# Public Health Assessment

**Final Release**

**Evaluation of recreational uses at beach areas at Lake Linden and along Torch Lake**
**Houghton County, Michigan**

**EPA FACILITY ID: MID980901946**

**Prepared by**
**Michigan Department of Community Health**

SEPTEMBER 30, 2014

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 60-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

# PUBLIC HEALTH ASSESSMENT

Evaluation of recreational uses at beach areas at Lake Linden and along Torch Lake
Houghton County, Michigan

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## Foreword

The Michigan Department of Community Health (MDCH) conducted this evaluation for the federal Agency for Toxic Substances and Disease Registry (ATSDR) under a cooperative agreement. ATSDR conducts public health activities (assessments/consultations, advisories, education) at sites of environmental contamination. The purpose of this document is to identify potentially harmful exposures and actions that would minimize those exposures. This is not a regulatory document and does not evaluate or confirm compliance with laws. This is a publicly available document and is provided to the appropriate regulatory agencies for their consideration.

The following steps are necessary to conduct public health assessments/consultations:

- Evaluating exposure: MDCH toxicologists begin by reviewing available information about environmental conditions at the site: how much contamination is present, where it is found on the site, and how people might be exposed to it. This process requires the measurement of chemicals in air, water, soil, or animals. Usually, MDCH does not collect its own environmental sampling data. We rely on information provided by the Michigan Department of Environmental Quality (MDEQ), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed – or could be exposed – to hazardous substances, MDCH toxicologists then determine whether that exposure could be harmful to human health, using existing scientific information. The report focuses on public health – the health impact on the community as a whole.

- Developing recommendations: In its report, MDCH outlines conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to chemicals. If there is an immediate health threat, MDCH will issue a public health advisory warning people of the danger, and will work with the appropriate agencies to resolve the problem.

- Soliciting community input: The evaluation process is interactive. MDCH solicits and considers information from various government agencies, parties responsible for the site, and the community. If you have any questions or comments about this report, we encourage you to contact us.

Please write to: Toxicology and Response Section
Division of Environmental Health
Michigan Department of Community Health
PO Box 30195
Lansing, MI 48909

Or call us at: 1-800-648-6942 (toll free)

For more information, please visit:
www.michigan.gov/mdch-toxics

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# Acronyms and Abbreviations

| | |
|---|---|
| <LOD | less than the level of detection |
| μg | micrograms |
| π | pi (3.141592654) |
| τ | lag time |
| $AE_d$ | dermal absorption efficiency |
| $AE_i$ | ingestion absorption efficiency |
| $AF_{adult}$ | soil adherence factor for an adult |
| $AF_{age1-6}$ | soil adherence factor for a child between the ages one and six |
| AT | averaging time |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| B | ratio of the $K_p$ of the stratum corneum to the $K_p$ of the viable epidermis |
| $BW_{adult}$ | body weight for an adult |
| $BW_{age1-6}$ | body weight for a child between the ages one and six |
| C & H | Calumet and Hecla |
| CF | conversion factor |
| cm | centimeter |
| DCC | Direct Contact Criteria |
| DF | age-adjusted soil dermal factor |
| dL | deciliter |
| $D_{sc}$ | effective diffusivity across stratum corneum |
| $ED_{adult}$ | exposure duration for an adult |
| $ED_{age1-6}$ | exposure duration for a child between the ages one and six |
| EF | exposure frequency |
| $EF_d$ | dermal exposure frequency |
| $EF_i$ | ingestion exposure frequency |
| EPA | U.S. Environmental Protection Agency |
| ET | exposure time |
| EV | event frequency |
| g | grams |
| GCC | Groundwater Contact Criteria |
| GLEC | Great Lakes Environmental Center |
| IF | age-adjusted soil ingestion factor |
| $IR_{adult}$ | soil ingestion rate for an adult |
| $IR_{age1-6}$ | soil ingestion rate for a child between the ages one and six |
| $I_{sc}$ | thickness of stratum corneum |
| kg | kilograms |
| $K_{ow}$ | octanol-water partition coefficient |
| $K_p$ | permeability coefficient |
| L | liter |
| LLVP | Lake Linden Village Park |
| MACTEC | MACTEC Engineering and Consulting of Michigan, Inc. |
| MDCH | Michigan Department of Community Health |
| MDEQ | Michigan Department of Environmental Quality |
| MDNR | Michigan Department of Natural Resources |

| | |
|---|---|
| MDNRE | Michigan Department of Natural Resources and Environment |
| mg | milligrams |
| MW | molecular weight |
| n | sample size (number of fish tested) |
| NAS | National Academy of Sciences |
| NPL | National Priorities List |
| OU | Operable Unit |
| PCB | polychlorinated biphenyl |
| PHA | Public Health Assessment |
| ppb | parts per billion |
| ppm | parts per million |
| RfD | reference dose |
| RSC | relative source contribution |
| $SA_{adult}$ | skin surface area for an adult |
| $SA_{age1\text{-}6}$ | skin surface area for a child between the ages one and six |
| SE | standard error |
| SF | oral cancer slope factor |
| SP | skin penetration per event |
| $SP_i$ | skin penetration per event for inorganic chemicals |
| SPMDs | semipermeable membrane devices |
| $SP_o$ | skin penetration per event for organic chemicals |
| t* | time to reach steady-state |
| THQ | target hazard quotient |
| TLAA | Torch Lake Area Assessment |
| TR | target risk level |
| WUPHD | Western Upper Peninsula Health Department |
| XRF | x-ray fluorescence |

## Torch Lake Superfund Site Public Health Assessment Documents: An Introduction

The federal Agency for Toxic Substances and Disease Registry (ATSDR) is mandated to provide public health activities (assessments, advisories, education) at National Priorities List (NPL, or "Superfund") sites. The Michigan Department of Community Health (MDCH) conducts these activities for ATSDR in Michigan, under a cooperative agreement.

Due to its size and complexity, the Torch Lake Superfund site in Michigan's Upper Peninsula was divided into three Operable Units (OUs), as stated in the United States Environmental Protection Agency (EPA)'s 1992 Record of Decision[1]:

- **OU1** includes surface tailings, drums, and slag pile/beach on the western shore of Torch Lake. These tailing piles include stampsands in Lake Linden, Hubbell/Tamarack City, and Mason, while a slag pile/beach is located in Hubbell.
- **OU2** includes groundwater and surface water, submerged tailings and sediments in Torch Lake, Portage Lake, the Portage Channel, and other bodies of water at the site.
- **OU3** includes tailings and slag deposits located in the north entry of Lake Superior, Michigan Smelter, Quincy Smelter, Calumet Lake, Isle-Royale, Boston Pond, and Grosse-Point.

MDCH previously produced several documents for the Torch Lake Superfund site: a Preliminary Health Assessment in 1989; a Site Review and Update in 1995; and a Health Consultation in 1998 requested by the Michigan Department of Environmental Quality (MDEQ)[2], which was conducting a Brownfields assessment at various locations within the site.

In 2007, MDEQ requested that MDCH provide further public health input on exposure issues for which there was new environmental and toxicological information. MDCH visited the site in June 2008 to gain a better understanding of MDEQ's concerns. The Western Upper Peninsula Health Department (WUPHD) accompanied MDCH, MDEQ, and EPA on this site visit. Issues discussed included:

- ►physical hazards
- ►inhalation of resuspended stampsands
- ►the potential for drinking water to be contaminated
- ►recreational exposure to contaminants along shoreline areas
- ►exposure via local sport-caught fish consumption.

Following the site visit, WUPHD requested that MDCH determine public health implications of these various exposure pathways.

MDCH will address the issues listed above in separate Public Health Assessment (PHA) documents. Each document will be released for public review and comment, following which MDCH will respond in a final document. Comments should be addressed to the first MDCH author listed (see "Preparers of Report" page) and sent to the address in the foreword.

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[1]United States Environmental Protection Agency (EPA).Superfund Record of Decision: Torch Lake, MI. Washington, D.C.: Office of Emergency and Remedial Response, United States Environmental Protection Agency; 1992 Sept. Report No.: EPA/ROD/R05-92/215.

## Summary

The Torch Lake Superfund site is located in Houghton County in the Keweenaw Peninsula of the Michigan Upper Peninsula. Contamination at the site and the surrounding area is primarily from historical copper production waste, which includes stampsands (a type of tailing), slag piles, and remains of industrial facilities, which supported copper production. Areas affected by the copper production wastes include recreational beaches along the shoreline of Torch Lake and other bodies of water in the area.

<u>The Michigan Department of Community Health (MDCH) is unable to determine if the chemicals present in recreational areas in and around the Torch Lake Superfund site could harm people's health. Elevated levels of arsenic, lead, and copper have been found, but chemical levels vary widely and many of the areas have not had enough samples collected to make this determination. Conclusions regarding specific locations at and around the Torch Lake Superfund site are below.</u>

1. *MDCH is unable to determine if the chemicals present in the Lake Linden area will harm people's health, as there are not enough data to make that determination.* Only a few samples have been analyzed from this area, which includes the Lake Linden Village Park (LLVP). Measurement of chemicals in the field indicates that chemical levels vary widely in this area. Bright blue water was previously seen in the LLVP, but the reason the water was colored blue has not been determined.

   <u>Next steps:</u>

   - MDCH recommends that additional sampling be conducted, by the appropriate regulatory agency, to better characterize these chemicals in publically accessible areas, such as the beach, campground, playground, and boat launch.
   - Potentially contaminated material, such as unnaturally blue water, has been observed in the Lake Linden area but not tested. MDCH recommends that people contact the Western Upper Peninsula Health Department (WUPHD) or the local Michigan Department of Environmental Quality (MDEQ) office if they see discolored or oddly colored soil or water so that the material can be identified and the source can be cleaned up, if necessary. Parents and guardians ought to discourage children from playing in that material, since its chemical makeup is not known at this time.
   - MDCH will evaluate any relevant new data if it becomes available.

2. *MDCH is unable to determine if the chemicals present in the Hubbell beach area will harm people's health.* Only a few samples had chemical levels measured by laboratory analysis. Field analysis of samples indicates that chemical levels vary widely. The extent of this contamination is unknown. This area includes portions of Torch Lake with ruins of dock pilings. Some type of grease-like material stuck to an individual's boat during fishing in this part of the lake.

Next steps:

- MDCH recommends that additional sampling of soil or stampsand be conducted, by the appropriate regulatory agency, to better characterize these chemicals in publically accessible areas, such as the swimming beach.
- MDCH will evaluate any relevant new data if it becomes available.

3. *MDCH concludes that the chemicals that have been identified in the Mason Stampsand area will not harm people's health.* This area includes a historic site (a partially sunken sand dredge) and is accessible to the public. Other chemicals and hazards that might be of concern, such as the suspected underground storage tank or undiscovered drums, could be present in the area.

Next steps:

- MDCH will evaluate any relevant new data if it becomes available.
- See the "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" public health assessment (ATSDR 2012) for more information on physical hazards in the Mason Stampsand area.
- MDCH recommends characterization of additional hazards at this location, by the appropriate regulatory agency.

4. *MDCH is unable to determine if the chemicals present at Boston Pond and Calumet Lake will harm people's health as only a small number of sediment samples were collected for each of these lakes.* Although chemical levels were not above the screening levels at Boston Pond and Calumet Lake, fewer than 17 samples were analyzed for each of these two locations. It is possible that higher chemical levels are present at one or both of those areas.

Next steps:

- MDCH recommends additional sampling be conducted, by the appropriate regulatory agency, to better characterize chemicals in these public lakes.
- MDCH will evaluate any relevant new data if it becomes available.

5. *MDCH concludes that unlimited consumption of fish from Torch Lake could harm people's health.* Elevated PCBs, from an unknown source, are present in the fish in Torch Lake. If people follow guidelines listed in the Eat Safe Fish Guide (formerly the Michigan Fish Advisory), the PCB concentrations in the fish are not expected to harm people's health. Follow the Statewide Safe Fish Guidelines, for fish species not listed in the Torch Lake specific guidelines.

Next steps:

- MDCH recommends identification of Torch Lake PCB source(s) and actions to address these sources be conducted by the appropriate regulatory agency.
- The MDEQ and Michigan Department of Natural Resources (MDNR) will continue to collect and analyze fish from Torch Lake.
- MDCH will evaluate any relevant new data when it becomes available.

## Purpose and Health Issues

The Michigan Department of Community Health (MDCH) previously produced several documents discussing public health issues at the Torch Lake Superfund site (ATSDR 1989; 1995; 1998). In 2007, the Michigan Department of Environmental Quality (MDEQ)[3], and the Western Upper Peninsula Health Department (WUPHD) requested that MDCH provide public health input on potential exposures based on new or updated information. This document addresses chemical exposure during recreational activities (for example, while swimming or fishing), primarily at beaches, and exposure via local sport-caught fish consumption. This document does not include any ecological assessments, such as discussion of impacts to wildlife or benthic communities, or discussion of physical hazards in the area. See the "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" health assessment (ATSDR 2012) for more information.

## Background

The Torch Lake Superfund site is located in Houghton County in the Keweenaw Peninsula of the Michigan Upper Peninsula. It was added to the National Priorities List (NPL), also known as Superfund, in 1984 due to the presence of copper production waste. Copper mining and reclamation occurred in this area from the 1890s until the late 1960s. Waste from the copper mining includes stampsands (a type of tailing), slag piles, and remains of industrial facilities which supported copper production. Stampsands are composed of the crushed rock or ore left over after the copper has been removed. Approximately 200 million tons of stampsands and slags were disposed of in Torch Lake, filling about 20% of the original lake volume. The thickness of the stampsand sediments may extend 70 feet down from the sediment-water interface in some locations. Stampsands from the shoreline and lake were dredged from the early to mid-1900s for copper reclamation activities. Processes used to remove any remaining copper from the stampsands included flotation and leaching chemicals. Some of the chemicals were present in the stampsands when they were returned to the lake or shoreline. Other wastes possibly present in the lake or along the shoreline include water pumped from the mines, explosives residues, barrels, and mining byproducts. (Weston 2007A)

Fish (sauger and walleye) from Torch Lake were found to have external and internal tumorous growths in 1979 and 1980. MDCH[4] issued fish consumption advisories for these two species in 1980. The fish advisory, issued due to tumors on the fish, was lifted in 1993, but other advisories were added in the 1990s due to mercury and polychlorinated biphenyl (PCB) concentrations in the fish. (MACTEC 2008)

[3] In 2010, the Michigan Department of Environmental Quality (MDEQ) merged with the Michigan Department of Natural Resources (MDNR) and became the Michigan Department of Natural Resources and Environment (MDNRE). In 2011, the MDNRE was separated back into the MDEQ and MDNR. In this document, "MDEQ" is used within the text, regardless of timeline. However, citations refer to the agency name at the time the reference was created.

[4] At the time of issuing the fish advisories, MDCH was the Michigan Department of Public Health.

Operable Unit (OU) 2, which includes Torch Lake, groundwater, and other surface water, was delisted (deleted from the NPL) in April 2002 along with Lake Linden, a portion of OU1[5]. The Lake Linden area includes a recreational park, with a public swimming beach, playground, campground, dock, and boat launch. An additional portion of OU1, Hubbell/Tamarack City, was delisted in 2004. The Hubbell/Tamarack City area that was delisted includes Hubbell Beach (Weston 2007A). Figure 1 presents an overview of the Torch Lake area.

During a visit to the site, the MDEQ identified sludgy material located in the Lake Linden Village Park (LLVP), which was analyzed and found to contain elevated levels of chemicals. The U.S. Environmental Protection Agency (EPA) conducted an emergency removal in the summer of 2007. The shoreline area was excavated and dredged, with concurrent sampling to confirm removal of the chemicals (Weston 2007B). See Appendix A for further discussion of the emergency removal.

## Discussion

<u>Environmental Contamination</u>

Although the contamination at the Torch Lake Superfund site and surrounding areas has been in existence for years, the large area and diversity of the historical mining contamination have resulted in very few comprehensive samplings. Due to the nature of the contamination, the chemical levels present in one area might not be similar to another area, even if the area is in close proximity.

