from activity at the smelter) measured above the detection limit during the activity-based sampling. There appears to be only one exposure scenario that generates any appreciable amount of airborne metal concentrations in the breathing zone: ATV use. The aggressive and intrusive nature of this form of recreation is likely to generate clouds of dust, bearing several different types of metals; this is expected to be at its worst during the warmer drier days of summer.

While ATV riders could experience concentrations in excess of appropriate exposure standards (i.e. acute exposure standards), the exposure duration (the amount of time it takes to traverse the quarter-mile stretch of HRT) and the exposure frequency (the number of times per week, month or year that one performs an intrusive activity on this quarter-mile stretch of HRT) are not sufficient to reasonably expect any health effects from the vast majority of individuals using the HRT or ATR.

ATSDR Child Health Initiative

Children may be at greater risk than adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their intake of hazardous substances. They are shorter than most adults, and therefore breathe dust, soil, and vapors closer to the ground. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Even before birth, children are forming the body organs they need to last a lifetime. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus, via the placenta, or

affect the fetus because of injury or illness sustained by the mother (ATSDR 1998). The obvious implication for environmental health is that children can experience substantially greater exposures than adults to toxicants that are present in soil, water, or air.

With regard to asbestos, the younger the age of exposure, the more likely one is to present with asbestos-related disease within one's life. This is due to the latency period between time of exposure and onset of disease, which can be 40 years or more when it comes to developing mesothelioma from asbestos exposure. There is very little chance of asbestos fibers, which are not water soluble, being transferred from a mother to a fetus or infant via placental transfer or breastfeeding, respectively. Finally, it is not known if asbestos will result in birth defects or other developmental effects in people.

Conclusions

- 1) Exposure to airborne asbestos or metals from *winter* recreational use of the quarter-mile stretch of Hancock-Ripley Trail near the Quincy Smelter site poses no apparent public health hazard.
- 2) Exposure to airborne asbestos or metals from *non-winter* recreational use of the quarter-mile stretch of Hancock-Ripley Trail near the Quincy Smelter site poses no apparent public health hazard.
- 3) If land use changes from recreational use to residential use, additional characterization of exposure will be needed to evaluate the public health hazard. An evaluation of residential exposure pathways and levels should be conducted if residential land use is anticipated.

Recommendations

While no actions are necessary to prevent and/or reduce exposures to asbestos and metals at QSS, lack of truly definitive data regarding asbestos concentrations near the trestle bridge portion of HRT suggests some low-tech, common-sense approaches to reducing risk where feasible. Some simple exposure barrier along the quarter-mile stretch of HRT would further reduce the likelihood of even minor exposures and could provide peace-of-mind to any in the area who may still have lingering health concerns about recreational use of the trail. Some examples of such an exposure barrier could include paving the quarter-mile stretch as it traverses QSS or depositing and maintaining a layer of crushed rock along HRT.

Public Health Action Plan

- 1) Franklin Township, the landowner, should discourage residential development on the grounds of the smelter site until a more thorough investigation is performed.
- 2) Franklin Township may want to consider the benefits of further risk reduction from some type of exposure barrier placed and maintained along the entire quarter-mile stretch at the trestle bridge.
- 3) MDCH staff will remain available for consultation with regard to exposure and health effects relative to the smelter site.

