Health Consultation

LITTLE BLACK CREEK SEDIMENTS
MUSKEGON COUNTY, MICHIGAN

EPA FACILITY ID: MID006031348

JULY 12, 2006

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

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

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MUSKEGON COUNTY, MICHIGAN

EPA FACILITY ID: MID006031348

Prepared by:

The Michigan Department of Community Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
The Agency for Toxic Substances and Disease Registry

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Acronyms and Abbreviations

µg	microgram
AE_d	dermal absorption efficiency
AE_i	ingestion absorption frequency
AF	soil adherence factor
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
AWRI	Annis Water Resources Institute
CF	conversion factor
DCC	Direct Contact Criteria
DF	age-adjusted soil dermal factor
EF_d	dermal exposure frequency
EF_i	ingestion exposure frequency
EPA	U.S. Environmental Protection Agency
GSI	Groundwater Surface Water Interface Criteria
GSIPC	Groundwater Surface Water Interface Protection Criteria
IEUBK	Integrated Exposure Update Biokinetic Model for Lead in Children
IF	age-adjusted soil ingestion factor
IRIS	Integrated Risk Information System
kg	kilogram
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg	milligram
MRL	Minimal Risk Level
PAH	polynuclear aromatic hydrocarbon
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PEC	Probable Effect Concentration
ppb	parts per billion
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RSC	relative source contribution
SF	oral cancer slope factor
SVOC	semivolatile organic compound
THQ	target hazard quotient
TMDL	Total Maximum Daily Load
TR	target cancer risk
VOC	volatile organic compound
WWTP	wastewater treatment plant

Summary

Little Black Creek in Muskegon County, Michigan, flows into Mona Lake, which empties into Lake Michigan. The creek's sediments contain elevated levels of metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs). Although the concentrations of the contaminants exceed the state's generic clean-up criteria for residential soils, only cadmium exceeded exposure-adjusted screening levels for the creek's sediments. The highest concentrations of cadmium occur where the creek passes the Peerless Plating Superfund site. This area of the creek does not appear attractive to play in, or otherwise use, due to surrounding dense brush, poor access, and nearby traffic. It is likely that, under current conditions, there is little or no exposure to the creek and its sediments in this area. Therefore, ***exposure to the cadmium in the sediments in Little Black Creek poses no apparent current public health hazard***.

Lead concentrations in the creek sediments exceed the state's generic clean-up criterion for residential soils in several samples. An exposure-adjusted screening level for lead, to determine the health risk of exposure to lead in the sediments, cannot be determined. However, the areas of the creek in which the highest concentrations of lead were found are likely to have little, if any, access: dense brush, steep banks, and neighboring industrial facilities all serve to restrict access to these areas. There is likely little or no exposure to the creek and its sediments in these areas. Therefore, ***exposure to the lead in the sediments in Little Black Creek poses no apparent current public health hazard***.

Because the concentrations of other contaminants do not exceed their respective screening levels, ***exposure to other contaminants in the sediments in Little Black Creek poses no apparent current public health hazard.***

Future changes in the use of the Little Black Creek corridor could increase the potential for exposure to the sediments in the creek. ***The future public health hazard of exposure to the sediments is indeterminate.*** Re-evaluation would be necessary dependent on proposed future uses. Alternatively, sediments of concern could be removed proactively.

Mercury levels detected in the sediments of Little Black Creek pose an indeterminate public health hazard. Although mercury was not detected in groundwater and surface water analyses, the detection limit was greater than the screening level of interest. Mercury is a bioaccumulative element that has been found in various fish species from inland lakes. It is possible that mercury in the sediments could enter the creek and impact concentrations in fish. The general consumption advisory issued by the Michigan Department of Community Health recommends that people restrict their consumption of large fish from inland lakes.

Exposure to contaminants deposited from Little Black Creek to floodplain soils during flood events poses an indeterminate public health hazard. There are no data for surficial soils in easily-accessed floodplain areas (e.g., public parks near residential areas). This information should be acquired to determine if a health threat exists.

Groundwater contaminated with petroleum products is venting to Little Black Creek near the creek's headwaters. Some contamination has been detected in the creek sediments in this area. Neighbors and passersby frequently detect noxious odors associated with the petroleum contamination. There are no data regarding concentrations of VOCs in the air near this area. Until contaminant concentrations in the air are known, ***chemicals present during odor events pose an indeterminate public health hazard***.

Purpose and Health Issues

In the fall of 2004, the Muskegon County Health Department requested assistance from the Michigan Department of Community Health (MDCH) in evaluating the public health implications of exposure to sediments in two Muskegon-area creeks, Ryerson Creek and Little Black Creek.

The purpose of this document is to discuss whether the contaminated sediments in Little Black Creek, which flows through rural Muskegon County, Muskegon Township, and the cities of Muskegon, Muskegon Heights, and Norton Shores (Figure 1), pose a health threat, currently or in the future, to recreational users of the creek and the surrounding area. (Ryerson Creek is discussed in a separate health consultation.)

Background

Little Black Creek in Muskegon County, Michigan is part of the Mona Lake watershed (Figure 1). MDCH, under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), previously evaluated the public health implications of contamination in the creek near the Peerless Plating Superfund (Peerless) site (Figure 2; ATSDR 1992, 1996). The U.S. Environmental Protection Agency (EPA) and the Michigan Department of Environmental Quality (MDEQ) have addressed most of the contamination at the Peerless site. However, environmental groups and local residents and officials are concerned that the contamination remaining near the Peerless site as well as pollutants from other sources to the creek may pose a public health threat. Along with several residential areas, there are two public parks along Little Black Creek: Johnny O. Harris Park, which connects to a trail following the creek downstream, and Mona Lake Park (Figure 2).

On February 14, 2005, MDCH met with approximately 30 people representing local health, government, and neighborhood associations at the Grand Valley State University Annis Water Resources Institute (AWRI) in Muskegon, Michigan. The purpose of the meeting was for MDCH to inform the attendees regarding the process of public health consultations, for AWRI to share research findings regarding Little Black Creek and Ryerson Creek (another contaminated creek which is addressed in a separate health consultation), and for the attendees to voice concerns about the contamination. Contact with contaminated sediments was the main concern at this meeting, however there were also concerns expressed about contaminated groundwater.

Little Black Creek and Muskegon Heights Area, Muskegon County

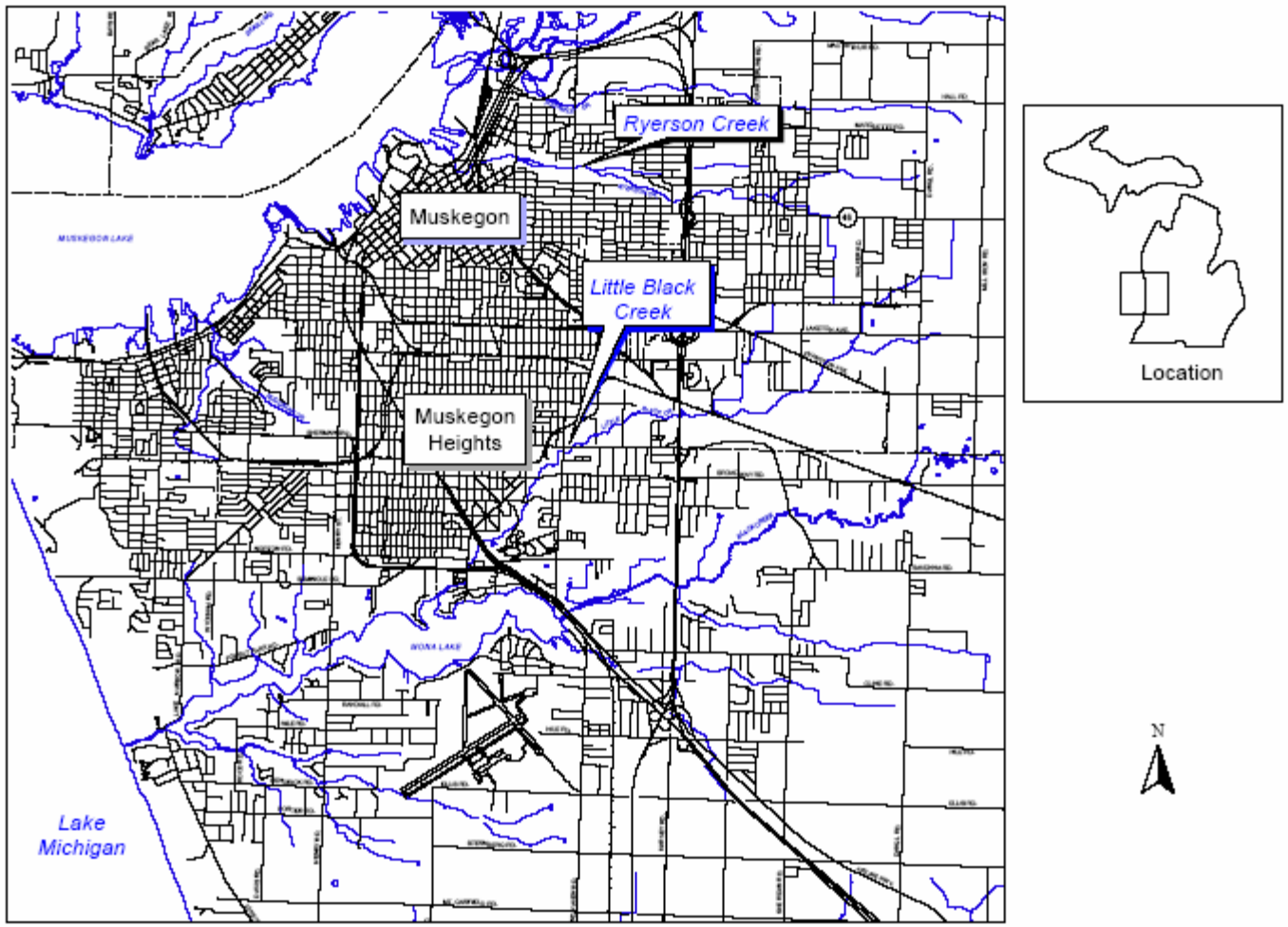
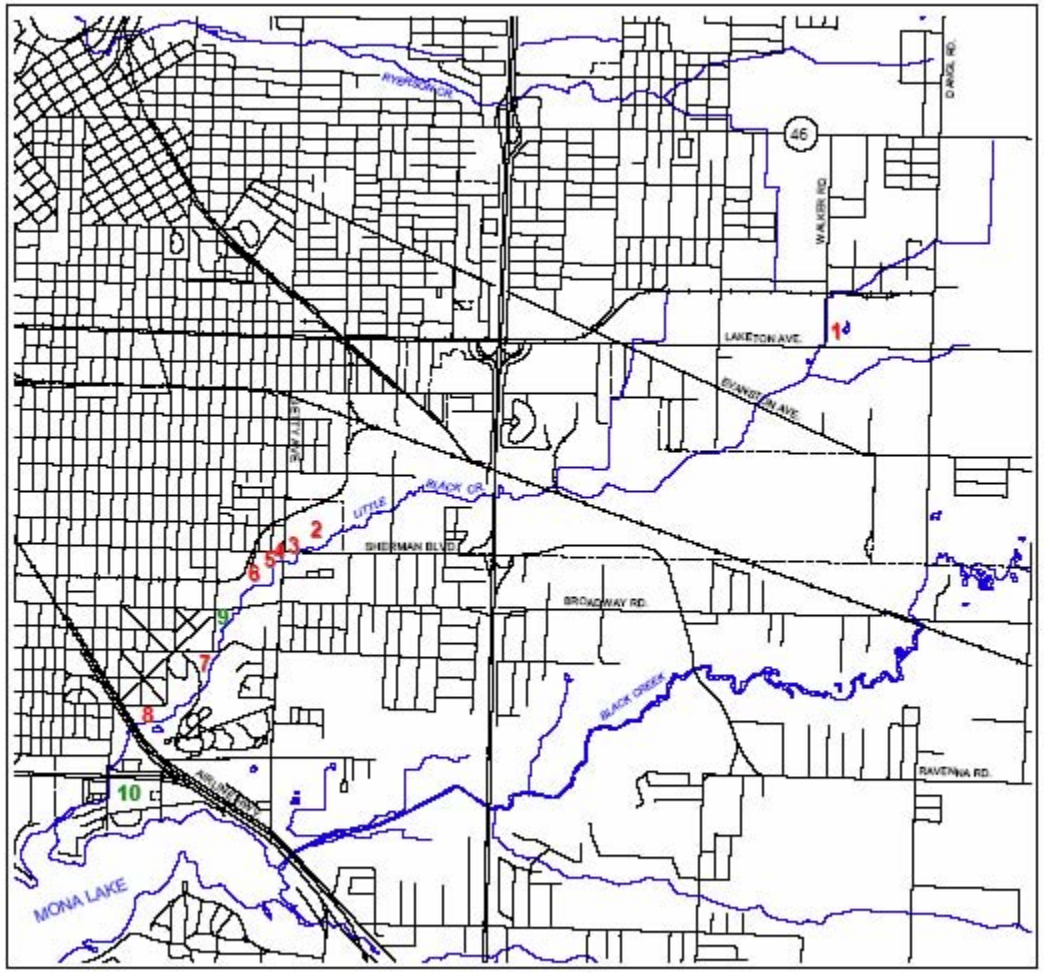