The MDEQ and the EPA have conducted sampling in LLVP, Hubbell Beach, Boston Pond, and Calumet Lake. These data are from several different reports with different sampling years. Data from additional areas sampled along the western shore of Torch Lake that may have public access but do not necessarily function as recreational beaches, were included in this discussion[6]. Current available sampling data may not be from, or directly applicable to, private- and residential-access beach areas along Torch Lake and northern Portage Lake.

The data were compared to site-specific screening levels that MDCH derived using the equations for the MDEQ Part 201 Generic Cleanup Criteria (MDEQ 2006A, 2006B) and to ATSDR soil comparison values. The Part 201 Generic Criteria are media-specific values that guide risk assessors evaluating a site for possible cleanup. There are no Part 201 criteria that address human exposure to chemicals in sediments or surface water. The inputs to the Residential and Commercial I Direct Contact Criteria (DCC) were adjusted to derive informal screening levels to evaluate dermal and oral (eating) exposure to sediments, such as when people wade in the shallows or sit at the shoreline. MDCH adjusted inputs into the equation that calculates the DCC to simulate a sediment exposure scenario for children and adults. These screening levels were calculated for a yearly 90 day exposure. (See Appendix B for further description.)

[5] Sites can be deleted from the NPL if the EPA believes that all appropriate responses have been taken to protect human health or the environment. This may not mean that all chemicals have been removed, just that all actions stipulated in EPA's Record of Decision for the site will have been completed.
[6] Although the former C & H power plant is on the western shore of Torch Lake, it is not discussed in this assessment and data from this location is not included.

Along with the calculated screening levels, soil and sediment data were also compared to ATSDR intermediate length exposures soil comparison values for children.[7] These comparison values are protective for an exposure more than 14 days, but less than a year.

The ATSDR comparison values are derived for oral exposure to (eating) soil and not do not account for dermal exposure (skin contact) to chemicals in the sediment. Chemicals that were above the screening levels are further discussed in the Exposure Pathways section.

Screening levels for water data were adjusted from the generic Groundwater Contact Criteria (GCC)[8]. The GCC identifies groundwater concentrations that are protective against adverse health effects to workers resulting from dermal exposure to contaminated groundwater. The GCC were adjusted and used as an informal screening value to evaluate dermal exposure to water, such as when children and adults are wading or playing in water-filled holes dug on the beach. Adjusted inputs to the GCC equations are discussed in Appendix B. Incidental ingestion of surface water, such as a gulp or two while playing in the water, is not evaluated against this screening level. It is considered separately in the Exposure Pathways section.

### *Soil and Sediments*

#### *Lake Linden Area*

##### Removal Action in 2007

In 2007, elevated chemical levels were identified in the LLVP, a delisted portion of the Torch Lake Superfund site. The park is along the north shore of Torch Lake and includes a public swimming beach, playground, campground, hiking paths, dock, and boat launch. Torch Lake water levels were low in 2007, down one to two feet, and contaminated material that had been submerged was revealed. White, clayey material was noticed in June of 2007 during a site visit by MDEQ representatives. The material was sampled and revealed elevated levels of PCBs, antimony, arsenic, barium, copper, and lead. Blue colored water was also present at the swimming beach in holes dug by beachgoers, but the water was not tested. The EPA carried out an emergency removal action in this area, removing about 970 tons of soil. See Appendix A for further discussion of the emergency removal. After excavation, soil samples were measured for antimony, arsenic, barium, copper, lead, total PCBs, and mercury (Weston 2007B). Table 1 presents the chemicals that exceeded the site-specific screening levels or comparison values at

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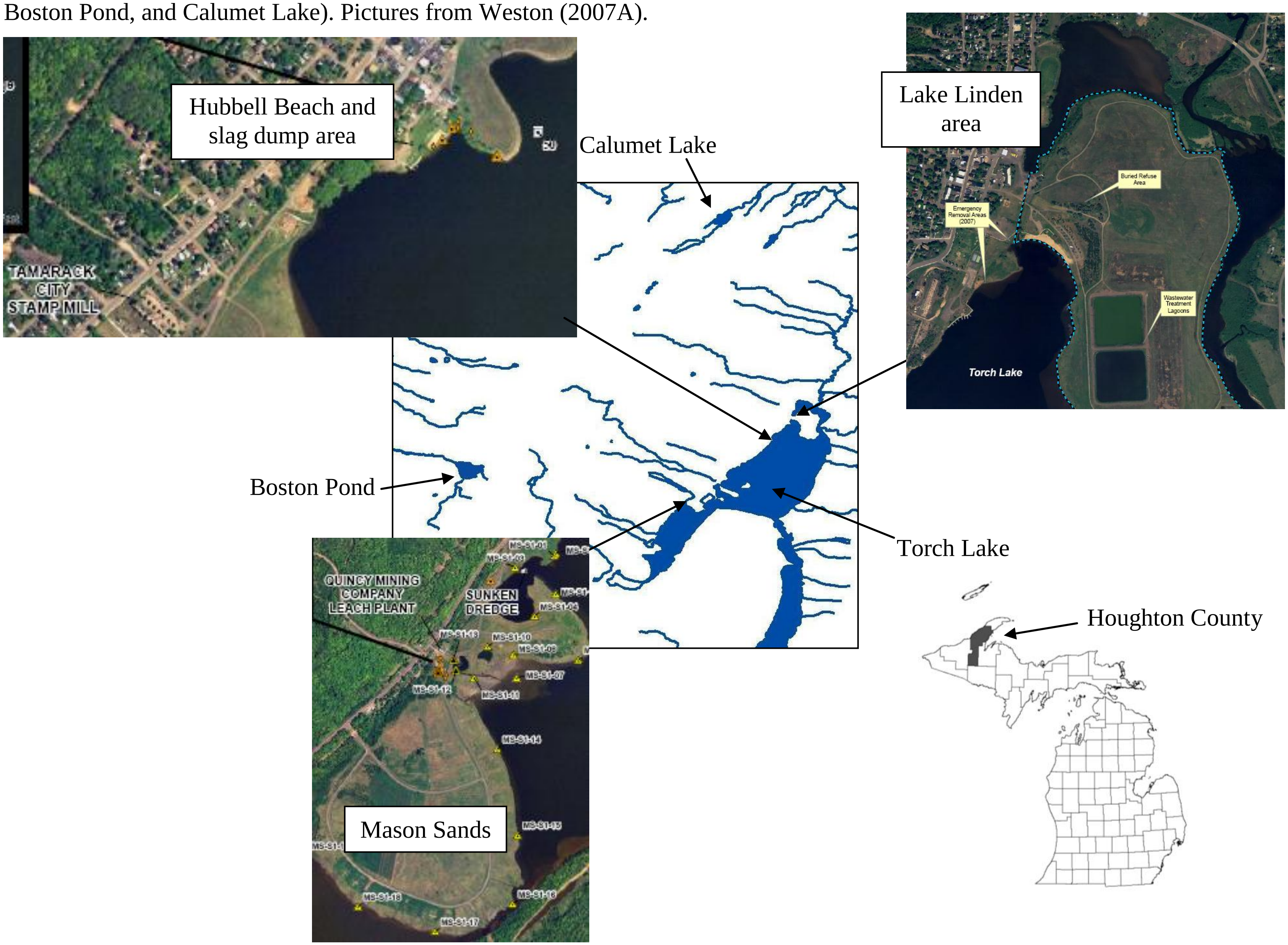
[7] If there were no intermediate comparison values available, the next selected were comparison values for a lifetime of exposure (chronic Environmental Media Evaluation Guides or Reference Dose Media Evaluation Guides).
[8] MDEQ's Groundwater Surface Water Interface Criteria may apply to Torch Lake as the lake is considered part of the surface waters of the state. However, this health assessment does not include a discussion of regulatory compliance.

Figure 1: Map of Torch Lake Superfund Site and surrounding areas (includes Lake Linden area, Hubbell Beach, Mason Stampsands, Boston Pond, and Calumet Lake). Pictures from Weston (2007A).



Lake Linden after the excavation. (See Table C-1 in Appendix C for the full list of chemicals measured.) Figure 2 is a picture of the beach area. Figure 3 is a picture of stampsand remaining at the LLVP after the excavation.

Most of the chemical levels in the samples were below the site-specific screening levels, except for arsenic in one soil sample (out of five samples total). The maximum PCB level in the sediment, "<1.05 parts per million (ppm)," indicates that that is the lowest level that could accurately be measured and that the actual level of PCBs in the sediment is lower than 1.05 ppm. The highest amount of PCBs in the sediment would then be approximately equal to or below the screening level. Arsenic will be discussed in the Exposure Pathways section.

Table 1: Maximum value for chemicals (in parts per million [ppm]) in soil and sediment after the excavation at Lake Linden in 2007 (Weston 2007B).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value in sediment (in ppm) | Maximum value in soil (in ppm) |
|---|---|---|---|---|
| Arsenic | 5.5 | 20[c] | 4 | **20** |
| Copper | 30,355 | 500 | **540** | **5,600** |
| PCBs (Total) | 1.0 | 0.4 | **<1.05** | 0.04 |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.

Figure 2: Beach area at the Lake Linden Village Park, picture taken July 2008 (MDCH).

Figure 3: Stampsand along the shore of Torch Lake near the Lake Linden Village Park beach, picture taken July 2008 (MDCH)

Torch Lake Area Assessment in 2007

The Lake Linden area was sampled as part of the Torch Lake Area Assessment, as documented in a report for the Emergency Response Branch of the Region V EPA in 2007. Areas near LLVP included in the assessment were the Lake Linden Sands (LLVP and the former Calumet Stamp Mill), the backwater area of Torch Lake, the Trap Rock slag dump, and Bootjack stampsands

(Weston 2007A). Thirty-nine soil samples were screened using an x-ray fluorescence (XRF) analyzer[9], and four samples were sent to a laboratory and analyzed for metals. (XRF analyzers can provide real-time measurements of chemicals and were used to guide sampling for laboratory analysis. The presence of multiple metals can cause XRF results to vary. XRF results may be similar to, higher, or lower than laboratory analyzed levels. This makes XRF data difficult to interpret.) Five samples were sent to a laboratory to be analyzed for PCBs. No PCBs were detected. Table 2 presents the maximum levels of inorganic chemicals without or over the site-specific screening levels or ATSDR comparison values. (See Table C-2 in Appendix C for the full list of chemicals measured during this sampling.)

Elevated arsenic and lead were detected in samples from the Lake Linden area. One XRF analyzed sample and one laboratory sample exceeded the arsenic screening level. One XRF analyzed sample and one laboratory analyzed sampled exceeded the lead screening level. Lead and arsenic will be discussed in the Exposure Pathways section.

Table 2: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Lake Linden area in 2007 (Weston 2007A).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Antimony | 280 | 20[c] | **60** | NT[d] |
| Arsenic | 5.5 | 20[e] | **33** | **36** |
| Cadmium | 1,829 | 30 | **89** | NT |
| Cobalt | 3,994 | 500 | **924** | 18 |
| Copper | 30,355 | 500 | **7,731** | **10,000** |
| Lead | 400[f] | NA[g] | **432** | **1,100** |
| Rubidium | NA | NA | 86 | NT |
| Tin | NA | 20,000 | <LOD[h] | NT |
| Titanium | NA | NA | 13,818 | NT |
| Zirconium | NA | NA | 367 | NT |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = Chemical was not tested (NT) in samples.
e = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
f = Part 201 Generic DCC (MDEQ 2005B).
g = Screening levels not available (NA).
h = Value is below the level of detection (<LOD).

[9] XRF analysis is useful, however it typically does not have as stringent quality assurance and quality control as laboratory analysis of soil samples. Results from XRF analysis may differ from laboratory analysis due to different sample preparation, quality assurance/quality control sampling, and instrument calibration and usage conditions. Field conditions are difficult, if not impossible, to control. XRF data should be verified by laboratory analysis.

### Michigan Department of Environmental Quality 2008 sampling

During a more recent sampling (2008), chemicals in 85 sediment and soil cores from the Lake Linden area were measured using an XRF analyzer (MDEQ 2009A). The samples were taken along the shoreline, through the emergency removal areas, to the end of the beach. Additional samples were taken along the creek in the LLVP. Maximum inorganic chemical levels without or over the site-specific screening levels or comparison values are in Table 3. (See Table C-3 in Appendix C for the full list of chemicals measured.)

Table 3: Maximum inorganic chemical levels in soil and sediment (in parts per million [ppm]) as measured by x-ray fluorescence (XRF) analyzer in the Lake Linden area in 2008 (MDEQ 2009A).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value in soil and sediment ( in ppm) |
|---|---|---|---|
| Antimony | 280 | 20[c] | **171** |
| Arsenic | 5.5 | 20[d] | **294** |
| Barium | 55,916 | 10,000 | **13,870** |
| Cadmium | 1,829 | 30 | **91** |
| Calcium | NA[e] | NA | 57,627 |
| Cesium | NA | NA | 137 |
| Copper | 30,355 | 500 | **11,661** |
| Lead | 400[f] | NA | **16,289** |
| Nickel | 60,710 | 1,000[c] | **1,500** |
| Palladium | NA | NA | 18 |
| Potassium | NA | NA | 43,116 |
| Rubidium | NA | NA | 118 |
| Scandium | NA | NA | 95 |
| Sulfur | NA | NA | 52,789 |
| Tellurium | NA | NA | 131 |
| Thorium | NA | NA | 228 |
| Tin | NA | 20,000 | 4,295 |
| Titanium | NA | NA | 7,389 |
| Tungsten | NA | NA | 150 |
| Uranium | NA | NA | 17 |
| Zircon | NA | NA | 947 |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
e = Screening level is not available (NA).
f = Generic Part 201 DCC (MDEQ 2005B).

Arsenic and lead levels were above the site-specific screening levels. Both the maximum arsenic and lead samples were from over a foot below the ground surface. Chemical levels obtained from XRF analysis when samples are analyzed in the field are subject to variability due to the unavoidable condition of the sample (it contains moisture and may have larger pieces that would have been sifted out prior to laboratory analysis). It should be noted that the XRF analysis was carried out in the field and that the samples were analyzed as they were collected. XRF data is most useful in highlighting locations that might have elevated levels of arsenic or lead. There were 13 exceedences of the lead screening level and 72 exceedences of the arsenic screening level. Samples with exceedences were in areas accessible to people, in lake bottom sediments offshore from the beach and the area where the creek meets Torch Lake. Many of the samples are more than six inches below the sediment or soil surface. However, since this is a recreational beach area, beachgoers may dig holes and come into contact with these sediments. Other chemicals were higher than the comparison values. Laboratory analysis of this material is necessary to accurately measure the chemicals present. Arsenic and lead will be discussed further in the Exposure Pathways section.

Several of the chemicals measured in the Lake Linden area do not have site-specific screening levels. These chemicals will be discussed in the Chemicals without Screening Levels section.

*Hubbell Beach*

The Hubbell Beach area was also sampled as part of the Torch Lake Area Assessment (Weston 2007B). Areas sampled in the vicinity of Hubbell Beach are the Hubbell Beach and slag dump; the former C & H Leach Plant and Hubbell Stampsands; and the Hubbell Docks, Mineral Building, and former C & H Smelter (Weston 2007A). Thirty-one samples were screened using an XRF analyzer, and three samples were sent to a laboratory for analysis for metals.

Table 4 presents the maximum levels of inorganic chemicals present during this sampling. Also included in Table 4 are MDEQ samples collected in August 2007 and reported in an appendix of Weston (2007A). Three samples were analyzed for PCBs. No PCBs were detected. (See Table C-4 in Appendix C for the full list of chemicals measured.)

Although several chemicals were above the site-specific screening levels, when measured with XRF analysis, only arsenic, copper, and lead levels were above the site-specific screening levels for the laboratory analyzed samples. These three chemicals (copper, arsenic, and lead) will be discussed in the Exposure Pathways section. XRF analysis showed elevated levels of antimony, chromium, iron and mercury, Laboratory analysis did not find elevated levels of iron and mercury in the same samples that had elevated levels measured by XRF. Results from laboratory analyses are more reliable than the XRF data. Additionally, samples that were analyzed by a laboratory had results lower than the XRF value. (Laboratory results ranged from four to 48 times lower than the corresponding XRF result.) Therefore, these chemicals will not be discussed further.

