PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN
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SUMMARY

The Lafarge Corporation - Alpena Plant is an operating portland cement production facility in northeast Alpena, Michigan. The plant began operations in 1908, and the Lafarge Corporation bought it in 1986. There has been a long history of cement dust blowing from the plant into the city to the southwest. Lafarge has recently begun using hazardous waste to supplement the fuel in their kilns. The plant has been in consistent violation of a Consent Agreement with the Michigan Department of Natural Resources/Department of Environmental Quality, because the effluent from their kilns contains more hydrogen chloride than the Agreement allows. The plant has also been frequently cited for many other violations of environmental regulations.

Citizens of Alpena are concerned about the potential health and environmental effects of emissions from the Lafarge plant and pollution from other sources in the city. They are also concerned about perceived high rates of incidence of various health problems, including cancer, in the city. A citizen petitioned the Agency for Toxic Substances & Disease Registry (ATSDR) for a health assessment of the hydrogen chloride emissions from the Lafarge plant.

Citizens of Alpena are also concerned about hydrogen chloride in the ambient air. Due to equipment and sampling delays, air data was not available for inclusion in this document. Nonetheless, air data that is currently being collected will be reviewed in a future document.

The contaminants that have been found in Alpena at concentrations potentially of human health concern (that is, the concentrations exceeded screening levels for further investigation) are lead in the soils and benzene and carbon tetrachloride in the air. The concentrations of these chemicals found in Alpena were below those at which adverse health effects have been seen and are comparable to those typically found in urban areas. A preliminary evaluation of available cancer data did not find a significantly high rate of cancer in Alpena County. From the currently available data and information, the Michigan Department of Community Health (MDCH) has not been able to identify an environmental cause for the health problems reported by some residents of Alpena. Therefore, this site is classified as "no apparent public health hazard." Further sampling and analysis of environmental media and further evaluation of health data are under way.

BACKGROUND

A. Site Description and History

The Lafarge Corporation Alpena Plant is located on the northeast[(1)] side of Alpena, Alpena County, Michigan (Figure 1). The Huron Portland Cement Company (later acquired by National Gypsum Company) built the plant between 1906 and 1908 and manufactured portland cement there from 1908 until approximately 1980, when they closed the plant (1). The Lafarge Corporation bought the plant in 1986 and has resumed cement production.

Cement dust from the plant has blown into the city whenever the wind was from the northeast and the plant was in operation. The operators have collected waste cement kiln dust (CKD) and disposed of it in three areas:

1. an 80-acre pile along the shore of Thunder Bay east of the plant (Figure 1). This pile has filled in part of Thunder Bay.
2. a former quarry northwest of the plant, west of Wessel Road, called the Wessel Road Quarry by the MDEQ, which has been closed and covered with soil. The resulting hill has been referred to by local residents as "Pike's Peak."
3. part of another quarry north-northeast of the plant, east of Wessel Road, which is in current use and regularly covered.

As one way to improve the economics of operating the plant, Lafarge has been mixing hazardous waste, obtained from other sites or producers, with the fuel in their kilns. Theoretically, under optimum conditions, the waste would be totally burned, leaving harmless combustion products, primarily carbon dioxide and water

vapor. In May 1986, the Michigan Department of Natural Resources (MDNR) issued a permit to Lafarge Corporation which allowed them to burn hazardous waste at their Alpena Plant. Local citizens and environmental organizations have opposed this operation and petitioned ATSDR to conduct a public health assessment of the situation in Alpena.

The MDNR and Michigan Department of Environmental Quality (MDEQ)[(2)] have frequently cited the Lafarge Corporation Alpena Plant for many violations of environmental regulations, including releases of hydrogen chloride above the limits specified in their permits. Excess hydrogen chloride emissions have been recorded when the plant was burning only conventional fuels as well as when hazardous waste was mixed with the fuel. The hydrogen chloride is thought to be formed from chlorides in the limestone and other raw material, as well as from chlorinated compounds in the hazardous waste mixed in the fuel (2).

From December 1996 through October 1997, a contractor for the MDEQ conducted field work for an Interim Response Investigation Action (IRIA) at the "National Gypsum Site," which is the pile of cement kiln dust (CKD) east of the plant described above. The IRIA included sampling of the CKD, groundwater in the area of the pile, and water and sediments from Thunder Bay near the pile. They found that the CKD had been transported into the Bay. The groundwater under the pile and surface water in the Bay near the pile had been affected by contact with the CKD (3).

In September 1999, the MDEQ began an investigation of the Wessel Road Quarry, a.k.a. "Pike's Peak." They found that the soil cover had eroded in places to expose the CKD. They also noted groundwater or leachate seeps into a pond in the north end of the former quarry. They collected samples of the CKD and of surface water and sediment from the pond and the creek feeding it. The analytical results are not available as of this writing (4, 5).

A physician (chiropractor) from Alpena has petitioned the federal Agency for Toxic Substances and Disease Registry (ATSDR) for a public health assessment of the hydrogen chloride emissions from the Lafarge Corporation Alpena plant (6). At the request of the ATSDR, the Michigan Department of Community Health (MDCH), working under a cooperative agreement with the Agency, prepared a health consultation in June 1998 regarding the hydrogen chloride emissions. This was to assist the Agency in determining whether a public health assessment is appropriate (2). The ATSDR and MDCH concluded that a public health assessment was needed.

B. Site Visits

On February 19 - 20, 1998, James Bedford and Brendan Boyle of MDCH and Sandie Coulberson, Kathryn Evans, and Ruby Palmer of ATSDR visited Alpena to

discuss the community's environmental health concerns. They met with several groups of area residents, toured the plant, and held a public meeting.
On June 16 - 17, 1998, Brendan Boyle and Michael Haars of MDCH and Sandie Coulberson of ATSDR visited Alpena to further discuss the community's environmental health concerns. They participated in a public meeting on the evening of June 16, at which the public comment draft of the health consultation was made available to the public. On June 17, a public availability session was held to further discuss the community's concerns.
On August 25, 1998, Boyle, Haars, John Filpus, and Bob Wahl of MDCH returned to Alpena. MDEQ staff gave them a windshield tour of the CKD pile. That evening they spoke at a public meeting of an environmental action committee, presenting the final draft of the health consultation.

C. Demographics, Land Use, and Natural Resource Use

According to the 1990 U.S. Census, the population of the City of Alpena was 11,307. The population of Alpena Township[(3)], which surrounds the City, was 9,540. There were approximately 2,600 people living within 1 mile of the Lafarge plant, and 13,700 living within 3 miles. A breakdown of the population in these two areas by age, race, and major ethnic group and selected economic statistics for the areas is given in Table 1. The population in both areas is predominantly white, with a mixture of central and western European ethnic groups (7). The entire population within 1 mile is designated urban by the U.S. Census definition.[(4)] The only urban area (by that definition) within the 1 mile radius is within the City of Alpena, west and southwest of the plant. The 1 mile radius covers most of the "North Side" of the city, on the left (northeast) bank of the Thunder Bay River. The land within 1 mile east, north, and northeast of the plant is Lafarge or former National Gypsum property, including a quarry and the CKD pile mentioned above, and uninhabited. Most of the City of Alpena (99.7% of the population, compare the "urban" population in the last column of Table 1 with the total city population above) is within 3 miles to the west and southwest of the plant. The area north and east of the plant and quarry is primarily used for recreation, with seasonal residences sparsely scattered in the area.
As shown in Table 1, there is little difference in race or ethnicity between the two areas around the Lafarge plant. The majority of people of Asian/Pacific descent who live in Alpena (relatively few people in all) live within 1 mile of the plant. The people living closer to the plant include a slightly higher percentage of people of Polish descent and a slightly lower percentage of people of German descent than the city as a whole. The population living within 1 mile of the Lafarge plant has a considerably lower median and average household income, a higher fraction living in poverty, and lower median and average home values than does the population living within a 3-mile radius of the plant (7).

The City of Alpena's municipal water supply uses water from Thunder Bay on Lake Huron, using an intake pipe approximately 3 miles southwest of the Lafarge Corporation plant (Figure 2). The MDEQ has no record of private wells in the area northeast of the plant, although it is possible that some seasonal or year-round residences in the area may have wells or private intakes from Lake Huron.

D. Health Outcome Data

A great deal of concern has been expressed by citizens of Alpena about perceived elevated rates of cancer for the general community and for those employed by local industries (2). The contaminants of concern in the community include several chemicals that are considered possible, probable, or proven human carcinogens (Table 3). The assessors have obtained statistical data on cancer incidences among residents of Alpena County from the MDCH Office of the State Registrar and Division of Health Statistics.

COMMUNITY HEALTH CONCERNS

A large number of health and environmental concerns have been voiced by community members. The following is a summary of these concerns. Each concern is listed once; however, some have been expressed as a concern by more than one member of the Alpena community.

Lafarge and Other Local Industry

In addition to the concerns regarding hydrogen chloride emissions that were cited in the petition that requested a Public Health Assessment (6), Alpena citizens have voiced many concerns regarding the Lafarge Corporation operation, and to a lesser extent other industries in the city, and their possible impact on health and the environment in the area.

Citizens have also voiced complaints about sulfur dioxide emissions from the Lafarge plant. Citizens have voiced concerns that a plant designed to make cement would not be able to appropriately and completely burn hazardous waste. Numerous accounts of plumes of smoke and fumes originating from the Lafarge plant have been received by MDCH staff or the Michigan Department of Environmental Quality (MDEQ) via the Pollution Emergency Alerting System (PEAS Hotline 800-292-4706). Citizens have stated that the plumes extended far into Thunder Bay and affected respiratory function in those who come in contact with them. Many concerns have been voiced about the pile of cement kiln dust (CKD) on the shore of Thunder Bay east of the Lafarge plant. The pile is eroding into the bay and may be contributing arsenic, mercury and other heavy metals to bay water and sediments. Fugitive dust from the pile is contributing to particulate matter in the air, which is a respiratory hazard and nuisance. Concerns have been expressed about the presence of asbestos-containing materials on site at the

Lafarge plant. Many concerns have been expressed about past and present work practices and environmental conditions at the Lafarge plant.

Several concerns have been expressed about the possible harmful contents of the fill material which was historically provided free of charge to Alpena citizens by Abitibi (now ABT Co.). Citizens have voiced concern that the fill contained fly ash and heavy metals, including lead. The possibility of lead poisoning, especially in children, has been raised by the citizens. There may be no complete or accurate record of where in the Alpena area the Abitibi fill material was used, raising concerns about whether all the potentially affected individuals could be identified.

Concern was voiced over hydrogen sulfide releases from ABT Co., the municipal sewage treatment plant, and the Fletcher Paper Company. These three facilities are located near the mouth of the Thunder Bay River, near the commercial center of Alpena.

In a comment on the health consultation, a citizen noted, "Thunder Bay Manufacturing is not listed in the chart on page RS-15 [of the Health Consultation (Reference 2)]. It is a source of methanol . . . Please refer to toxic release inventories to determine what Thunder Bay Manufacturing contributes to the toxic chemicals in Alpena's air." (8)

One concern about the HCl released from Lafarge is that it might combine with formaldehyde from other plants to form phosgene gas (8).

Cancer

A great deal of concern has been expressed about perceived elevated rates of cancer for the general community and for those employed by local industries (2). Concerns have been expressed that the State of Michigan Cancer Registry may not capture the number of cancer cases in Alpena because many people have sought treatment outside of the area.

Other Symptoms and Diseases

Many people have reported perceived elevated rates of various symptoms and diseases. The following is a list of symptoms and diseases that have been identified as concerns by the community: rare birth defects; attention deficit disorder/attention deficit hyperactivity disorder (ADD/ADHD); migraine and/or cluster headaches; asthma and other respiratory problems; severe nose bleeds; irritation/inflammation of the eyes, nose and throat; multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS, also known as "Lou Gehrig's Disease"); Parkinson's Disease; other central nervous system disorders; and Lupus. There have been numerous accounts of people experiencing symptoms including nose bleeds, respiratory distress including asthma, and headaches which were greatly reduced or absent when not in Alpena.

Students at one Alpena school are perceived to experience a large number of incidents of seizure disorder.

Miscellaneous Concerns

- A concern has been raised about potential exposure pathways for environmental contaminants that could result in exposure from multiple sources. The exposure pathways identified were fish, soil, and air.
- The concern was raised that as body burdens of chemicals increase, the immune system's ability to function decreases, adversely impacting humans and animals.
- The fact that children are more susceptible to chemical exposures was identified as a major concern.

- Many have voiced concern regarding decreased quality of life due to environmental conditions and events.

- Several concerns were raised related to the risk from transport of hazardous waste through the streets of Alpena.

- Perceived elevated rates of mental illness and alcoholism in Alpena, directly or indirectly related to environmental problems, were raised as a concern.
- Concerns over rumors of napalm being transported to Alpena to be burned in Lafarge's kilns have been raised.

- Concerns about declining game fish in Thunder Bay and the Thunder Bay River have been expressed.