Figure 1.

Little Black Creek, Muskegon County: Pollution Sources and Selected Features



Pollution Sources

1 Marathon Petroleum
2 Keating Ave Sewer
3 Peerless Plating
4 Getty Street Pump Station
5 Webb Chemical Company
6 Defunct Landfill
7 Former Wastewater Treatment Plant
8 Merriam Street Sewer

Selected Features

9 Johnny O. Harris Park
10 Mona Lake Park

N

Figure 2.

On April 7, 2005, MDCH accompanied MDEQ field staff in a site visit for both creeks. This allowed MDCH to gain first-hand information about the characteristics of the creeks and their surrounding environments.

On June 14 and November 28, 2005, MDCH and MDEQ attended community-input meetings, hosted by the Mona Lake Watershed Council and the Great Lakes Alliance, regarding Little Black Creek. The purpose of the meetings was for MDCH to update stakeholders on the progress of the health consultation and hear community concerns, for MDEQ to discuss its upcoming sampling program for the creek, and for the community to provide information to both agencies regarding historical use of the creek and potential areas for sampling. MDCH and MDEQ conducted another site visit at sections of Little Black Creek before arriving at each meeting.

Discussion

Sources of Contamination to Little Black Creek

There are many known or suspected sources of contamination to Little Black Creek. Williams and Beck, Inc., a consulting firm that assisted AWRI in its Mona Lake Watershed Study, provided MDCH with maps and lists of potential contaminant sources to the creek. Over 100 potential sources were identified, including current and former industries, gas stations, illicit dumps, landfills, and storm drains. Twenty-nine of those sources likely have had historical or on-going chemical impacts on the creek (Williams & Beck, Inc. 2003). MDCH did not investigate all the sources named, but focused its efforts on sites for which MDEQ had environmental, primarily sediment, data.

MDEQ identified several sites along Little Black Creek that may have contributed to sediment contamination (Figure 2). Near the headwaters of the creek is the defunct Marathon Petroleum refinery. Downstream, the Keating Avenue storm sewer discharges to the creek slightly upstream from the Peerless site. The sewer receives non-contact cooling water discharges from several area industries (R. Fountain, City of Muskegon, personal communication, 2005). Downstream from the Keating Avenue storm sewer discharge is the Peerless site, then the municipal sanitary/industrial wastewater pump station, the Webb Chemical Company, and a closed municipal landfill. Further downstream is the City of Muskegon Heights' former wastewater treatment plant (WWTP), which has gone through several acquisitions, and the Merriam Street storm sewer. Each of these sites is discussed individually below. Comparison of contaminant levels to state screening levels is discussed in the "Environmental Contamination" section of this document.

Defunct Marathon Petroleum Refinery

The Marathon Petroleum Company formerly operated a refinery near the headwaters of Little Black Creek. In 1977, MDEQ (then the Michigan Department of Natural Resources [MDNR]) conducted several biological and water quality surveys of the creek. Surface water of the creek near Evanston Road had high concentrations of aluminum, chromium, lead, and zinc. The findings were attributed to either groundwater contamination or a waste hauler illegally dumping (MDNR 1977). (During the April 7,

2005 site visit by MDCH, a local citizen living near the defunct refinery claimed that garbage trucks would dump waste in the area during the 1950s and 1960s. Additional anecdotal evidence, told to a representative of the Mona Lake Watershed Council, indicated that another neighbor of the Marathon property emptied tankers of crude oil in Hulbert drain in the late 1970s as directed by his employer.) No sediment sampling occurred during the 1977 surveys.

In 1985, MDEQ sampled sediments in Little Black Creek at two locations near groundwater seeps containing suspected petroleum contaminated groundwater from Marathon's property. The samples contained concentrations of lead that were greater than the Michigan background concentration for this metal, as well as polycyclic aromatic hydrocarbons (PAHs) and oil/grease, indicating that petroleum-contaminated seepage was entering Little Black Creek along the west side of Marathon's property (MDNR 1985). Marathon conducted dredging of the creek in 1993 under an agreement with the Muskegon County Drain Commissioner, to meet discharge-permit requirements (Tolbert 1993). Post-dredging sampling, as well as the 1985 MDEQ sampling, indicated that the concentrations of lead found do not exceed the current Michigan clean-up criteria that address skin contact with or incidental ingestion (swallowing) of dry soil. (There are no generic clean-up criteria in Michigan for sediments.)

It should be noted that local residents still detect petrochemical odors regularly in the air around the Marathon site (MDEQ 2003). MDCH and MDEQ staff readily detected odors in this area during the April 7 and November 28, 2005 site visits. At the very least, these odors are a nuisance and decrease the quality of life for these residents. Further study, specifically ambient air sampling for volatile organic compounds (VOCs) associated with petroleum products (e.g., benzene, toluene, ethylbenzene, xylenes, and phenols), would provide information regarding the identity and concentration of the airborne compounds and help determine if a health threat is posed by these odors.

Keating Avenue Storm Sewer

The Keating Avenue storm sewer formerly received industrial discharges from several businesses along Keating Avenue. The largest contributor of wastewater, during dry weather, into the sewer was the Kersman Company, now called Coil Anodizers (MDNR 1970, Newell 1970a-c). Local companies (Coil Anodizers, American Coil and Spring, Johnson Products, American Porcelain, and Sealed Power) now discharge their process wastewater to the sanitary sewer system and reportedly release only non-contact cooling water, which is considered innocuous, and storm water to the Keating Avenue storm sewer (MDNR 1979; R. Fountain, City of Muskegon, personal communication, 2005).

In 1977, the MDEQ (then the MDNR) conducted several biological and water quality surveys of Little Black Creek. Sediments below the Keating outfall had concentrations of cadmium, lead, nickel, and zinc greater than the Michigan background concentrations for these metals (MDNR 1977), but the concentrations do not exceed the current state criteria addressing skin contact with or incidental ingestion of dry soil.

Peerless Plating Superfund Site

The Peerless Plating Company was an abandoned electroplating facility proposed for listing as a National Priorities List (NPL or "Superfund") site in 1988. MDCH has been involved in public health activities at the site since 1983 and has written a Preliminary Health Assessment and a Site Review and Update document discussing the health hazards found there (ATSDR 1992, 1996). Remedial activities taken by the U.S. EPA include removing chemicals and wastes remaining on-site after the facility closed, treating and removing contaminated soil, and pumping and treating groundwater from under the site (EPA 2004). The groundwater treatment system has been operating since the summer of 2002. The discharge limit is set at 12 micrograms per liter (ug/L) for cadmium (EPA 2002). Previously, the treated groundwater was released to Little Black Creek but is now discharged to the Muskegon County Wastewater Management System (Alexander 2005a).

During construction of the groundwater treatment system, previously unidentified soil contamination was discovered and found to be widespread in the subsurface both vertically and horizontally. Because of the difficulties and expense of excavating soil below the water table and underneath a building addition of a neighboring business, contaminated soil was only excavated to the water table and/or left under the building addition. The Peerless property has been limited to industrial/commercial use with no groundwater use or construction activities that could potentially expose contaminated soils left in place (EPA 2002).

Ongoing sampling indicates that sediment cadmium concentrations remain high in this area (see the "Environmental Contamination" section of this document). It is not clear whether the contamination in the sediment is from unaddressed historic deposition, erosion of contaminated soils into the creek, or uncaptured contaminated groundwater discharging to the creek (or a combination of the three).

Municipal Sanitary/Industrial Wastewater Pump Station (Getty Street)

The Getty Street sewage pump station has failed at least twice in the past 11 years, allowing raw sewage, industrial wastewater, and domestic debris to bypass the station and enter the creek directly (MDEQ 2003). There are no environmental data for this portion of Little Black Creek. However, contamination attributed to one of the failures was detected further downstream in the vicinity of the Merriam Street storm sewer (discussed later in this section).

Webb Chemical Company

The Webb Chemical Company remediated contaminated groundwater at its property from 1992 to 2001, using a pump-and-treat remedy and releasing the wastewater, which met drinking-water standards, to Little Black Creek (MDEQ 2003). The contaminants were chlorinated solvents, their breakdown products, and PAHs. There were no environmental data regarding soil or sediments available to review for this document. Webb Chemical will continue to monitor the groundwater via existing on-site test wells.

Defunct Municipal Landfill

MDEQ has documented evidence of debris eroding into Little Black Creek from the former landfill. During the 1977 biological and water quality surveys of the creek, MDEQ noticed an increase in the levels of oils, phosphorus, lead, and aluminum in the sediments in this stretch of the creek, either from the landfill or an unknown source (MDNR 1977). Further sediment sampling in 1996 and 2001 confirmed the presence of metals and semivolatile organic compounds (SVOCs) (Walker 2000, 2001). According to MDEQ, the landfill had been used to dispose of building materials but not garbage. The landfill operators would occasionally burn brush and tree limbs there, which would account for the presence of SVOCs. (This type of burning generates PAHs, which are a group of SVOCs.) (H. Hopkins, MDEQ Remediation and Redevelopment Division – Grand Rapids District, personal communication, 2006.)

Former Wastewater Treatment Plant

The former WWTP is a former Resource Conservation and Recovery Act (RCRA) site and is now part of EPA's RCRA Brownfield Prevention Pilot. The plant was built in 1917 and used by the City of Muskegon Heights until 1974. It was leased to Systech in 1975 and used for treatment of wastes from metal finishing operations. Documented environmental releases (two groundwater pressure relief valve leaks) and permit violations started during Systech's ownership. Tricil acquired the plant in 1983, followed by Laidlaw in 1990, who performed closure (environmental clean-up) activities. Safety-Kleen purchased the property in the early 1990s. The City of Muskegon Heights is the current owner (Williams & Beck 2004).