Quincy Smelter, Houghton County, Michigan

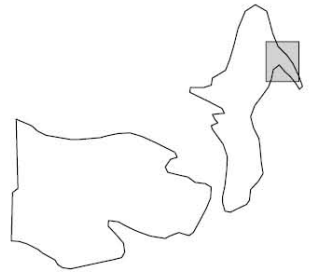
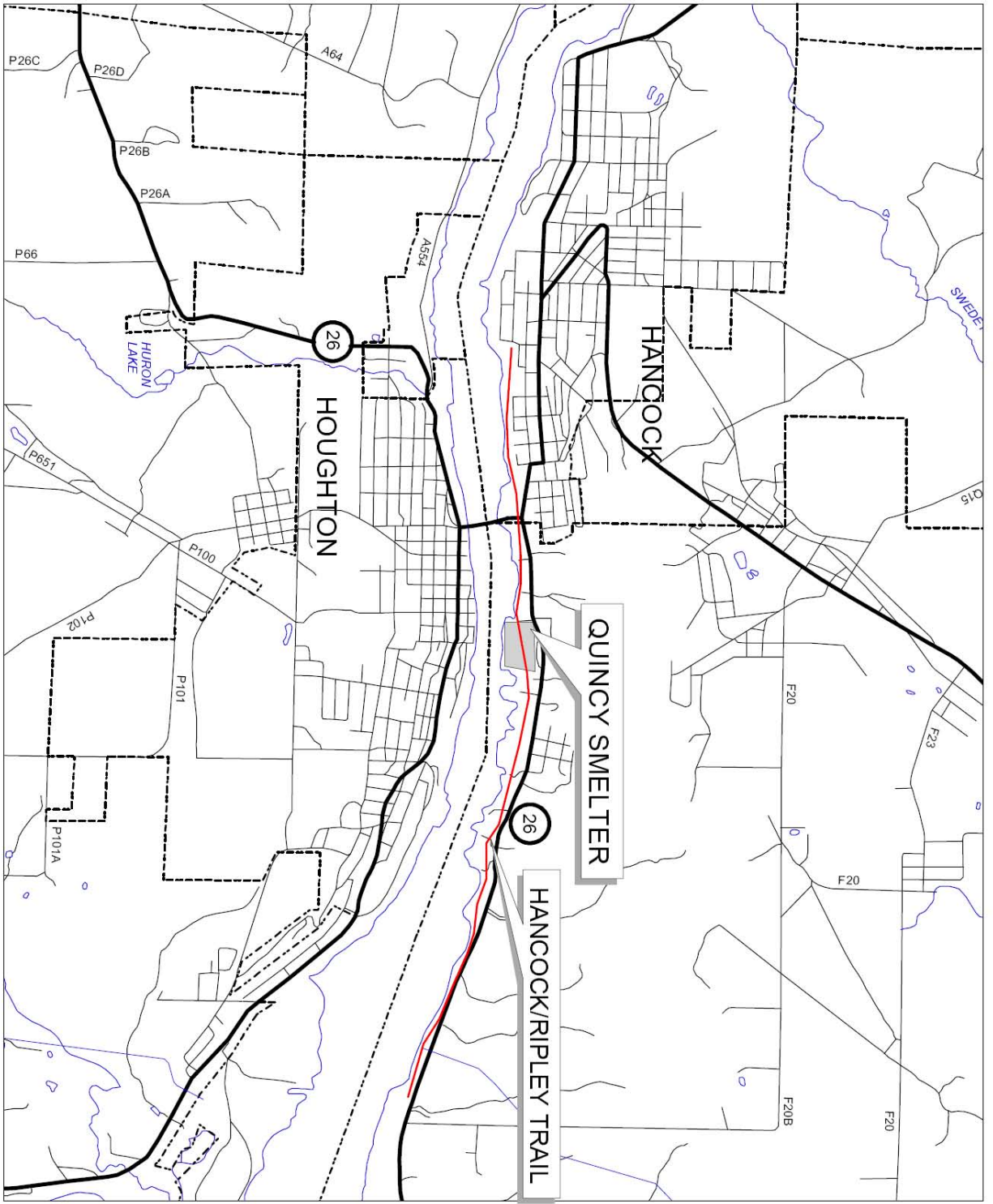
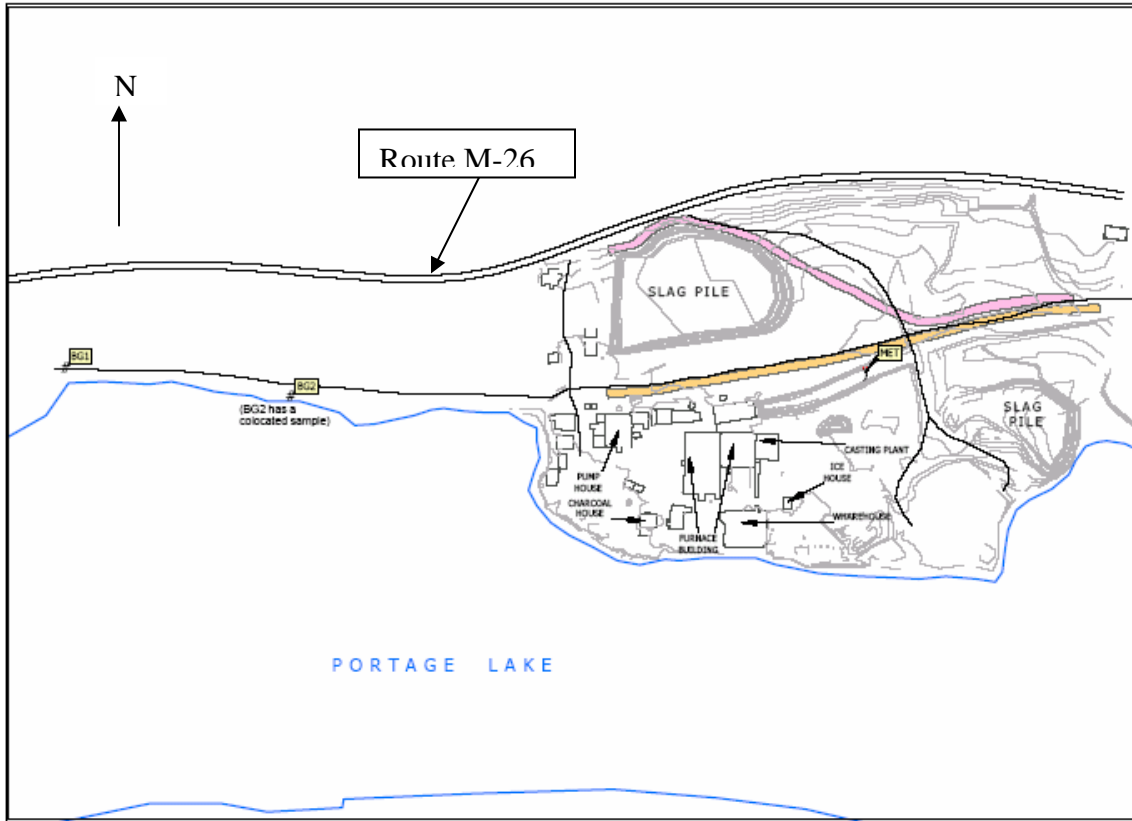