- The MDCH has issued an advisory that people should strictly limit their consumption of lake trout taken from Lake Huron (see Table 2 for details), in part because of dioxin contamination (9). This dioxin might come in part from the Lafarge plant, although there have been several other documented or potential sources of the contaminants within the watershed of the lake. The contaminants recently appeared in the fish. People in Alpena perceive that this appearance coincided with the first burning of hazardous waste in the Lafarge kilns (10).

- Concerns over adverse impact of environmental contaminants on garden plants have been raised.

- Many concerns related to the health of domestic and wild animals, including contaminated Bald Eagle eggs at South Point, have been raised.

- Much concern over the historical, widespread dumping of contaminants into the Thunder Bay and Thunder Bay River has been voiced.

ENVIRONMENTAL CONTAMINANTS AND OTHER HAZARDS

The sampling results discussed in this assessment were taken from the available investigations of the Lafarge plant and other environmental concerns in the Alpena area. They are not adjusted for limitations or bias in the sampling programs. The tables presented in this assessment include maximum and median concentrations in the samples collected. Health discussions are based on the maximum concentrations reported and long-term, frequent exposure scenarios, which are reasonably conservative assumptions.

Contaminants of concern for this assessment were selected from those chemicals for which the concentration in at least one environmental medium exceeded a health-based and medium-specific comparison value. Lifetime exposure to concentrations of chemicals at or below the appropriate comparison values is not expected to result in any significant risk of adverse health effects. Comparison values used in this assessment include:

ATSDR Environmental Media Exposure Guides (EMEGs): Concentrations computed from the ATSDR Minimal Risk Levels (MRLs)[(5)] for chronic exposure of a child, assuming pica behavior for soil ingestion[(6)]

ATSDR Cancer Risk Evaluation Guides (CREGs)[(7)]

ATSDR Reference Dose Media Evaluation Guides (RMEGs): Concentrations computed from the U.S. EPA Reference Doses (RfDs)[(5)] for chronic exposure of a child, assuming pica behavior for soil ingestion

U.S. EPA Reference Concentration (RfCs)[(5)] for chronic exposure

U.S. EPA Drinking Water Health Advisories, Lifetime (LTHA) (11)

U.S. EPA Safe Drinking Water Act Maximum Contaminant Levels (MCLs) (11)

U.S. EPA Safe Drinking Water Act Maximum Contaminant Level Goals (MCLGs) (11)

If a chemical is found in a medium for which no comparison values exist, or for which there is no CREG available for a carcinogen, the chemical is retained as a contaminant of concern. Contaminants of concern identified from environmental data referenced in this assessment are listed in Table 3.

To identify other chemicals that might contribute to environmental contamination in the Alpenaarea, the MDCH searched the Toxic Chemical Release Inventory (TRI) data base for 1987 through 1997. Industrial facilities that use, produce, or process more than the specified amounts of chemicals on a specified list are required to file annual reports on their releases to the environment or their transfers to other facilities with the U.S. EPA. These reports are compiled into the TRI. The

TRI database includes information on releases or transfers from seven facilities within the Alpena postal ZIP code: ABT Company (formerly Abitibi-Price), Fletcher Paper Company, two Lafarge Corporation locations (their main plant and the M-32 Paxton Quarry located approximately 10 miles west of Alpena, reported in 1992 only), Panel Processing, Inc. (1988-92), Systech Environmental Corporation (1992-1993), and Thunder Bay Manufacturing (1994-97). ABT Company and Fletcher Paper Company are located along the Thunder Bay River in the center of Alpena. Panel Processing, Inc. was located approximately 3 miles north of downtown Alpena. Systech Environmental Corporation is a subsidiary of Lafarge Corporation and is located adjacent to the main Lafarge Corporation Alpena plant. Thunder Bay Manufacturing is located approximately 1 mile northwest of downtown Alpena. The chemicals on which each facility filed at least one report and the nature of the releases and transfers reported are summarized in Table 4 (12).

A. On-Site Contamination

Groundwater

During the IRIA in 1997, the contractor installed a total of 14 monitoring wells in the vicinity of the CKD pile (Figure 1). They installed 11 wells on the property in January 1997, and collected samples from them late in the month. In June 1997, they installed three additional wells on the property and one more approximately 8 miles away to provide a background sample (Figure 3). They collected samples from all 14 wells in late June and early July 1997. They collected two samples from every well each time the wells were sampled. One sample of each pair was filtered to determine the concentrations of metals dissolved in the water. The results are summarized in Table 5 (3).

Many of the samples from the wells on or near the CKD pile, both filtered and unfiltered, exceeded U.S. EPA or MDEQ drinking water standards in one or more of these parameters: antimony, arsenic, cadmium, chromium, lead, manganese, mercury, nickel, selenium, sodium, thallium, or pH (11, 13). The pH values of many of the samples from the wells on or near the pile were high enough to pose a hazard for skin contact (14). The unfiltered background sample contained 1,800 parts per billion (ppb) sodium and did not contain any other metals above the detection limit. The filtered background sample contained 8,300 ppb aluminum, 270 ppb barium, 41 ppb copper, 12 ppb lead, 390 ppb manganese, and 1,900 ppb sodium. The background sample had a pH of 7.4. All of these parameters are within drinking water or skin contact standards (3, 11, 13, 14). In several other samples, the concentration of a "dissolved" metal was also higher than the "total" concentration of the same metal in the corresponding split (3).

Surface cement kiln dust (CKD)

In March 1993, the MDNR collected three samples of CKD from a large pile located east of the Lafarge plant (Figure 1), and had the samples analyzed for selected metals (Table 6). In August, the MDNR collected two additional samples from the same pile. These samples were analyzed for a different set of metals (also in Table 6). The available documentation of these sampling events does not include any information on the sample depths or exact locations (3).

During the IRIA in December 1996, the contractor collected samples of material from 0 to 6 inches deep at 11 locations on the pile. They analyzed the samples for yet a third set of metals (also in Table 6) (3). The samples contained arsenic concentrations above MDEQ Clean-up Criteria for Residential Use and background levels typically found in Michigan. Many other metals, such as barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, thallium, titanium, and vanadium were present. Some of the samples were at concentrations above background or ATSDR Comparison Values, although not above the MDEQ Clean-Up Criteria (13, 15).

On August 7, 1998, the MDEQ collected 15 samples of CKD from the pile, including eight surface samples (0-6 inches deep) and seven subsurface samples (between 6-12 inches and 3-3.5 feet deep). They mixed portions of these samples with equal weights of water and measured the pH of the resulting fluid. The pH of the surface samples ranged from 9.1 to 12.3, with a median of 11.65. The pH of the subsurface samples ranged from 10.3 to 12.4, with a median of 12.0 (16).

B. Off-Site Contamination

Surface Soil

In April 1992, a resident of Alpena collected two soil samples, one from her property south of the Thunder Bay River (Residence A in Figure 2) and a second from a relative's property north of the river (Residence B, also in Figure 2). She had them analyzed at a commercial laboratory for cadmium, chromium, lead, and mercury. The laboratory reported that the sample from Residence B contained 610 parts per million (ppm) lead, which is above the MDEQ's Generic Clean-up Criteria for Industrial, Commercial, or Residential Uses (400 ppm) (13, 17).[(8)] The residents reported these results to the MDNR, who initiated an investigation of soil contamination at these properties and in Alpena as a whole. In June and July 1992, the MDNR collected additional soil samples from these properties, from 1 and 6 inches deep. The MDNR collected three samples from each depth at Residence A, and five samples from each depth at Residence B. These samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (also in Table 7) (18). None of these samples contained lead concentrations above the MDEQ Generic Clean-up Criteria. Two 6-inch-deep samples collected from Residence B contained arsenic concentrations in excess of the MDEQ Generic

Clean-Up Criteria for Residential Use (13). None of the arsenic concentrations was outside the range found in Michigan background soils (15).[9]

From June through August 1992, the MDNR also collected 27 surface soil samples (1" deep) from other residences, school yards, and parks throughout the city of Alpena. They analyzed these samples for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Table 8 summarizes the results for these samples and those from Residences A and B discussed in the preceding paragraph. One sample contained a lead concentration in excess of the MDEQ Clean-Up Criteria for Industrial, Commercial, or Residential Use (13). It was collected from a residential yard along a major thoroughfare south of the Thunder Bay River. The highest arsenic concentration (33 ppm) was found in soil from a residential yard north of the river, within 0.5 miles of the Lafarge Plant. The second-highest arsenic concentration (23 ppm) was found in soil from the playground of Ella White Elementary School on the southwest side of the city (Figure 3) (18). These two samples and one collected near a railroad track contained arsenic concentrations outside the range found in background soil in Michigan (15). These three and four other samples, including the sample with the highest lead concentration cited above, contained arsenic concentrations above the MDEQ Generic Clean-Up Criteria for Residential Use (13).

During this time, the MDNR also collected 13 samples of subsurface soil, from 6" to 12" deep, from residential yards, school yards, and parks around the city. These included five samples at the same locations where surface soil samples were collected and five background samples from soil that was 12" deep at five locations around the outskirts of the city. These samples were also analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Table 9 summarizes the results from these sampling events and the 6" deep samples collected from Residences A and B, discussed above. The highest lead concentration (451 ppm, above the MDEQ Generic Clean-Up Levels) was found in a sample collected from 6 inches deep on the grounds of Lincoln Elementary School, north of the Thunder Bay River and not far from Residence B (see Figure 3).

In November 1992 in response to these results, the Alpena Public Schools hired a contractor who, beginning on November 30, 1992, collected 17 surface soil samples (1" deep) from yards of Ella White School (five samples), Lincoln School (7 samples), other schools in their district, and a city park to determine the extent of the arsenic and lead contamination found in school yards by the MDNR (see above) (19). They had these samples analyzed for arsenic and lead (Table 8). The samples with the lead and arsenic concentrations above the MDEQ Clean-Up Criteria were collected from the yard at Lincoln School. The samples from Ella White School contained between 0.2 and 0.9 ppm arsenic (Table 10) (18). On December 22, 1992, a contractor for the Alpena Public Schools collected 14 soil

samples from the yard at Lincoln School and nine samples from the yard at Ella White School. These samples were analyzed for lead and arsenic (Tables 8 and 10). The arsenic in the soil at Ella White School was believed to have leached from a bench made of treated lumber located near the sampling point. The bench was replaced by one not made of treated lumber. The Alpena Public Schools removed the lead- or arsenic-contaminated soil from the two school yards and disposed of it appropriately (19, 20).

In 1996, as part of an investigation of regional soil contamination in Alpena, a contractor for a citizen's environmental action group collected samples of surface (0 to 0.4 inches deep) and subsurface (4 to 6 inches deep) soils from 11 locations in ten residential yards in the city. They analyzed the samples for various metals, and the results are summarized in Tables 8 and 9 (21). None of these samples contained any metal at a concentration exceeding the MDEQ Generic Clean-up Criteria (13).

Abitibi Fly Ash

In connection with investigations of specific questions about soil quality in the city between October 1991 and June 1992, the MDNR collected five samples of fly ash originally obtained from Abitibi Corporation at various locations around Alpena, and analyzed them for metals. All five samples contained arsenic at concentrations above the MDEQ Residential Use Criteria (Table 11) (22).

Ambient Air

From March 10, 1995, through March 4, 1996, at 6 or at 12 day intervals, a contractor for Lafarge Corporation, under MDEQ supervision, collected air samples at four sampling stations in and near Alpena. These locations were as follows: Besser Junior High School (Figure 2), Lincoln Elementary School, on North Point (east of Lafarge), and on the southwest part of the Lafarge Plant property. The samples from the first three locations were analyzed for metals, volatile and semi-volatile organic chemicals, and suspended particulate material (total and less than 10 microns in size). The samples from Lincoln School were also analyzed for chlorinated dibenzodioxins and dibenzofurans. The samples from the station on the Lafarge property were only analyzed for suspended particulate material less than 10 microns in size (PM-10). Table 12 summarizes the results of the chemical analysis, and Table 13 summarizes the results of the sampling for particulate material. There was no discernable pattern for the detection of the metals or for most of the volatile organic chemicals. The concentrations of benzene, ethylbenzene, toluene, and xylenes (BTEX) at any one sampling site all tended to peak on the same date, although that date varied from site to site. Peak concentrations occurred at Besser School on April 27, 1995, at Lincoln School on both August 1, 1995, and January 4, 1996, and at North Point on July 8, 1995. Relatively high concentrations of semi-volatile organic chemicals were found on November 29, 1995 and again during January 1996. Relatively high concentrations

of particulate matter were detected at all locations on March 28, 1995; June 20, 1995; July 14, 1995; and October 12, 1995. In general, the PM-10 measurements on the Lafarge property were the highest, followed by Lincoln School, Besser Junior High School, and North Point, although there were exceptions to the sequence. Octachlorodibenzodioxin was found in nearly every sample. Hepta- and hexachlorodibenzodioxins, and octa-, hepta-, and hexachlorodibenzofurans were found in many samples collected primarily in March through May 1995 and again in November 1995 into March 1996. Other chlorinated dibenzodioxins and dibenzofurans were detected less frequently. The highest concentrations of all the congeners were found mainly on April 15, 1995, and again on January 1996 (23).
The MDEQ did not accept the data from the 1995 sampling because it did not meet the agency's quality control standards. They requested another year of sample data, which Lafarge collected from May 4, 1997, through May 11, 1998. Samples were collected from the following locations: from the Immanuel Lutheran School; adjacent to Besser Junior High School on the south; from the north and south sides of the Sunrise Center; approximately 3 blocks northwest of Lincoln School (see Figure 2); from the same locations on North Point; and, from the same locations on the southwest corner of the Lafarge property. They analyzed the samples from Immanuel Lutheran School, the Sunrise Center, and North Point for volatile organic chemicals and PM-10 only. They analyzed the samples from Lafarge again for PM-10 only. The results are summarized in Tables 12 and 13. Again, the BTEX concentrations at each site tended to rise and fall together, with peaks occurring at Immanuel Lutheran School on December 6, 1997, at the south side of the Sunrise Center on April 29, 1998, at the north side of the Sunrise Center on May 11, 1998, and on North Point on January 11, 1998. During this sampling there was little correlation between PM-10 measurements on the Lafarge property with those elsewhere. In general the PM-10 measurements on the Lafarge property were the highest, followed by the Sunrise Center, Immanuel Lutheran School, and North Point, although there were exceptions to the sequence (24).
Citizens of Alpena have expressed concerns about hydrogen chloride in the ambient air. Due to equipment and sampling delays, air data was not available for inclusion in this document. Nonetheless, air data that is currently being collected will be reviewed in a future document.