The City is investigating the possibility of developing this property into residential housing and hired an environmental consultant to identify remaining environmental issues. Groundwater and soils were tested but creek sediments were not. (The area of the property where the operations had taken place is set back from Little Black Creek.) The consultants found some increased contaminant concentrations in groundwater down-gradient of the site and some residual contamination in on-site soils but not at levels of public health concern. If any groundwater is discharging to Little Black Creek from this site, it is likely not significantly affecting the creek (Williams & Beck 2004).

Merriam Street Storm Sewer and Vicinity

MDEQ conducted several biological and water quality surveys of Little Black Creek in 1977, 1991, and 1996 that included the area of the creek around the Merriam Street storm sewer. The earlier sampling indicated that the storm sewer appeared to have little measurable effect on the creek (MDNR 1977). In 1991 and 1996, the specific sampling site for this area was at Airline Highway. The sediments from the 1991 sampling had increased levels of aluminum, barium, chromium, copper, lead, titanium, and zinc, but this was attributed to a failure at the municipal sanitary/industrial wastewater pump station upstream 10 days earlier (see discussion for the pump station above), which had released 80,000 gallons of untreated wastewater to Little Black Creek in a 24-hour period (MDNR 1992). The concentrations had decreased by the 1996 sampling. According to MDEQ, there are no industrial sources of pollutants to the creek in this area, and

increased concentrations may be more reflective of sediment transport and deposition patterns (Walker 2000).

Environmental Contamination

As an initial screening tool, MDCH compared the concentrations of chemicals found in Little Black Creek sediments to the current MDEQ Part 201 Generic Residential and Commercial I Direct Contact Criteria (DCC) to select chemicals requiring further investigation. The residential DCC identifies a soil concentration that is protective against adverse health effects (cancer or noncancer) due to long-term dermal exposure to and incidental ingestion of contaminated soil (MDEQ 2001). The criteria are not applicable to the evaluation of contaminated sediments in streams. However, inputs to the algorithm used to calculate the DCC can be adjusted to assist in determining public health implications of exposure to contaminated sediments (Appendix A). This results in an informal, adjusted screening level. MDCH chose to use current, rather than historic, criteria values for all samples because the current values were calculated using the most up-to-date information on chemicals, fate and transport modeling, and exposure pathways and therefore have a greater margin of protection.

The chemicals found in Little Black Creek sediments following sampling events dating back to the 1970s are listed in Table 1. Those chemicals in bold print exceeded the Part 201 residential DCC.

Table 1. Chemicals detected in Little Black Creek sediments, Muskegon County, Michigan. (Sampling events occurred between 1977 and 2004.)

Metals	*Organics*
Aluminum	Acenaphthene
Arsenic	Anthracene
Barium	Benzo(a)anthracene
Beryllium	**Benzo(a)pyrene**
Cadmium	Benzo(b)fluoranthene
Calcium[1]	Benzo(g,h,i)perylene
Chromium[2]	Benzo(k)fluoranthene
Cobalt	bis(2-ethylhexyl)phthalate
Copper	Butyl benzyl phthalate
Cyanide	Carbon disulfide
Iron	Chrysene
Lead	Dibenz(a,h)anthracene
Lithium	1,2-Dichloroethene (total)[3]
Magnesium	Diethyl phthalate
Manganese	Di-n-butyl phthalate
Mercury	Fluoranthene
Nickel	Fluorene
Potassium[1]	Indeno(1,2,3-cd)pyrene
Selenium	4-Methylphenol
Silver	Naphthalene
Sodium	**PCBs (as Aroclor 1254)**[4]
Strontium	Phenanthrene
Thallium	Pyrene
Titanium[5]	Tetrachloroethene
Vanadium	Toluene
Zinc	1,1,1-Trichloroethane
	Trichloroethene
	Vinyl chloride

Notes:

1. There are no Part 201 criteria for calcium and potassium. These elements are macronutrients. Any incremental exposure from the creek's sediments should not cause adverse health effects.
2. Total chromium concentrations were compared to the more-protective criteria for hexavalent chromium.
3. Total 1,2-dichloroethene concentrations were compared to the more-protective criteria for cis-1,2-dichloroethene.
4. PCBs = polychlorinated biphenyls
5. There are no Part 201 criteria for titanium. Based on concentrations for other non-heavy metals, MDCH does not expect exposure to titanium in Little Black Creek to result in adverse health effects.

References: MDEQ 2004a; Rediske 2005 (unpublished data); Walker 2000, 2001

Arsenic, cadmium, lead, benzo(a)pyrene, and PCBs exceeded their respective Part 201 residential DCC. MDCH adjusted the screening levels for arsenic, cadmium, benzo(a)pyrene, and PCBs to consider the less frequent exposure expected with sediments (Appendix A). Table 2 shows these chemicals, along with the concentrations found, the residential DCC for each chemical, and the adjusted DCC for each chemical.

Table 2. Concentrations of selected chemicals in sediments of Little Black Creek, Muskegon County, Michigan, and comparison to screening levels. (Samples taken between 1977 and 2004. All concentrations in parts per million [ppm].)

Chemical	**No. detections / No. samples**	**Concentration Range**	**Residential DCC[1] (No. exceedances)[2]**	**Adjusted DCC[1] (No. exceedances)[2]**
Arsenic	29 / 29	0.63 – 20	7.6 (10)	21 (0)
Cadmium	36 / 42	0.5 – 4,260	550 (6)	**1,600 (3)**
Lead	42 / 42	7.9 – 2,100	400 (7)	See text
Benzo(a)pyrene	5 / 8	0.5 – 5.1	2 (3)	5 (0)
PCBs	5 / 8	0.42 - 3	1 (1)	10 (0)

Notes:

1. DCC = Direct Contact Criteria
2. Comparisons made after rounding criteria and concentrations to least number of significant digits.

References: MDEQ 2004a, Rediske 2005 (unpublished data)

Arsenic, benzo(a)pyrene, and PCBs do not exceed their respective adjusted DCC. Therefore, documented levels of these chemicals in the sediments of Little Black Creek are not a public health concern.

The three samples that exceeded the adjusted DCC for **cadmium** were located in the stretch of Little Black Creek next to Peerless. Concentrations ranged from 2,300 to 4,260 parts per million (ppm). These samples are retained for further evaluation under the "Exposure Pathways Analysis" and "Toxicological Evaluation" sections of this document.

Some sediment concentrations of **lead** exceeded its residential DCC addressing dry soils. These samples were located primarily around the defunct municipal landfill and the Merriam Street storm sewer outfall area. There was one sample each at the Keating Street storm sewer outfall and Peerless that also exceeded the criterion, however higher concentrations were found at the downstream sites. The DCC for lead is determined using the IEUBK model (Integrated Exposure Uptake Biokinetic Model for Lead in Children), which considers other environmental lead sources along with contaminated soil (EPA 2004). Due to the complexity of the model, it is difficult to adjust the DCC for lead in sediments. Therefore, samples containing elevated concentrations of lead are evaluated further in the "Exposure Pathways Analysis" and "Toxicological Evaluation" sections of this document.

Although sediment **mercury** concentrations did not exceed the generic DCC for residential soils, 10 samples (out of 22 analyzed for the metal) exceeded the MDEQ Groundwater Surface Water Interface Protection Criterion (GSIPC) of 0.1 ppm. The GSIPC identifies a soil concentration of a chemical that is not expected to leach and contaminate groundwater at levels greater than the corresponding GSI criterion. The GSI is a groundwater concentration that is protective of a receiving surface water (MDEQ 1999). The GSI for mercury, a bioaccumulative element, is based on the protection of fish for human consumption.

When mercury enters surface water, microorganisms change it to methylmercury, a highly toxic form that builds up in fish and, subsequently, in animals that eat fish, including humans. (Fish can also take up the methylmercury directly from the water

column but to a much smaller degree when compared to that from the food chain [ATSDR 1999c].) Currently, there is a fish-consumption advisory for certain Mona Lake fish species (carp, smallmouth bass, and walleye), however the advisory was triggered by PCB concentrations in these species. When there are no lake-specific data regarding concentrations of mercury in fish tissue, MDCH provides a general advisory to the public, suggesting that people limit their meals of large fish from these lakes (MDCH 2004).

Groundwater and surface water analyses of Little Black Creek have either not included tests for mercury or not detected mercury. However, the reported detection limits (ranging from 0.2 to 0.5 parts per billion [ppb]) are greater than the GSI for the metal (0.0013 ppb; MDEQ 2004b). It is possible that levels of mercury detected historically in Little Black Creek exceeded the GSI and impacted concentrations in fish.

Some areas along Little Black Creek may be prone to flooding during winter thaws and heavy rains. There is no information available regarding possible contamination of non-wetland floodplain areas.

AWRI researchers have compared concentrations of contaminants in Little Black Creek sediments to the chemicals' respective Probable Effect Concentrations (PECs). A PEC is a consensus-based sediment quality guideline that represents the levels at which adverse ecological effects are likely (Steinman et al. 2003). While adverse impacts on aquatic organisms are expected, these comparisons are not directly applicable to the determination of public health implications.

Exposure Pathways Analysis

To determine whether persons are, have been, or are likely to be exposed to contaminants, MDCH evaluates the environmental and human components that could lead to human exposure. An exposure pathway contains five elements: (1) a source of contamination, (2) contaminant transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population. An exposure pathway is considered complete if there is evidence, or a high probability, that all five of these elements are, have been, or will be present at a site. It is considered either a potential or an incomplete pathway if there is no evidence that at least one of the elements above are, have been, or will be present, or that there is a lower probability of exposure. The exposure pathway elements for Little Black Creek sediments are shown in Table 3:

Table 3. Pathways of human exposure to contaminants found in sediments in Little Black Creek, Muskegon County, Michigan.

Source	Environ-mental Transport and Media	Chemicals of Concern	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Little Black Creek sediments (various polluters)	Sediment	Metals, PAHs[1], PCBs[2], VOCs[3]	Creek sediment	Dermal contact, incidental ingestion	Recreational users of Little Black Creek	Past	Potential
						Present	Potential
						Future	Potential
	Fish and other aquatic wildlife	Mercury, cadmium, PCBs	Little Black Creek, Mona Lake	Ingestion	Consumers of fish and other aquatic species	Past	Complete
						Present	Potential
						Future	Potential
	Sediment	Metals, PAHs[1], PCBs[2], VOCs[3]	Flood-plain soils	Dermal contact, incidental ingestion, inhalation	Persons living along or using the creek's floodplain	Past	Potential
						Present	Potential
						Future	Potential
Little Black Creek (Marathon Petro-leum)	Groundwater, surface water	VOCs[3]	Air around headwaters of creek	Inhalation	Persons living near the creek's headwaters, passersby	Past	Complete
						Present	Complete
						Future	Potential

Notes:
1. PAHs = polynuclear aromatic hydrocarbons
2. PCBs = polychlorinated biphenyls
3. VOCs = volatile organic compounds

Sediments

Persons wading or playing in the creek could be exposed to the contaminated sediments. As discussed in the "Environmental Contamination" section of this document, the only chemicals that remain of concern, when considering intermittent contact with the sediments under current conditions, are cadmium and lead.

The **cadmium** exceedances occurred adjacent to the Peerless site, which does not appear attractive for playing in or near because of surrounding dense brush, poor access, and nearby traffic. However, this area of the creek is not completely inaccessible (Figures 3 and 4), though if access did occur, it would likely be less than the 90 days/year assumed when adjusting the screening level (see Appendix A): the dense brush on the south bank would be nearly impenetrable from late spring through late fall, and winter weather would reduce the amount of outdoor activity, especially in wet areas. If future improvement or development along Little Black Creek allowed easier accessibility to the area by Peerless, harmful exposures to cadmium in the sediment could occur.