Figure 1.

Figure 2. Overview of study area for August 2004 activity-based sampling. The 0.25-mile stretch of the Hancock/Ripley Trail traversing the Quincy Smelter Site is shown below in orange. The “alternate trail route” is shown below in pink. Note the labeled large slag piles located in the NW and SE corners of the site as well as the presence of Portage Lake, just south of the site.



The orange-shaded area is the portion of the Hancock/Ripley Trail as it traverses the Quincy Smelter Site. The pink-shaded area is the “alternative trail.”

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Preparers of Report

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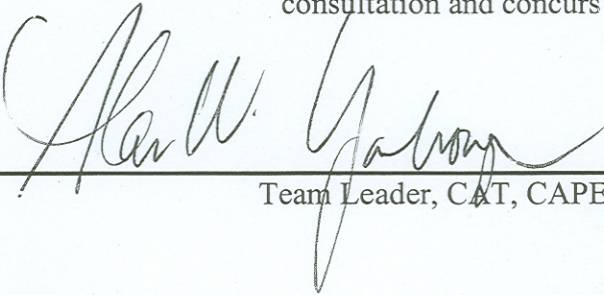
Certification

This Quincy Smelter Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement Partner



Technical Project Officer, Cooperative Agreement Team (CAT), Cooperative Agreement and Program Evaluation Branch (CAPEB), Division of Health Assessment and Consultation (DHAC), ATSDR