Surface Water

During the IRIA, the contractor collected samples of surface water from eight locations along the Thunder Bay shoreline near the CKD pile on January 23, July 2, and September 3, 1997. They analyzed the samples for selected metals (Table 14) and also filtered the samples collected on January 23 and July 2, 1997, to determine the concentrations of metals dissolved in the water. The only metal detected in the filtered samples was aluminum. The two samples collected on July

2, 1997, that contained the highest total concentrations of metals also had the highest pH levels. One sample collected on January 23, 1997, had a pH level outside the U.S. EPA's acceptable range for drinking water, and all eight samples collected on July 2, 1997, had pH levels outside that range, with six samples also containing higher lead concentrations than the U.S. EPA Drinking Water Action Level (11). The IRIA report did not include the pH levels for the September 3, 1997, samples (3).

For information on background levels on October 1 and 2, 1997, the contractors also collected five water samples apiece from Squaw Bay (a subunit of Thunder Bay approximately 6 miles southwest from the CKD pile, see Figure 3) and from Misery Bay (approximately 5 miles east of the CKD pile, and outside of Thunder Bay, Figure 3). They analyzed the background samples without filtering for selected metals, and found only low concentrations of aluminum, potassium, and thallium (Table 15). The IRIA report did not include the pH values for these samples (3).

Municipal Water Supply

The MDEQ Division of Drinking Water and Radiological Protection monitors all municipal water supplies in the state by analyzing samples of the water they produce on a regular basis. The finished water put out by the Alpena municipal water system is sampled on a regular schedule, with different chemical groups analyzed at different intervals. Table 16 lists the schedule and latest sampling dates in MDEQ files. The Michigan Department of Public Health (MDPH)/MDEQ[(10)] monitoring has never found any chemical in Alpena City water at a concentration in excess of U.S. EPA Maximum Contaminant Levels (MCLs) except in transient events (25, 26, 27). The results of recent monitoring, sampling and analysis are summarized in Table 17. The only chemicals that were found generally at concentrations less than health-based standards for drinking water in these recent samples were arsenic, barium, bis(2-ethylhexyl)phthalate, chlorodibromomethane, chloroform, chromium, dibromoacetic acid, dichloroacetic acid, dichlorobromomethane, sodium, and trichloroacetic acid. Once, on March 22, 1995, the chloroform concentration exceeded the MCL for total trihalomethanes (chlorodibromomethane, chloroform, dichlorobromomethane, and other similar chemicals). A follow-up sample on June 15, 1995, as well as other later samples contained much lower concentrations of these trihalomethanes which totaled less than the MCL. The MDPH concluded that the exceedance of the MCL on March 22, 1995, was a transient event and no further action was required (25). The arsenic concentration in one sample, collected on June 12, 1995, exceeded the ATSDR CREG (compare Table 5, for example) but did not exceed the MCL (28). Compounds of chromium with the metal in the hexavalent oxidation state are classified as known human carcinogens (U.S. EPA Class A), but there is not

sufficient information available about the metal to produce a CREG. No information is available as to the oxidation state of the chromium detected in the city water on May 30, 1996 (26, 27, 29).

Trihalomethanes (including chlorodibromomethane, chloroform, and dichlorobromomethane) and haloacetic acids (including dibromoacetic acid, dichloroacetic acid, and trichloroacetic acid) can be produced when chlorine is added to water that contains organic material (30, 31, 32, 33). Bis(2-ethylhexyl)phthalate, commonly used as a plasticizer, is found everywhere in the environment, and is a common laboratory contaminant (34). The arsenic, barium, and chromium concentrations in the city water were much lower than those found in the groundwater or surface water near the CKD pile. The surface water and groundwater samples collected during the IRIA were not analyzed for any organic chemicals or for sodium (see preceding sections for the list of metals for which they were analyzed) (3).

Sediments

During the IRIA in September and October 1997, the contractor collected 31 samples of sediment from offshore in Thunder Bay from the cement kiln dust pile. For data on background levels, they also collected five sediment samples from Squaw Bay (a subunit of Thunder Bay, approximately 6 miles southwest from the CKD pile, Figure 3) and two sediment samples from Misery Bay (approximately 5 miles east of the CKD pile, and outside of Thunder Bay, Figure 3). All these samples were analyzed for selected metals. The samples from the two background areas contained similar concentrations of the metals. The sediment from the area off the CKD pile (Table 18) contained higher concentrations than did the background samples (Table 19) of metals that were also present in the CKD in the pile (Table 6). This result indicated that CKD had been transported from the pile into the bay (3).

Biota - Fish

A 1993 MDNR summary of results of dioxin and furan analyses of fish taken from Michigan waters from 1983 through 1988 lists seven lake trout taken from Lake Huron at Alpena, but does not indicate the dates, lengths, or the collecting agencies. All the fish were analyzed as whole fish samples. One fish was only analyzed for 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD). For the others, only the total concentrations of chlorinated dibenzodioxin or dibenzofuran congeners with each number of chlorines from 4 through 8 and chlorines at the 2, 3, 7, and 8 positions were listed (35).

On October 10, 1985, the MDNR collected five brown trout between 18 and 25 inches in length from Lake Huron at Alpena. Fillets from these fish were analyzed for PCBs, DDT and its metabolites, chlordane and related compounds, and dieldrin.

On July 23, 1986, the MDNR collected ten brown trout between 19 and 25 inches in length from Thunder Bay, and the fillets were analyzed for metals and PCBs.
On June 29, 1989, the MDNR collected nine carp between 21 and 30 inches in length, one 15-inch channel catfish, and ten walleye between 17 and 24 inches in length from the mouth of the Thunder Bay River. The same day, they collected ten carp between 15 and 30 inches in length, one 18.5-inch redhorse sucker, four smallmouth bass between 12 and 19 inches in length, and five walleye between 14.6 and 18.5 inches in length from Lake Besser on the Thunder Bay River (above the Ninth Street Dam) in Alpena. Fillet samples were analyzed for mercury, PCBs, various pesticides, and selected chlorinated organic compounds.[(11)]
On June 19, 1991, the MDNR collected ten brown trout between 16 and 18 inches in length and had fillet samples analyzed for the standard suite of chemical contaminants.
On June 25, 1991, the MDNR collected ten walleye between 19 and 28 inches in length and subjected extracts of the whole fish to their standard analysis.
On June 1, 1992, the MDNR collected ten brown trout between 20 and 26 inches in length and six lake whitefish between 18 and 24 inches in length from Thunder Bay and subjected fillet samples from the fish to their standard analysis.
On June 4, 1992, the MDNR collected ten carp between 19 and 25 inches in length and nine lake trout between 24 and 31 inches in length from Thunder Bay, and they subjected extracts of the whole fish to their standard analysis. Five of these trout were also analyzed for chlorinated dibenzodioxins and dibenzofurans.
On June 13, 1993, the MDNR collected 100 alewives between 3 and 5 inches in length from Thunder Bay. These were composited as whole fish into two samples of 50 fish each.
On June 14, 1993, the MDNR collected ten carp between 21 and 27 inches in length, eight lake trout between 19 and 26 inches in length, and ten walleye between 15 and 25 inches in length from Thunder Bay.
On June 22 and 23, 1993, the MDNR collected 50 chub, of which five were between 10 to 10.5 inches in length, five of them were between 10.5 to 11 inches in length, the others were between 6 and 7 inches in length. Skinless fillet samples of the ten longer chub were composited into two samples of five fish apiece and sorted by length. The remaining chub were composited as whole fish into two samples containing 20 fish apiece. The samples of alewife and chub, skinless fillets of the carp, and fillets with skin of the lake trout and walleye were all subjected to MDNR's standard analysis. The lake trout fillets were also analyzed for chlorinated dibenzodioxins and dibenzofurans.
Between August 12 and August 25, 1993, the MDNR collected seven brown trout between 18 and 24 inches in length from Thunder Bay. Skin-on fillet samples were subjected to MDNR's standard analysis.

On October 12, 1993, the MDNR collected two channel catfish that were 17.5 and 25 inches in length from Thunder Bay. Skinless fillet samples were subjected to MDNR's standard analysis.
On October 15, 1993, the MDNR collected nine carp between 18 and 28 inches in length from Lake Besser on the Thunder Bay River, and had extracts of the whole fish analyzed for their standard suite of chemicals.
On June 27, 1994, the MDNR collected ten carp between 21 and 24 inches in length and ten lake trout between 25 and 28 inches in length from Thunder Bay and subjected extracts from each whole fish to their standard analysis. Extracts from five of the lake trout (between 25 and 27 inches in length and comprising 5 of the 6 shortest fish of the species collected that day) were also analyzed for chlorinated dibenzodioxins and dibenzofurans.
On June 16, 1995, the MDNR collected 10 carp between 21 and 23 inches in length, 10 lake trout between 25 and 28 inches in length, and 10 walleye between 17 and 24 inches in length from Thunder Bay and subjected extracts of each whole fish to their standard analysis.
On September 15, 1995, the MDNR collected three spottail shiners (length not reported) and five walleye between 21 and 24 inches in length from Thunder Bay and subjected extracts of each whole fish to their standard analysis.
On June 26, 1996, the MDNR collected ten lake trout between 20 and 25 inches in length and ten lake whitefish between 19 and 26 inches in length from Thunder Bay and subjected fillet samples of each fish to their standard analysis.
On August 20, 1998, the MDNR collected ten lake whitefish between 21 and 25 inches in length from Thunder Bay and analyzed fillet samples for the standard suite of chemical contaminants plus chlorinated dioxins and furans.
On August 22, 1998, the MDNR collected 11 lake trout between 23 and 26 inches in length and nine walleye between 20 and 27.4 inches in length and analyzed extracts of the whole fish for the standard suite of chemical contaminants plus chlorinated dioxins and furans. Analytical results are summarized in 20, 21 Tables.
The concentrations of contaminants in lake trout and lake whitefish collected from Thunder Bay are similar to those in individuals of the same species collected elsewhere in northern Lake Huron (35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45).
Most fish collected from Thunder Bay contained PCBs in excess of the MDCH's first level of concern, 0.05 ppm. The Department advises that pregnant women, nursing mothers, women who intend to have children, and children under age 15 should not eat more than one meal per week if the fish tissue exceeds 0.05 ppm.
One carp and one walleye, the longest of each species, collected from Lake Besser in 1989 contained more than 0.5 ppm of PCBs, and five of the whole carp collected from Lake Besser in 1993 exceeded that level also. Five of the brown trout collected in 1986, some of the carp collected each year from 1989 through 1992,

the larger of the two channel catfish collected in 1993, one lake trout collected in 1992, and one walleye collected in 1991 contained PCBs above the U.S. FDA Tolerance Level of 2 ppm. The larger channel catfish collected in 1993, some lake trout collected each year from 1992 through 1994, and one walleye apiece in the 1993 and 1995 collections contained chlordane in excess of the MDCH Level of Concern/U.S. Food and Drug Administration (FDA) Tolerance Level of 0.3 ppm. The larger channel catfish collected in 1993, one walleye apiece in the 1989, 1991, and 1995 collections from the bay, as well as one smallmouth bass and one walleye collected from Lake Besser in 1989, all contained mercury above the MDPH Level of Concern of 0.5 ppm. Most of the lake trout collected from 1983 through 1998 and four of the lake whitefish collected in 1998 which were analyzed for chlorinated dibenzodioxins and dibenzofurans all contained the chemicals that, with a combined toxicity expressed as a toxic equivalent of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD), were above the MDCH Level of Concern of 10 parts per trillion (ppt) 2,3,7,8-TCDD equivalent (35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45).