Figure 3. Little Black Creek behind Peerless Plating Superfund Site (looking east), April 7, 2005, Muskegon County, Michigan.

Figure 4. Little Black Creek behind Peerless Plating Superfund Site (looking west), April 7, 2005, Muskegon County, Michigan.

It is possible that the reservoir of contaminated sediments near the Peerless site could be mobilized during a moderate rain event and transported downstream (MDEQ 2004b, Steinman et al. 2003). If sediments are transferred to areas more heavily used by children, such as the Johnny O. Harris Park, children and other frequent users of the park might be exposed to unacceptable and potentially harmful levels of cadmium. The Peerless Plating Company operated from 1937 to 1983 (EPA 2004). It is not known when the cadmium first appeared in the sediments. However, the evidence to-date suggests that cadmium at concentrations of public health significance has *not* been transported downstream. At the November 28, 2005 community meeting, AWRI researchers suggested that the culvert in the creek near the intersection of Sherman and Getty Streets (immediately downstream from Peerless) is preventing large amount of contaminated sediments from washing downstream. If this culvert were damaged or removed during a road construction project or other development in the area, then it is possible that cadmium concentrations of public health concern could be flushed downstream.

The **lead** exceedances occurred primarily downstream of the Peerless site, near the defunct municipal landfill and the Merriam Street storm sewer outfall. During its June 14 site visit, MDCH noted that the areas where the lead exceedances occurred are difficult to access. The Keating outfall and Peerless areas have industrial facilities on one side of the creek and dense brush on the other. The creek banks near the closed landfill are steep and overgrown and both sides of the creek are occupied by private businesses. The Merriam outfall area also has dense brush, impeding any access. Therefore, under current conditions, the likelihood of exposure above the DCC to lead-contaminated sediments in Little Black Creek is minimal, and any exposure that might occur should not result in adverse health effects. If the culvert at Sherman and Getty Streets were damaged or removed, as discussed above, then it is possible that lead concentrations of public health concern could be flushed downstream.

Some local schools' science classes have used the creek for ecological and environmental lessons (GLOBE 2005). According to the MDEQ staff person who oversaw recent testing conducted by one such class, few children entered the creek (at Johnny O. Harris

Park) and those that did wore rubber boots (D. Wierzbicki, MDEQ Remediation and Redevelopment Division – Grand Rapids Office, personal communication, 2005). However, one area resident has reported anecdotally that this has not always been the case and that school children used to enter the creek without any protective measures. Nonetheless, it is likely that any exposure that occurred was brief and would not result in adverse health effects.

The Muskegon County Health Department, with assistance from the Mona Lake Watershed Council, has erected signs in public areas near Little Black Creek that ask people not to enter the creek. This action likely has helped reduce exposure to the sediments.

Fish and Other Aquatic Wildlife

The **mercury** in the sediments in Little Black Creek might be entering the water column as methylmercury and accumulating in fish in the creek or Mona Lake. Painted turtles and muskrat, though primarily herbivorous, occasionally eat fish (National Wildlife Federation 2005) and may bioaccumulate methylmercury. Snapping turtles eat both aquatic plants and animals (National Wildlife Federation 2005) and would likely bioaccumulate methylmercury. (There are wetlands that could support these species near the headwaters of the creek, in Johnny O. Harris Park, and north and west of the Mona View cemetary.) Although there is a general inland lake mercury advisory, which would apply to Mona Lake and its watershed, some persons might ignore it and eat fish or other aquatic wildlife from the lake or the creek, potentially exposing themselves to mercury in these species. There is information available for mercury levels in fish sampled from Mona Lake (MDEQ 2005). However, there is no information regarding mercury levels in fish or other aquatic wildlife from Little Black Creek, to what extent local persons may eat muskrat or turtles, or the population of muskrat and turtles in the creek.

Cadmium can be taken up by water plants such as cattails and marsh grass (ATSDR 1999a), some of which were evident in Johnny O. Harris Park and are food sources for muskrat and turtles (National Wildlife Federation 2005). Cadmium also can be taken up by fish and generally is found in higher concentrations in older animals (ATSDR 1999a). Some persons might catch and eat fish, muskrat, or turtles from Little Black Creek and could be exposed to cadmium in these animals. However, there is no information regarding cadmium levels in these species, to what extent local persons may eat muskrat or turtles, or the population of muskrat and turtles in the creek.

As discussed in the "Environmental Contamination" section earlier, Mona Lake fish are under a fish-consumption advisory due to **PCBs**. Some of these fish may swim upstream into Little Black Creek to feed or spawn. People may catch and eat these fish and expose themselves to PCB levels that could be harmful in the long term.

Floodplain Soils

Little Black Creek can overflow its banks during the spring thaw and heavy rains. Contaminated sediments might be transferred to soil during these overflows. If flooding occurs in areas normally used by the public, the likelihood and frequency of exposure

would increase. There are no data available regarding levels of contaminants in easily-accessed floodplain soils. If contamination were found in floodplain soils in residential areas, the generic residential DCC would apply.

Ambient Air near Headwaters

People living near or passing by the headwaters of Little Black Creek, near the defunct Marathon refinery, have complained about petroleum-like odors. As stated earlier, there are no data regarding ambient air concentrations of VOCs during odor events.

Toxicological Evaluation

Cadmium

Cadmium is a naturally occurring element and is usually found in zinc, lead, and copper ores. It has been used in electroplating and coating, metal alloys, batteries, pigments, and stabilizers for plastics. Cadmium is a component of tobacco and tobacco smoke (ATSDR 1999a).

Harmful effects as a result of dermal (skin) exposure to cadmium are not likely to occur (ATSDR 1999a).

The primary target for oral cadmium toxicity is the kidney. The kidneys remove waste and toxins from the bloodstream, so any decreased function can have severe health consequences. Toxic effects caused by long-term oral cadmium exposure include renal tubular dysfunction, decreased glomerular filtration, and increased calcium excretion, which can lead to decreased vitamin D metabolism and bone disorders. Cadmium also interferes with gastrointestinal uptake of iron, which can lead to anemia (ATSDR 1999a).

ATSDR has set the chronic oral Minimal Risk Level (MRL) of cadmium at 0.0002 milligrams per kilogram body weight per day (mg/kg/day) (ATSDR 1999a). An MRL is defined as "an estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects" (ATSDR 2005). If a 10-kg child (a default weight assumption) were to eat 200 mg/day (2E-4 kg, another default assumption, which is less than 1/8 teaspoon) of the most contaminated sediment in Little Black Creek *every day*, the daily dose of cadmium would be 0.0852 mg/kg/day.

$$\frac{2E-4 kg_{Sediment}/day}{10 kg_{BW}} \times \frac{4{,}260 mg_{Cadmium}}{1 kg_{Sediment}} = 0.0852 mg_{Cadmium}/kg_{BW}/day$$

MDCH assumed that exposure would be limited to 90 days per year (about ¼ of the year). Therefore, the child's averaged daily dose for 90 days' exposure would be 0.0213 mg/kg/day (0.0852 / 4), which rounds to 0.02 mg/kg/day, 100 times greater than the MRL. An adult would eat less soil per day (100 mg/day) and weigh more (70 kg) than a child, resulting in a lower dose (0.006 mg/kg/day) and lower averaged dose (0.006 / 4 = 0.0015 mg/kg/day), but still a rate greater than the MRL. These doses, 0.02 mg/kg/day for a child and 0.0015 mg/kg/day for an adult, would increase the risk of harmful effects that could occur upon oral exposure to the sediments in Little Black Creek. However, as

discussed earlier, a person is not likely to be exposed to the highest concentrations of cadmium found, near Peerless, due to the difficult accessibility of the site. Currently, more easily accessible areas of the creek have concentrations of cadmium below the exposure-adjusted screening level. Exposure to these concentrations should not result in adverse health effects. If access to areas of the creek where concentrations in the sediment are high is improved, or if concentrations of public health concern are flushed downstream to more public areas, then the risk of harmful exposure would increase.

Cadmium is considered a probable human carcinogen when inhaled (EPA 1992, ATSDR 1999a). There is insufficient evidence to determine whether the metal is carcinogenic when exposure occurs orally. Recent studies suggest that cadmium may be an endocrine disruptor and play a role in prostate and breast cancer (Stoica et al. 2000, Achanzar et al. 2001, Johnson et al. 2003, Saturag and Moore 2004). These preliminary findings indicate the need for further study into the toxicity and carcinogenicity of cadmium.

Lead

Like cadmium, lead is a naturally occurring element. It is used in a number of occupational settings and by hobbyists. Sources for lead exposure include battery manufacture and repair, plumbing, pipe fitting, jewelry and pottery making, stained glass making, emissions from foundries and smelters, and some imported or folk remedies. Lead was used in residential paint before its use was discontinued in 1978 (ATSDR 1999b).

Lead is well-known for its neurotoxic effects, causing learning and behavioral difficulties in children. Nervous system effects in adults include decreased reaction times, weakness in the hands and ankles, and impaired memory. It can also damage the kidneys, the reproductive system, and cause anemia. Rather than an external dose in mg/kg/day, the level of lead in the body, usually expressed as blood levels, is used to determine the potential for adverse health effects. This approach is used because exposure can occur from several different sources including air, food, water, and soil contamination. Models that account for multiple exposures to lead often are used to assess potential effects from exposure to lead in the environment (ATSDR 1999b). As discussed earlier in the "Environmental Contamination" section of this document, the criterion for lead in soil is based on the IEUBK model. All potential sources of lead must be evaluated to determine if the contribution from contaminated sediment or soil is significant. Most often, lead-based paint in older homes is the most important source of lead in a person's environment. In the City of Muskegon Heights, 59 percent of the homes were constructed before the 1950s, when the lead in paint was at its highest concentration, and 96 percent of the homes were constructed before the 1980s (GeoLytics 2002), before lead use in residential paint was discontinued. Due to the level of poverty in the City of Muskegon Heights (30 percent of the population lives below the poverty level [GeoLytics 2002]), it is likely that many of these homes have not had the paint removed or sealed.

The National Toxicology Program recently reported that lead and lead compounds may be "reasonably anticipated to be a human carcinogen" (NTP 2004). The EPA Integrated Risk Information System (IRIS) lists lead as a "B2" (probable) carcinogen (EPA 1993).

The determination by these agencies was based on limited evidence in human studies and sufficient evidence in animal studies. The human studies investigated occupational settings in which workers primarily were exposed via inhalation. Any exposure to the lead in Little Black Creek sediments and nearby soils would likely occur primarily through ingestion. It is unknown whether oral exposure has as great a cancer risk as inhalation exposure.

Mercury

Mercury is a naturally occurring metal. In its elemental form, it is used in thermometers, barometers, and some electrical equipment (cathode ray tubes, switches). Mercury compounds are emitted to the air from coal-fired electrical plants and some manufacturing plants. Methylmercury, an organic mercury compound, is formed by bacteria in soil or water where airborne mercury compounds have deposited. Methylmercury builds up in the aquatic food chain, with higher concentrations being found in predator fish (ATSDR 1999c).

Exposure to high levels of mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Methylmercury exposure can have adverse cardiovascular effects for adults, resulting in elevated blood pressure and incidence of heart attack (ATSDR 1999c).

Dermal exposure to and unintentional ingestion of the mercury-containing sediments of Little Black Creek should not result in any harm. It is not likely that the mercury could volatilize (enter the air) and be inhaled. The exposure pathway of concern for mercury in the Little Black Creek sediments is that of ingesting contaminated fish. As discussed earlier in the "Environmental Contamination" section of this document, Little Black Creek empties into Mona Lake, which is under a fish-consumption advisory for PCBs in several species (carp, smallmouth bass, walleye) (MDCH 2004). Persons eating fish from either the lake or Little Black Creek might be at risk of methylmercury toxicity. It is likely that toxic effects would not manifest themselves immediately but build up over time and appear insidiously. However, as discussed earlier in this document, it is not known whether mercury in the creek sediments have entered the creek itself.