Table 4: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Hubbell Beach area in 2007 (Weston 2007A).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Antimony | 280 | 20[c] | **466**[d] | **37**[d] |
| Arsenic | 5.5 | 20[e] | **2,505** | **230** |
| Cadmium | 1,829 | 30 | **137**[d] | 19[d] |
| Chromium | 3,834[f] | 300[f] | **7,850** | 76[d] |
| Cobalt | 3,994 | 500 | **1,653** | 48 |
| Copper | 30,355 | 500 | **840,928** | **74,000**[d] |
| Iron | 239,642 | NA[g] | **544,540** | 63,000[d] |
| Lead | 400[h] | NA | **28,724**[d] | **6,800**[d] |
| Mercury | 240 | NA | **340**[d] | 7[d] |
| Nickel | 60,710 | 1,000[c] | **2,744** | 540 |
| Rubidium | NA | NA | 144[d] | NT[i] |
| Silver | 3,754 | 300[c] | **1,059**[d] | **330**[d] |
| Tin | NA | 20,000 | 27,016[d] | NT |
| Titanium | NA | NA | 25,083 | NT |
| Zinc | 263,607 | 20,000 | **261,353** | 5,400 |
| Zirconium | NA | NA | 1,054 | NT |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = Maximum level from August 2007 MDEQ sampling (Weston 2007A).
e = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
f = Screening level is for chromium VI.
g = Screening level not available (NA).
h = Generic Part 201 DCC (MDEQ 2005B).
i = The chemical was not tested (NT) for in the sample.

Bordering one side of Hubbell Beach is an area of land that was a municipal and slag dump. There are anecdotal reports of swimmers and divers being able to visually identify items, such as household wastes, including a refrigerator and car batteries, and pieces of slag (A. Keranen, MDEQ Upper Peninsula District Office, personal communication, 2010; S. Baker, MDEQ, personal communication 2012). Swimmers and those walking or playing along the shore may encounter physical hazards along with unknown chemicals. For further information on physical hazards present at this location and the Torch Lake Superfund site, please review the “Physical Hazards in the Torch Lake Superfund Site and Surrounding Area” public health assessment (ATSDR in draft).

*Mason Stampsands*

Torch Lake Area Assessment in 2007

Another area sampled as part of the Torch Lake Area Assessment (Weston 2007A) was the Mason Stampsands. Thirty-seven samples were screened using an XRF analyzer, and seven samples were sent to a laboratory for analysis. All seven of the samples were analyzed for PCBs.

No PCBs were detected. Table 5 presents the maximum levels of inorganic chemicals without or over the site-specific screening levels or comparison values. (See Table C-5 in Appendix C for the full list of chemicals measured during this sampling.) Figure 4 and 5 are of the expanse of the stampsand at Mason. Locations included in this area were the Mason Area Ruins, Mason Sands, and Tamarack Sands.

Figure 4: Expanse of partial vegetative cover toward the dredge at Mason, picture taken July 2008 (MDCH).

Figure 5: Expanse of exposed stampsand at Mason, picture taken 2008 (MDCH).

Table 5: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Mason Stampsands in 2007 (Weston 2007A).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison values[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Arsenic | 5.5 | 20[c] | **74** | **10** |
| Cobalt | 3,994 | 500 | **902** | 25 |
| Copper | 30,355 | 500 | **275,954** | **19,000** |
| Lead | 400[d] | NA[e] | **631** | **1,100** |
| Rubidium | NA | NA | 95 | NT[f] |
| Tin | NA | 20,000 | 428 | NT |
| Titanium | NA | NA | 18,070 | NT |
| Zirconium | NA | NA | 189 | NT |

**Bold** values are those that exceed the screening levels.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
d = Part 201 Generic DCC (MDEQ 2005B).
e = Screening levels not available (NA).
f = The chemical was not tested (NT) for in the sample.

In the samples analyzed by XRF analysis, the maximum levels of copper, arsenic, and lead were above the site-specific screening levels, while in the laboratory analyzed samples only the maximum level of lead and arsenic were above the screening level. Arsenic, lead, and copper were above the comparison values. Arsenic, lead, and copper will be discussed in the Exposure Pathways section.

Removal Action in 2008

Arsenic-containing stampsand was removed from Mason in November 2008 by the EPA's Emergency Removal Branch (EPA 2008A). Thirty tons of arsenic contaminated stampsand and soil and 10 drums with residual waste were removed. After the contaminated material was removed, XRF analysis identified less than 5.0 ppm arsenic in the remaining soil. Laboratory analysis for arsenic in the remaining soil confirmed that highest level of arsenic was 1.6 ppm, which is below the screening level of 5.5 ppm for arsenic.

The Mason stampsands area includes structures from historical mining activities. In Torch Lake, just offshore is a sand dredge (Calumet and Hecla/Quincy Reclaiming Sand Dredge). See Figure 6. It is a state registered historical site (state registered historical site number P23275). Visitors and residents are allowed access to this location, and graffiti is on many visible areas and interior walls of the dredge (S. Baker, MDEQ, personal communication, 2012). Ruins of a building are present near the shore and are used for recreational activities, such as paintball (Figure 7). For further information on physical hazards present at this location and the Torch Lake Superfund site, please review the "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" public health assessment (ATSDR 2012).

Figure 6: Partially sunken Calumet and Hecla/Quincy Reclaiming Sand Dredge at Mason, picture taken July 2008 (MDCH).

Figure 7: Ruins at Mason with paintball marks, picture taken July 2008 (MDCH).

*Boston Pond and Calumet Lake*

Michigan Department Environmental Quality sampling in 2008

In June of 2008, MDEQ collected five sediment samples from Boston Pond and seven sediment samples from Calumet Lake (MDEQ 2009B). MDEQ's purpose was to gather initial sediment screening data, since these locations had not been previously sampled.

Figure 8 shows a portion of Boston Pond and the access from the road, while Figure 9 shows the parking area for Calumet Lake. Table 6 presents the maximum levels of inorganic chemicals from both Boston Pond and Calumet Lake sampling over the site-specific screening levels or comparison values. (See Table C-6 in Appendix C for the full list of chemicals measured.)

Figure 8: Boston Pond and driveway entry, picture taken July 2008 (MDCH).

Figure 9: Calumet Lake and parking area, picture taken July 2008 (MDCH).

Table 6: Maximum levels (in parts per million [ppm]) of inorganic chemicals in Boston Pond and Calumet Lake sediment collected in 2008 (MDEQ 2009B).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison values[b] (in ppm) | Maximum value in Boston Pond sediment (in ppm) | Maximum value in Calumet Lake sediment (in ppm) |
|---|---|---|---|---|
| Copper | 30,355 | 500 | **3,300** | **13,000** |

a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.

No inorganic chemical values exceed the site-specific screening levels, but copper exceeded the comparison value. Since the sample size was small for these areas (only five sediment samples from Boston Pond and seven sediment samples from Calumet Lake), it is not known whether higher chemical levels are present elsewhere in sediments of these two bodies of water.

Organic chemicals were only detected in the sediment from Calumet Lake. The chemical over the site-specific screening levels or comparison values are presented in Table 7. (See Table C-7 in Appendix C for the full list of chemicals measured.) Levels of the organic chemicals were not above site-specific screening levels, but the maximum benzo(a)pyrene levels was above the comparison value. Again, because of the small sample size, chemicals might not be sufficiently characterized at these two locations. Higher chemical levels could be present elsewhere in sediments from Calumet Lake or Boston Pond.

Table 7: Maximum level (in parts per million [ppm]) of detected organic chemicals in Calumet Lake sediment collected in 2008 (MDEQ 2009B).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum level in sediment (in ppm) |
|---|---|---|---|
| Benzo(a)pyrene | 0.53 | 0.1 | **0.22** |

a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.

Environmental Protection Agency sampling in 2010

Sediments from Boston Pond (10 samples) and Calumet Lake (10 samples) were collected again in May 2010 and analyzed for metals, organic chemicals, and PCBs (SulTRAC 2010). These data were evaluated and several different data quality issues exist, as documented in the EPA's data validation reports. Therefore, these data were not reliable and will not be discussed.

*Groundwater and Surface Water*

Municipal and private drinking water wells are discussed in a separate document. See the "Evaluation of Municipal and Residential Drinking Water around the Torch Lake Superfund site (Houghton County), Michigan" public health assessment for more information (ATSDR 2012).

*Lake Linden Area*

Removal action in 2007

Torch Lake water levels were low in 2007, down one to two feet, and contaminated material that had been submerged was above water. Blue colored water was observed at the swimming beach in holes dug by beachgoers; however, the water was not tested. The EPA carried out an emergency removal action in this area. See Appendix A for further discussion of the emergency removal. Following the removal, surface water samples were taken from Torch Lake, in the LLVP beach area (two samples), and a creek running through the park (one sample). Samples were measured for antimony, arsenic, barium, copper, lead, mercury, zinc, silver, and vanadium (Weston 2007B). No chemicals were present above the site-specific screening levels. However, there were only three samples, one from the creek and two from Torch Lake water at the beach. It is unknown whether additional sampling (more sample locations or a different sampling event) would have had elevated chemical levels. (See Table C-8 in Appendix C for the full list of chemicals measured.)

Michigan Department Environmental Quality sampling in 2008

The MDEQ sampled groundwater, in August 2008, in the Lake Linden area. The sampling area was a stampsand peninsula, which rises 30 feet above the lake level. (Before addition of the stampsands, Torch Lake was 121 feet deep at this location.) According to the MDEQ report (MDEQ 2009A), the stampsand characteristics of the man-made peninsula cause a preferential groundwater flow into Torch Lake. Ninety sample locations, out of 226, were identified as potential groundwater discharge locations to the lake. Table 8 presents the maximum values of chemicals without or over the site-specific screening levels. (See Table C-9 in Appendix C for the full list of chemicals measured.) As there is no screening level for lead, it will be discussed in the Exposure Pathways section.

Table 8: Maximum value for chemicals in groundwater (in parts per billion [ppb]) in the Lake Linden area in 2008 (MDEQ 2009A).

| Chemical | Screening levels[a] (ppb) | Maximum value in groundwater (ppb) |
|---|---|---|
| Ammonia | NA[b] | 80,000 |
| Arsenic | 408 | 83 |
| Chloride | NA | 620,000 |
| Copper | 996,408 | 13,000 |
| Iron | 7,866,379 | 54,000 |
| Lead | NA | 48 |
| Nitrogen | NA | 83,000 |

**Bold** values are those over the screening level.
a = Screening levels are discussed in Appendix B.
b = Screening levels are not available (NA).

*Torch Lake*

Torch Lake fish were found to have higher PCB levels, in the filets, compared to fish found in Lake Superior and other nearby bodies of water. Fish will accumulate chemicals from water, and levels in the fish can be up to thousands of times higher than in the water.

To determine if the water in Torch Lake had higher PCB levels than other nearby bodies of water, semi-permeable membrane devices (SPMDs) were deployed in Torch Lake, Portage Lake, the Keweenaw Waterway (Houghton County), and Huron Bay in Lake Superior (Baraga County) (GLEC 2006).

The SPMDs contain plastic tubing filled with a solution that is similar to fish fat. Chemicals will move through the tubing and into the solution, which retains chemicals that tend to accumulate in lipids (fats), such as PCBs. This means that SPMDs can act as models for bioconcentration (more chemicals present in the animals than in the environment) that can occur in animals (Chapman 2009).

SPMDs (four per site) were placed at 10 sites, five within Torch Lake and the other five placed in the outlet from Torch Lake, the north and south entries to the Keweenaw Waterway, Dollar Bay (Portage Lake), and Huron Bay (Lake Superior), and left for 28 days. After collection, each site's samples were composited and analyzed for 83 PCB congeners (GLEC 2006). Note that the purpose of this data was to determine if a source of PCBs is present in Torch Lake. Data from this study does *not* represent PCB water levels to which people might be exposed. Table 9 presents the total PCB levels in the SPMDs.

Table 9: Total PCB levels (in micrograms per liter [µg/L]) in the semipermeable membrane devices (SPMDs) deployed in Torch Lake and nearby waterbodies in 2005 (GLEC 2006).

| Watershed | Sites | Total PCB levels[a] (µg/L) |
|---|---|---|
| Torch Lake | Trap Rock River | 23 |
| | Lake Linden area | 75 |
| | pilings near Peninsula Copper Industries | 151 |
| | Mason Sands | 24 |
| | eastern side of Torch Lake, toward outlet of lake | 78 |
| | outlet of Torch Lake | 63 |
| Portage Lake | Dollar Bay | 22 |
| Keweenaw Waterway | north entry | 25 |
| | south entry | 24 |
| Lake Superior | Huron Bay | 24 |

a = These PCB levels are not the levels present in Torch Lake water.

Increased concentrations of total PCBs were identified in SPMDs deployed in Torch Lake (23 to 151 µg/L) as compared to sites in other watersheds (range 22 to 25 µg/L). Additionally, more PCB congeners were detected in Torch Lake (15 to 42 congeners) as compared to sites in other watersheds (13 to 16 congeners). From the data collected in the report, the main basin of Torch Lake was identified as a source of PCBs, with potential sources to the lake on the western side (GLEC 2006).

*Boston Pond and Calumet Lake*

In May 2010, 10 surface water samples each were taken from Boston Pond and Calumet Lake. All 20 samples were analyzed for metals, PCBs, and select organic chemicals. For those metals with site-specific screening levels, no sample results were above the site-specific screening levels. A majority of the results were below the detection limit for the analytical method. All PCB results were below the detection limits. Organic chemicals were below the detection limit for the analytical method (SulTRAC 2010).

## *Fish*

*Torch Lake*

The Michigan Fish Contaminant Monitoring Program has tested fish from Torch Lake in 1988, 2000, and 2007. The edible portions of the fish (filets) are tested for a variety of chemicals, including mercury and PCBs. Table 10 presents the average chemical levels in four species of fish caught in Torch Lake.

Table 10: Chemical levels (mean ± standard error [SE]) in parts per million (ppm) in fish from Torch Lake[a].

| Species | Years collected | Mercury (in ppm)[b] | Total PCBs (in ppm) | Total Chlordane (in ppm) | Total DDT (in ppm) |
|---|---|---|---|---|---|
| Northern Pike | 1988, 2000, and 2007 | 0.326 ± 0.03 (n = 28)[c] | 0.069 ± 0.01 (n = 30) | 0.001 ± 0 (n = 10) | 0.011 ± 0.002 (n = 30) |
| Smallmouth Bass | 1988 and 2000 | 0.325 ± 0.04 (n = 22) | 0.072 ± 0.01 (n = 22) | 0.006 ± 0.001 (n = 3) | 0.014 ± 0.001 (n = 21) |
| Walleye | 1988, 2000, and 2007 | 1.56 ± 0.10 (n = 36) | 0.117 ±0.02 (n = 35) | 0.003 ± 0 (n = 27) | 0.019 ± 0.003 (n = 36) |
| White Sucker | 2007 | 0.64 ± 0.09 (n = 10) | 0.014 ± 0.005 (n = 10) | 0.001 ± 0 (n = 9) | 0.004 ± 0.001 (n = 10) |

a = Fish data was obtained from the Michigan Fish Contaminant Monitoring Program (J. Bohr, MDEQ).
b = Arithmetic mean plus or minus (±) the standard error (SE).
c = Number of fish tested.

MDCH has current fish consumption guidelines in Torch Lake for northern pike, smallmouth bass, and walleye due to mercury and PCB levels (MDCH 2009). Additionally, Torch Lake also falls under the Statewide Safe Fish Guidelines for other species of fish (rock bass, yellow perch, crappie, and muskellunge). See the Statewide Safe Fish Guidelines for more information (www.michigan.gov/eatsafefish).

*Boston Pond*

Yellow perch and white sucker were collected from Boston Pond in 2000. Average chemical amounts in those fish are presented in Table 11. There are no water body-specific guidelines for Boston Pond, but it is still included in the Statewide Safe Fish Guidelines.

Fish from Calumet Lake have not been collected; there may not be any sport-fish in the lake. However, any fish in Calumet Lake are included in the Statewide Safe Fish Guidelines.