C. Quality Assurance and Quality Control

During the IRIA, analysis of filtered groundwater samples sometimes found higher concentrations of metals than did the analysis of the corresponding unfiltered samples (3). It is not known whether this is due to normal variation between samples or to inadvertent contamination during the laboratory analysis.

The 1983-1988 lake trout dioxin analyses were carried out at three laboratories, one in Sweden (five samples), a U.S. EPA laboratory in Duluth (two samples, 2,3,7,8-TCDD only), and a U.S. EPA laboratory in Research Triangle Park (RTP) North Carolina (this was a replicate analysis of one of the samples analyzed at the Duluth laboratory). The split analyzed at RTP contained the highest concentrations of 2,3,7,8-TCDD, octachlorodibenzodioxin, 2,3,7,8-hexachlorodibenzofurans, octachlorodibenzofuran, total chlorinated dibenzodioxins, and total chlorinated dibenzofurans of all these samples. The 2,3,7,8-TCDD concentration in the RTP split was three times that found in the Duluth split of the same sample. The reported detection limits from the RTP laboratory were higher than the concentrations of the same congeners found in the Swedish laboratory, and 100 times the detection limits reported by the Swedish laboratory.

Before 1989, the analysis of fish collected by the MDNR was carried out at an MDNR laboratory. Since 1989, the fish analysis has been carried out at an MDPH/MDCH laboratory. There was some evidence that the MDNR laboratory analysis was not as reliable as the MDPH/MDCH laboratory analysis.

D. Physical and Other Hazards

The City of Alpena, the Lafarge Alpena plant, and the CKD pile pose no special physical hazards that do not occur in any other towns of similar size, with

comparable industrial facilities, or in areas of similar topography. Lafarge maintains its own security arrangements to deter unauthorized access to its property. The CKD pile is partially fenced, and trespassers have been observed on the pile. The slopes of the CKD pile are generally stable, except for steep bluffs along the southern shoreline where wave action cuts into and erodes the material (3).

PATHWAYS ANALYSES

To determine whether nearby residents are exposed to contaminants migrating from the site, ATSDR evaluates the environmental and human components that lead to human exposure. An exposure pathway contains five major elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and the presence of an exposed population. An exposure pathway is considered a completed pathway if there is evidence that all five of these elements are currently present or have been present in the past. An exposure pathway is considered a potential pathway if one or more of these elements is not known to have been present, but could possibly have been present. An exposure pathway can be eliminated from consideration if one of the elements is not present and could never be present. The following sections discuss the most important exposure pathways at this site.

A. Completed Exposure Pathways

Air

Air sampling has found various chemicals in the air in Alpena which, at times, was at concentrations of human health concern (Table 12). There are many ways by which these chemicals could have entered the air, for example: releases from industrial facilities; emissions from vehicles and other combustion engines; and, household use of products containing volatile chemicals. The air in many other cities in the U.S. contains similar concentrations of many of these chemicals (46, 47).

Current and former residents of Alpena have reported a history of cement kiln dust (CKD) blowing from what is now the Lafarge Corporation Alpena Plant into the residential areas of Alpena (48). The density of particulate matter less than 10 microns in diameter in the air in Alpena has exceeded the U.S. EPA standard for the annual average concentration in 16 out of approximately 400 samples collected from 4 locations between March 1995 and June 1998 (Table 13) (23, 24, 49).[(12)] Anyone living in or visiting Alpena and breathing the air would be exposed to these chemicals.

Soil

Alpena - residential areas

The surface soil in Alpena contains some chemicals at concentrations potentially of human health concern (Tables 7, 8, 9). Many of these chemicals are also found at similar concentrations in the soil in many other American cities (51). There are many possible sources for these chemicals, including: deposition of cement dust from what is now the Lafarge Corporation Alpena Plant; deposition from other airborne sources; transportation of soil from contaminated areas; paint and chemicals flaking from walls and other objects; and, consumer use of household chemicals. People living in or visiting the city might be exposed to the chemicals in the soil by direct contact, ingestion, or inhalation of fugitive dust.

Cement Kiln Dust (CKD) pile

The CKD in the pile east of the Lafarge plant contains various metals at concentrations potentially of human health concern (Table 6). The pile is partially fenced; however, trespassers on the pile have been observed. The nearest residential area to the pile is to the west, with the Lafarge plant in between. The pile's topography attracts motorcycle and off-road vehicle users. Any access to the pile is not likely to be frequent or prolonged. Children of the age likely to be subject to pica behavior are not likely to be on the pile. Trespassers might be exposed to the dust by dermal contact, incidental ingestion, and inhalation of fugitive dust.

Fugitive dust from the CKD pile might blow onto neighboring parcels, including Thunder Bay, the Lafarge plant and quarry, the public road running across the Lafarge property, and recreational parcels to the east. Workers at the plant and quarry as well as people using the road might come into dermal contact with, incidentally ingest, or inhale the dust from the pile. Strong easterly winds might carry the dust from the pile past the Lafarge plant into the City of Alpena. In addition, grinding, transport, and other operations at the Lafarge plant have released large amounts of CKD into the air, where winds can carry it onto neighboring properties. Lafarge has implemented procedures to reduce the release of CKD, although some is still released.

Surface Water

CKD is blown over Thunder Bay from the Lafarge plant and from the piles near the plant by the wind. CKD settles into the water. The CKD in the piles and on the land surface elsewhere by the bay shore is washed into the water by runoff after rains. Groundwater that has leached chemicals out of the CKD discharges into the bay. Water-soluble chemicals in the CKD and suspended CKD particles can be transported through the water to drinking water intakes. As mentioned above, the Alpena City water system takes water from Thunder Bay, approximately 3 miles southwest of the Lafarge plant (Figure 2). It seems unlikely that bay water from the area offshore from the plant would reach the city water intake. The major water inlet to the bay, the Thunder Bay River, is located between the plant and the intake.

Flow out of the river would probably divert any water migrating from the plant toward the intake to the southeast, toward the mouth of the bay. However, it is possible that there are other private, unrecorded drinking water intakes on the north shore of Thunder Bay. People using the bay near the CKD pile for recreation, swimming, boating, fishing, water skiing, and similar activities, might incidentally ingest water from the bay.

Thunder Bay Fish

Fish living in Thunder Bay near the CKD pile might ingest contaminated water or biota that has lived in sediments contaminated by water or airborne dust from the CKD pile. Contaminants thus ingested might be absorbed into the fish's tissues. If the fish are caught and eaten by humans, the consumer might be exposed to the contaminants. The fish in Thunder Bay, Lake Huron (as a whole), and Lake Besser do contain contaminants (Tables 20, 21), but there is no available evidence to connect this contamination with the CKD pile. The MDCH has issued advisories that people are to restrict their consumption of several species and sizes of fish taken from Thunder Bay, Lake Huron, and all inland lakes in Michigan[13] including Lake Besser. This information is summarized in Table 2 (9).

B. Potential Exposure Pathways

Groundwater

The groundwater under the CKD pile east of the Lafarge plant is contaminated with various metals at concentrations exceeding U.S. EPA MCLs and other health-based criteria (Table 5). The CKD in the pile extends below the water table. The closed CKD landfill in the Wessel Road Quarry northwest of the plant has no liner, and the former quarry used for the landfill extended below the water table. The quarry had been filled with water before the CKD was deposited there. The creek that had fed that pond still feeds another pond in the north end of the quarry (5). Groundwater seeps into the active quarry currently used as a CKD landfill, and it needs to be continually pumped from the quarry to prevent the water from coming into contact with the CKD. Rainwater and groundwater seeping through the CKD might dissolve various metals from the dust. Groundwater in the area of the CKD pile by the lakeshore flows to the south, southeast, or southwest, directly into Thunder Bay (3). Currently there are no producing wells in the area of the contaminated groundwater or downgradient between the pile and the bay. It is unlikely that such a well could be installed in the future. Alpena County has a well permitting program which began in January 1998. The Alpena municipal water system takes its water from Thunder Bay, approximately 3 miles southwest of the CKD pile (Figure 2). In addition, there may be surface water intakes on Thunder Bay east of the CKD pile that do not appear in any official records. See the "Surface Water" subsection under "Completed Exposure Pathways" above for a more complete discussion of this pathway.

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1. ATSDR > Public Health Assessments & Consultations

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

The primary benchmarks against which exposures are evaluated for their potential for causing non-cancer adverse health effects are the Minimal Risk Levels (MRLs), developed by ATSDR, and Reference Doses (RfDs) and Reference Concentrations (RfCs), developed by the U.S. EPA. It is generally accepted that a person exposed to a dose of a chemical less than an MRL, RfD, or RfC is not likely to experience noncancerous adverse health effects. The MRLs, RfDs, and RfCs are lower than the observed threshold exposures, with safety factors included to allow for different responses between species and between individuals. However, these values may not be protective for individuals who are hypersensitive to chemical exposures, including the very young, the very old, individuals whose bodies are under stress from illness, and individuals who have an allergic response to the chemical.

When MRLs, RfDs, and RfCs are not available, the threshold exposures may be used to evaluate the risk of actual exposure. The threshold exposures include Lowest Observed Adverse Effect Levels (LOAELs) and No Observed Adverse Effect Levels (NOAELs). In a given experiment, with exposure route, species, and health effect specified, the LOAEL is the lowest exposure at which an adverse effect was observed, and the NOAEL is the highest exposure at which no effect was observed.

For chemicals which may cause cancer, the risk is evaluated in a different manner from non-cancer health risks. As described above,[(14)] the risk of contracting cancer is generally presumed to have no threshold exposure levels. That is, any exposure to a cancer-causing chemical poses some increased risk of contracting the disease in one's lifetime. The risk from any exposure is estimated by multiplying the

exposure by published potency factors. The potency factors are derived from laboratory or epidemiological data using various mathematical models to yield an upper bound for the actual risk, which might be much lower and even zero. For this assessment, the risk of cancer is considered significant if it is estimated that a lifetime exposure to the chemical under the circumstances specified would result in one extra case of cancer among 1,000,000 people exposed.

Exposure doses for this assessment are computed using the following standard assumptions (52):

1. an adult weighing 70 kilograms (154 pounds) who drinks 2 liters (approximately 2 quarts) of water, incidentally ingests 100 milligrams of soil, and breathes in 23 cubic meters of air each day
2. a 10-year-old child who weighs 30 kilograms (66 pounds), drinks 1 liter (approximately 1 quart) of water, incidentally ingests 100 milligrams of soil, and breathes in 15 cubic meters of air each day
3. an infant weighing 10 kilograms (22 pounds) who drinks 1 liter (approximately 1 quart) of water, incidentally ingests 200 milligrams of soil, or, if subject to pica behavior,(15) deliberately ingests 5,000 milligrams of soil, and breathes in 3.8 cubic meters of air each day.

Exposure doses due to dermal absorption from soil are estimated using the standard exposure values for dermal exposure in Reference 52, Appendix D, Exhibit D.6, and the recommended absorption factor values from Reference 53.

The environmental concentrations used in these evaluations are the maximums found in each medium, a reasonably conservative assumption. For media in which data are available over a period of time, the maxima will be compared with acute and intermediate-term exposure MRLs. The medians over time will be compared with chronic exposure MRLs and RfDs and will be used to estimate cancer risks.

Ambient Air

The concentration of benzene in the air samples collected during both sampling periods consistently exceeded the ATSDR CREG; however, they were less than the EMEG for intermediate-term exposure of 15-364 days (Table 12) (23, 24). The concentrations were within the range typically found in air in urban areas (Reference 46, Table 5-2), primarily due to evaporation from gasoline. The observed concentrations were considerably below the levels at which any adverse health effects have been observed in epidemiologic studies of humans or laboratory studies of animals (46).

The concentration of bromomethane in one sample collected from North Point on December 11, 1995, slightly exceeded the EMEG (or MRL) for chronic exposure, but not the EMEGs/MRLs for acute or intermediate-term exposure (both 190 $\mu g/m^3$) (Table 12). Bromomethane was only found in samples collected on four sampling days out of a total of 78 in either sampling period (23, 24). Therefore, the

documented potential exposure was for only a short period, and the intermediate-term exposure MRL is the appropriate standard. It is not likely that anyone would incur any adverse health effects from the bromomethane in the air. There is no evidence available linking bromomethane exposure to cancer (54).

Carbon tetrachloride was only occasionally found in the 1995-1996 samples; however, it was consistently found in the 1997-1998 samples at concentrations above the CREG but below the EMEGs for acute or intermediate-term inhalation exposure (there is no EMEG/MRL available for chronic inhalation exposure). The concentrations were within the range typically found in urban or rural areas. There are no natural sources for carbon tetrachloride. It is currently primarily made as an intermediate stage in the production of other chemicals. However, it was widely used in the past in household products such as cleaning fluids and pesticides. The chemical is highly volatile and breaks down very slowly in the environment. It is now found in the air all over the world whether there are nearby sources or not. The concentrations observed in the air in Alpena were considerably lower than those at which adverse health effects have been observed to occur (55).