Children's Health Considerations

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

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

It is not known if children are more susceptible to the effects of cadmium exposure than adults are. As discussed in the "Toxicological Evaluation" section of this document, children playing in the creek near the Peerless site could be exposed to harmful concentrations of cadmium, as could adults but to a lesser degree. It is likely, however, that this section of Little Black Creek is not attractive for playing in or near because of surrounding dense brush, poor access, and nearby traffic (Figures 3 and 4). It is possible that the reservoir of contaminated sediments near the Peerless site can be mobilized during a moderate rain event and transported downstream (MDEQ 2004b, Steinman et al. 2003). If sufficient quantities of sediments were transferred to areas more heavily used by children, such as the Johnny O. Harris Park (Figure 2), children might be exposed to unacceptable and potentially harmful levels of cadmium. However, as discussed earlier, sediment transfer is not expected to occur under current conditions. Should the culvert at Sherman and Getty Streets be damaged or removed during road construction or development in the area, it is possible that contaminated sediments, at concentrations of public health concern, could be flushed downstream to more accessible areas.

Young children, especially those from urbanized, low-income populations, are at the greatest risk for experiencing lead-induced health effects. Children under 5 years old absorb lead from the gastrointestinal tract more efficiently than do adults (about 50% versus 15% relative absorption, respectively). Thumb-sucking and pica behavior (consuming large quantities of non-food items) can increase the amount of lead-contaminated dust and dirt being transferred to the gastrointestinal tract. Deficits in some nutrients, including calcium, iron, and zinc, can exacerbate the toxic effects of lead. Lead can pass through the placenta to a developing fetus and can be secreted through breast milk (ATSDR 1999b). When considering the effects that lead in the sediments of Little Black Creek might have on children's health, one should also consider and address other sources of lead so that overall exposure is minimized.

Very young children are more sensitive to mercury than are adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also pass to a nursing infant through breast milk. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage (ATSDR 1999c). Mercury levels in the sediments of Little Black Creek might be contributing to elevated mercury in Mona Lake fish.

Community Health Concerns

During the February 14 and June 14 community meetings, a local resident expressed concern that several school science classes would enter Little Black Creek (at Johnny O. Harris Park) as part of the lessons regarding environmental and ecological systems. According to an MDEQ staff person who oversaw environmental sampling conducted by the 5th-grade science class from the Martin Luther King, Jr. Elementary School (GLOBE 2005), few children entered the creek and those that did were wearing rubber boots (D.

Wierzbicki, MDEQ Remediation and Redevelopment Division – Grand Rapids Office, personal communication, 2005). It is likely that any exposure that occurred was brief and would not result in adverse health effects.

MDCH received a phone call from the Mona Lake Watershed Council regarding a perceived high rate of cancers, especially testicular and breast cancers, along Little Black Creek. MDCH discussed the caller's concerns and instructed her in gathering information so that MDCH can determine whether a cancer cluster investigation is indicated. (Appendix D contains a factsheet called "Cancer Clusters: Common Questions.") MDCH also conferred with the Muskegon County Health Department, to learn what studies the local agency may have conducted. Discussion of the state and county health departments' reviews of health outcome data is in Appendix C, under the response to Comment #16.

Conclusions

For a description of the ATSDR Health Hazard Categories, please see Appendix B.

Present Conditions

Exposure to the cadmium in the sediments in Little Black Creek poses no apparent current public health hazard. The only area of the creek that exceeds the exposure-adjusted screening level for cadmium is next to Peerless. It is not likely that this area of the creek receives much, if any, access. Concentrations downstream of Peerless are below the exposure-adjusted screening level for cadmium. It does not appear that there is significant (from a public health standpoint) movement of the sediments downstream.

Exposure to the lead in the sediments in Little Black Creek poses no apparent current public health hazard. The areas of the creek where sediment lead concentrations exceeded the MDEQ generic DCC for residential soils are difficult to access due to the presence of dense brush, steep banks, and private businesses abutting the creek. More accessible areas of the creek have lead concentrations below the DCC.

Exposure to other contaminants, other than mercury, in the sediments of Little Black Creek poses no apparent current public health hazard. The concentrations of the other chemicals in the creek's sediments are below the screening values.

Exposure to contaminants deposited during flood events from Little Black Creek to floodplain soils poses an indeterminate public health hazard. There are no data for surficial soils in easily-accessed floodplain areas.

Mercury levels detected in the sediments of Little Black Creek pose an indeterminate public health hazard. Dermal or oral exposure to the mercury as it exists in the sediment poses no apparent public health. However, the mercury may become methylated and enter the food chain, ending up in fish or other aquatic wildlife in the creek or in Mona Lake. People who eat fish, muskrat, or turtles from the creek might be exposed levels of methylmercury that would be harmful in the long term.

Concentrations of VOCs volatilizing from Little Black Creek's headwaters near the defunct Marathon Petroleum property pose an indeterminate public health hazard. The identities and concentrations of chemicals in the air during odor events are not known.

Future-use Conditions

The future use of the Little Black Creek corridor is not clear. A boardwalk or trail may be developed in areas currently not used for public recreation. The former WWTP and the Merriam Street storm sewer vicinities could be redeveloped for residential use. (During floodplain soil sampling in May 2006, MDEQ and MDCH noticed sewer installation occurring in these areas.) If the future land use changes, exposure pathways that were described previously as "potential" could become "complete." Additionally, development activities that take place in or near Little Black Creek could cause relatively inaccessible contaminated sediments to be flushed downstream to areas where exposure could more likely occur. Because plans for future use of the area have not been finalized, ***the future public health hazard of exposure to the sediments in Little Black Creek is indeterminate***. Reevaluation may be necessary as land use changes along the creek. Alternatively, sediments of concern could be removed proactively.

Recommendations

1. Continue monitoring concentrations of cadmium in the creek's sediments at and downstream of the Peerless site to confirm that significant amounts of cadmium are not being transported downstream.
2. Educate local residents, particularly in neighborhoods with older houses and young children, about sources of lead and how to prevent exposure.
3. Maintain the current general inland lake mercury advisory.
4. Characterize easily-accessed floodplain soils and address any contamination found.
5. Characterize ambient air during odor events near the creek's headwaters and address findings as necessary.

Public Health Action Plan

1. The EPA and the MDEQ Remediation and Redevelopment Division's (RRD's) Superfund Section are responsible for overseeing regulatory action at the Peerless site. Other entities (AWRI researchers, environmental consultants for responsible parties) will provide their findings to these agencies.
2. The Muskegon County Health Department, with assistance from MDCH, will provide information to local residents regarding lead exposure. (This is a continuing program at the county health department.)
3. MDCH will maintain, and update as necessary, the fish consumption advisory, based on fish data collected by the MDEQ Fish Contaminant Monitoring Program.
4. MDCH will request that MDEQ field staff take several samples from floodplain soils in areas that receive high public use. (MDCH and MDEQ sampled floodplain soils in May 2006 and will release the findings in a separate health consultation.)

5. MDCH will request that the Muskegon County Health Department and the MDEQ Air Quality Division develop an air sampling plan for the area around Little Black Creek's headwaters.

MDCH will remain available as needed for future consultation at this site.

If any citizen has additional information or health concerns regarding this health consultation, please contact MDCH's Division of Environmental and Occupational Epidemiology at 1-800-648-6942.

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Appendix A. Adjustment of MDEQ Residential Direct Contact Criteria to Address Contact with Contaminated Sediments in Little Black Creek

(Note: This exercise is being applied to *current* site conditions. Future conditions may warrant re-evaluation.)

The purpose of the MDEQ Generic Residential and Commercial I Direct Contact Criteria (DCC) is to protect against adverse health effects due to long-term ingestion of and dermal exposure to contaminated soil. The generic DCC are only protective of chronic, not acute, effects and does not address inhalation of any volatile chemicals. The generic DCC may be adjusted to address the protection of persons who may come into contact with contaminated sediments, such as by wading or playing in Little Black Creek. The following discussion will demonstrate how the criteria were adjusted to account for a person standing in the creek. To be protective, MDCH assumed that a person would have exposure to the creek and its sediments from childhood through adulthood.

Arsenic is a known human carcinogen (EPA 1998). Benzo(a)pyrene is a probable human carcinogen (EPA 1994). Polychlorinated biphenyls (PCBs) also are probably human carcinogens (EPA 1997). Cadmium is a probable human carcinogen but only by inhalation (EPA 1992). Therefore the DCC for cadmium will be adjusted using the algorithm for noncarcinogens. The equation used to determine the Residential DCC of a known or probable carcinogen is below (MDEQ 2001):

$$Residential DCC_{carcinogen} = \frac{TR \times AT \times CF}{SF \times [(EF_i \times IF \times AE_i) + (EF_d \times DF \times AE_d)]}$$

TR is the target cancer risk, or the acceptable risk. An "acceptable" risk may range from 1 in 10,000 to 1 in 1,000,000, meaning that no more than one additional person in ten thousand (1E-4) or one million (1E-6) persons who are exposed to a specific carcinogen will die from cancer compared to a similar population not exposed to the carcinogen. The target risk in this exercise is set at 1 in 100,000 (**1E-5**).

AT is the averaging time factor, which, for carcinogens, is equivalent to the average human lifespan of 70 years, or **25,550 days**. When a chemical is found to be carcinogenic in laboratory animals, the research typically involves a high dose of the chemical given to the animal over a short period of time. Based on the assumption that a high dose of a carcinogen received over a short period of time is equivalent to a corresponding low dose spread over a lifetime, human exposures are calculated by prorating the total cumulative dose over an average person's lifetime.

CF is the conversion factor used so that the appropriate units appear in the product of the equation. This factor is equal to 1,000,000,000 micrograms per kilogram (**1E+9 µg/kg**).

SF is the oral cancer slope factor, which is an estimate of the increased cancer risk from a lifetime exposure to a chemical. It is a probability estimate that is used only for

comparative purposes. It is not a predictive tool. The SF for arsenic is 1.5 per milligram per kilogram-day [**1.5 (mg/kg-day)$^{-1}$**] (EPA 1998). The SF for benzo(a)pyrene is **4.1 (mg/kd-day)$^{-1}$** (EPA 1994). The SF for PCBs, focusing on sediment ingestion, ranges from 1.0 to 2.0 (mg/kg-day)$^{-1}$ (EPA 1997). For this exercise, MDCH chose to use the more protective SF of **2.0 (mg/kg-day)$^{-1}$**.

EF_i is the ingestion exposure frequency. It is assumed in this exercise that a child or adult would be exposed to the sediment in the creek **90 days** (3 months) per year.

IF is the age-adjusted soil ingestion factor. It assumes that a child through the age of six years eats 200 mg of soil per day, and that an adult will eat 100 mg of soil per day for 24 years. Each ingestion total (years X amount eaten/year) is divided by the respective default body weight and the resulting quotients are summed. In this exercise, the ATSDR default child body weight of 10 kg was used rather than the EPA default of 15 kg, to provide greater protection. Therefore, IF in this exercise is equal to **154 mg-year/kg-day**.

AE_i is the ingestion absorption efficiency (a science-based estimate of what percentage of a chemical is absorbed through the gastrointestinal tract) and is chemical-specific. For arsenic, benzo(a)pyrene, and PCBs the AE_i is **0.5** (50 percent) (MDEQ 2003).