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



Team Leader, CAT, CAPEB, DHAC, ATSDR

Appendix A

Photos of the Quincy Smelter Site



Appendix B



Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

October 8, 2004

Debbie A. Begalle
Forest, Minerals, and Fire Mgt Division
Western UP District Supervisor
Michigan Department of Natural Resources
1990 US 41 West
Marquette, MI 49855

Dear Ms. Begalle:

In response to the identification of bulk asbestos-containing materials (ACM) in buildings and on the site of the former Quincy Smelter, and along the Hancock-Ripley Trail, MDNR has indefinitely closed the snowmobile trail as of July 14, 2004. This decision was based on concerns of potential visitor exposure to airborne asbestos fibers released from building structures and from recreational use of the trail. MDNR has requested consultation with the Agency for Toxic Substances and Disease Registry (ATSDR) and the Michigan Department of Community Health (MDCH), to evaluate health hazards associated with public use of the trail.

To conduct this evaluation, ATSDR and MDCH reviewed historical information of environmental sampling performed on and around the Quincy Smelter site. It was determined that the existing information did not provide a sufficient basis for concluding whether the presence of ACM on the site and on the trail posed a public health hazard. It was recommended that additional air sampling be performed to more accurately determine potential exposures to individuals who may access areas on and around the trail as it courses through the site. By collaboration among the U.S. Environmental Protection Agency (USEPA), the Michigan Dept. of Environmental Quality (MDEQ), ATSDR and MDCH, a Sampling and Analysis Plan was developed to evaluate inhalation exposures to asbestos and metals. The primary objectives of the air sampling were to determine the levels of exposure that could be experienced by individuals using the trail under conditions without direct contact with the trail surface, those involved in intrusive recreational activities (i.e. bike riding and ATV riding) on the trail, and those who could be walking on the trail while intrusive activities were occurring. This "activity-based" sampling was conducted between August 15th and 19th, 2004. The USEPA performed baseline and activity-based air sampling along the existing trail adjacent to the Quincy Smelter, approximately a quarter-mile length, and along a potential alternate trail adjacent to Highway 26. Background samples were obtained at four locations upwind from the trail. Three soil samples from the trail were also taken for analysis. ATSDR and MDCH reviewed the sampling protocol prior to the start of the sampling and were

confident that the protocol would improve our ability to characterize potential exposures resulting from recreation use of the trail.

For the purpose of addressing the immediate concern regarding re-opening the snowmobile trail in time for the 2004-05 season scheduled to start on December 1, 2004, ATSDR and MDCH focused on the baseline and background sampling performed at the site. This sampling, performed without the disturbance of soil, most closely represented conditions present during the snowmobile season in which snow cover would prevent dispersal of any soil or dust particles. Activity based sampling that was performed at the site was more applicable to the off-season for snowmobile usage. Evaluation of exposures through use of the trail for other recreational purposes during the off-season (non-winter seasons) will be addressed in a future document.

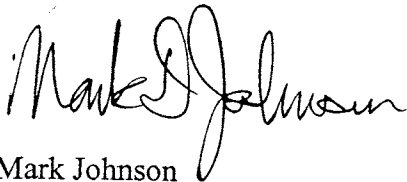
Using a Transmission Electron Microscopy (TEM) analytical methodology (ISO 10312), asbestos was not detected in any of the 8-hour baseline sampling performed at 12 trail and 3 alternate trail locations for either of two days of sampling (a total of 30 samples). One of the 10 background samples, representing four locations, had an airborne concentration of 0.0005 structures per cubic centimeter. It is our opinion that this concentration of airborne asbestos does not pose a public health hazard for individuals using the snowmobile trail.

Based on the detection of elevated metals concentrations from historical sampling of surface soil, slag material, and stampsands at the Quincy Smelter site, air samples at the same locations and activities were collected and analyzed to determine the exposures concentrations of metals. The evaluation of the metal results will be provided in the future Health Consultation. However, the significant snow cover between December and March would prevent dispersion of any fugitive metal-containing dust from these sources. Therefore, the airborne metals do not pose a public health hazard for users of the trails during the snowmobile season.