The hepta-, and octachloro- dibenzodioxins and dibenzofurans found in many air samples in the 1995-1996 sampling are among the least toxic of the congeners, from 100 to 1,000 times less toxic than 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD), considered the most toxic of the class. Only one sample, collected on April 15, 1995, at Lincoln School, contained 2,3,7,8-TCDD. However, the measured 2,3,7,8-TCDD concentration did not exceed the CREG. Toxicity Equivalency Factors (TEFs) are used to derive 2,3,7,8-TCDD Toxic Equivalents (TEQ) for the concentrations of dioxins and furans detected in the air. A TEQ is greater than the CREG for the sample collected on April 15, 1995 only (23). There are no specific data available on adverse health effects from inhalation of chlorinated dibenzodioxins and dibenzofurans. The CREG used in this document was derived from a U.S. EPA-published unit risk for inhalation of a mixture of hexachlorodibenzodioxins which was derived in turn from data on oral exposure of laboratory animals (56). Applying similar assumptions to these data indicates that the doses of dioxins and furans that people in Alpena would have experienced from breathing the air between March 1995 through March 1996 would not likely have equaled the MRLs for oral exposure and would have been much less than the doses at which adverse health effects have been observed in epidemiological studies of humans or laboratory studies of animals. Some people exposed to chlorinated dibenzofurans and some laboratory animals fed chlorinated dibenzodioxins developed liver cancer at increased rates. The U.S. EPA has classified mixtures of hexachlorodibenzodioxins as probable human carcinogens (U.S. EPA Class B2). The International Agency for Research on Cancer has determined that 2,3,7,8-TCDD can cause cancer in humans. The U.S. Department of Health and Human

Services has determined that it is reasonable to expect that 2,3,7,8-TCDD can cause cancer (57, 58). However, because the documented exposure period to the most toxic dioxins was very short, any increased risk of contracting cancer from exposure to dioxins or furans in the air of Alpena is unlikely.

The maximum concentrations of chloroform, 1,2-dichloroethane, methylene chloride, 1,1,2,2-tetrachloroethane, trichloroethylene, and vinyl chloride found in these air samples exceeded their respective CREGs, though they did not exceed their EMEGs, RfCs, or LOAELs for non-cancer health effects (Table 12) (30, 59, 60, 61, 62, 63). Benzyl chloride, dibenzo(a,h)anthracene, 1,4-dichlorobenzene, and nickel were also detected at concentrations below their EMEGs, RfCs, or LOAELs for non-cancer health effects and are considered to be carcinogens, but there are no CREGs available for inhalation exposure (47, 56, 64, 65). However, all these chemicals only exceeded the CREGs, or were detected at all, in a very few samples collected during the two sampling periods (23, 24). The average concentrations were probably much less than the CREGs, and no resident of Alpena would be likely to incur any apparent increased risk of contracting cancer from their exposure to these chemicals in the air.

For other chemicals detected in the air of Alpena, there are no health standards available to evaluate the risk of adverse health effects from exposure by inhalation. There may be no data available relating inhalation of a chemical to adverse health effects. As described above for dioxins and furans, the health risks from inhalation of a chemical could be extrapolated from information on health effects from ingestion of the chemical. However, there are uncertainties about the relative efficiency of absorption through the lungs compared to the gastrointestinal tract. Assuming that chemicals are absorbed from the lungs as efficiently as from the gastrointestinal tract, no one was likely to breathe in enough acenaphthene, anthracene, barium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chlorobenzene, chrysene, 1,2-dichlorobenzene, dichlorodifluoromethane, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, pyrene, 1,2,4-trichlorobenzene, trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, or zinc from the air in Alpena between March 1995 through March 1996, or May 1997 through May 1998, (Table 12) to exceed ATSDR MRLs, U.S. EPA RfDs, or to incur any apparent increased risk of contracting cancer (23, 24,47, 56, 66, 67, 68, 69).[(16)]

There is no information available on the health effects from inhalation or ingestion of acenaphthylene, 1-ethyl-4-methylbenzene, 2-methylnaphthalene, perylene, phenanthrene, 1,2,4-trimethylbenzene, or 1,3,5-trimethylbenzene (31, 47, 56, 70).

The above discussion addresses the large number of airborne chemicals on an individual basis. People living in Alpena are likely to have been exposed to all or some of the chemicals simultaneously. The health effects from exposure to various

mixtures might differ from the exposure to the individual chemicals, either in the magnitude of toxic response or in the type of response. The health risk from exposure to a mixture of chemicals that act on the body by similar mechanisms might be proportional to the total concentration of the mixture rather than the concentrations of the individual components. The health risk based on the total concentrations of several families of chemicals, such as PAHs and chlorinated straight-chain hydrocarbons (*e.g.*, carbon tetrachloride, chloroform, 1,2-dichloroethane, and trichloroethylene), are estimated to be relatively low.

It is possible that chemicals might also interact and cause the following: increase the risk above that which was calculated by addition of individual chemical risks; decrease the risk; or, generate an adverse health effect that the individual chemicals do not produce. There is very little information available on such interactions.[(13)] The generally low concentrations of the chemicals found in the air in Alpena suggests that such synergistic or antagonisitc effects are not likely to occur. The molecules of the two chemicals are not likely to meet or reach the target organ within the time range necessary to produce the enhanced or subdued reaction.

Particulate Matter

Particulate matter in the air can cause inflammation of the lungs and aggravate asthma when inhaled. Very fine particles, such as those 2.5 µm and smaller, may pose a greater risk than larger particles. Some epidemiologic studies indicate that there is no threshold level for these effects, and that they may occur to some extent whenever there are particles in the air. There have been few direct studies of the health effects of air containing concentrations of particles similar to those found in Alpena. The conclusion that there is no threshold is based on data from studies of incidents of much higher particle concentration. The particle concentrations measured in Alpena air did not exceed the current U.S. EPA standards (49). The U.S. EPA has proposed a revision to the standards, specifically setting standards for fine particles smaller than 2.5 µm in diameter (50).

In addition, the available data for Alpena is total suspended particulates and particulate matter less than 10 µm in diameter. It is not possible to estimate the concentration of fine particles in the air from this data, beyond the obvious conclusion that the concentration of the particles smaller than 2.5 µm is going to be less than the total concentration or the concentration of particles smaller than 10 µm. The MDEQ plans to install a monitor to measure the concentration of particulate matter less than 2.5 µm in Alpena.

Surface Water

The analysis of the surface water samples collected from Thunder Bay at the shore of the CKD yielded distinctly different results between the total concentrations of metals in unfiltered samples and the concentrations of dissolved metals in filtered samples. The unfiltered samples contained a wide range of metals, some at

concentrations above ATSDR Comparison Values and U.S. EPA MCLs. The only metal that was found in the filtered samples was aluminum, which was found at lower concentrations than in the unfiltered samples (Table 5). It appears that the majority of the metals found in the unfiltered samples were bound in the suspended particles which were removed by the filtering process. It can be argued that the dissolved concentrations are most relevant to human health considerations. The metals bound in the particles are likely to be in compounds that are not soluble in water, and therefore are not likely to be absorbed in the intestines should anyone drink the water. On the other hand, the stomach generates some fairly strong acid, which might leach out some metals that had remained in the particles and thereby liberate the metals for absorption. As a conservative assumption, we will consider exposures based on the total concentrations of the metals in the water.

The most likely exposure to the water directly offshore from the CKD pile is going to be recreational, boaters, anglers, swimmers, water skiers, and the like. Any ingestion of lake water by these people is going to be incidental and infrequent. They are not likely to ingest as much of any of the metals found in the water as has been observed to cause adverse health effects. The measured pH of the water from the bay did not exceed the level at which skin contact is considered hazardous (14). The only known drinking water intake on Thunder Bay is approximately 3 miles southwest from the CKD pile. It is possible that there are other private intakes along North Point east of the CKD pile. These possible intakes would be 1 mile or more east of the CKD pile. It is likely that the metals at the CKD pile would be diluted and dispersed to below the MCLs before they would reach the possible intakes. In addition, the Thunder Bay River flows into the bay between the CKD pile and the Alpena municipal water system intake. The cross current from the river's flow is likely to help prevent water from the area of the CKD pile from reaching the municipal water intake.

Municipal Water System

On March 22, 1995, as seen in Table 17, the concentration of chloroform, and hence the total trihalomethane concentration, in Alpena city water exceeded both the MCL and ATSDR's EMEG for chloroform. The concentration of chloroform and other trihalomethanes in the water on other days was generally much lower than the MCL and EMEGs. A child drinking the water on March 22, 1995, might have ingested enough chloroform to slightly exceed the MRL for chronic exposure, though he or she would not be likely to ingest enough to exceed the acute or intermediate-term MRLs. No one would have been likely to ingest enough chloroform or other trihalomethanes from the city water to incur any adverse non-cancer health effects. A lifetime of drinking water containing the amounts of chloroform and other trihalomethanes found in Alpena city water is not likely to result in any apparent increased risk of contracting cancer (30, 32, 33).

No other chemical was found in the city drinking water at concentrations that exceeded U.S. EPA MCLs or MDEQ Generic Clean-up Criteria (Table 17) (11, 13).

Alpena Soils

No one is likely to ingest as much arsenic from the soil on the site as has been observed to cause adverse health effects.[17] A lifelong resident of Alpena might incidentally ingest enough arsenic from the soil to incur a low increased risk of contracting cancer (28). Nonetheless, arsenic in these soils is not considered a health hazard because it is unlikely that constant or even frequent contact with the localized areas of contamination will occur, especially since the area soils are usually covered with snow for several months of the year.

A child subject to pica behavior might ingest enough cadmium each day from the soil in some areas of Alpena to exceed the MRL for chronic exposure (there are no MRLs available for acute or intermediate-term ingestion of the metal). However, he or she would not be likely to ingest as much of the element as has been seen to cause adverse health effects in humans or animals. Some laboratory animals whose food contained high concentrations of cadmium developed cancer of the prostate or leukemia. There is some inconclusive evidence from studies of workers who breathed cadmium dust in their employment that links exposure to cadmium with cancer of the lungs and of other organs. Some laboratory animals who breathed air containing cadmium compound dusts developed lung cancer at higher rates than animals not exposed to cadmium. The U.S. EPA has classified cadmium as a probable human carcinogen (U.S. EPA Class B1). There is not sufficient information available about cadmium to evaluate the increased risk of contracting cancer after ingesting the element (71).

Chromium is found in the environment primarily in compounds, rather than as the pure metal. When chromium combines with other elements, it may end up in any of several oxidation or valence states, the most common of which are trivalent (or chromium(III)) and hexavalent (or chromium(VI)). Chromium in the trivalent state is an essential nutrient. Trivalent chromium compounds are practically nontoxic except when ingested in extremely large amounts. Exposure to the trivalent compounds has not been linked to cancer. Hexavalent chromium compounds can irritate the skin on contact, can irritate the respiratory tract when breathed in, and can damage the kidney and liver when ingested in large amounts. Workers who breathed hexavalent chromium compounds developed lung cancer more often than workers who were not exposed to the compounds. Trivalent chromium compounds are more common in the environment. Naturally-occurring chemical reactions tend to convert hexavalent chromium compounds to trivalent chromium compounds. The analyses cited in this assessment reported the concentrations of all chromium found in the samples, and did not distinguish between or identify the valence levels

found. A child subject to pica behavior might ingest enough chromium from the soil in a day in some residential areas of Alpena to exceed the RfD for chronic ingestion of hexavalent chromium (there are no MRLs available for acute or intermediate-term ingestion of the metal). No one would be likely to ingest more chromium from the soil than has been observed to cause adverse health effects in epidemiologic studies of humans or laboratory studies of animals exposed to compounds of the metal in either valence state. It is not likely that anyone would come into contact with as much hexavalent chromium compounds in the soil in Alpena as has caused dermal reactions in humans or laboratory animals. There is not enough information available on chromium to evaluate the risk of developing cancer after ingesting hexavalent chromium (29).

No one is likely to ingest as much copper in a day from the soil in Alpena as has been seen to cause adverse health effects in epidemiologic studies on humans or laboratory studies on animals. Ingestion and other exposure to copper has not been linked to cancer (72).

After high concentrations of lead, up to 2,600 ppm, were found in soil samples collected on the Lincoln School grounds in late 1992 (Tables 8 and 10), that soil was removed and disposed of properly. The concentrations of lead in soil samples collected from residential areas of Alpena in other sampling rounds (up to 595 ppm, Tables 7, 8, 9) were similar to the concentrations typically found in smaller urban areas. The lead in these areas is generally attributed to the historic use of gasoline and house paints that contained lead. Some children living in areas where the lead concentrations in the soil are similar to those found in Alpena have been found to have elevated amounts of lead in their blood, bones, and other organs of their bodies. Children can ingest lead from several sources over the same time period. Soil lead levels in the range found in Alpena generally do not pose any health hazard unless interior house dust or paint in the child's residence also contain high concentrations of the metal. Because lead tends to accumulate in the body, many cities, counties, and states have programs to monitor the lead levels in the blood of children in areas where similar levels of lead might be expected in the soil or the housing is old enough that lead-based interior paint is likely to be present (51). The incidence of adverse health effects related to exposure to lead is not likely to be higher in Alpena than in other urban areas. The MDCH and the district health department serving Alpena both have programs in place to monitor children's blood lead levels and to address the potential health problems from childhood lead exposure.