EF_d is the dermal exposure frequency. Similar to EF_i above, it is assumed that a person would be exposed to the sediment in the creek no more than **90 days** per year.

DF is the age-adjusted soil dermal factor. It considers exposed skin surface area, a soil adherence factor (AF), number of events per day, and the exposure duration and divides the product of those factors by the body weight. Respective subfactors are determined for a child and an adult and then summed. The default AF for children is 0.2 milligrams per square centimeter (mg/cm^2), meaning 0.2 mg of soil would adhere to each square centimeter of exposed skin (MDEQ 2001). The default AF is applicable to the 95th percentile of children playing in *dry* soil (95 percent of children would have less soil adhering). In this case, however, the creek sediments would be wet and likely adhere more readily than dry soil. Conversely, a child or adult would likely rinse off the majority of the sediment when coming out of the creek. An AF value of 0.2 mg/cm^2 also applies to the *50th* percentile of children playing in *wet* soil. This value affords some protection against adhered sediments, even though the majority, if not all, of the sediment would be washed off. Similar to the IF above, MDCH used the ATSDR default child body weight of 10 kg when calculating the DF. No adjustments were made for the adult subfactor. The DF in this exercise is equal to **459.6 mg-year/kg-day**.

AE_d is the dermal absorption efficiency (a science-based estimate of what percentage of a chemical is absorbed through the skin) and is chemical-specific. The value for arsenic is **0.03** (3 percent). The value for benzo(a)pyrene is **0.13** (13 percent). The value for PCBs is **0.14** (14 percent) (MDEQ 2003).

The adjusted Residential DCC for arsenic is calculated as follows:

$$Adjusted\ Residential DCC_{Arsenic} = \frac{1E-5 \times 25{,}550 \times 1E+9}{1.5[(90 \times 154 \times 0.5)+(90 \times 459.6 \times 0.03)]}$$

$$Adjusted\ Residential DCC_{Arsenic} = 20{,}846\,\mu g/kg = 21 mg/kg$$

The units mg/kg are equivalent to parts per million (ppm).

The adjusted Residential DCC for benzo(a)pyrene is calculated as follows:

$$Adjusted\ Residential DCC_{Benzo(a)pyrene} = \frac{1E-5 \times 25{,}550 \times 1E+9}{4.1[(90 \times 154 \times 0.5)+(90 \times 459.6 \times 0.13)]}$$

$$Adjusted\ Residential DCC_{Benzo(a)pyrene} = 5{,}063\,\mu g/kg = 5 mg/kg$$

The adjusted Residential DCC for PCBs is calculated as follows:

$$Adjusted\ Residential DCC_{PCBs} = \frac{1E-5 \times 25{,}550 \times 1E+9}{2[(90 \times 154 \times 0.5)+(90 \times 459.6 \times 0.14)]}$$

$$Adjusted\ Residential DCC_{PCBs} = 10{,}042\,\mu g/kg = 10 mg/kg$$

The equation used to determine the Residential DCC of a noncarcinogen is below (MDEQ 2001):

$$Residential DCC_{noncarcinogen} = \frac{THQ \times RfD \times AT \times CF \times RSC}{(EF_i \times IF \times AE_i)+(EF_d \times DF \times AE_d)}$$

THQ is the target hazard quotient. A hazard quotient is the relationship of an exposure dose to the Reference Dose (discussed below) of a chemical. If the quotient (exposure value divided by reference value) is less than or equal to 1, no adverse health effect would be expected. For this exercise, the THQ is **1**.

RfD is the Reference Dose, an estimated concentration of a chemical that a person can be exposed to orally for a lifetime without experiencing negative health effects. Although uncertainty exists in deriving the estimate, the agency deriving the value (usually EPA) strives to protect the most sensitive population. The RfD for cadmium is **1E-3 (0.001) mg/kg/day** (EPA 1992).

AT is the averaging time, which, for noncarcinogens, is equal to the exposure duration in years times 365 days/year. For this exercise, the exposure duration will be 30 years, from childhood through early adulthood. Therefore, AT is **10,950 days**.

CF is a conversion factor and is the same as that for carcinogens, **1E+9 µg/kg**.

RSC is the relative source contribution. There may be other exposures that the receptor population may face beside the exposure of immediate concern. For this exercise, it is assumed that all exposure to cadmium occurs via the sediments in Little Black Creek. Therefore the RSC is **1 (100 percent)**.

EF_i is the ingestion exposure frequency and, for this exercise, is the same as that used for carcinogens, **90 days/year**.

IF is the age-adjusted soil ingestion factor and, for this exercise, is the same as that used for carcinogens, **154 mg-year/kg-day**.

AE_i is the ingestion absorption efficiency, which, for cadmium is **0.5 (50 percent)** (MDEQ 2003).

EF_d is the dermal exposure frequency and, for this exercise, is the same as that used for carcinogens, **90 days/year**.

DF is the age-adjusted soil dermal factor and, for this exercise, is the same as that used for carcinogens, **459.6 mg-year/kg-day**.

AE_d is the dermal absorption efficiency, which, for cadmium is **0.001 (0.1 percent)** (MDEQ 2003).

The adjusted Residential DCC for cadmium is calculated as follows:

$$Adjusted\ ResidentialDCC_{Cadmium} = \frac{1 \times 0.001 \times 10{,}950 \times 1E+9 \times 1}{(90 \times 154 \times 0.5) + (90 \times 459.6 \times 0.001)}$$

$$Adjusted\ ResidentialDCC_{Cadmium} = 1{,}570{,}607\ \mu g / kg = 1{,}600 mg / kg$$

Appendix B. ATSDR Public Health Hazard Categories

Depending on the specific properties of the contaminant(s), the exposure situations, and the health status of individuals, a public health hazard may occur. Sites are classified using one of the following public health hazard categories:

Urgent Public Health Hazard
This category applies to sites that have certain physical hazards or evidence of short-term (less than 1 year), site-related exposure to hazardous substances that could result in adverse health effects. These sites require quick intervention to stop people from being exposed. ATSDR will expedite the release of a health advisory that includes strong recommendations to immediately stop or reduce exposure to correct or lessen the health risks posed by the site.

Public Health Hazard
This category applies to sites that have certain physical hazards or evidence of chronic (long-term, more than 1 year), site-related exposure to hazardous substances that could result in adverse health effects. ATSDR will make recommendations to stop or reduce exposure in a timely manner to correct or lessen the health risks posed by the site.

Indeterminate Public Health Hazard
This category applies to sites where critical information is lacking (missing or has not yet been gathered) to support a judgment regarding the level of public health hazard. ATSDR will make recommendations to identify the data or information needed to adequately assess the public health risks posed by this site.

No Apparent Public Health Hazard
This category applies to sites where exposure to site-related chemicals might have occurred in the past or is still occurring, but the exposures are not at levels likely to cause adverse health effects. ATSDR may recommend any of the following public health actions for sites in this category:

- cease or further reduce exposure (as a preventive measure)
- community health/stress education
- health professional education
- community health investigation.

No Public Health Hazard
This category applies to sites where no exposure to site-related hazardous substances exists. ATSDR may recommend community health education for sites in this category.

For more information, consult Chapter 9 and Appendix H in the 2005 ATSDR Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/PHAManual/index.html).

Appendix C. Public Comments Received and MDCH's Response – Little Black Creek Sediments, Muskegon County, Michigan

MDCH compiled the comments received and organized them to follow, in general, the narrative of the health consultation, paraphrasing as necessary. Several parties had the same comments. In these instances, MDCH combined the comments. This Responsiveness Summary does not list the comments' authors, to maintain their privacy.

1. **The language in the "Purpose and Health Issues" section does not indicate that *future* health hazards are also considered in this health consultation. MDCH/ATSDR should consider future land-use changes when determining the level of public health hazard posed by the contamination. Also, if the contaminated sediment is removed in the future, the downstream risks to the watershed from sediment transport during the removal action may be greater than if the contaminated sediment were left in place. One commenter suggested adding this statement: "If future development were to occur in areas of heavy metal and PCB sediment contamination, then the risks should be reevaluated for human health and reintroduction of contaminants at the new development area and those downstream from sediment disruption."**

MDCH has added language to the consultation discussing how potential land-use changes may affect the future public health hazard category for this site. Any future remedial activities that take place in or along the creek would need to be fully investigated for feasibility and environmental impact.

2. **Webb Chemical's pump-and-treat remediation process (mentioned in the "Sources of Contamination to Little Black Creek" section) has been shut down since July 2001. When the remediation process was operating, the discharge water that was generated was treated to drinking water standards before being released to Little Black Creek. Webb Chemical will continue to monitor existing test wells on-site into the foreseeable future.**

The language in the health consultation has been corrected to reflect this information.

3. **The data cited for the defunct landfill are from 1977, almost 30 years ago. Yet, if there are not any more recent data, we must act on the information we have and correct any contamination. According to the Muskegon County Drain Commissioner, the landfill along East Broadway, west of Getty Street, was not lined. Little Black Creek traverses through that landfill site.**

Upon further review of the MDEQ documents pertaining to Little Black Creek, MDCH found additional and more recent environmental data for the creek in the area of the defunct landfill. MDCH has added the data to the health consultation.

4. **At the Merriam Street sewer, the contamination present appears to be due to transport. This seems to contradict the assertion that significant amounts of sediments are not moving downstream. Where did the contamination at the Merriam Street sewer originate and how significant is it?**

MDEQ stated that some, if not all, of the contamination at the Merriam Street sewer was attributable to the failure of the municipal sanitary/industrial wastewater pump station further upstream (near Getty Street). The release of 80,000 gallons of untreated wastewater over a 24-hour period to Little Black Creek created a "flushing" of the creek, one which even the wetlands preceding the Merriam Street sewer (those west and north of Mona View cemetery) could not absorb nor lessen the flow. Other chemicals present may have leached from nearby railroad ties, as a railroad crosses the creek here. The chemicals detected in this area did not exceed their respective Part 201 residential Direct Contact Criteria and, therefore, are not of public health concern.

5. Please refer to Williams & Beck, Inc.'s report "Potential Pollution Sources to Little Black Creek, Muskegon County, Michigan," dated October 28, 2003 for further information on probable and possible contaminant sources.

MDCH acquired this report and the Environmental Data Resources, Inc. reports upon which the list of potential contaminant sources is based. This extensive database includes underground and above-ground storage tanks, wastewater treatment plants, landfills, and current and former industries. Some of these potential sources for contamination would only affect water quality of the creek whereas others would affect the sediments as well. MDCH focused its investigation on those sites for which environmental data, primarily sediment data, existed.

6. The environmental data are being compared to "current" state criteria. What were the criteria at the time the sampling was done? Have the numbers changed? If so, why?

The current state criteria were promulgated under Part 201 of the Natural Resources and Environmental Protection Act, Act 451 of 1994, as amended (last updated in 2004). Act 307 of 1982 preceded Part 201. In Act 307, "Type A" criteria referred to background or detection concentrations, "Type B" criteria referred to residential standards, and "Type C" were site-specific criteria. The first listing of residential chemical criteria for the state was assembled and released in 1990. The list included about 30 carcinogens and 30 non-carcinogens. The criteria considered only groundwater used for drinking water, direct contact with soils, and soil concentrations protective of groundwater.