Table 11: Chemical levels (mean ± standard error [SE]) in parts per million (ppm) in fish from Boston Pond[a].

| Species | Year collected | Mercury (in ppm)[b] | Total PCBs (in ppm) | Total Chlordane (in ppm) | Total DDT (in ppm) |
|---|---|---|---|---|---|
| Yellow Perch | 2000 | 0.073 ± 0.007 (n = 10)[c] | ND[d] | ND | ND |
| White Sucker | 2000 | 0.023 ± 0.003 (n = 9) | ND | ND | 0.003 ± 0 (n = 2) |

a = Fish data was obtained from the Michigan Fish Contaminant Monitoring Program (J. Bohr, MDEQ).
b = Arithmetic mean plus or minus (±) the standard error (SE).
c = Number of fish tested.
d = ND=Not detected

Exposure Pathways Analysis

An exposure pathway contains five elements: (1) the chemical source, (2) contamination of environmental media, (3) an exposure point, (4) a human exposure route, and (5) potentially exposed populations. An exposure pathway is complete if there is a high probability or evidence that all five elements are present. Table 12 describes human exposure to chemicals in the Torch Lake Superfund site beach areas, Boston Pond, or Calumet Lake (Houghton County), Michigan. As wells have been installed in areas with stampsands, ingestion of (drinking) well water is a potential exposure route for residents and visitors to the Torch Lake area. However, the drinking water exposure route is evaluated in a separate health consultation (See the "Evaluation of Municipal and Residential Drinking Water around Torch Lake [Houghton County], Michigan" health assessment for further information [ATSDR 2012]).

Table 12: Exposure pathway for chemicals present at the beach areas in or near the Torch Lake Superfund site, Boston Pond, or Calumet Lake (Houghton County), Michigan.

| Source | Environmental Medium | Exposure Point | Exposure Route | Exposed Population | Time Frame | Exposure |
|---|---|---|---|---|---|---|
| Historical mining activities (inorganic and possibly organic, like PCBs, chemicals) | Soil | Beaches and recreational shore areas | Incidental ingestion, Inhalation, Dermal contact | Residents and tourists | Past Present Future | Complete |
| | Sediment and surface water | Beaches and recreational shore areas | Incidental ingestion, Dermal contact | Residents and tourists | Past Present Future | Complete |
| | Groundwater | Beaches and recreational shore areas | Incidental ingestion, dermal contact | Residents and tourists | Past Present Future | Complete |
| Historical mining and related activities (PCBs) | Sediment (transfer to the fish) | Sport-caught fish | Ingestion | Residents and tourists | Past Present Future | Complete |

Dermal contact is considered the primary exposure route. Inhalation of sediments or wet sand is not expected to occur, as the material is water saturated and not expected to become airborne. Chemicals present are not expected to volatilize and are not expected to be inhaled. People may swallow small amounts of the soil, sediment, or water while engaging in recreational beach activities. People may also be exposed to PCBs from eating fish from Torch Lake, Boston Pond, or Calumet Lake.

Overall, elevated levels of arsenic, copper, and lead are present in the Lake Linden, Hubbell Beach, and Mason area. People may encounter elevated levels of these chemicals, among others, at other locations in and around the Torch Lake Superfund site. Based on the sampling done to date, the elevated chemical levels are not consistently present. The maximum levels overall for laboratory analyzed samples are 230 ppm for arsenic, 74,000 ppm for copper, and 6,800 ppm for lead. Only a limited number of samples had laboratory analysis. XRF analysis was carried out on a much larger group of samples. The maximum levels from the XRF samples are even higher, at 2,505 ppm for arsenic, 840,928 ppm for copper, and 28,724 ppm for lead[10].

*Lake Linden area*

The Lake Linden area discussed in this document includes the LLVP, backwater area of Torch Lake, Trap Rock slag dump, and Bootjack Stampsands. (See Figure D-1 in Appendix D for a larger picture of the area.) Note that the entire backwater area of Torch Lake, including the Trap Rock slag dump and Bootjack stampsands, is not part of the Torch Lake Superfund site.

The LLVP consists of a beach, camping locations, picnic, hiking, and playground facilities. People are expected to encounter the surface water of the creek and Torch Lake, the sand, lake bottom sediment, and soil while engaged in recreational activities at this site. Blue colored water, previously observed at this location, may contain other chemicals (than lead, arsenic, or copper) and might be attractive for children.

Adults and children may encounter spots of elevated levels of arsenic, copper, and lead in soil and sediment while playing in the LLVP or walking along the shoreline, but are not expected to come into contact with consistently elevated levels of these chemicals. This is because levels of these chemicals varied widely in the Lake Linden area. A majority, approximately 75%, of the samples analyzed with XRF, were below the detection limit for arsenic and approximately 20% of the samples were below the detection limit for copper and lead.[11] Additionally, XRF and laboratory samples are processed differently. The levels of chemicals from the XRF analysis are better suited to provide an indication of locations where further sampling should be carried out rather than be used in estimating exposure.

The backwater area of Torch Lake is located along the original northern shoreline of Torch Lake and includes surface water and shoreline created from the stampsand dumped into the lake. A school is adjacent to this area. South of the backwater area is an area of stampsand where an old municipal dump was located and that currently houses two wastewater treatment lagoons. There is open access to this area.

Also accessible are the Trap Rock slag dump and the Bootjack Stampsands. They are both located along Bootjack Road along the Trap Rock River. The Trap Rock slag dump is an open area with slag boulders and was a location previously used for transformer disposal. The Bootjack stampsands is an area that accumulated stampsands when Lake Linden stampsands were redistributed (Weston 2007A).

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[10] XRF analysis is useful, however it typically does not have as stringent quality assurance and quality control as laboratory analysis of soil samples. Results from XRF analysis may differ from laboratory analysis due to different sample preparation, quality assurance/quality control sampling, and instrument calibration and usage conditions. Field conditions are difficult, if not impossible, to control. XRF data should be verified by laboratory analysis.

[11] Due to the small number of laboratory analyzed samples and the number of XRF analyzed samples reported as below the level of detection (<LOD), it is not possible to calculate averages or the 95% upper confidence limit on the mean. Detection limits can vary widely for every chemical measured in every sample.

Children and adults swimming in Torch Lake may occasionally drink some of the water. This exposure, called incidental ingestion, represents a very small amount of what adults would drink during a day (approximately 0.005% [0.0001 L/day] of a daily intake [2.0 L/day]). For children, incidental ingestion would represent about 1.0% [0.01 L/day] of a daily intake [0.83 L/day]). There were only three surface water samples evaluated. Groundwater samples (Table 9) had higher levels of chemicals, including lead, than the surface water samples (Table 8). Groundwater is flowing into Torch Lake and chemicals would end up in the lake from the groundwater; however, the chemical levels would be diluted in the lake.

*Hubbell Beach area*

The Hubbell Beach area includes the Hubbell Beach, Hubbell slag dump, the former C & H Leach Plant, Hubbell stamp sands, Hubbell Docks, Mineral Building, and former C & H Smelter. The Hubbell Beach is part of a Township Park that includes a boat launch, docks, and a playground. The slag dump is adjacent to Hubbell Beach (see Figure D-2 in Appendix D). People may encounter arsenic or copper in the soil while at Hubbell Beach or engaged in other recreational activities at these places, but will not encounter consistently elevated levels of the chemicals. In the Hubbell Beach area, approximately 66% of samples analyzed by XRF were below the arsenic detection level, about 31% were below the copper detection level, and approximately 60% were below the lead detection level[12].

Although people who swim at Hubbell Beach will also be swimming in Torch Lake, surface water samples were not taken off the shore of Hubbell Beach. Groundwater discharge into different areas of Torch Lake may have differing amount of chemicals and could result in chemical levels that are different in various shoreline areas of Torch Lake. Due to the limited number of surface water samples evaluated, it is unknown if chemical levels would be the same or different at this location than those taken of the Lake Linden area.

The Hubbell Docks are vacant land, about three to four acres, with scrap metal, wood, some firebrick, minor amounts of stampsand, and one to two inches in diameter coal pieces. The property includes a solid concrete retaining wall (approximately 900 feet long and four feet thick) along the edge of Torch Lake. The Hubbell Docks have evidence of recreational use (old fire remains) and are accessible to the public.

The Mineral Building includes a dilapidated building (physical hazards may exist at this location), debris, empty drums, ash, newer construction-related debris, slag, and stampsands. Concrete bins located inside the building had green and blue staining on their interior walls. Various colored and stained material, such as red-stained stamp sands, gray stamp sands, gray slag, white powder, brown-stained soil, and yellow-stained soil, were located on this property. Poor site security was reported during a 2007 site visit (Weston 2007A).

[12] Due to the small number of laboratory analyzed samples and the number of XRF analyzed samples reported as below the level of detection (<LOD), it is not possible to calculate means or the 95% upper confidence limit on the mean. Detection limits can vary widely for every chemical measured in every sample.

The former C & H Smelter is in the vicinity of an operating industrial facility along M-26. People could access this location. Elevated levels of copper, arsenic, and lead are present in various places throughout this area.

*Mason Stampsands area*

Areas included in the Mason Stampsands location are Mason Area Ruins, Mason Sands, and Tamarack Sands. Mason Sands include the Quincy Mining Company Leach Plant ruins, a beached sand dredge, a smokestack, stampsands, and other mining-era building ruins (see Figure D-3 in Appendix D). As the sand dredge is a registered historical site, the public has access to it, and to the whole area. (The red paint on the dredge is reportedly lead-based [Weston 2007A].) The building ruins appear to be used for paintball, and graffiti is present on both the ruins and inside and outside the dredge. An emergency removal for arsenic-contaminated soil and stampsand was carried out in this area in November 2008.

Since people use this area for recreational purposes, it is possible that people had previously encountered lead- and arsenic-contaminated materials. Due to the low number of samples that detected lead and arsenic, people would not be expected to be exposed to consistently elevated levels of these chemicals. However, additional chemicals or hazards could be present at this location. In the Mason Stampsands area, approximately 88% of samples analyzed by XRF were below the arsenic detection level, about 9% were below the copper detection level, and around 53% were below the lead detection level.[13] This indicates that people might encounter varying levels of chemicals across the site. Based on the limited number of laboratory analyzed samples, only lead levels were above the site-specific screening levels.

Biosolids, which are sludge material from the wastewater treatment plant, are applied to the vegetative cover present at the site. These biosolids might contain chemicals, such as metals, or biological material, such as bacteria, that could cause people to become ill upon exposure. For this reason, access to the area where the biosolids are applied is restricted during and for 30 days after the application.

*Boston Pond and Calumet Lake*

Boston Pond and Calumet Lake are used for boating, fishing, and swimming. Samples taken from this area do not have chemical levels greater than the site-specific screening levels. Based on the data (Tables 6 and 7), people would not encounter elevated levels of chemicals. However, only a limited number of samples were taken from these locations and may not represent the entire area.

*Torch Lake fish*

Fish from Torch Lake have elevated levels of mercury and PCBs. Michigan has a Statewide Safe Fish Guidelines, as mercury contamination is present in most inland lakes throughout the state. Investigation into PCB levels has shown that Torch Lake may have a source of PCBs (GLEC 2006). PCB levels in the fish may be due to this source. People could ingest elevated levels of

[13] Due to the small number of laboratory analyzed samples and the number of XRF analyzed samples reported as below the level of detection (<LOD), it is not possible to calculate means or the 95% upper confidence limit on the mean.

PCBs from eating sport-caught fish; however, people following the Eat Safe Fish Guide (formerly the Michigan Fish Advisory) would reduce their exposure to PCBs from fish.

Chemicals without Screening Levels

Certain chemicals, listed below, at this site have no site-specific screening levels.

| | Chemical | |
|---|---|---|
| Calcium | Sulfur | Thorium |
| Potassium | Tellurium | Uranium |
| Tin | Cesium | Titanium |
| Tungsten | Selenium | Palladium |
| Rubidium | Zircon or Zirconium | Scandium |

These chemicals were found in soil and sediment samples from the Lake Linden area using XRF analysis. As stated above, field samples analyzed by XRF do not have the preparation that laboratory analyzed samples would have. The XRF-measured levels of the chemicals that are present in these samples might be higher or lower than would have been found in samples processed for laboratory analysis.

Calcium and potassium are nutrients required for people's bodies to function. Upper tolerable levels for calcium are 2.5 grams per day for adults and children over one year old (NAS 2001). Upper tolerable levels for potassium range from 0.4 grams per day, for infants, to 5.1 grams per day, for lactating women (NAS 2004). In most cases, people's bodies will remove the excess calcium or potassium without a problem. People with kidney dysfunction could have difficulty removing excess potassium or calcium (NAS 2001, 2004). People are not expected to absorb enough through the skin or inadvertently ingest enough soil or sediment to cause health effects.

Tin can be found in brass, pewter, soldering materials, and has been used to line metal food, beverage, and aerosol cans. Metallic tin is absorbed poorly in the gastrointestinal tract and has low toxicity. If people happen to ingest and absorb high levels of tin, stomachache, anemia, and liver and kidney problems may result (ATSDR 2005A).

Tungsten, a metal, is present in alloys and can be found in light bulbs, high-speed tools, welding electrodes, turbine blades, golf clubs, darts, fishing weights, gyroscope wheels, phonograph needles, and bullets. Tungsten has a low toxicity. It is not expected that people would encounter high enough levels of tungsten from dermal contact to cause health effects (ATSDR 2005B).

Rubidium might be present in potassium minerals, such as feldspar and mica (USGS 2006). It is a metal and naturally radioactive (USGS 2003). Rubidium has a low toxicity and people have a typical intake of 1.0 to 5.0 mg per day (Bogden and Klevay 2000).

Sulfur, in the form of sulfuric acid, can be produced from copper mining and smelting (USGS 2009A). Sulfur is present in every cell of the human body. It is in proteins, is necessary for stabilization of proteins, and is part of the metabolic system that removes toxic substances from the body (Sardesai 1998).

Tellurium, along with selenium, is associated with copper production. It can be present in anode slimes at copper refineries. Tellurium was also a component in blasting caps (USGS 2009B). Tellurium is normally found in people's bodies, primarily in the bones. Besides occupational exposure, people may be exposed to tellurium compounds through food or outside air. Health effects, including a garlic odor of sweat and breath, are mainly seen in people occupationally exposed (NLM 2010)

Zirconium is found in the earth's crust with concentrations ranging from 150 to 300 ppm (NLM 2009). Zirconium silicate, or zircon, was used as a coating on foundry molds and in the refractory bricks and blocks in furnaces (USGS 2009C). Health effects have been identified in workers breathing in zirconium compounds. Other than occupational exposure, people may be exposed to zirconium compounds in cosmetics or antiperspirants and through food. Some people have had dermal effects (exposures in the skin) from applying products with zirconium (NLM 2009).

Cesium, thorium, and uranium all have radioactive isotopes (forms with different numbers of neutrons). Uranium may be present in the shale that is in and around the Jacobsville Sandstone formation, located in the Keweenaw Peninsula (WUPHD 2009).

Palladium is a platinum group metal (USGS 2010). Scandium and titanium are also metals. Background levels of titanium, statewide, range from 13 to 227 ppm (MDEQ 2005A). There is not enough information available on palladium to determine levels that could cause harm to people's health.

Overall, it is not expected that the levels of the chemicals without site-specific screening levels will cause harm to people's health. Many of the ones listed above are nutrients or have low toxicity.

### Toxicological Evaluation

People may encounter contamination present at the Torch Lake Superfund site and nearby areas. Some of the areas, both those discussed in this report and other areas that may have mining waste that have not been characterized, are accessible to the public. Depending on the amount of time individuals spend there, it is possible that they will be exposed to chemical levels that can cause health effects. Even though levels of chemicals are not consistently elevated across the areas discussed in this report, there is the potential that areas not evaluated have levels that may be of concern. The information below is provided because chemical levels could range widely in and around the Torch Lake Superfund site.