The concentrations of mercury found in Alpena soil samples were within the range found in background soil samples in Michigan (15). There are no MRLs or RfDs available for ingestion of mercury in general, though there are comparison values for a few specific mercury compounds, including mercuric chloride,

methylmercury, and phenylmercuric acetate. No one is likely to ingest enough mercury from the soil in Alpena to exceed the MRLs or RfDs for these mercury compounds. No one is likely to ingest or absorb through the skin as much mercury from the soil in Alpena as has been observed to cause adverse health effects in epidemiological studies of people or laboratory animal studies. Some laboratory animals whose food contained high concentrations of mercury compounds developed cancers of the stomach (mercuric chloride) or kidneys (methylmercuric chloride, phenylmercuric acetate). The U.S. EPA has classified methylmercury compounds as possible human carcinogens (U.S. EPA Class C) and has decided that inorganic mercury compounds are not classifiable as to their carcinogenicity (U.S. EPA Class D). There is not sufficient information available to evaluate the cancer risk from exposure to mercury (73). The incidence of adverse health effects related to exposure to mercury is not likely to be higher in Alpena than elsewhere in Michigan.

No one is likely to ingest as much nickel in a day from the soil in Alpena as has been seen to cause adverse health effects in epidemiologic studies on humans or laboratory studies on animals. Some workers in nickel refineries and sintering plants who breathed dusts and fumes containing nickel and nickel-containing compounds developed cancers of the lungs and nose. Some laboratory animals who breathed air containing nickel oxide or nickel subsulfide (Ni_3S_2) dust developed lung and adrenal cancer. The U.S. EPA has classified nickel refinery dust and nickel subsulfide as known human carcinogens (U.S. EPA Class A) by the inhalation route. There is not sufficient evidence available to determine whether ingestion of nickel or nickel compounds is related to cancer (64).

A child subject to pica behavior might ingest enough zinc each day from the soil in some areas of Alpena to exceed the MRL for non-cancer adverse health effects on chronic or intermediate-term exposure (there is no MRL available for acute exposure). However, he or she would not be likely to ingest as much zinc in a day from the soil as has been observed to cause adverse health effects in epidemiological studies of humans or laboratory animal studies over any duration. Zinc is also an essential nutrient. There is no evidence linking exposure to zinc with cancer (67).

Soils - Cement Kiln Dust pile

No one is likely to spend so much time on the cement kiln dust pile east of the Lafarge Alpena plant that they would incidentally ingest soil, absorb through the skin, or inhale fugitive dust containing so much of any of the metals found in the cement kiln dust which exceeds any health-based standards for any relevant term of exposure. No one is likely to be exposed to metals at levels of contaminants that have been observed to cause adverse health effects in epidemiologic studies of

humans or laboratory studies of animals (28, 29, 31, 51, 56, 64, 67, 68, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80).

The very high alkalinity of the CKD, reflected in the high pH of water in contact with the material, can cause irritation and even corrosion of skin it comes into contact with when wet (14).

Thunder Bay Fish

To evaluate the potential human health hazards from consuming fish from Thunder Bay, we assume the maximum concentrations of the contaminants found (a conservative assumption) in edible-portion (fillet) samples, since humans rarely eat fish without cleaning them. Our standard meal will be 0.5 pound (227 grams) of fish, eaten 4 times a week to represent a person who uses the fish as a major part of their diet.

Several of the contaminants found in fish from Thunder Bay are considered probable human carcinogens: chlordane, chlorinated dibenzodioxins and dibenzofurans, and polychlorinated biphenyls (PCBs). As mentioned above, any exposure to a carcinogen is usually presumed to increase one's risk of contracting cancer by a finite amount, and health agencies frequently differ as to what increased cancer risk is considered acceptable or how the risk is to be calculated. A person who follows the MDCH Sportfish Consumption Advisories might ingest as much of these carcinogenic contaminants as the ATSDR considers to pose a "moderate" increased risk of contracting cancer (57, 58, 81, 82).

A person eating Thunder Bay catfish as a major portion of their diet might ingest enough chlordane to exceed the MRLs for non-cancer adverse health effects on acute, intermediate-term, or chronic exposure, although they would not be likely to ingest as much chlordane has been observed to cause adverse health effects in epidemiologic studies of humans or laboratory studies of animals. Some laboratory animals whose food or water contained chlordane developed liver cancer. The U.S. EPA has classified chlordane as a probable human carcinogen (U.S. EPA Class B2). A lifetime of subsistence eating of fish containing the chlordane concentration found in Thunder Bay catfish might result in a high increased risk of contracting cancer (81).

A person eating lake trout or lake whitefish from Thunder Bay (or from anywhere in Lake Huron) as a major portion of their diet might ingest enough chlorinated dibenzodioxins and dibenzofurans to exceed the MRLs for non-cancer adverse health effects on intermediate-term or chronic exposure, although they would not be likely to ingest as much of the chemicals as has been observed to cause adverse health effects in epidemiologic studies of humans or laboratory animals. Some laboratory animals whose food or water contained chlorinated dibenzodioxins developed cancers of the liver, thyroid, lung, and palate. The U.S. EPA has classified chlorinated dibenzodioxins as probable human carcinogens (U.S. EPA

Class B2). A lifetime of subsistence consumption of lake trout or lake whitefish from Thunder Bay, or anywhere in Lake Huron, might result in a high increased risk of contracting cancer from the chlorinated dibenzodioxins ingested (57, 58).
Mercury in fish is most likely to be in an organic compound. A person eating smallmouth bass, walleye, or catfish from Thunder Bay or Lake Besser as a major portion of their diet might ingest enough mercury to exceed the MRLs for adverse non-cancer health effects from acute or intermediate-term ingestion of organic mercury compounds (there is no MRL for chronic ingestion available), although they would not be likely to ingest as much of the metal as has been observed to cause adverse health effects. Some laboratory animals whose food contained high concentrations of mercury compounds developed cancers of the stomach (mercuric chloride) or kidneys (methylmercuric chloride, phenylmercuric acetate). The U.S. EPA has classified methylmercury compounds as possible human carcinogens (U.S. EPA Class C) and has decided that inorganic mercury compounds are not classifiable as to their carcinogenicity (U.S. EPA Class D). There is not sufficient information available to evaluate the cancer risk from exposure to mercury (73).
A person who eats channel catfish or carp from Thunder Bay might ingest as much PCBs each day, body weight for body weight, as has been observed to affect the immune system, liver, blood, and the development of the young in laboratory animals whose feed contained PCBs for a year or more. A person who follows the consumption advisories in the last column of Table 2 would not be likely to ingest enough PCBs to exceed the MRLs or RfD for non-cancer adverse health effects.
Some laboratory animals whose feed contained PCBs developed cancer of the liver. The U.S. EPA has classified PCBs as probable human carcinogens (U.S. EPA Class B2). A person who eats catfish from Thunder Bay as a major part of his diet for his lifetime might ingest enough PCBs to incur a very high increased risk of contracting cancer (82).

B. ATSDR Child Health Initiative

As shown in Table 1, approximately 25% of the population of Alpena was under 17 years of age and approximately 6% was under 4 years of age according to the 1990 U.S. Census. These children are included in the population considered in the "Soil - Alpena residential," "Ambient Air," and "Surface Water - Municipal Water" exposure pathways.
Children can be particularly vulnerable to environmental toxicants. Some unique vulnerabilities of children to environmental toxicants in general are discussed below.
Before birth, children are forming the body organs that need to last a lifetime. This is the time when chemical injury may lead to serious adverse health effects. Injury during key periods of growth and development may lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the

mother may lead to exposure of the fetus, via the placenta, or may affect the fetus because of injury or illness sustained by the mother (83).

After birth, children may have greater exposures to environmental toxicants than adults. Pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults. For example, children in the first 6 months of life drink 7 times as much water per pound as the average adult living in the United States. Two characteristics of children further magnify their exposures to toxicants in the environment: (1) play activities close to the ground, which increase their exposure to toxicants in dust and soil plus toxicants in airborne particulate matter, and (2) typical hand-to-mouth behavior, which increases intakes of any toxicants. In addition, teenagers may accidentally wander or deliberately trespass onto or into restricted locations. The obvious implication for environmental health is that children can experience substantially greater "doses" than adults to toxicants that are present in soil, water, or air. This fact has been demonstrated very clearly for children's exposures to pesticides in the diet (83).

Lead and mercury, two chemicals of concern in this assessment, have been seen to interfere with the neurological and mental development of young children. The documented concentrations of lead and mercury in the soil in Alpena (Tables 7, 8, 9) are comparable to those typically found in urban areas (51, 73). The MDCH and the district health department serving the city have programs in place to monitor the levels of lead in children's blood and to address the potential health effects from exposure to lead.

C. Health Outcome Data Evaluation

In 1993, in response to a request from the Health Officer and Medical Director of the District Health Department serving Alpena County, the Michigan Department of Public Health Division of Health Statistics reported that the total rate of death from cancer of all kinds in Alpena County during 1991 was not significantly higher than the rate in the State as a whole (84). Data from 1992-1994 supports this conclusion (85). This very preliminary analysis is limited, because it is based on only one or a few years of data. Countywide statistics may not identify more localized areas where cancer incidence may be high, and statistics on the rates of incidence of cancer may not identify specific kinds of cancer that may occur at high rates.

Residents of the City and the County of Alpena have expressed concern about the occurrence of cancer, asthma, and birth defects, among other adverse health effects, in their communities. The MDCH, Environmental Epidemiology Division, Site Assessment Section obtained Alpena health outcome data from the MDCH Division for Vital Records and Health Statistics (Vital Records). Vital Records compiled cancer incidence data from the Michigan Cancer Registry and mortality data from the Michigan Resident Death Files. In addition, Vital Records compiled

asthma-related hospitalization data from the Michigan Inpatient Database and birth defect data from the Michigan Birth Defect Registry. They provided data for Alpena County as a whole and for the postal ZIP code that contains the City of Alpena (49707).

Cancer

MDCH Vital Records Division provided the numbers of cases of cancer and deaths involving cancer occurring in 20 commonly-affected organs between 1985 through 1995 in both Alpena County and the zip code that contains the City of Alpena (49707). The numbers of cases and deaths were compared with those that occurred in the State of Michigan over the same period, adjusting for the population, age, sex, and racial characteristics of the county or ZIP code area. The ratios between the numbers of cases or deaths that were found to those which are found in a similar population in the state as a whole are referred to as the standardized incidence ratios (SIR) and the standardized mortality ratios (SMR), respectively. The SIR and SMR calculations showed that incidence and mortality rates for cancers of 20 commonly-affected organs did not increase over time and were generally less in Alpena County than in the State of Michigan as a whole during the time period. However, the occurrence of cancers of the rectum or cervix did appear to be more frequent in the county during part of the time under investigation. The SIRs for rectal cancer in the county or ZIP code were statistically significantly above 1.0 in 1986 and 1987. During 5 other years, the SIRs for rectal cancer exceeded 1.0 but were not of statistical significance. MDCH Vital Records Division reviewed the records and determined that the apparent incidence of these cancers was falsely elevated due to misdiagnoses during those years. Colon cancers are commonly misdiagnosed as rectal cancers. Therefore, rectal and colon cancers are often combined into one category for investigation purposes. Despite the difficulty of misdiagnosis, the MDCH Vital Records will monitor rectal cancer SIRs for Alpena County annually. Colorectal cancer SIRs and SMRs in Alpena County and ZIP code 49707 were significantly greater than 1.0 during 1987 only, and did not increase over the eleven-year period.

Alpena County and ZIP code 49707 SIRs for cervical cancer were significantly greater statistically than 1.0 during 1985 and 1988 only, and showed no significant trends over the period. MDCH Vital Records Division reviewed the records and determined that the reported incidences of these cancers were also inflated due to misdiagnosis. Pre-invasive cervical disease is frequently misdiagnosed as cervical cancer. The SIRs were not significantly above 1.0 during any year using the corrected statistics.

Analysis of cancer incidence and mortality data does have limitations. The Michigan Resident Death Files and the Michigan Cancer Registry data from before 1985 are not as reliable as later data. Therefore, time trends in cancer incidence and

mortality cannot be determined before 1985. Also, for uncommon cancers, SMRs or SIRs can be greater than one but not statistically significant. This makes it difficult to decide if certain elevated SMRs or SIRs are associated with environmental exposures or are due to chance alone.