MDCH chose to compare the environmental data for Little Black Creek, both historic as well as current, to the current Part 201 criteria because these criteria have been calculated using the most up-to-date information on chemicals, fate and transport modeling, and exposure pathways. Historic revisions of the criteria, regardless of whether they became more or less restrictive, occurred for a variety of reasons:

- improved understanding of the toxicity of specific chemicals or chemical classes;
- realization and understanding of additional exposure pathways (such as breathing contaminated dust or the intrusion of vapors from soil into buildings);
- additions of chemicals not on the original list (Part 201 currently addresses over 250 chemicals);
- revisions to state or federal regulatory rules;

•improved analytical techniques (detecting smaller concentrations or distinguishing between chemicals in the same family);

•accounting for aesthetic considerations, which may cause a more restrictive criterion than a health-based value; and

•improvements in fate and transport, or other, models that allow understanding of a chemical's movement through the environment.

For further information regarding the history and previous values of the State of Michigan cleanup criteria, please contact the MDEQ Remediation and Redevelopment Division Toxicology Unit.

7. Cadmium and lead levels in Little Black Creek's sediments exceed Michigan Part 201 criteria. The cadmium discovered by the Peerless Plating site is near the highest level discovered in the Great Lakes region. There are complete exposure pathways. Doesn't this constitute a health hazard?

Not necessarily. When determining the degree of a public health hazard, one must consider various aspects of exposure: how much a person is exposed to, by what route (breathing, eating, touching), and the duration (contact time and frequency) of that exposure. People are likely being exposed to contaminants when they enter Little Black Creek. However, the expected frequency of exposure to easily accessible areas of the creek, which have lower concentrations of cadmium than the area near Peerless, should not result in adverse health effects. Under current conditions, MDCH does not expect people to be exposed to the sediments in Little Black Creek next to the Peerless site. If a person is not exposed to a potentially hazardous chemical, there is no public health hazard.

8. Don't the wetlands adjacent to the creek west of Mona View Cemetary and upstream from US-31 qualify as a floodplain? Surficial samples from the area west of Mona View exceed the Probable Effect Concentration.

Yes, the wetlands can be viewed as floodplain areas. However, they would not have the degree of access that floodplains in public-use areas have. MDCH is concerned about regular exposure to floodplain soils, such as in public parks near residential areas or schools. The language in the health consultation has been clarified.

The Probable Effect Concentration is a criterion that addresses ecological risk and is not directly applicable to the determination of public health implications.

9. If "significant amounts of cadmium have not been transported downstream" (from the Peerless site to more accessible areas such as Johnny O. Harris Park or Mona Lake), show the evidence.

While some cadmium has been transported downstream, the amounts are not of public health significance when comparing the downstream concentrations to the Adjusted DCC. This point has been clarified in the health consultation.

10. There is inadequate information, especially about downstream transfer, to conclude that there are no safety concerns and that no active cleanup is

necessary. It is likely that contaminated sediments are being transported to Mona Lake. MDCH/ATSDR should address this exposure point as well. Mona Lake sediments should be monitored. Cadmium, lead and mercury levels should be monitored in the mouth of the creek and the floodplains after storms and the spring thaw.

Please see the response to Comment #9 regarding evidence of downstream transfer. At the November 28, 2005 community meeting, AWRI researchers suggested that the culvert in the creek near the intersection of Sherman and Getty Streets (immediately downstream from Peerless) is preventing large amounts of contaminated sediments from flushing downstream. If this culvert were damaged or removed during a road construction project, then it is possible that cadmium concentrations of public health concern could be flushed downstream. Discussion of this possibility has been added to the health consultation.

The report for the Preliminary Watershed Assessment conducted by AWRI for the Mona Lake watershed (2003) discussed an investigation of the potential of Little Black Creek to transport cadmium associated with suspended sediment. Researchers collected water samples at various locations in the creek one day after a ½-inch rain event. (Runoff from rain events would increase stream turbulence and the amount of sediment suspended into the water column.) The results indicated that about 50% of the cadmium-contaminated sediment that became suspended at the Peerless site was deposited further downstream, primarily in the stretch of the creek downstream of Peerless (and upstream of the Johnny O. Harris Park) and in the Mona View wetlands. Very little suspended cadmium was observed near or at the mouth of the creek. Although more research is needed to determine long-term implications, these preliminary data suggest that contaminated sediments do not appear to be transported to and deposited, at concentrations of public-health concern, in areas that are easily and frequently accessed by the public.

MDCH and MDEQ sampled floodplain soils in easily accessible areas (e.g., Johnny O. Harris Park) in May 2006, to determine if sediments from the creek were transferred to surficial soils during flood events. The results of that investigation will be made public and MDCH will assess public health implications of exposure to that soil in a follow-up health consultation.

Although Mona Lake is affected by inputs from Little Black Creek and other sources, the evaluation of the lake is outside the purview of this report.

11. MDCH/ATSDR should consider the cumulative risk of exposure to multiple sources: sediment contact, soil contact, fish eating, etc.

MDCH does not yet have soil data. As stated in the response to Comment #10, MDCH will assess public health implications of exposure to soil in easily accessible floodplain areas when the data become available. Cumulative risk of exposure to multiple sources also will be discussed in that follow-up document.

12. The health consultation states that the likelihood of exposure to lead-contaminated sediments in Little Black Creek is minimal, but how can people not be exposed?

(MDCH assumed that the commenter is not seeking ways to avoid exposure but is expressing disbelief that exposure is unlikely.) MDCH has changed the language in the health consultation to indicate that the likelihood of exposure to lead-contaminated sediments *above the Direct Contact Criterion* is minimal. Exposure likely is occurring where people can easily enter the creek and where lead has been detected, but that exposure, by itself, is not expected to cause a blood lead level greater than the CDC level of concern.

13. One would not consume only cadmium when eating fish from Little Black Creek. The list of chemicals of concern for fish and other aquatic wildlife in the health consultation is unrealistically narrow. MDCH/ATSDR needs to consider other metals, especially bioaccumulating metals (e.g., mercury). PAHs and PCBs should also be included since both classes of chemicals include specific compounds that can also bioaccumulate.

The MDEQ Fish Contaminant Monitoring Program tracks the concentrations of "Persistent Bioaccumulative and Toxic" chemicals (PBTs) in fish. The "priority" PBTs, listed by EPA, are mercury, PCBs, dioxins/furans, alkyl-lead (organic lead compounds), benzo(a)pyrene (a PAH), and several pesticides and their breakdown products. Note that cadmium is not included on this list.

MDCH discussed the possibility of mercury accumulating, as methylmercury, in fish and aquatic wildlife inhabiting Little Black Creek. However, there are no fish-tissue data from the creek. There *are* data from Mona Lake, which is under a fish-consumption advisory for PCBs in several species. MDCH issues an advisory when a "trigger" concentration is reached in a specified proportion of the fish sampled. While there may be mercury in Mona Lake fish, the analytical results for those sampled did not indicate that mercury levels were above the "trigger" level.

Benzo(a)pyrene in fish is more likely to occur from the process of smoking or broiling the fish rather than from environmental contaminant uptake.

People are exposed to alkyl-lead contamination by breathing air containing exhaust from engines using "anti-knock" fuel additives and not through eating fish. These compounds have been banned from use in automotive fuels but still have limited use in the U.S.

For information regarding the concentrations of PBTs in fish from Mona Lake, refer to the MDEQ Fish Contaminant Monitoring website at http://www.deq.state.mi.us/fcmp/default.asp. To view the most recent MDCH Family Fish Consumption Guide, refer to http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf.

14. MDCH/ATSDR should be proactive and use the Precautionary Principle. With additional toxicity information coming out on cadmium, the Reference Dose could be lowered in the future. Also, lead has recently been classified as a probable human carcinogen.

(Note: the defining statement of the Precautionary Principle, as shown on the *Science and Environmental Health Network* website, is: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" [http://www.sehn.org/precaution.html].) It is true that not everything is known about the toxicity of chemicals. As the field of toxicology continues to evolve, screening levels for chemicals may go up or down. Currently, the EPA Reference Dose and the ATSDR chronic oral Minimal Risk Level (MRL) for cadmium are both based on human data, the preferred data to use when deriving these values. When human data are available, critical-effect doses do not have to be extrapolated from laboratory animal results and researchers have more certainty about the expected effects. There is an extensive database showing that, currently, the kidney is the most sensitive organ regarding cadmium toxicity. If EPA lowers the Reference Dose, or ATSDR lowers the MRL, for cadmium in the future, then MDCH may reevaluate this site. For now, MDCH is satisfied with the protectiveness of the screening levels.

As discussed in the "Toxicological Evaluation" section of the health consultation, it is unknown whether oral exposure to lead would have as great a cancer risk as inhalation exposure, the primary route cited regarding carcinogenicity. Exposure to the lead in Little Black Creek would occur via ingestion, not inhalation. Currently, central nervous system detriments in children are the critical effects expected following oral exposure to lead.

15. If the creek sediments pose no apparent health hazard, why have warning signs been erected and why do children need personal protective equipment to study the creek during their class?

The Muskegon County Health Department and local groups worked together to produce and erect those signs. MDCH was not consulted. It is the prerogative and responsibility of local health agencies to take action (beyond state or federal recommendations) where they think it is necessary.

From a general protocol perspective, persons conducting environmental studies should wear protective equipment, even when a hazard is not apparent. The minimum amount of safety gear worn by state or federal agency staff (MDCH, MDEQ, EPA) when taking environmental samples includes steel-toed boots and hand protection.

16. Several commenters expressed concern regarding a perceived high cancer incidence rate. Special cancers of concern were testicular and breast cancer. Also, the Muskegon area reportedly has five times the kidney dialysis rate of any place in the country.

The only cancer incidence evaluations that MDCH has conducted in the Muskegon area occurred in 1991 and 1995, when the agency was the Michigan Department of Public Health. (The 1995 evaluation was an update of the 1991 investigation.) These evaluations were conducted as part of the public health assessment performed at the Bofors-Nobel Superfund site, along Big Black Creek (which also empties into Mona Lake). The carcinogens of concern were benzidine and 3,3'-dichlorobenzidine, both being linked to bladder cancer. MDCH analyzed bladder cancer and all-cancers incidence rates for the zip-code areas 49442 (Muskegon) and 49444 (Muskegon Heights) and compared the rates to those for Muskegon County and the State of Michigan. The data did not indicate a trend of higher incidence of bladder cancer or all-cancers combined in the studied areas (MDPH 1995).

MDCH conferred with the public health epidemiologist at the Muskegon County Health Department to determine if other cancer cluster investigations had been conducted. In 2004, responding to a citizen's complaint, the county agency evaluated cancer data from several ZIP codes in Muskegon County: 49441, 49442, 49444, and 49445. (The citizen had been concerned about a perceived elevated incidence of cancers along his street in the 49444 area.) The epidemiologist evaluated incidence and death rates for all cancers combined. The 49444 area had the highest age-adjusted incidence and death rates when compared with the other ZIP code areas, Muskegon County, and the State of Michigan. The county health department then developed a questionnaire and conducted surveys of the cancer patients (or their family members) whose addresses were on the street of concern. (Some patients had already passed away.) Only five families responded to the survey, which looked at gender, race, type of cancer, age at diagnosis, family history of cancer, and health risk factors. Four homes had their water analyzed by MDEQ for volatile organic compounds. The only compound detected was chloroform at a concentration well below its drinking water criterion. The epidemiologist concluded that the data were not sufficient to correlate cancer incidence with environmental exposures (J. Chang, Muskegon County Health Department, personal communication, 2006). Persons interested in more information regarding the local agency's efforts in this matter should contact the Muskegon County Health Department.

Some information regarding local residents' cancer diagnoses (primarily breast cancer) was given to MDCH. Additional information is necessary before a cancer cluster investigation can be considered. MDCH prepared the factsheet, "Cancer Clusters: Common Questions," in response to public concerns regarding perceived clusters in general. The factsheet is attached to this document as Appendix D and also is available at the MDCH website at http://www.michigan.gov/documents/Cancer_Clusters_Q&A_116888_7.pdf.