#### *Arsenic*

People ingest small amounts of arsenic in food and water (ATSDR 2007A). Although there currently is no known function for arsenic in humans, animal studies have shown that arsenic is necessary in the diet (NAS 2001). U.S. dietary inorganic arsenic intake ranges from 0.21 to 1,276 micrograms (μg)/day, with a mean of 50.6 μg/day for women and a mean of 58.5 μg/day for men. Typical levels of arsenic in food are 20-140 μg/kilogram (kg) (ATSDR 2007A). Foods that contain arsenic, mainly in the form of organic arsenic, are dairy products, meat, poultry, fish, grains, and cereal (NAS 2001).

Chronic oral exposures of 50-100 µg/kg-day (3,500-7,000 µg/day for a person weighing 70 kg) are associated with neurological or hematological signs of arsenic toxicity. Symptoms of oral arsenic toxicity are nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to the blood vessels and sensation of pins and needles in hands and feet. Dermal exposure to arsenic can result in direct irritation of skin. Long term arsenic exposure can result in changes to the skin, such as darkened areas and corns or warts on people's palms, soles, and torsos (ATSDR 2007A).

Inorganic arsenic is genotoxic and studies have shown that it can cause cancer in humans. Arsenic can cross the placenta. Inorganic arsenic, from exposure by either inhalation (breathing it) or ingestion (eating it), is a developmental toxicant, possibly resulting in developmental impairment and congenital malformation (ATSDR 2007A).

It is unknown if repeated long-term exposure to elevated arsenic present at certain locations in the Lake Linden and Hubbell Beach areas could cause health effects in people. (Arsenic levels at Mason, Boston Pond, and Calumet Lake were below the site-specific screening levels. Note that, areas at Calumet Lake and Boston Pond could have elevated arsenic levels that have not been identified.) The extent of the contamination has not been fully characterized and is present in multiple areas, so people may be exposed to a range of arsenic levels depending on their activities.

*Lead*

Lead has been removed from many paints, ceramic products, caulking, and pipe solder in the past 30 years. Older houses may still have paint containing lead. Children, in older homes, are often exposed to lead from ingesting paint chips or dust. Although sources of lead have been reduced, people still encounter lead in their daily lives. Almost all (99%) of publicly supplied drinking water has less than 5.0 µg/L lead. Lead in food ranged from less than 0.0004 to 0.5234 µg/g. People have an average dietary intake of 70 µg/day, for a person weighing 70 kg (ATSDR 2007B).

Children are more vulnerable to lead poisoning as compared to adults. Children absorb, on average, 50% of ingested lead while adults absorb between 6-80% of ingested lead depending on recent food consumption. Although lead can be absorbed through the skin, absorption of inorganic lead from dermal (skin) exposure appears to be less efficient than absorption from ingestion or inhalation. In studies measuring the amount of lead absorbed after dermal exposure, people's absorption ranged from less than or equal to 0.3% to possibly as high as 30% of the applied dose (ATSDR 2007B).

Whether absorbed by ingestion, inhalation, or dermal exposure, lead is distributed throughout the body. Similarly, in both adults and children, the main target is the nervous system, although lead will affect every organ system. Large amounts of lead can cause anemia, kidney damage, colic, muscle weakness, and brain damage. Small amounts of lead can also cause effects on blood, development, and behavior. Even at low blood lead levels, adverse effects may include delays or impairments in development. Pregnant women exposed to lead can have problems with the developing fetus at blood lead levels less than 20 µg/deciliter (dL). Alterations in immune function or any cognitive defects that occur during childhood from lead exposure can persist into adulthood. Lead and lead compounds are reasonably anticipated to be carcinogens (ATSDR 2007B).

Adults older than 60 years and postmenopausal women are vulnerable to specific effects of lead, which include problems with memory, hypertension (high blood pressure), and reduced kidney function. There is a significant association of an increase in systolic blood pressure with an increase of blood lead levels (ATSDR 2007B).

People may be drinking small amounts of water (0.0001 L/day for adults and 0.01 L/day for children) from Torch Lake, while swimming or doing other recreational activities. Even if the lead levels in the groundwater were not diluted, ingestion of the maximum amount of lead measured would only be up to 0.48 µg/day. Groundwater is diluted when it flows into the lake, and people would be exposed to levels lower than this. Because the levels are expected to be lower and this exposure would be more than seven times lower than levels from drinking water (water with lead at 4 µg/L, the MDEQ Residential Drinking Water Criteria, would result in children drinking 3.32 µg/day, using water intake of 0.83 L/day).

It is unknown if repeated long-term exposure to elevated lead present at certain locations in the Lake Linden and Hubbell Beach areas could cause health effects in people. Levels of lead in Mason, Calumet Lake, and Boston Pond were not over the screening level. Note that, areas at Calumet Lake and Boston Pond could have elevated lead levels that have not been identified. The extent of the contamination has not been characterized and is present in multiple areas, so people may be exposed to a range of lead levels depending on their activities.

*Copper*

Copper is a reddish metal and compounds containing copper are typically blue-green (ATSDR 2004). Copper is an essential trace mineral and is a necessary part of enzymes responsible for iron metabolism (NAS 2001). Infants (0 to 6 months) should have 200 µg of copper per day and adults can have up to 10,000 µg of copper per day without any adverse effects (NAS 2001). Adults in the U.S. have a median copper intake that ranges from 930 to 1,300 µg/day (ATSDR 2004). People typically encounter copper in foods and drinking water (ATSDR 2004). Foods that contain copper are organ meats, seafood, nuts, seeds, wheat bran cereals, whole grain products, and cocoa products (NAS 2001).

Ingesting too much copper can result in gastrointestinal distress (nausea, vomiting, and diarrhea) and liver damage. People with certain conditions, such as Wilson's Disease, may be more sensitive to the effects of excessive copper intake (NAS 2001). Because copper is essential, people's bodies regulate the levels of copper absorbed and excreted to maintain normal levels (ATSDR 2004).

Copper is not expected to be well absorbed through the skin, but information is not readily available on this topic. People might develop rashes (allergic contact dermatitis) from dermal (skin) contact with copper. People can also breathe in copper particles, which may result in irritation of the nose and throat (ATSDR 2004).

Because copper mining and wastes from the copper production industry are present throughout the Keweenaw Peninsula, people might encounter elevated copper levels in many locations. People, especially children, may ingest enough copper to cause gastrointestinal distress, however, as stated earlier, people's bodies usually regulate the amount they need and excrete the rest, without resulting in toxicity.

Children's Health Considerations

Children could be at greater risk as compared to adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate result in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Certain chemicals of concern, such as lead, produce greater adverse effects in children as compared to adults. Children may have both increased absorption and increased susceptibility to these chemicals.

The Torch Lake Superfund site and surrounding areas includes recreational parks and beaches where children play, especially during the summer months. Bright blue water was previously observed at Lake Linden and contained unknown chemicals. This water, if present again, or other discolored media, may be a novel items for children to play with.

Ruins present at these locations are used for recreational activities, such as paintball and fire pits. Physical or unknown chemical hazards are present at many of these locations. Children might have a greater risk of injury due to the attractiveness of playing among the ruins. Physical hazards associated with areas in and around the Torch Lake Superfund site are discussed in "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" public health assessment (ATSDR 2012).

## Community Health Concerns

Members of the communities near the Torch Lake Superfund site have expressed concerns about proximity and use of several of these locations (A. Keranen, MDEQ Upper Peninsula District Office, personal communication, 2010; S. Baker, MDEQ, personal communication, 2012). These concerns are listed below:

1. An individual expressed concern about the presence of the Hubbell slag dump adjacent to Hubbell Beach. The Hubbell slag dump, also used as a municipal dump, borders the beach area and there are anecdotal reports of old appliances, barrels, household wastes, and car batteries being visible along the lake drop-off and bottom. The individual further stated that he would not take his children swimming at the Hubbell Beach.
2. Other individuals have expressed concerns with the LLVP beach. Their concerns dealt with the possibility of contaminated material still being present at the beach, as an

emergency removal was needed in 2007, after the location was delisted from the Superfund site. Some have reported no longer using that beach.

3. Concerns have also been expressed regarding the Tamarack City Stampmill. It is located in Hubbell and consists of stampmill ruins and piles of rubble. A local township supervisor has requested, on multiple occasions, for processes and funding to clean up this location. The stampmill is adjacent to a playground, with only a small "No Trespassing" sign present. The ruins have graffiti and other signs of trespassing, such as lawn chairs, trash, and remnants of a fire. Physical hazards at this location are discussed further in the "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" public health assessment (ATSDR 2012).
4. While fishing near the pilings along the western shore of Torch Lake, a person's boat anchor, and later boots, acquired material that had a "bearing grease" consistency. The angler was fishing for walleye at night and did not see the material until he and the boat were at home the next morning. The material on his boots stained the carpet in his home. The angler needed to use a solvent to clean off the material and speculated that he may have dropped his anchor in a drum at the bottom of the lake.

## Conclusions

<u>MDCH is unable to determine if the chemicals present at and around the Torch Lake Superfund site could harm people's health.</u> Elevated levels of arsenic, lead, and copper are present, but chemical levels vary widely and many of the areas have not had enough samples collected to make this determination. Conclusions regarding specific locations at and around the Torch Lake Superfund site are below.

<u>MDCH is unable to determine if the chemicals present in the Lake Linden area will harm people's health, as there are not enough data to make that determination.</u> Only a few samples have been analyzed from this area, which includes the Lake Linden Village Park (LLVP). Measurement of chemicals in the field indicates that chemical levels vary widely in this area. Bright blue water was previously seen in the LLVP, but the reason the water is colored blue has not been determined.

<u>MDCH is unable to determine if the chemicals present in the Hubbell beach area will harm people's health.</u> Only a few samples had chemical levels measure by laboratory analysis and field analysis indicates that chemical levels vary widely. The extent of this contamination is unknown.

<u>MDCH concludes that the chemicals that have been identified in the Mason Stampsand area will not harm people's health.</u> This area includes a historic site (a partially sunken sand dredge) and is accessible to the public. Other chemicals and hazards that might be of concern, such as the suspected underground storage tank or undiscovered drums, could be present in the area.

<u>MDCH is unable to determine if the chemicals present at Boston Pond and Calumet Lake will harm people's health as only a small number of sediment samples were collected for each of these lakes.</u> Although chemical levels were not above the site-specific screening levels at

Boston Pond and Calumet Lake, less than 17 samples were analyzed for each of these two locations. It is possible that higher chemical levels are present at one or both of those areas.

MDCH concludes that unlimited consumption of fish from Torch Lake could harm people's health. Elevated PCBs, from an unknown source, are present in the fish in Torch Lake. If people follow the Eat Safe Fish Guide (formerly the Michigan Fish Advisory), the PCB concentrations in the fish are not expected to harm people's health. Follow the Statewide Safe Fish Guidelines, for fish species not listed in the Torch Lake specific guidelines.

## Recommendations

1. Characterize, more fully, the contamination at the Lake Linden area, Hubbell Beach area, Calumet Lake, and Boston Pond.
    - Additional sampling of soil or stampsand, by the appropriate regulatory agency, is needed to better characterize these chemicals in publicly accessible areas, such as the beach, campground, playground, and boat launch areas.
    - Field results from an XRF need to be confirmed by laboratory analysis. Interferences from field conditions, such as moisture content, and other chemicals present can then be accounted for and will result in a more reliable data set.
    - Potentially contaminated material, such as unnaturally blue water, has been observed in the Lake Linden area but not tested. MDCH recommends that people contact the WUPHD or the local MDEQ office if people see discolored or oddly colored materials so that they can be identified and addressed. Children ought to be discouraged from playing in that material, since its chemical makeup is not known at this time.
    - MDCH will evaluate any relevant new data if it becomes available.

2. Characterize additional potential hazards, such as the presence of a suspected underground storage tank or undiscovered drums, in the Mason Stampsands area.
    - See the "Physical Hazards in the Torch Lake Superfund Site and Surrounding Area" public health assessment (ATSDR 2012) for more information on physical hazards, such as the suspected underground storage tank.
    - Characterization of additional hazards at this location, by the appropriate regulatory agency, is needed.

3. The MDNR and MDEQ will continue to sample fish from Torch Lake.

4. Identify the sources of PCBs to Torch Lake. PCB levels in the fish will not decrease if there is a continuing source to the lake.

## Public Health Action Plan

1. MDCH will evaluate any relevant new data, on this or the other areas discussed, that becomes available.

2. The MDEQ will continue to analyze chemical levels in fish from Torch Lake and other bodies of water in the area on a rotating basis. MDCH will update any fish guidelines based on new information.

## Report Preparation

This Public Health Assessment was prepared by the Michigan Department of Community Health (MDCH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency reviewers are listed below.

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Appendix A: Lake Linden Emergency Removal in Summer and Fall 2007

Below is a summary of the emergency removal actions taken from July to October 2007. Additional information is available at http://www.epaosc.org/site/site_profile.aspx?site_id=3346.

The Lake Linden Village Park (LLVP) is a delisted portion of the Torch Lake Superfund site. Attractions present at the LLVP include a public swimming beach, playground, campground, hiking trail, dock, and boat launch. Torch Lake water levels were low in 2007, down one to two feet from normal levels, and contaminated material that had formerly been submerged was revealed. White, clayey material was identified in June of 2007, during a site visit by Michigan Department of Environmental Quality (MDEQ) representatives. Samples of this material were taken and elevated PCBs, antimony, arsenic, barium, copper, and lead were identified. Blue colored water was also present at the swimming beach, in holes dug by beach-goers (Weston 2007B).

In July 2007, the Western Upper Peninsula Health Department (WUPHD) and the Village of Lake Linden restricted public access to portions of the swimming beach. At this time, the EPA emergency response began at this location. Attempts were made to reproduce conditions where blue colored water was observed, but were unsuccessful. Samples of the soil, sediment, and surface water were collected. Based on the results of those initial samples, a grid was overlaid on the area and samples were collected from zero to three inches below the ground surface (bgs) and from 12 to 18 inches bgs. The samples were analyzed for antimony, arsenic, barium, copper, lead, and PCBs (Weston 2007A). Table A-1 presents the maximum value from that sampling, both the zero to three and 12 to 18 inch bgs samples, along with site-specific screening levels. Site-specific screening levels are discussed in Appendix B.

Table A-1: Maximum level of chemicals (in parts per million [ppm]) present in soil samples from the Lake Linden emergency removal area prior to soil excavation in June 2007 (Weston 2007B).

| Chemical | Screening level[a] (ppm) | Maximum level in soil (ppm) |
|---|---|---|
| Antimony | 280 | 3.1 |
| Arsenic | 5.5 | **65** |
| Barium | 55,916 | 120 |
| Copper | 30,355 | 7,100 |
| Lead | 400[b] | **470** |
| PCBs | 1.0 | <0.7 |

**Bold** values are above the screening level.
a = Screening level are discussed in Appendix B.
b = Screening level is the MDEQ Part 201 Generic Residential Direct Contact Criteria.

In early August, nine sediment samples were taken in the LLVP swimming beach area. The samples were from zero to six inches below the sediment-water interface and were analyzed for antimony, arsenic, barium, copper, lead, and PCBs. Samples were taken near the white, clayey material as well (Weston 2007A). Table A-2 presents the maximum value of chemicals in the sediments along with site-specific screening levels. The site-specific screening levels include factors to account for increased adherence of wet sediments.

Table A-2: Maximum levels of chemicals (in parts per million [ppm]) in sediment samples from the Lake Linden emergency removal area prior to sediment excavation in June 2007 (Weston 2007B).

| Chemical | Screening level[a] (ppm) | Maximum level in sediment (ppm) |
|---|---|---|
| Antimony | 280 | <7.4 |
| Arsenic | 5.5 | 4.1 |
| Barium | 55,916 | 930 |
| Copper | 30,355 | 1,700 |
| Lead | 400[b] | **1,300** |
| PCBs | 1.0 | <1.05 |

**Bold** values are above the screening level.
a = Screening level are discussed in Appendix B.
b = Screening level is the MDEQ Part 201 Generic Residential Direct Contact Criteria.

Due to the elevated levels of lead (soil and sediment) and arsenic (soil), the EPA determined that there was an imminent and substantial threat to public health, welfare, and the environment present at this location and emergency removal action would continue. The site was divided into two areas, Area 1 (near the swimming beach) and Area 2 (closer to the boat docks; see Figure C-1), and x-ray fluorescence (XRF) screening was used to identify the locations with elevated contamination (Weston 2007B).