Asthma

The 1996 asthma-related hospitalization rate for Alpena County residents was lower than the 1996 hospitalization rate for residents of the entire State of Michigan. The rate was lower for county residents than in the state as a whole for each age group: 0-14 years, 15-44 years, 45-64 years, and 65 years and older. The data from the Michigan Inpatient Database is categorized by the home address of the patient and not by location of the hospital. Therefore, hospitalizations of Alpena County residents outside Alpena County are still attributed to Alpena County.

Analysis of asthma-related hospitalization data also has limitations. Asthma-related hospitalizations are dependent on many variables other than environmental exposures. Physicians from various geographical locations differ in their definition and treatment of asthma, and their tendency to hospitalize patients with asthma. This results in variable hospitalization rates due to case management rather than environmental exposures.

Birth Defects

The number of Alpena County residents born from 1992 through 1996 who were diagnosed with one or more specified defects before their second birthday was compared with the number of similar birth defects that occurred over the same time period in a population of similar size, maternal age, and sex of white Michigan residents. Again, if the ratio of observed to expected birth defects is approximately equal to 1.0, the specific birth defect or group of birth defects does not occur more or less frequently in Alpena County than in the State of Michigan as a whole. A ratio of observed to expected birth defects greater than 1.0 indicates that the birth defect or group of birth defects was more common in Alpena County than in the State of Michigan as a whole. Similarly, a ratio of observed to expected birth defects that is less than 1.0 indicates the birth defect or group of birth defects was less common in Alpena County than in the State of Michigan as a whole. All reportable birth defects combined and all reportable congenital anomalies combined were less common in Alpena County residents than in residents of the State as a whole. Each reportable anomaly, classified by organ system, and each specific major congenital anomaly either did not occur at all, was less common, or was only slightly more common, but not beyond chance occurrence, in the county than in the state over that time period.

Analysis of birth defect data has limitations similar to those of cancer data. The Michigan Birth Defect Registry was established in 1992. Therefore, trends in birth

defect numbers and rates cannot be determined before 1992. Also, because birth defects occur infrequently, elevations in birth defect numbers are seldom statistically significant. This makes it difficult to determine if certain elevated birth defect numbers or rates are associated with environmental exposures or are due to chance alone.

The available health outcome data does not indicate any readily apparent increases of cancer, asthma, or birth defects in Alpena County compared against the State of Michigan as a whole. The incidence of rectal cancer in the county appeared to be high in 2 years, 1986 and 1987, of the 11 years investigated. It can be difficult to distinguish colon cancers from rectal cancers, and medical statisticians and researchers prefer to combine statistics on the two cancer sites. The MDCH will monitor the SIRs for rectal, colon, and colorectal cancer in the county annually.

D. Community Health Concerns Evaluation

A large number of health and environmental concerns have been voiced by community members. The following is a summary of some of these concerns (in **bold face**) followed by MDCH's response. Each concern is listed once; however, some have been expressed as a concern by more than one member of the Alpena community. Other community concerns, as listed in the "Community Health Concerns" section above, will be addressed in future sections of this Public Health Assessment.

Lafarge and other Local Industry

Several concerns have been expressed about the possible harmful contents of the fill material historically provided free of charge to Alpena citizens by Abitibi (now ABT Co.). Citizens have voiced concern that the fill contained fly ash and heavy metals including lead. The possibility of lead poisoning, especially in children, has been raised by the citizens. There may be no complete or accurate record of where in the Alpena area the Abitibi fill material was used, raising concerns about whether all the potentially affected individuals could be identified. Preliminary analysis of data on Abititi fly ash (Table 11) found that though it contained high concentrations of lead compared to the background, the lead concentrations were not of public health concern. The ash did contain arsenic concentrations at levels of public health concern. MDCH will address the health concerns more fully in a separate Health Consultation.

In a comment on the Health Consultation, a citizen noted, "Thunder Bay Manufacturing is not listed in the chart on page RS-15 [of the Health Consultation (Reference 2)]. It is a source of methanol . . . Please refer to toxic release inventories to determine what Thunder Bay Manufacturing contributes to the toxic chemicals in Alpena's air."(8) Our original search of the U.S. EPA's Toxic Chemicals Release Inventory (TRI) database through the Right to Know Network did not return any reports from Thunder Bay Manufacturing in

Alpena. A later search using the Environmental Defense Fund Scorecard World Wide Web site provided the information needed to locate these reports, which are summarized in Table 4 (12, 86).

One concern about the HCl released from Lafarge is that it might combine with formaldehyde from other plants to form phosgene gas (8). We have investigated this possibility, and have found that any phosgene generated by a reaction between hydrogen chloride and formaldehyde in the atmosphere is not likely to contribute any significant increased health risk. Thermodynamic considerations predict that only a very small amount of phosgene would be produced by that mechanism. The reaction between formaldehyde and hydrogen chloride to form phosgene and hydrogen:

$2HCl + H_2CO \longrightarrow 2H_2 + Cl_2CO$

is very endothermic at room temperature, that is, the reaction must absorb energy to occur. The reverse reaction is somewhat more likely to occur, and the ultimate, equilibrium state is going to favor HCl and formaldehyde over phosgene and hydrogen by a significant amount. The final phosgene concentration would be roughly one-millionth that of the hydrogen chloride. That is, if the initial concentration of HCl was 1 part per million (ppm) and the initial concentration of formaldehyde was 0.5 ppm, there would be approximately 1 part per trillion phosgene and 2 parts per trillion hydrogen produced. The OSHA standard for workplace exposure to phosgene is 0.1 ppm, and 2 ppm phosgene in the air is considered Immediately Dangerous to Life and Health (87). The equilibrium phosgene concentration under the conditions cited is approximately 100,000 times lower than the OSHA workplace standard. To produce a phosgene concentration of even 1 per cent of the OSHA workplace standard (0.001 ppm) requires a HCl concentration of at least 1,000 ppm or a formaldehyde concentration of at least 500 ppm, substantially above the levels of Immediate Danger to Life and Health (HCl - 50 ppm, formaldehyde - 30 ppm [87]).

Cancer

A great deal of concern has been expressed about perceived elevated rates of cancer for the general community and for those employed by local industries (2). See above under "Health Outcome Data Analysis" for a preliminary evaluation of the available data on cancer incidence and mortality. More complete and thorough evaluation of available cancer data will be carried out as the Public Health Assessment process continues.

Concerns have been expressed that the State of Michigan Cancer Registry may not capture the number of cancer cases in Alpena because many people have sought treatment outside of the area. The MDCH cancer registry does collect information on the residences of the patients. Its county and health district incidence and mortality statistics are based on the usual place of residence of the

patients, and not on the location of their treatment. There are limits to the reliability of the reports, as stated in MDCH, *Cancer Incidence and Mortality, Michigan 1994*, p. 55:

It is not possible to accurately estimate the completeness of case ascertainment by county. *Consequently, it is recommended that county and health district comparisons of incidence data should be attempted with caution*. Observed differences between counties may be the result of factors other than a true difference in incidence, including: . . . the lack of universal interstate and provincial exchange agreements with most states and Canada to permit the sharing of data. Michigan has developed exchange agreements with Wisconsin, Illinois, Florida, New York, Pennsylvania, California, Ohio, and Indiana under which cases among Michigan residents reported to these registries are forwarded to and added to the Michigan registry of cases. This exchange with the other states resulted in improved reporting generally throughout the state (85).

It can also be noted that the cancer incidence and death rates in Emmet, Saginaw, Washtenaw, or Wayne Counties, the locations of major hospitals that attract patients from Alpena seeking advanced treatment, were not significantly higher than the rates in Michigan as a whole in 1992 through 1994 (85).

More complete and thorough evaluation of available cancer data will be carried out as the Public Health Assessment process continues.

Other Symptoms and Diseases

Citizens have expressed the concern that there may be elevated rates of Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder (ADD/ADHD), Lupus, Multiple Sclerosis (MS), amyotrophic lateral sclerosis (ALS, also known as "Lou Gehrig's Disease"), and Parkinson's Disease in the community, and that these conditions may be related to contaminants in the environment. Some scientists believe that toxins in the environment may disrupt the development of brain processes, which may lead to ADHD. Lead is one such possible toxin. Some animal studies suggest that children exposed to lead may develop symptoms associated with ADHD, but only a few such cases have been found (88). It is wise to use caution when considering why any individual or group has ADD/ADHD, because very little is known about what actually causes ADD/ADHD. There are too many possibilities to determine any single cause and more research is needed.

Several studies have found that exposure to various environmental contaminants might contribute to the development of Parkinson's Disease. No contaminant has yet been firmly identified as a cause, however (89).

According to current research, neither lupus nor MS has been linked to environmental contaminants, though the causes of both diseases are not known. Research is going on to identify the causes of these diseases (90, 91). There is a

high incidence of ALS in Guam and Japan, suggesting that the disease might be related to an environmental toxin. No toxin has yet been connected to any case of ALS; however, the fact that the incidence of ALS is uniform elsewhere in the world tends to argue against an environmental cause. The cause of ALS is also not known at this time, though research is going on to identify the cause or causes (92, 93). Additional information will be made available in the site repository at the Alpena Public Library. Information on ADHD, ALS, Lupus, and Parkinson's Disease may be obtained through the World Wide Web sites listed in the Reference list (88, 89, 90, 92, 93).

Students at one Alpena school are perceived to experience a large number of incidents of seizure disorders. Alpena Public Schools nursing staff have told MDCH staff that they have also noticed an increased incidence of seizure disorders in the last two years among the students at the school in question. They have also observed that the number of students treated for asthma and upper respiratory infection has increased over the past 5-6 years with a concomitant increase in asthma attacks (94).

MDCH is evaluating the relationship between environmental contaminants and asthma or seizure disorders.

More complete and thorough evaluation of available data on other health effects will be carried out as the Public Health Assessment process continues.

Miscellaneous Concerns

- **The fact that children are more susceptible to chemical exposures was identified as a major concern.** ATSDR and MDCH share the citizens' concern that children are more susceptible to chemical exposures. The section "ATSDR Child Health Initiative" above addresses these issues.
- **Concerns over rumors of napalm being transported to Alpena to be burned in Lafarge's kilns have been raised.** According to all available information, these were only rumors, and there were never any documented plans by anyone to burn napalm in the Lafarge kilns.
- **Concerns about declining game fish in Thunder Bay and the Thunder Bay River have been expressed.** According to MDNR Fisheries Division staff, fish populations in Thunder Bay are generally very strong. The populations of some species are at relatively low levels, largely attributed to natural cycles and interspecies competition. The CKD pile might have buried a prime spawning ground for yellow perch, although it is but one place around the bay where wetlands that perch spawn may have been filled. Whitefish also spawn on a reef within a couple of hundred yards from the CKD pile, and they might take up contaminants from the pile (10).
- **The MDCH has issued an advisory that people should strictly limit their consumption of lake trout taken from Lake Huron (see Table 2 for**

details), in part because of dioxin contamination (9). This dioxin might come in part from the Lafarge plant, although there have been several other documented or potential sources of the contaminants within the watershed of the lake. The contaminants relatively recently appeared in the fish. People in Alpena perceive that this appearance coincided with the first burning of hazardous waste in the Lafarge kilns (10). Lake trout and lake whitefish collected from the entire length of Lake Huron contain similar concentrations of chlorinated dibenzodioxins and dibenzofurans (all generally referred to as "dioxins"). The oldest dioxin analysis from Thunder Bay on record (date not available, between 1983 and 1988) found higher concentrations of dioxins than did later analyses of similar samples (Table 20) (35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45). There are other locations where dioxins have been found in the environment within the Lake Huron watershed from potential sources other than Lafarge. Lafarge may not be the only possible source of dioxins in the Alpena area. On the days when relatively high concentrations of dioxins were detected in the air at Lincoln School, the wind was from the northwest to west or southeast, not from the direction to the plant from the school (east northeast) (95).

- **Concerns over adverse impact of environmental contaminants on garden plants have been raised.** No direct sampling of plants in the Alpena area has come to MDCH's attention. The soil in residential areas of the city has been found to contain several metals, including antimony, arsenic, barium, beryllium, cadmium, copper, lead, manganese, mercury, nickel, and zinc (Tables 7, 8, 9). Many of these occur naturally in the environment or can be traced to the combustion of fossil fuels. Cadmium is the most mobile of these metals in an aqueous environment and, therefore, the most likely to be absorbed and accumulated by plants. The cadmium concentration in the soil of Alpena residential areas ranged from not detectable to 2.8 ppm. While the maximum concentration is higher than the natural soil concentrations, generally less than 1 ppm with an average of 0.4 ppm (71), it is not so much higher that the plants in the area would be likely to accumulate enough cadmium to pose a health risk.
- **Many concerns related to the health of domestic and wild animals, including contaminated Bald Eagle eggs at South Point, have been raised.**

MDCH has passed the citizens' concerns about wild animals, birds, and fish on to the Michigan Department of Environmental Quality and Michigan Department of Natural Resources. We will discuss with them the interrelationships between the conditions of wildlife and of human health in the same area.