The public health epidemiologist at the Muskegon County Health Department examined several variables associated with end-stage renal disease (ESRD) in Muskegon County. This was a case-control study in which 180 ESRD patients were compared with 262 other participants who did not have ESRD. ESRD prevalence rates in Muskegon County were at least 14% higher, and an average of 30.5% higher,

than the State of Michigan from 1988 to 1995. In the United States, ESRD rates for males predominate over females and blacks predominate over whites. The relative risk estimates correlated with ESRD in Muskegon County in this study were greatest among individuals who drank alcohol frequently, did not have routine physical checkups regularly, were overweight, and had a diagnosis of hypertension or diabetes. According to the study, ESRD patients tend to have lower levels of education, less income, heavy industrial employment, and fewer owned houses. (The study did not investigate the possibility of chemical exposure outside the workplace.) There is obviously a problem with kidney disease in Muskegon County. There is likely more than one cause for this condition in this area, and it likely needs both public and private health actions to correct it (Chang 1997).

17. Are cyanobacteria blooms relevant to this discussion?

No. Text regarding the algae blooms has been removed.

18. Why not use "potential" health hazard instead of "indeterminate?" Can you use a ranking system for the public health hazard categories?

The term "potential" is no longer an official ATSDR hazard category and should not have been paired with "indeterminate," which is an official category. ATSDR has been notified of this discrepancy and is changing its factsheet. MDCH has re-written Appendix B to better define the hazard categories and actions that might be necessary to mitigate those hazards. The term "potential" may be used in the text of a health consultation, such as when determining exposure pathways (see Table 3 in the health consultation).

ATSDR assigns each hazard category a number, which indicates the severity of a hazard (1 being Urgent, 5 being No Hazard). However, these numbers are not necessarily used for ranking or prioritizing the hazards, which is a risk management process and outside the authority of MDCH or ATSDR.

19. The conclusions drawn regarding the potential for the Peerless site to be contributing cadmium contamination to Little Black Creek water or sediments are not consistent with the statement in the Summary section: "exposure to the cadmium in the sediments in LBC poses no apparent current or future public health hazard."

The *presence* of a chemical does not necessarily mean that *exposure* to that chemical will occur. Similarly, if exposure occurs, adverse health effects are *not* guaranteed. Please refer to the response to Comment #7.

20. MDCH/ATSDR conclude that the public health hazard of mercury levels is indeterminate. Isn't this reason to do additional investigation?

Investigating the incremental contribution that mercury in Little Black Creek sediments is making toward the level of methylmercury in fish from the creek or Mona Lake is not likely to help clarify the "indeterminate" public health hazard. There are probably other inputs of mercury into the water column, specifically, deposition of mercury air emissions as well as other streams, such as Big Black

Creek, which may have mercury contamination. Currently, the fish consumption advisory for Mona Lake is based on concentrations of PCBs in fish sampled from that lake. If people adhere to the advisory for Mona Lake, or to MDCH's general inland lake mercury advisory, then they should be protected from harmful exposure to methylmercury in fish.

21. "Difficulty of access" to contaminated areas is not sufficient for the protection of human health. There should be further restriction to these areas. You cannot predict where children will play regardless of how hard it is to get to certain areas of the watershed.

It is true that those persons intent on accessing an area will probably succeed, unless physical barriers are in place. Although there is no man-made physical barrier to Little Black Creek near Peerless, the site does not appear to be an attractive spot for children or adults. The creek banks, shown in Figures 3 and 4 in the health consultation, are covered with very dense brush on the south side and are on private property on the north side. This area of the creek also is near a heavily traveled road. As mentioned in the health consultation, if access is occurring, it is likely less than the 90 days/year assumed by MDCH when adjusting the screening level to consider intermittent exposure to the sediments. Decreasing the expected exposure would increase the screening level. MDCH does not feel it is necessary to further restrict this area at this time.

22. Little Black Creek does not flow primarily through the City of Muskegon Heights, but extends upstream of the city limits many miles.

The language has been changed in the health consultation to reflect this fact.

23. "Economically disadvantaged" populations are not the only persons who may catch and eat fish, muskrat, or turtles from the creek. The economic status of an individual should have no impact on the level of public health and environmental impact that is acceptable. Eliminate the term.

The term has been eliminated.

24. This is an environmental justice issue. The quality of life has been hindered. Exposure to the contamination is shortening lives.

The following is taken from the ATSDR Public Health Assessment Guidance Manual (2005): "Environmental justice refers to efforts to ensure that all populations, regardless of their economic status or political power, are treated equally with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. These efforts help ensure that no population unfairly shoulders the negative human health and environmental impacts of pollution."

Several commenters expressed concern that environmental justice was not being served by MDCH/ATSDR's concluding that the creek poses no apparent public health hazard. There is also concern in the community that, unless the creek sediments are deemed a public health hazard, improvements to the Mona Lake watershed as a whole will not occur. However, the neighborhoods near Little Black

Creek do not appear to be ignored, as one commenter wrote: "We currently have local, state, and federal elected officials engaged in the process of cleaning up Little Black Creek not only for environmental reasons but as a way of providing the much needed environmental justice for the area."

The MDCH Mission Statement is: "MDCH will protect, preserve, and promote the health and safety of the people of Michigan with particular attention to providing for the needs of vulnerable and under-served populations." By protecting for *all* populations, MDCH ensures that environmental justice is not an issue.

When MDCH was asked for a public health opinion of Little Black Creek's sediments, the agency indicated the main parameter it considers when evaluating sites is the potential for harmful exposure. Under current conditions, MDCH does not expect harmful exposures to occur. Discussion has been added to the health consultation regarding future use of the creek.

25. The ecosystem in the creek is poor compared to other creeks studied.
MDCH and ATSDR agree that the ecosystem in the creek is poor. However, addressing ecological impacts is outside the purview of this assessment.

26. Several dogs in the area have died from cancer.
Sometimes domestic animals can act as indicators for environmental quality. Animals likely have similar risk factors for developing cancer as do humans: advancing age, exposure to chemicals in and outside the home, and "lifestyle choices" (i.e., the owner's lifestyle choices may reflect on the health of the pet). MDCH cannot address pet health in a public health assessment. Concerned pet-owners should consult with their veterinarians.

27. As anecdotal information, a neighbor of the Marathon property personally emptied tankers of crude oil in Hulbert drain from 1977-1981 for his company.
This information has been passed on to the MDEQ.

28. Why not use the arithmetic mean between 1E-6 (1 in 1,000,000) and 1E-4 (1 in 10,000) for the target cancer risk, rather than the geometric mean (in Appendix A)? Using the arithmetic mean would result in a more protective Direct Contact Criterion.
(Note: The arithmetic mean between two numbers is the sum of those numbers divided by 2. The geometric mean between two numbers is the square root of the product of those numbers.) The Michigan state legislature determined 1 in 100,000 (1E-5) to be the acceptable level of risk for the MDEQ Part 201 and other cleanup programs.

29. Discuss issues quantitatively (with data) rather than qualitatively (descriptors).

MDCH has attempted to reach all audiences with its health consultation by including data, for those interested or knowledgeable about the scientific aspects of this site, and discussing that data qualitatively, for persons without a scientific background.

Appendix D. MDCH Cancer Clusters Factsheet

Updated February 21, 2006

Michigan Department of Community Health
MDCH
Jennifer M. Granholm, Governor
Janet Olszewski, Director

Cancer Clusters: Common Questions

You know several people in your neighborhood who have been diagnosed with or died from cancer within the past few years. You're worried. Is there something wrong in this area? Why does it seem so many people are getting cancer?

What is a cancer "cluster?"
A cancer cluster is a greater-than-expected number of cancer cases that occurs within a group of people in a geographic area over a specific period. A cluster may be "perceived" (i.e., a person notices what seems to be a high number of cancer cases) or "real" (i.e. statistical analysis of cancer incidence data shows that the number of cases is higher than would be predicted).

How is a cancer cluster identified?
Concerns regarding a perceived cancer cluster first should be discussed with a public health professional, either from your local health department or the Michigan Department of Community Health (MDCH). This person can help determine if an initial evaluation is necessary.

Simply counting the number of cancers found in a specific geographic area is not enough to determine if a cluster is present. An initial evaluation of a perceived cancer cluster requires the following information:

- □ cancer(s) of concern (breast, lung, prostate, etc.),
- □ number of cases,
- □ year of diagnosis for each case, and
- □ geographic area of concern.

The person asking for the evaluation should provide this information. The information can be compared to data from the state as a whole, from the county in which the community is situated, or from nearby or similar geographic areas.

Further investigation may be warranted if:

- ►the rate of one type of cancer is increased,
- ►a rare type of cancer is seen at a high rate, or
- ►a type of cancer is seen in a group not usually affected by that cancer, such as a cancer in children that is normally seen in adults.

If a review is indicated, cancer incidence data must be evaluated by a qualified statistician or epidemiologist.

The larger the population of the geographic area investigated, the easier it is to interpret the information. For example, a cancer analysis in one zip code area is often difficult to interpret. Analysis of several zip codes, such as for a city, generally provides more certainty. Analysis of a single neighborhood would not have the statistical power to draw clear conclusions.

What causes cancer clusters?
A cancer cluster may be due to chance, miscalculation of the expected number of cancer cases, exposure to known causes of cancer (such as smoking), or exposure to unknown causes of cancer. In most cases, no specific cause can be determined for a cancer cluster.

What causes cancer?
Cancer is a common illness - 1 out of 3 people will develop cancer in their lifetime.

The cells in your body are constantly being damaged and repairing that damage. This is normal. When damage is not repaired, cancer can develop. The development of cancer can be thought of as a series of events, each with a certain likelihood of happening, rather than as a single, all-or-nothing occurrence. These steps take time. The total time between a cell being damaged to a cancer being detected is called the latency period. Blood-related cancers, such as leukemia, may take 4-5 years to develop; solid tumors, such as those found in lung cancer, may have a latency period of decades.

Environmental factors that may affect a person's likelihood of developing cancer include:

- ♦Lifestyle choices (nutrition, tobacco use, physical activity)
- ♦Naturally occurring exposures (UV light, radon)
- ♦Medical treatments (radiation, immune system-suppressing drugs)
- ♦Occupational exposures
- ♦Pollution

Many people believe that much of our cancer risk comes from chemical pollutants in our air, food, or water. However, most of our cancer risk comes from lifestyle choices. Non-environmental risk factors include age, race, gender, and genetic factors.

Just because you might be exposed to a carcinogen (a cancer-causing agent) does not mean that you will develop cancer as a result of that exposure. If you are concerned about developing cancer, you should discuss this matter with your physician. Many cancers are successfully treated if they are discovered in the early stages.

Other Sources of Information:

Check with your local health department regarding perceived cancer clusters in your area. If necessary, your local agency can refer you to MDCH for further information.

View the MDCH factsheet called "Cancer and the Environment" at http://www.michigan.gov/documents/mdch_Cancer&Environment_86809_7.pdf

View Michigan or county data regarding certain forms of cancer at the MDCH Cancer Registry. http://www.michigan.gov/mdch, under "Statistics and Reports."

Learn more about cancer cluster investigations at the Centers for Disease Control and Prevention website. http://www.cdc.gov/nceh/clusters/default.htm

Get cancer information from the American Cancer Society website.
http://www.cancer.org/docroot/home/index.asp

Certification

This **Little Black Creek Sediments** Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures. Editorial review was completed by the cooperative agreement partner.

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

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

Team Leader, CAT, CAPEB, DHAC, ATSDR