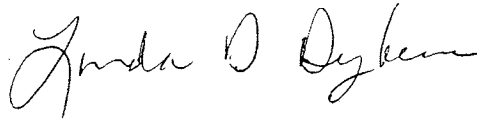
In summary, on the basis of the baseline air sampling conducted by USEPA, use of either the Hancock-Ripley Trail or the proposed alternate trail do not pose a public health hazard from exposure to airborne asbestos or metals for snowmobile users of the trail. Therefore, ATSDR and MDCH concur that the MDNR decision as to the continued closure of the trail for snowmobile use need not be based on public health concerns from airborne asbestos or metal exposure. Use of the trail outside of the snowmobile season will be the subject of an additional evaluation, to be documented in a Health Consultation.

Should you need additional information, please contact Mark Johnson and Michelle Watters (ATSDR: 312-886-0840) or Linda Dykema and Erik Janus (MDCH: 517-335-9084).

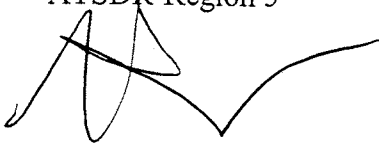
Sincerely,



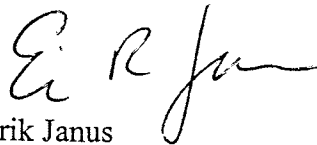
Mark Johnson
Senior Environmental Health Scientist
ATSDR-Region 5



Linda Dykema
Section Manager, Toxicologist
Michigan Department of Community Health



Michelle Watters
Environmental Health Medical Officer
ATSDR-Region 5



Erik Janus
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Appendix C



Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

August 7, 2006

Debbie A. Begalle
Forest, Minerals, and Fire Mgt Division
Western UP District Supervisor
Michigan Department of Natural Resources
1990 US 41 West
Marquette, MI 49855

Dear Ms. Begalle:

This letter is a follow-up to the October 8, 2004 letter that our agencies, the Agency for Toxic Substances and Disease Registry (ATSDR) and the Michigan Department of Community Health (MDCH), sent to you concerning recreational use of the Hancock-Ripley Trail adjacent to the former Quincy Smelter in Franklin Township, Michigan. In that letter, ATSDR and MDCH concluded that "on the basis of the baseline air sampling conducted by USEPA in August 2004, use of either the Hancock-Ripley Trail or the proposed alternate trail do not pose a public health hazard from exposure to airborne asbestos or metals for snowmobile users of the trail." As a continuation of MDNR's requested consultation on evaluating health hazards associated with public use of the trail, this letter addresses recreational use of the trail during the non-snowmobile season.

The August 2004 air sampling was conducted by USEPA along the approximately quarter-mile length of the existing trail adjacent to the Quincy Smelter, and also along a potential alternate trail adjacent to Highway 26. Background samples were collected at four locations upwind from the trail. The objective of the activity-based air sampling was to determine the levels of inhalational exposure to asbestos and metals that could be experienced by individuals using the trail under conditions without direct contact with the trail surface. This would include individuals who could be involved in intrusive recreational activities (i.e. bike riding and ATV riding) on the trail, and those who could be walking on the trail while intrusive activities were occurring.

In our assessment, ATSDR and MDCH focused on the results from this activity-based sampling to evaluate potential exposures for continued recreational use of the trail by ATV users, bike riders, joggers, and walkers after the close of the snowmobile season. The evaluation was conducted for both asbestos fibers and metals. To evaluate the health hazards associated with airborne exposure to asbestos fibers released from building structures and to metals from stamp sands used as trail aggregate during recreational use of the trail, ATSDR and MDCH reviewed historical information and data from the activity-

based sampling performed by the USEPA on and around the Quincy Smelter site in August 2004.