Area 1 was identified as being 200 feet by 200 feet and was excavated to a depth of 18 inches. Approximately 905.5 tons of soils and sediments were removed from Area 1. Area 2 was identified as being three feet by 200 feet and was excavated to a depth of 18 inches. Approximately 64.69 tons of soil and sediment were removed from Area 2. Samples (5 total) were collected from the excavation site to verify that the contaminated soil was removed. There were several soil samples above the arsenic screening level and one soil sample above the lead screening level. One sediment sample was above the lead screening level and one sediment sample was possibly slightly above the PCB screening level. Data from the post-excavation sampling, from soil, sediment, and water, is in Table 1 and Table 8 in the main body of the document. Area 1 was filled with clean soil and Area 2 was filled with rock (riprap). WUPHD lifted the swimming advisory after the emergency removal was completed (Weston 2007B).

Appendix B: Calculation of the site-specific screening levels.

Soil screening levels, based on the MDEQ generic Residential Direct Contact Criteria (DCC)
This section discusses the variables used in Equations B-1, B-2, and B-3 for calculation of the generic Residential Direct Contact Criteria (DCC). The generic DCC identifies a soil concentration that is protective against adverse health effects due to long-term, daily ingestion (eating) of and dermal (skin) exposure to contaminated soil. Different input values were used for the variables to develop site-specific screening levels for chemicals in the sediment/soil and water at residential beaches around the Torch Lake Superfund site. Equation B-1 (MDEQ 2005B) is the algorithm used to develop the soil screening levels for a carcinogen.

Equation B-1: Soil screening levels algorithm for a carcinogen.

$$Carcinogen\ soil\ screening\ level = \frac{TR \times AT \times CF}{SF \times [(EF_i \times IF \times AE_i) + (EF_d \times DF \times AE_d)]}$$

Inputs to the algorithm are as follows:

- The slope factor (SF) is a chemical-specific value calculated by the EPA or the MDEQ to indicate the risk of cancer associated with exposure to a specific substance.
- Ingestion absorption efficiency ($AE_i$) is the amount of chemical that will be absorbed by the gastrointestinal tract. This value can be either a chemical-specific or a default value.
- Dermal absorption efficiency ($AE_d$) is the amount of the chemical that can be absorbed through the skin. This value can be either a chemical-specific or a default value.
- The target risk level (TR) is one additional cancer above the background cancer rate per 100,000 people.
- The averaging time (AT) for a carcinogen is the number of days in 70 years, which represents a lifetime.
- The conversion factor (CF) is a value that accounts for differences in the units used for the variables.
- The ingestion exposure frequency ($EF_i$) and dermal exposure frequency ($EF_d$) are the number of days per year a person is exposed to the chemical. For Torch Lake recreational areas, an exposure frequency of 90 days (three months), for both the $EF_i$ and $EF_d$ was selected to represent the summer months.
- The age-adjusted soil ingestion factor (IF) and age-adjusted soil dermal factor (DF) were calculated based on Equations B-3 and B-4, respectively. The values in Table B-1 list the inputs to the equation.

Table B-1: Variables for generic Residential Direct Contact Criteria (DCC) and soil screening levels for a carcinogen.

| Variables for the Soil screening levels algorithm for a carcinogen (Equation B-1) | Generic DCC inputs | Screening level inputs |
|---|---|---|
| TR (target risk level) | 1.0E-5 | 1.0E-5 |
| AT (averaging time; in days) | 25,550 | 25,550 |
| CF (conversion factor; in µg/kg) | 1.0E+9 | 1.0E+9 |
| SF (oral cancer slope factor; in $[mg/kg\text{-}day]^{-1}$) | chemical-specific[a] | chemical-specific[a] |
| $EF_i$ (ingestion exposure frequency; in days/year) | 350 | 90[b] |
| IF (age-adjusted soil ingestion factor; mg-year/kg-day) | 114 | 114 |
| $AE_i$ (ingestion absorption efficiency) | chemical-specific or default[a] | chemical-specific or default[a] |
| $EF_d$ (dermal exposure frequency; in days/year) | 245 | 90[b] |
| DF (age-adjusted soil dermal factor; in mg-year/kg-day) | 353 | 9,531[c] |
| $AE_d$ (dermal absorption efficiency) | chemical-specific or default[a] | chemical-specific or default[a] |

a = from MDEQ (2006C)
b = 90 days (three months) to represent the summer
c = see Equation B-4 and Table B-4

Equation B-2 (MDEQ 2005B) is the algorithm used to develop the generic DCC and soil screening levels for a noncarcinogen.

Equation B-2: Soil screening levels algorithm for a for a noncarcinogen.

$$Noncarcinogen\ soil\ screening\ level = \frac{THQ \times RfD \times AT \times CF \times RSC}{[(EF_i \times IF \times AE_i) + (EF_d \times DF \times AE_d)]}$$

DCC is the screening level calculated from the equation. Certain inputs (AT, CF, $EF_i$, IF, $AE_i$, DF, and $AE_d$) to the algorithm are described above. Values used for these inputs are in Table B-2.

Other inputs to the algorithm are:

- The Target Hazard Quotient (THQ) and relative source contribution (RSC) are default values of 1.0. The THQ is the ratio of the chronic daily dose of the chemical divided by the reference dose for that chemical. If the value is one, that indicates the daily dose of the chemical is equal to the reference dose for that chemical. The RSC is the proportion of the person's daily intake of a chemical from the soil. If the RSC is one, a person's entire exposure to a chemical is assumed to be from the soil.

- The reference dose (RfD) is a chemical-specific value that is a conservative estimate of the daily intake that a human can have with minimal risk of adverse effects over a lifetime of exposure. This was calculated by either the EPA or the MDEQ.

Table B-2: Variables for generic Residential Direct Contact Criteria (DCC) and soil screening levels for a noncarcinogen.

| Variables for the Generic DCC Algorithm for a noncarcinogen (Equation B-2) | Generic DCC inputs | Screening level inputs |
|---|---|---|
| THQ (target hazard quotient) | 1 | 1 |
| RfD (reference dose; in mg/kg/day) | chemical-specific[a] | chemical-specific[a] |
| AT (averaging time; in days) | 10,950 | 10,950 |
| CF (conversion factor; in µg/kg) | 1E+9 | 1E+9 |
| RSC (relative source contribution) | 1 | 1 |
| $EF_i$ (ingestion exposure frequency; in days/year) | 350 | 90[b] |
| IF (age-adjusted soil ingestion factor; mg-year/kg-day) | 114 | 114 |
| $AE_i$ (ingestion absorption efficiency) | chemical-specific or default[a] | chemical-specific or default[a] |
| $EF_d$ (dermal exposure frequency; in days/year) | 245 | 90[b] |
| DF (age-adjusted soil dermal factor; in mg-year/kg-day) | 353 | 9,531[c] |
| $AE_d$ (dermal absorption efficiency) | chemical-specific[a] | chemical-specific[a] |

a = from MDEQ (2006C)
b = 90 days (three months) to represent the summer
c = see Equation B-3 and Table B-3

Equation B-3 (MDEQ 2005B) is used for calculation of the age-adjusted soil ingestion factor (IF), an input in for both carcinogen and noncarcinogen screening levels. Variables used in the equation are in Table B-3.

Equation B-3: Equation for age-adjusted soil ingestion factor (IF) used in calculation of the soil screening levels.

$$IF = \left( \frac{IR_{age1-6} \times ED_{age1-6}}{BW_{age1-6}} \right) + \left( \frac{IR_{adult} \times ED_{adult}}{BW_{adult}} \right)$$

IF represents the amount of soil ingested, adjusted for age. The IF value for the calculated screening levels is 114 mg-year/kg-day).

Inputs to the equations were as follows:

- The default MDEQ values were used for exposure duration for children ages one to six ($ED_{age1-6}$) and adults and ($ED_{adult}$) and the body weight for children ages one to six ($BW_{age1-6}$) and adults ($BW_{adult}$).
- The soil ingestion rate for children ages one to six ($IR_{age1-6}$) and adults ($IR_{adult}$) was set at 200 and 100 milligrams per day (mg/day), respectively, based on recommendations from the EPA for children (EPA 2008B) and the default MDEQ value.

Table B-3: Variables for age-adjusted soil ingestion factor (IF).

| Variables for the age-adjusted soil ingestion factor | Generic inputs | Screening level inputs |
|---|---|---|
| $IR_{age1-6}$ (soil ingestion rate; in mg/day) | 200 | 200[a] |
| $ED_{age1-6}$ (exposure duration; in years) | 6 | 6 |
| $BW_{age1-6}$ (body weight; in kg) | 15 | 15 |
| $IR_{adult}$ (soil ingestion rate; mg/day) | 100 | 100 |
| $ED_{adult}$ (exposure duration; in years) | 24 | 24 |
| $BW_{adult}$ (body weight; in kg) | 70 | 70 |

a = EPA (2008)

Equation B-4 (MDEQ 2005B) is used for calculation of the age-adjusted soil dermal factor (DF), an input in both the Screening level algorithm for a carcinogen (Equation B-1) and noncarcinogen (Equation B-2). Variables used in the equation are in Table B-4.

Equation B-4: Equation for the age-adjusted soil dermal factor (DF) used in calculation of soil screening level.

$$DF = \left( \frac{SA_{age1-6} \times EV \times AF_{age1-6} \times ED_{age1-6}}{BW_{age1-6}} \right) + \left( \frac{SA_{adult} \times EV \times AF_{adult} \times ED_{adult}}{BW_{adult}} \right)$$

DF represents the amount of soil that comes into contact with the skin, adjusted for age.

The variables were adjusted to represent skin contact with sediments. Inputs to the equation are as follows:

- MDEQ default values were used for both adult ($BW_{adult}$) and children ages one to six ($BW_{age1-6}$) body weight, exposure duration for adults ($ED_{adult}$) and children ages one to six ($ED_{age1-6}$), and event frequency (EV).
- Skin surface area (SA) is the amount of skin exposed to the sediments. Values were used that represent approximately 75% of the total surface area for both child (ages one to six) (EPA 2008B) and adult variables (EPA 1997). This is the amount of surface area that would be potentially exposed during recreational beach activities such as wading or playing in water-filled recreationally dug holes.
- Event frequency (EV) was set to one to indicate coming into contact with the sediments once per day.

- Adjusted values were used for adult ($AF_{adult}$) and children ages one to six ($AF_{age1\text{-}6}$) soil adherence factors. The soil adherence factor (AF) is the amount of soil that sticks to the skin. A weighted $AF_{age1\text{-}6}$ was calculated using data from a study measuring sediment adherence to children, ages seven to twelve. Shoaf et al. (2005) measured the amount of sediment that adhered to various body parts (face, forearms, hands, lower legs, and feet) of the children after they played in a tide flat (EPA 2008B). The $AF_{adult}$ value, of 0.5 mg/cm$^2$, was from data on adults gardening with feet, legs, faces, arms, and hands exposed (EPA 1997).

Table B-4: Variables for age-adjusted soil dermal factor (DF).

| Variables for age-adjusted soil dermal factor | Generic inputs | Screening level inputs |
|---|---|---|
| DF (age-adjusted soil dermal factor; in mg-year/kg-day) | 353 | 9,531 |
| $SA_{age1\text{-}6}$ (skin surface area; in cm$^2$/event) | 2,670 | 5,800 |
| EV (event frequency; in event/day) | 1 | 1 |
| $AF_{age1\text{-}6}$ (soil adherence factor; in mg/cm$^2$) | 0.2 | 3.0 (weighted AF)[a] |
| $ED_{age1\text{-}6}$ (exposure duration; in years) | 6 | 6 |
| $BW_{age1\text{-}6}$ (body weight; in kg) | 15 | 15 |
| $SA_{adult}$ (skin surface area; in cm$^2$/event) | 5,800 | 15,000 |
| $AF_{adult}$ (soil adherence factor; in mg/cm$^2$) | 0.07 | 0.5[b] |
| $ED_{adult}$ (exposure duration; in years) | 24 | 24 |
| $BW_{adult}$ (body weight; in kg) | 70 | 70 |

a = weighted AF based on data in EPA (2008)
b = EPA (1997)

Table B-5: Soil screening levels, both carcinogen and noncarcinogen, are listed below (in parts per million [ppm]).

| | | | |
|---|---|---|---|
| Screening levels for Noncarcinogens (in ppm) | | | |
| antimony | 280 | nickel | 60,710 |
| barium | 55,916 | selenium | 3,994 |
| cadmium | 1,829 | silver | 3,754 |
| chromium (VI) | 3,834 | strontium | 503,250 |
| cobalt | 3,994 | zinc | 263,607 |
| copper | 30,355 | benzo(g,h,i)perylene | 591 |
| iron | 239,642 | fluoranthene | 12,428 |
| manganese | 37,544 | phenanthrene | 619 |
| mercury | 240 | pyrene | 7,768 |
| molybdenum | 3,994 | | |
| Screening levels for Carcinogens | | | |
| arsenic | 5.5 | benzo(b)fluoranthene | 5.3 |
| PCBs | 1.0 | chrysene | 534 |
| benzo(a)anthracene | 5.3 | indeno(1,2,3-cd)pyrene | 5.3 |
| benzo(a)pyrene | 0.53 | | |

<u>Water screening levels, based on the MDEQ generic Groundwater Contact Criteria (GCC)</u>
This section discusses the variables used in Equations B-5 and B-6 for calculation of the generic Groundwater Contact Criteria (GCC). The GCC is protective of only chronic, not acute, effects, and it addresses only dermal exposure and not incidental ingestion or inhalation of any volatiles (MDEQ 2006D). The generic GCC was developed to address utility workers encountering chemicals in groundwater through dermal exposure. The GCC may be adjusted to address the protection of people who are exposed to contaminated surface water, such as wading in a lake or playing in recreationally dug holes on the beach. Potential incidental ingestion of water or contact with sediments suspended in water are exposures that are not included in the screening level. Additional uncertainty may be present in the amount of skin people have exposed to the water. Equation B-5 (MDEQ 2006C) is the algorithm used to develop the generic GCC and water screening levels for a carcinogen.

Equation B-5: Water screening level algorithm for a carcinogen.

$$\textit{Carcinogen water screening level} = \frac{BW \times AT \times TR \times CF_1}{SF \times SA \times SP \times EV \times EF \times ED \times CF_2}$$

Inputs to the algorithm are as follows:

- Two of the inputs are specific to the chemical:  the slope factor and skin penetration per event (SP). The slope factor (SF) is a chemical-specific value calculated by the EPA to indicate the risk of cancer associated with exposure to a specific substance. The SP is described in Equation B-7 and B-8.

- The target risk level (TR), averaging time (AT), and the two conversion factors ($CF_1$ and $CF_2$) are default values for the algorithm. The TR one additional cancer above the background cancer rate per 100,000 people. The AT for a carcinogen is the number of days in 70 years, which represents a lifetime of exposure, and the two CF are values that account for differences in the units used for the input variables.
- The exposure frequency (EF) is the number of days per year a person is exposed to the chemical. For Torch Lake recreational areas, an exposure frequency of 90 days (three months) was selected to represent the summer months.
- The exposure duration (ED) is the number of years that an individual would be visit or live at a specific location. For adult residents, the default is 30 years. MDCH used the a value of 6 years to represent exposure of a child under age 6.
- The skin surface area (SA) was changed from the value for minimal exposure in a worker to a value that is approximately 75% of the total surface area for a child, ages one to six, 5,800 $cm^2$.

Table B-6: Variables for generic Groundwater Contact Criteria (GCC) and screening levels for a carcinogen.

| Variables for the Generic GCC Algorithm for a carcinogen (Equation B-5) | Generic inputs | Screening level inputs |
|---|---|---|
| BW (body weight; in kg) | 70 | 15[d] |
| AT (averaging time; in days) | 25,550 | 25,550 |
| TR (target risk level) | $10^{-5}$ | $10^{-5}$ |
| $CF_1$ (conversion factor 1; in µg/mg) | 1.0E+3 | 1.0E+3 |
| SF (oral slope factor; in $[mg/kg/day]^{-1}$) | chemical-specific[a] | chemical-specific[a] |
| SA (skin surface area; in $cm^2$) | 3,300 (adult) | 5,800 (child) |
| SP (skin penetration per event; in cm/event) | chemical-specific or default[b] | chemical-specific or default[b] |
| EV (event frequency; in event/day) | 1 | 1 |
| EF (exposure frequency; in days/year) | 20 | 90[c] |
| ED (exposure duration; in years) | 21 | 6 |
| $CF_2$ (conversion factor 2; in $L/cm^3$) | 1.0E-3 | 1.0E-3 |

a = from MDEQ (2006C)
b = See Equations B-7, B-8, B-9, and B-10
c = 90 days (three months) to represent the summer
d = represent the body weight of a child less than six years of age

Equation B-6 is the algorithm (MDEQ 2006D) for calculating a GCC and the water screening levels for a noncarcinogen.

Equation B-6: Water screening level algorithm for a noncarcinogen.

$$Noncarcinogen\ water\ screening\ level = \frac{THQ \times RfD \times BW \times AT \times CF_1}{SA \times SP \times EV \times EF \times ED \times CF_2}$$

Certain inputs (CF and EF) to the algorithm are described above. Values used for these inputs are in Table B-6.

Other inputs to the algorithm follow:

- The AT was changed from the default of 7,665 days to 10,950 (30 years x 365 days) to account for a residential exposure as opposed to the default worker exposure.
- The Target Hazard Quotient (THQ) has a default value of 1.0. The THQ is the ratio of the chronic daily dose of the chemical divided by the reference dose for that chemical.
- The reference dose (RfD) is a chemical-specific value that is a conservative estimate of the daily intake that a human can have with minimal risk of adverse effects over a lifetime of exposure.
- The exposure duration (ED) is the number of years that an individual would be visit or live at a specific location. For adult residents, the default is 30 years. MDCH used the a value of 6 years to represent exposure of a child under age 6.
- The skin surface area (SA) was changed from the value for minimal exposure in a worker to a value that is approximately 75% of the total surface area for a child, ages one to six, 5,800 $cm^2$.

Equations (MDEQ 2006D) for the calculation of the skin penetration per event for inorganic (Equation B-7) and organic (Equation B-8) chemicals are as follows.

Equation B-7: Equation for the skin penetration per event for inorganic chemicals ($SP_i$) used in calculation of Groundwater Contact Criteria (GCC).

$$SP_i = K_p \times ET$$

Skin penetration per event for inorganic chemicals ($SP_i$) is the output for the equation. The inputs to the equation are permeability coefficient ($K_p$) and exposure time (ET). $K_p$ values are chemical specific or default, as determined by MDEQ. They represent the rate that the chemical penetrates the skin. The ET is a default value of 2.0 hours/event.

Table B-7: Variables for generic Groundwater Contact Criteria (GCC) and screening levels for a noncarcinogen.

| Variables for the Generic GCC Algorithm for a noncarcinogen (Equation B-6) | Generic inputs | Screening level inputs |
|---|---|---|
| THQ (target hazard quotient) | 1.0 | 1.0 |
| RfD (reference dose; in mg/kg/day) | chemical-specific[a] | chemical-specific[a] |
| BW (body weight; in kg) | 70 | 15 |
| AT (averaging time; in days) | 7,665 | 10,950 |
| $CF_1$ (conversion factor 1; in µg/mg) | 1.0E+3 | 1.0E+3 |
| SA (skin surface area; in $cm^2$) | 3,300 (adult) | 5,800 (child) |
| SP (skin penetration per event; in cm/event) | chemical-specific or default[b] | chemical-specific or default[b] |
| EV (event frequency; in event/day) | 1 | 1 |
| EF (exposure frequency; in days/year) | 20 | 90[c] |
| ED (exposure duration; in years) | 21 | 6 |
| $CF_2$ (conversion factor 2; in $L/cm^3$) | 1.0E-3 | 1.0E-3 |

a = from MDEQ (2006C)
b = See Equations B-7, B-8, B-9, and B-10
c = 90 days (three months) to represent the summer

Table B-8: Variables for skin penetration per event for inorganic chemicals ($SP_i$).

| Variables for skin penetration per event for inorganic chemicals | Generic and screening level inputs |
|---|---|
| $K_p$ (permeability coefficient; in cm/hour) | chemical-specific or default[a] |
| ET (exposure time; in hours/event) | 2.0 |

a = from MDEQ (2006C)

If the MDEQ does not specify a $K_p$ for an inorganic substance, the default of 0.001 centimeter/hour is used.

For organic substances, a $K_p$ can be calculated (Equation B-8 [MDEQ 2006D]).

Equation B-8: Equation for calculation of the permeability coefficient ($K_p$).

$$\log K_p = -2.80 + (0.67 \times \log K_{ow}) - (0.0056 \times MW)$$

A $K_p$ for organic substances can be calculated using the molecular weight (MW) of the substance and the octanol-water coefficient ($K_{ow}$). The $K_{ow}$ is a value that estimates the substance's tendency to partition between lipid and water phases. Table B-9 presents the variables and their units.

Table B-9: Variables for permeability coefficient ($K_p$).

| Variables for permeability coefficient | Generic and screening level inputs |
|---|---|
| $K_{ow}$ (octanol-water partition coefficient) | chemical-specific[a] |
| MW (molecular weight; in g/mole) | chemical-specific[a] |

a = from MDEQ (2006C)

The calculated $K_p$ can then be used to calculate the skin penetration per event for organic chemicals ($SP_o$), as described in Equation B-9 (MDEQ 2006D). Certain variables for the calculation of $SP_o$ need to be derived. The derivations of those variables are described in the equations included in Equation B-10 (MDEQ 2006D).

Equation B-9: Equations for the skin penetration per event for organic chemicals ($SP_o$) used in calculation of Groundwater Contact Criteria (GCC).

If ET ≤ t*, then: $SP_0 = 2 \times K_p \times \sqrt{\frac{6 \times \tau \times ET}{\pi}}$

If ET > t*, then: $SP_o = K_p \times \left\lfloor \frac{ET}{1+B} + 2\pi \left( \frac{1+3B+3B^2}{(1+B)^2} \right) \right\rfloor$

Table B-10: Variables for skin penetration per event for organic chemicals ($SP_o$).

| Variables for skin penetration per event for organic chemicals | Generic and screening level inputs |
|---|---|
| ET (exposure time; in hours/event) | 2.0 |
| t* (time to reach steady-state; in hours) | chemical-specific[a] |
| $K_p$ (permeability coefficient; in cm/hour) | chemical-specific[b] |
| τ (lag time; in hours) | chemical-specific[a] |
| π (pi) | 3.141592654 |
| B (ratio of the $K_p$ of the stratum corneum to the $K_p$ of the viable epidermis) | chemical-specific[a] |

a = Calculate using equations listed in Equation B-10.
b = Calculate using Equation B-8

Equation B-10: Equations for calculation of B, τ, and t*.

Calculate B: $B = K_p \times \left( \frac{\sqrt{MW}}{2.6} \right)$

Calculate $D_{sc}$: $D_{sc} = 10^{(-2.80-0.0056MW)} \times I_{sc}$

Calculate τ: $\tau = \frac{I_{sc}^2}{6 \times D_{sc}}$

Calculate t*: If B ≤ 0.6, then $t^* = 2.4 \times \pi$

If B > 0.6, then $t^* = \left( b - \sqrt{b^2 - c^2} \right) \left( \frac{I_{sc}^2}{D_{sc}} \right)$

Calculate c and b: $c = \frac{1 + 3B + 3B^2}{3(1+B)}$

$$b = \frac{2(1+B)^2}{\pi} - c$$

Values used for the inputs in the equations in Equation B-10 are presented in Table B-11.

Table B-11: Variable for Equation B-9, calculation of B, τ, and t*.

| Variables for B, $D_{sc}$, τ, and t*(equations listed in Equation B-10) | Generic and screening level inputs |
|---|---|
| $K_p$ (permeability coefficient; in cm/hour) | chemical-specific[a] |
| MW (molecular weight; in g/mole) | chemical-specific[b] |
| $D_{sc}$ (effective diffusivity across stratum corneum; in $cm^2$/hours) | calculate with MW and $I_{sc}$ |
| $I_{sc}$ (thickness of stratum corneum; in cm) | 0.001 |
| π (pi) | 3.141592654 |
| c | calculate with B |
| b | calculate with B, π, and c |

a = Calculate using Equation B-8
b = from MDEQ (2006B)

Table B-12: Water contact screening levels, both carcinogen and noncarcinogen are listed below (in parts per billion [ppb]).

Screening levels for Noncarcinogens

| | | | |
|---|---|---|---|
| aluminum | 8,653,017 | iron | 7,866,379 |
| antimony | 9,177 | manganese | 1,232,399 |
| barium | 1,835,489 | mercury | 7,866 |
| boron | 8,390,805 | silver | 123,240 |
| copper | 996,408 | vanadium | 131,106 |

Screening levels for a Carcinogen

| | | | |
|---|---|---|---|
| arsenic | 408 | benzene | 1,088 |

Appendix C: Expanded Tables

Table C-1: Maximum value for chemicals (in parts per million [ppm]) in soil and sediment after the excavation at Lake Linden in 2007 (Weston 2007B).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value in sediment (in ppm) | Maximum value in soil (in ppm) |
|---|---|---|---|---|
| Antimony | 280 | 20[c] | <7.4 | 2.0 |
| Arsenic | 5.5 | 20[d] | 4 | **20** |
| Barium | 55,916 | 10,000 | 170 | 45 |
| Copper | 30,355 | 500 | **540** | **5,600** |
| Lead | 400[e] | NA | 130 | 280 |
| Mercury | 240 | NA | NT[f] | 0.06 |
| PCBs (Total) | 1.0 | 0.4 | **<1.05** | 0.04 |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
e = Part 201 Generic DCC (MDEQ 2005B)
f = Chemical was not tested (NT) in samples.

Table C-2: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Lake Linden area in 2007 (Weston 2007A).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Aluminum | 50,000[c] | 50,000 | NT[d] | 13,000[e] |
| Antimony | 280 | 20[f] | **60** | NT |
| Arsenic | 5.5 | 20[g] | **33** | **36** |
| Barium | 55,916 | 10,000 | <LOD[h] | NT |
| Beryllium | 410[c] | 100[g] | NT | 1.6 |
| Cadmium | 1,829 | 30 | **89** | NT |
| Chromium | 3,834[i] | 300[i] | 188 | 28 |
| Cobalt | 3,994 | 500 | **924** | 18 |
| Copper | 30,355 | 500 | **7,731** | **10,000** |
| Iron | 239,642 | NA[j] | 88,591 | NT |
| Lead | 400[c] | NA | **432** | **1,100** |
| Lithium | 4,200[c] | NA | NT | 11 |
| Manganese | 37,544 | 3,000[f] | 1,842 | 740 |
| Mercury | 240 | NA | <LOD | 0.2 |
| Molybdenum | 3,994 | 300[f] | 26 | NT |
| Nickel | 60,710 | 1,000 | <LOD | 49 |
| Rubidium | NA | NA | 86 | NT |
| Selenium | 3,994 | 300[g] | 7 | NT |
| Silver | 3,754 | 300[f] | 126 | 2.4 |
| Strontium | 503,250 | 100,000 | 855 | 440 |
| Tin | NA | 20,000 | <LOD | NT |
| Titanium | NA | NA | 13,818 | NT |
| Zinc | 263,607 | 20,000 | 388 | 420[e] |
| Zirconium | NA | NA | 367 | NT |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = Part 201 Generic DCC (MDEQ 2005B).
d = Chemical was not tested (NT) in samples.
e = Value is estimated.
f = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
g = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
h = Value is below the level of detection (<LOD).
i = The screening level and comparison value are for chromium VI.
j = Screening levels not available (NA).

Table C-3: Maximum inorganic chemical levels in soil and sediment (in parts per million [ppm]) as measured by x-ray fluorescence (XRF) analyzer in the Lake Linden area in 2008 (MDEQ 2009A).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value in soil and sediment ( in ppm) |
|---|---|---|---|
| Antimony | 280 | 20[c] | **171** |
| Arsenic | 5.5 | 20[d] | **294** |
| Barium | 55,916 | 10,000 | **13,870** |
| Cadmium | 1,829 | 30 | **91** |
| Calcium | NA[e] | NA | 57,627 |
| Cesium | NA | NA | 137 |
| Chromium | 3,834[f] | 300[f] | 162 |
| Cobalt | 3,994 | 500 | 243 |
| Copper | 30,355 | 500 | **11,661** |
| Iron | 239,642 | NA | 63,267 |
| Lead | 400[g] | NA | **16,289** |
| Manganese | 37,544 | 3,000[c] | 1,228 |
| Molybdenum | 3,994 | 300[c] | 22 |
| Nickel | 60,710 | 1,000[c] | **1,500** |
| Palladium | NA | NA | 18 |
| Potassium | NA | NA | 43,116 |
| Rubidium | NA | NA | 118 |
| Scandium | NA | NA | 95 |
| Selenium | 3,994 | 300[d] | 13 |
| Silver | 3,754 | 300[c] | 131 |
| Strontium | 503,250 | 100,000 | 301 |
| Sulfur | NA | NA | 52,789 |
| Tellurium | NA | NA | 131 |
| Thorium | NA | NA | 228 |
| Tin | NA | 20,000 | 4,295 |
| Titanium | NA | NA | 7,389 |
| Tungsten | NA | NA | 150 |
| Uranium | NA | NA | 17 |
| Vanadium | 750[g] | 500 | 235 |
| Zinc | 263,607 | 20,000 | 1,940 |
| Zircon | NA | NA | 947 |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
e = Screening level is not available (NA).
f = Screening level is for chromium VI.
g = Generic Part 201 DCC (MDEQ 2005B).

Table C-4: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Hubbell Beach area in 2007 (Weston 2007A).

| Chemical | Screening level[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Aluminum | 50,000[c] | 50,000 | NT[d] | 15,000 |
| Antimony | 280 | 20[e] | **466**[f] | **37**[f] |
| Arsenic | 5.5 | 20[g] | **2,505** | **230** |
| Barium | 55,916 | 10,000 | <LOD[h] | 1,300[f] |
| Beryllium | 410[c] | 100[g] | NT | 8[f] |
| Cadmium | 1,829 | 30 | **137**[f] | 19[f] |
| Chromium | 3,834[i] | 300[i] | **7,850** | 76[f] |
| Cobalt | 3,994 | 500 | **1,653** | 48 |
| Copper | 30,355 | 500 | **840,928** | **74,000**[f] |
| Iron | 239,642 | NA[j] | **544,540** | 63,000[f] |
| Lead | 400[c] | NA | **28,724**[f] | **6,800**[f] |
| Lithium | 4,200[c] | NA | NT | 12 |
| Manganese | 37,544 | 3,000[e] | 1,286[f] | 1,100[f] |
| Mercury | 240 | NA | **340**[f] | 7[f] |
| Molybdenum | 3,994 | 300[e] | 30[f] | 45[f] |
| Nickel | 60,710 | 1,000[e] | **2,744** | 540 |
| Rubidium | NA[j] | NA | 144[f] | NT |
| Selenium | 3,994 | 300[g] | 92[f] | 6[f] |
| Silver | 3,754 | 300[e] | **1,059**[f] | **330**[f] |
| Strontium | 503,250 | 100,000 | 522[f] | <220 |
| Tin | NA | 20,000 | 27,016[f] | NT |
| Titanium | NA | NA | 25,083 | NT |
| Zinc | 263,607 | 20,000 | **261,353** | 5,400 |
| Zirconium | NA | NA | 1,054 | NT |

**Bold** values are those that exceed the screening levels or comparison values.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = Generic Part 201 DCC (MDEQ 2005B).
d = The chemical was not tested (NT) for in the sample.
e = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
f = Maximum level from August 2007 MDEQ sampling (Weston 2007A).
g = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
h = The level was below the level of detection (<LOD).
i = Screening level is for chromium VI.
j = Screening level not available (NA).