Asbestos Results

The activity-based samples were analyzed by transmission electron microscopy (TEM), using a direct analytical method (ISO 10312). Overall, 116 samples were submitted for analysis, including background, perimeter, and personal monitors. Only 2 of the 58 samples taken at background locations near the site or at perimeter locations along the trail when there were no activities taking place detected asbestos fibers. In the 18 samples from personal monitors collected during the various activities and analyzed by the direct TEM analytical method, asbestos fibers were detected in about half of the samples. The results of the direct TEM analyses suggest that ATV riders using the Hancock-Ripley trail adjacent to Quincy Smelter could be exposed to concentrations up to 0.01 asbestos structures per cubic centimeter. Other recreational trail users would be expected to have lower levels of exposure while the ATVs are in use, up to 0.003 structures per cubic centimeter. Given the assumption that individuals would only be infrequently involved in recreational activities on the trail performed by individuals and that the length of time an ATV would take to traverse the ¼ mile trail is short, it is our opinion that these concentrations of airborne asbestos do not pose a public health hazard for individuals using the trail.

One of the challenges of analyzing air samples that have been collected in a dusty environment is the problem of overloading the filter with particulates, thereby obscuring the detection of asbestos fibers. Since dust overloading was a problem for some of the Hancock-Ripley Trail samples and prevented their analysis by the direct TEM method, seven of the remaining ten samples were analyzed by the indirect TEM method (ISO 13794). However, the limitation of the indirect method is that many of the asbestos structures identified may not have been actually present in the same dimensions in the sampled air. Therefore, the results are only used qualitatively as an indication of the presence or absence of airborne asbestos that may be generated during on-site activities.

The indirect analysis indicated that the area immediately adjacent to the trestle bridge, where previous asbestos abatement activity had occurred, had higher levels of the chrysotile form of asbestos than the remainder of the trail sampled. Because this was revealed using the indirect method, it is not possible to determine if the asbestos was from non-respirable clusters. To minimize any possibilities of exposure from this stretch of the trail, as well as to the remainder of the ¼ mile trail near the smelter, consideration should be given to installation and maintenance of an exposure barrier such as pavement.

Metals results

Metal analyses were also performed on the activity-based air samples. As anticipated from the detection of metals from historic sampling of surface soil, slag material, and stamp sands at the Quincy Smelter site, activity-based air samples revealed that particulate aerosols created during recreational activities contained several metals, predominantly copper. The air concentrations of copper and most other metals were highest for the second of two ATV riders riding in tandem. Walkers, bikers and the first ATV rider typically were exposed to lower concentrations of all metals. Similar to the evaluation of asbestos,

exposure of recreational users to airborne metals resulting from use of this ¼ mile stretch of the Hancock-Ripley Trail does not present a public health hazard since the duration of exposure is considered to be very limited.

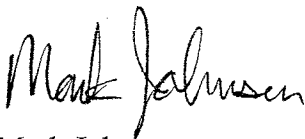
Summary

The results of the activity-based air sampling conducted by USEPA, indicate that use of either the Hancock-Ripley Trail or the proposed alternate trail does not pose a public health hazard from exposure to airborne asbestos or metals from the described recreational use of the trail. Therefore, ATSDR and MDCH concur that the MDNR's decisions for public use of the Hancock-Ripley trail adjacent to the former Quincy Smelter need not be based on public health concerns from airborne asbestos or metal exposure. However, consideration should be given to paving the stretch of the trail adjacent to the trestle bridge to further minimize any possible exposure to the higher levels of asbestos found there.

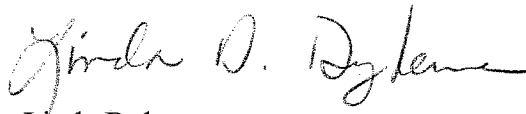
If land uses change at the site, such as to residential development, a re-evaluation of public health risks should be considered. An elaboration of this evaluation and presentation of the sampling data will be documented in a Health Consultation that is under preparation by MDCH and ATSDR.

Should you need additional information, please contact Mark Johnson (ATSDR: 312-886-0840) or Linda Dykema and Erik Janus (MDCH: 517-335-9084).

Sincerely,



Mark Johnson
Senior Regional Representative
ATSDR-Region 5



Linda Dykema
Manager, Toxicology & Response Section
Michigan Department of Community Health



Erik Janus
Toxicologist
Michigan Department of Community Health

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