Table C-5: Maximum inorganic chemical levels (in parts per million [ppm]), from laboratory and x-ray fluorescence (XRF) analysis, in soil samples from the Mason Stampsands in 2007 (Weston 2007A).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison values[b] (in ppm) | Maximum value from XRF analysis (in ppm) | Maximum value from laboratory analysis (in ppm) |
|---|---|---|---|---|
| Aluminum | 50,000[c] | 50,000 | NT[d] | 27,000 |
| Antimony | 280 | 20[e] | <LOD[f] | NT |
| Arsenic | 5.5 | 20[g] | **74** | **10** |
| Barium | 55,916 | 10,000 | 834 | NT |
| Beryllium | 410[c] | 100[g] | NT | <5 |
| Cadmium | 1,829 | 30 | <LOD | NT |
| Chromium | 3,834[h] | 300[h] | <LOD | 20 |
| Cobalt | 3,994 | 500 | **902** | 25 |
| Copper | 30,355 | 500 | **275,954** | **19,000** |
| Iron | 239,642 | NA[i] | 158,600 | NT |
| Lead | 400[c] | NA | **631** | **1,100** |
| Lithium | 4,200[c] | NA | NT | 8 |
| Manganese | 37,544 | 3,000[e] | 945 | 790 |
| Mercury | 240 | NA | 16 | 0.51 |
| Molybdenum | 3,994 | 300[e] | 14 | NT |
| Nickel | 60,710 | 1,000[e] | 14 | 34 |
| Rubidium | NA | NA | 95 | NT |
| Selenium | 3,994 | 300[g] | <LOD | NT |
| Silver | 3,754 | 300[e] | 145 | 5 |
| Strontium | 503,250 | 100,000 | 569 | <270 |
| Tin | NA | 20,000 | 428 | NT |
| Titanium | NA | NA | 18,070 | NT |
| Zinc | 263,607 | 20,000 | 132 | 170 |
| Zirconium | NA | NA | 189 | NT |

**Bold** values are those that exceed the screening levels.
a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = Part 201 Generic DCC (MDEQ 2005B).
d = The chemical was not tested (NT) for in the sample.
e = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
f = The level was below the level of detection (<LOD).
h = Screening level is for chromium VI.
g = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
i = Screening levels not available (NA).

Table C-6: Maximum levels (in parts per million [ppm]) of inorganic chemicals in Boston Pond and Calumet Lake sediment collected in 2008 (MDEQ 2009B).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison values[b] (in ppm) | Maximum value in Boston Pond sediment (in ppm) | Maximum value in Calumet Lake sediment (in ppm) |
|---|---|---|---|---|
| Antimony | 280 | 20[c] | ND[d] | 8 |
| Arsenic | 5.5 | 20[e] | 1.5 | 5 |
| Barium | 55,916 | 10,000 | 20 | 46 |
| Beryllium | 410[f] | 100[e] | 1.1 | 2 |
| Cadmium | 1,829 | 30 | ND | 0.3 |
| Chromium | 3,834[g] | 300 | 20 | 32 |
| Cobalt | 3,994 | 500 | 12 | 13 |
| Copper | 30,355 | 500 | **3,300** | **13,000** |
| Iron | 239,642 | NA[h] | 21,000 | 17,000 |
| Lead | 400 [f] | NA | 14 | 160 |
| Manganese | 37,544 | 3,000[c] | 210 | 290 |
| Mercury (total) | 240 | NA | 0.08 | 0.3 |
| Nickel | 60,710 | 1,000[c] | 34 | 31 |
| Selenium | 3,994 | 300[e] | ND | 0.8 |
| Silver | 3,754 | 300[c] | 6.9 | 14 |
| Vanadium | 750 [f] | 500 | 41 | 78 |
| Zinc | 263,607 | 20,000 | 71 | 140 |

a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
d = The chemical was not detected (ND).
e = The comparison value is the ATSDR chronic environmental media evaluation guide for a child.
f = Part 201 Generic DCC (MDEQ 2005B).
g = Screening level is for chromium VI.
h = Screening levels not available (NA).

Table C-7: Maximum level (in parts per million [ppm]) of detected organic chemicals in Calumet Lake sediment collected in 2008 (MDEQ 2009B).

| Chemical | Screening levels[a] (in ppm) | ATSDR Comparison value[b] (in ppm) | Maximum level in sediment (in ppm) |
|---|---|---|---|
| Benzo(a)anthracene | 5.3 | NA[c] | 0.97 |
| Benzo(a)pyrene | 0.53 | 0.1 | **0.22** |
| Benzo(b)fluoranthene | 5.3 | NA | 1.4 |
| Benzo(g,h,i)perylene | 591 | NA | 0.32 |
| Chrysene | 534 | NA | 1.8 |
| Fluoranthene | 12,428 | 20,000 | 1.7 |
| Indeno(1,2,3-cd)pyrene | 5.3 | NA | 0.26 |
| Phenanthrene | 619 | NA | 0.93 |
| Pyrene | 7,768 | 2,000[d] | 2.4 |
| Toluene | 250[e] | 1,000 | 0.075 |

a = Screening levels are discussed in Appendix B.
b = Comparison values are the ATSDR intermediate environmental media evaluation guide for a child.
c = Comparison value was not available (NA).
d = The comparison value is the ATSDR Reference Dose Media Evaluation Guide for a child.
e = Part 201 Generic DCC (MDEQ 2005B).

Table C-8: Maximum value for inorganic chemicals in surface water (in parts per billion [ppb]) after the removal action at Lake Linden in 2007 (Weston 2007B).

| Chemical | Screening levels[a] (ppb) | Maximum value in surface water (ppb) |
|---|---|---|
| Antimony | 9,177 | ND[b] |
| Arsenic | 408 | ND |
| Barium | 1,835,489 | 200 |
| Copper | 996,408 | 32 |
| Lead | NA[c] | ND |
| Mercury | 7,866 | ND |
| Silver | 123,240 | ND |
| Vanadium | 131,106 | ND |
| Zinc | 110,000,000[d] | ND |

a = Screening levels are discussed in Appendix B.
b = The chemical is not detected (ND).
c = Screening level is not available (NA).
d = Part 201 Generic GCC (MDEQ 2006A).

Table C-9: Maximum value for chemicals in groundwater (in parts per billion [ppb]) in the Lake Linden area in 2008 (MDEQ 2009A).

| Chemical | Screening levels[a] (ppb) | Maximum value in groundwater (ppb) |
|---|---|---|
| Aluminum | 8,653,017 | 24,000 |
| Ammonia | NA[b] | 80,000 |
| Arsenic | 408 | 83 |
| Barium | 1,835,489 | 28,000 |
| Benzene | 1,088 | 11 |
| Boron | 8,390,805 | 1,400 |
| Chloride | NA | 620,000 |
| Copper | 996,408 | 13,000 |
| Iron | 7,866,379 | 54,000 |
| Lead | NA | 48 |
| Manganese | 1,232,399 | 12,000 |
| Nickel | 74,000,000[c] | 150 |
| Nitrogen | NA | 83,000 |
| Vanadium | 131,106 | 30 |

**Bold** values are those over the screening level.
a = Screening levels are discussed in Appendix B.
b = Screening levels are not available (NA).
c = Part 201 Generic GCC (MDEQ 2006A).

Appendix D: Additional maps of areas discussed in this document.

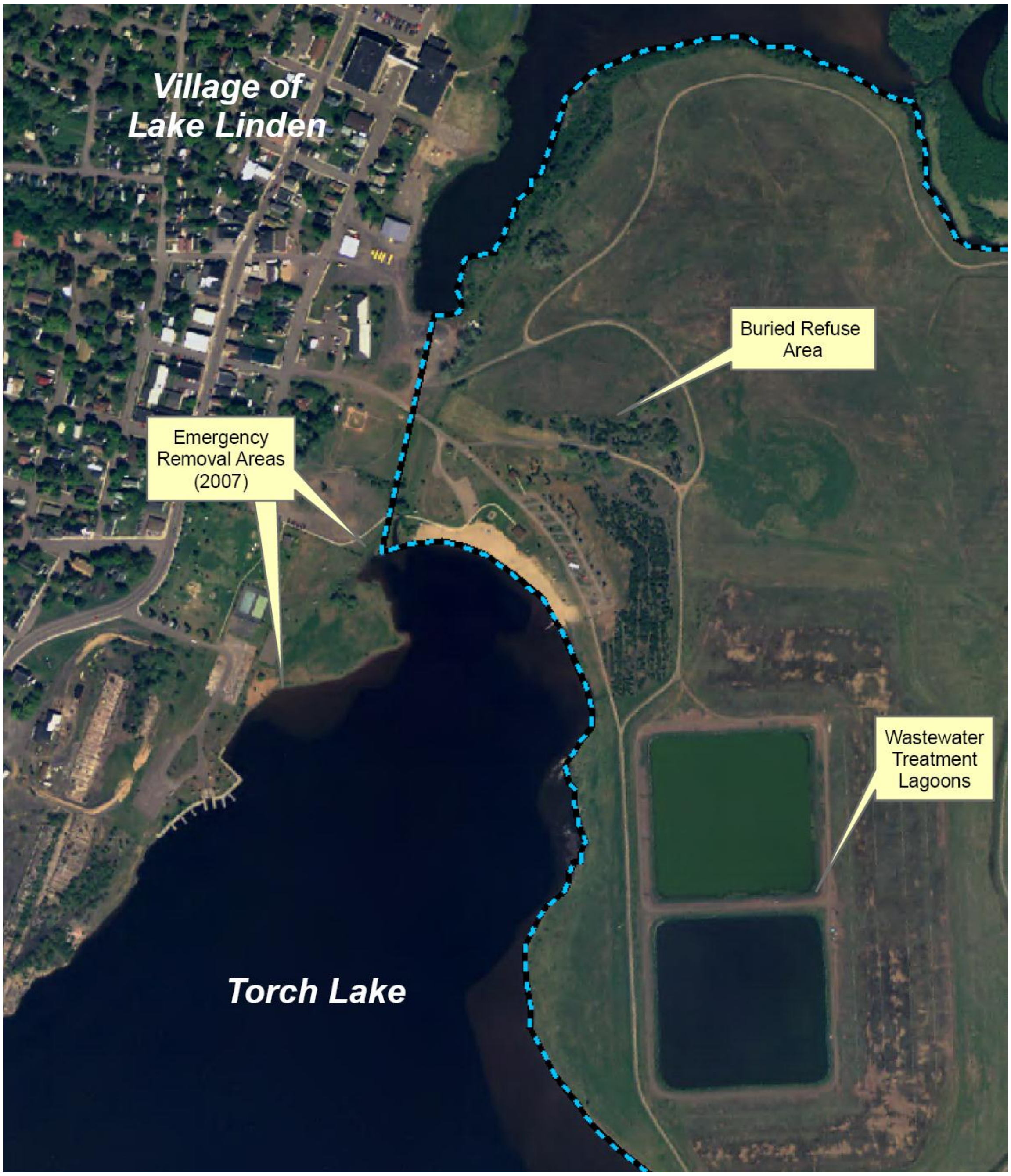


Figure D-1: Map of the Lake Linden area (MDEQ 2009A).


Figure D-2: Map of the Hubbell Beach and slag dump area (Weston 2007A). HubbellB-2, -3, and -4 are sample locations.


Figure D-3: Map of the Mason stampsands area (Weston 2007A). Triangles with MS-S1-XX are sample locations.

Appendix E: MDCH Responses to Public Comments and Questions Received on the "Evaluation of Recreational Uses at Beach Areas at Lake Linden and Along Torch Lake" Public Health Assessment.

MDCH compiled the comments and questions received at the May 15, 2013 community meeting in Lake Linden, Michigan. Questions and comments pertaining to the recreational exposure (exposure during outdoor activities) document are addressed here.

Questions and comments pertaining to the inhalation of airborne stampsands are addressed in an appendix of that document. That document is available on-line and in print at the locations mentioned in the next paragraph.

Other questions and comments received that did not apply to either document specifically are listed in a separate responsiveness summary. The responsiveness summary is available at www.michigan.gov/mdch-toxics, under "Health Assessments and Related Documents," then "Torch Lake Superfund Area." It also is available at the public repositories for the Torch Lake Superfund Site: the Lake Linden-Hubbell Public School Library in Lake Linden, Michigan, and the Portage Lake District Library in Houghton, Michigan.

**Would you let your children use the beaches or handle the stampsands? (This question was directed to EPA and MDEQ.)**

The MDEQ Remediation and Redevelopment Division Director, present at the May 15, 2013 meeting, answered yes, unless there was information that showed high levels of lead or arsenic.

As discussed in the public health assessment document, adults and children who accidently swallow several gulps of water while swimming in Torch Lake are not expected to be exposed to high enough chemical levels to cause health effects. Because of low water levels, unusual-looking soil and sediments, like the bright blue, pink, and yellow/brown material removed at the Lake Linden Village Park in 2007, might be seen at shoreline areas and beaches. The material removed in 2007 had high levels of arsenic, lead, and PCBs. There could be more material with high arsenic, lead, and PCBs present in Torch Lake or along the shoreline. People, especially children, should not come into contact with soil, sediment, or water that is brightly or oddly colored.

Adults and children can reduce their possible exposure to chemicals by:

- washing their hands before eating,
- not digging deep holes in the sand or sediment, especially in stampsand areas, and
- avoiding soil, sediment, or water that looks unusual or abnormal.

**Why won't local officials do anything about the Hubbell beach area? There is debris from the slag/municipal dump in the water and along the beach. Why won't people put up warning signs?**

The Hubbell Beach has warning signs stating that the water is not tested for bacteria and that there is no lifeguard on duty. According to the township supervisor, Torch Lake Township staff checks the beach area every day and removes glass and dumped garbage. Visitors to the beach should call the Torch Lake Township office (906-296-0214) if they have concerns about the beach or park maintenance.

**If the lake doesn't support a fish population, how can people be allowed to go in it?**

Aquatic organisms are much more sensitive to certain metals and other chemicals than are humans. Chemical levels that are harmful to fish are not always a concern to human health. Note that it is possible, in some areas, that fish populations cannot be supported because there are inadequate habitat or food sources.

**If the area had a community swimming pool, we would not have to worry about exposure to chemicals or trash in Torch Lake.**

Comment noted.

**The surface material at Lake Linden is not stampsand but rather "goo" on top of the stampsands.**

Comment noted. The material that was removed at Lake Linden was not identified as stampsand in the PHA.

**Potential disproportionate health impact to tribal members harvesting and consuming fish from Torch Lake or connected waterbodies should be assessed. Recommending that people limit consumption is not a solution to the contamination.**

Language has been added to the PHA recommending that sources of PCBs to Torch Lake be identified and addressed. Only chemical levels in Torch Lake fish were presented in this PHA. People eating large (over the fish consumption guidelines) or unlimited amounts of Torch Lake fish, such as tribal members and subsistence consumers, will be exposed to higher PCB levels than people who follow the fish consumption guidelines. Exposure to high enough levels of PCBs from eating fish could lead to long-term health effects in some individuals. This is acknowledged in the conclusions of the PHA.

Portage Lake fish were not discussed in the PHA. KBIC provided fish from Portage Lake this year (2013) for analysis. The results will be included in future Eat Safe Fish Guides (formerly the Michigan Fish Advisory).

**When the PHA reports say, "More information needed," who will do that – EPA and MDEQ? When? Where will the sampling take place? What will you test for? If EPA/MDEQ won't sample, why not? The health reports say it's needed. It sounds like MDCH doesn't do the sampling. Will MDCH conduct follow-up assessment after any additional data is collected?**

The MDEQ Remediation and Redevelopment Division Director, present at the May 15, 2013 meeting, indicated that MDEQ would collect environmental samples where a risk is suspected (e.g., areas where PCBs were used or released, odd-colored media). The agency would be interested in results of the "Integrated Assessment of the Torch Lake Area of Concern" being conducted by Noel Urban and colleagues at Michigan Technological University, to help guide investigative efforts. Also, MDEQ would work with the WUPHD regarding sampling local drinking water wells. Other divisions at MDEQ, such as the Water Resource Division, may obtain data as well. In some instances, MDEQ may request assistance from U.S. EPA's Emergency Removal program.

MDCH will evaluate any future data as needed.