The MDCH has begun to address and investigate the other concerns expressed by the citizens of Alpena, and will report any and all future findings in future documents updating this Public Health Assessment. An information repository has been established at the Alpena Public Library. In addition to the information contained in this Health Assessment, MDCH fact sheets on hydrogen chloride and cancer clusters, and information about ADD/ADHD, lupus, and MS have been placed in this repository.

Next Section **Table of Contents**

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

CONCLUSIONS

Previous sampling has found concentrations of lead in the soil and of benzene and carbon tetrachloride in the air in Alpena that are somewhat elevated but not to the levels at which adverse health effects have been observed. In general the levels of these chemicals in the city were similar to those typically found in urban areas. The benzene and carbon tetrachloride may have multiple industrial sources. The lead contamination in soil may have several sources, including lead paint, cement kiln dust, or residuals from historic use of leaded gasoline. As a precaution, the state and district health departments have screening programs in place to find children who might be at risk of health problems from exposure to lead in order to initiate appropriate treatment to prevent the problems.

Fish from Thunder Bay and northern Lake Huron contain various contaminants at concentrations that require the MDCH to issue advisories to limit consumption of the fish. The sources for this contamination have not been identified, and may not be related to the Lafarge Corporation Alpena Plant.

Preliminary evaluation of available cancer incidence data does not indicate that the population in the area has a high incidence of cancer. MDCH has not been able to identify environmental causes for many of the health complaints received in the process of the health assessment. Citizens of Alpena have expressed concerns

about hydrogen chloride in the ambient air. HCl data is being collected and a health opinion will be produced in the form of a subsequent consultation. As of this writing there is one sampling meter collecting HCl data. A second HCl meter and a 2.5-micron particulate sampling device are soon to be operational.
Based upon evaluations conducted to date, the site is categorized as one of no apparent health hazard. MDCH will continue to monitor health outcome data for the area and be available for consultation as additional data and information becomes available.

RECOMMENDATIONS

MDCH continues to support activities for collecting additional environmental data in the Alpena area, including air sampling to measure hydrogen chloride concentrations, sampling of fish from Thunder Bay, and sampling of groundwater near the Wessel Road Quarry, a.k.a. "Pike's Peak."
People fishing in Thunder Bay, the Thunder Bay River, or other Michigan waters and taking the fish for food should follow the MDCH fish consumption advisories.
Workers carrying out any remedial action on the lakeshore CKD pile should follow appropriate precautions to minimize their own and the public's exposure to the CKD.

PUBLIC HEALTH ACTIONS

Public Health Actions Completed or In Progress

The MDCH has established an information repository at the Alpena Public Library. This repository contains information relating to this assessment and reference information on health concerns.
The Lafarge Corporation has purchased equipment for air sampling and donated it to the District Health Department, who has temporarily installed it at their Alpena offices. The MDEQ is operating and maintaining the equipment and collecting data. The ATSDR Exposure Investigation Branch, through MDCH contacts, consulted and advised on the installation and operation.
MDCH Environmental Epidemiology Division staff has met with staff of MDCH Division for Vital Records and Health Statistics and requested an updated health statistics database specifically targeted to the concerns expressed by Alpena residents.
MDCH and the district health department serving Alpena have programs in place to monitor blood lead concentrations in children.
The appropriate branches of the MDEQ, Ontario Ministry of Energy and the Environment, U.S. EPA, and other arms of the state, provincial, and federal governments are addressing the question of the contamination in the fish in Lake

Huron, Thunder Bay, the Thunder Bay River, and other waterbodies in their respective jurisdictions.

Public Health Actions Planned

MDCH Environmental Epidemiology Division will review Alpena health statistics annually. Any increased incidence of any reviewed health outcome, including Standardized Incidence Ratios for colon, rectal, and colorectal cancer, will be further investigated.

MDCH will continue to evaluate health complaints received from the Alpena community.

The MDCH will request of both the MDEQ and MDNR that additional fish be collected from Thunder Bay to monitor the levels of contaminants.

The MDCH Environmental Epidemiology Division will provide support for the childhood blood lead-level screening programs conducted by the district health department serving Alpena and the Lead Abatement Section of the MDCH.

PREPARERS OF REPORT

Michigan Department of Community Health
John Filpus, Environmental Engineer

David Wade, Toxicologist

Michael Haars, Community Involvement/Health Education Specialist

Robin Freer, GIS Specialist

Robert Wahl, Epidemiologist

Brendan Boyle, Principal Investigator

ATSDR Regional Representative

Louise Fabinski
Regional Services, Region V
Office of the Assistant Administrator

ATSDR Technical Project Officer

Alan Yarbrough
Division of Health Assessment and Consultation
Superfund Site Assessment Branch
State Programs Section

CERTIFICATION

This Lafarge Corporation - Alpena Plant Public Health Assessment was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.

Alan W. Yarbrough
Technical Project Officer, SPS, SSAB, DHAC, ATSDR

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

Richard Gillig
Chief, State Program Section, SSAB, DHAC, ATSDR

REFERENCES

1. Haltiner, R. The Town That Wouldn't Die. 1986.
2. Michigan Department of Community Health, for ATSDR. Health Consultation for Lafarge Corporation - Air Pollution, Alpena, Michigan, Public Comment Draft. June 16, 1998.
3. Snell Environmental Group, for MDEQ. Final Technical Memorandum #1, Interim Response Investigative Action, National Gypsum Site, Alpena, Michigan, MERA ID No. 040095. April 1998.
4. Alpena News. CKD in quarry probed. The Alpena News. September 16, 1999.
5. Vick, J., MDEQ. Personal communication. September 17, 1999.
6. Vorraro, L.J., Thunder Bay Chiropractic Center. Letter to J. Steward, ATSDR, Subject: Petition for assessment of hydrochloric acid emissions in Alpena. November 14, 1997.
7. U.S. Census Bureau. 1990 Census Data. 1990. (From GeoLytics, Inc. CensusCD. 1996.)
8. Hunter, M. Letter to S. Coulberson, ATSDR, re: Health Consultation for Lafarge Corporation - Air Pollution. September 7, 1998.
9. Michigan Department of Community Health. 1999 Michigan Fish Advisory. <http://www.mdch.state.mi.us/pha/fishadvi.htm> January 1999.
10. Johnson, J., MDNR Fisheries Division. Personal communication. September 23, 1998.
11. U.S. Environmental Protection Agency, Office of Water. Drinking Water Regulations and Health Advisories. EPA 833-R-96-001. February 1996.
12. U.S. Environmental Protection Agency. Toxic Chemical Release Inventory data base, 1987-1997, accessed through the Right to Know Network at <http://www.rtk.net>. July 20, 1998, May 6, 1999, June 2, 1999.

13. Howard, A.J., MDEQ ERD. Memorandum to ERD staff, subject: Interim Environmental Response Division Operational Memorandum #18: Part 201 Generic Cleanup Criteria Tables. August 31, 1998. Available at <http://www.deq.state.mi.us/erd/>.
14. Larsen, L.D., MDEQ. Memo to: R. Wagner, MDEQ. Subject: Human Health Effects of High pH in Water and Cement Kiln Dust Waste. August 21, 1998.
15. Michigan Department of Natural Resources, Waste Management Division. Michigan Background Soil Survey. Revised April 1991.
16. Lindsay, D., MDEQ. Activity Report, Facility: National Gypsum, Alpena County. August 11, 1998.
17. Brighton Analytical, Inc. Laboratory results for Patricia DeJohn, 217 McKinley, Alpena, Michigan 49707. May 6, 1992.
18. Michigan Department of Natural Resources. Alpena Metals Soils Results. ca. December 1992.
19. McConnell Consulting, Inc. for Alpena Public Schools. Lincoln and Ella White Elementary Schools, Initial Abatement. February 9, 1993.
20. Gagne, F., Alpena Public Schools Maintenance Division. Personal communication. September 17, 1998.
21. Ward, D., Rollins Environmental Inc./Encotec. Facsimile transmission to W. Freese, subject: preliminary Alpena residential metal results. December 19, 1996.
22. Michigan Department of Natural Resources. Environmental data, October 22, 1991 through June 16, 1992. Received March 1, 1999.
23. NTH Consultants, Ltd., for Lafarge Corporation. Report on: Assessment of Ambient Air Monitoring Data. May 20, 1996.
24. NTH Consultants, Ltd., for Lafarge Corporation. Data Summaries on: Ambient Air Monitoring Program, Alpena Michigan. August 17, 1998.
25. Michigan Department of Environmental Quality, Division of Drinking Water and Radiological Protection. MDEQ DWRP/Michigan Department of Public Health Division of Water Supply Laboratory Reports, March 29, 1995-December 20, 1999. Provided June 24, 1998, January 24, 2000.
26. Roycraft, Dianne, MDEQ DWRP. Private communication. July 17, 1998.
27. Renken, S., MDEQ DWRP. Personal communication. January 25, 2000.
28. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic, Update, Draft for Public Comment. August 1998.
29. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chromium, Update, Draft for Public Comment. August 1998.
30. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chloroform, Update. September 1997.

31. National Library of Medicine. Hazardous Substances Database. Available through TOXNET at <http://toxnet.nlm.nih.gov/servlets/simple-search>. Accessed August 19, 1999.
32. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Bromodichloromethane. ATSDR/TP-89/04. December 1989.
33. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Bromoform/Chlorodibromomethane. ATSDR/TP-90/05. December 1990.
34. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Di(2-ethylhexyl)phthalate, Update. ATSDR/TP-92/05. April 1993.
35. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1993 Annual Report. 1993.
36. Michigan Department of Environmental Quality. Fish Contaminant Monitoring Program, 1995 Annual Report. 1995.
37. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1986 Annual Report. November 1986.
38. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1991 Annual Report. December 1991.
39. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1992 Annual Report. 1992.
40. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1988 Annual Report. 1988.
41. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1990 Annual Report. September 1990.
42. Michigan Department of Environmental Quality. Fish Contaminant Monitoring Program, 1997 Annual Report. 1997.
43. Michigan Department of Environmental Quality. Draft Fish Contaminant Data. July 20, 1999.
44. Michigan Department of Environmental Quality. Fish Contaminant Monitoring Program, 1998 Annual Report. 1998.
45. Michigan Department of Natural Resources. Fish Contaminant Monitoring Program, 1994 Annual Report. 1994.
46. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Benzene, Update. September 1997.
47. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polycyclic Aromatic Hydrocarbons, Update. August 1995.
48. Filpus, J., Alpena resident 1960-1971, *inter alia*. Personal recollections. February 17, 1999.

49. U.S. Environmental Protection Agency, Office of Air & Radiation. 1995 National Air Quality: Status and Trends. Available online at <http://www.epa.gov/oar/aqtrnd95/>. Accessed July 24, 1998.
50. U.S. Environmental Protection Agency, Office of Air & Radiation. Fact Sheet -- Updated Air Quality Standards. <http://www.epa.gov/ttn/oarpg/naaqsfin/o3pm.html> June 25, 1997.
51. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead, Update. July 1999.
52. Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual. March 1992.
53. U.S. Environmental Protection Agency, Region 3, Hazardous Waste Management Division. Region III Technical Guidance Manual Risk Assessment, Assessing Dermal Exposure from Soil. December 1995. Available online at <http://www.epa.gov/reg3hwmd/solabsg2.htm>. Accessed July 29, 1998.
54. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Bromomethane. ATSDR/TP-91/06. September 1992.
55. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Carbon Tetrachloride, Update. ATSDR/TP-93/02. May 1994.
56. U.S. Environmental Protection Agency. Integrated Risk Information System. Available online at <http://www.epa.gov/ngispgm3/iris/index.html>. Accessed July 29, 1998.
57. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorinated Dibenzo-*p*-dioxins, Update, Draft for Public Comment. September 1997.
58. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorodibenzofurans. ATSDR/TP-93/04. May 1994.
59. Agency for Toxic Substances and Disease Registry. Toxicological Profile for 1,2-Dichloroethane, Update. ATSDR/TP-93/06. May 1994.
60. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Methylene Chloride, Update. ATSDR/TP-92/13. April 1993.
61. Agency for Toxic Substances and Disease Registry. Toxicological Profile for 1,1,2,2-Tetrachloroethane, Update, Draft for Public Comment. August 1994.
62. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Trichloroethylene, Update. September 1997.
63. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Vinyl Chloride, Update. September 1997.
64. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Nickel, Update. September 1997.

65. Agency for Toxic Substances and Disease Registry. Toxicological Profile for 1,4-Dichlorobenzene, Update. ATSDR/TP-92/10. April 1993.
66. ICF - Clement Associates. Comparative Potency Approach for Estimating the Cancer Risk Associated with Exposure to Mixtures of Polycyclic Aromatic Hydrocarbons. Interim Final Report to U.S. EPA for the Office of Health and Environmental Assessment. 1998. cited in Roy F. Weston, Inc. Remedial Investigation Report for J & L Landfill, Rochester Hills, Michigan. December 1991.
67. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Zinc, Update. ATSDR/TP-93/15. May 1994.
68. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Barium. ATSDR/TP-91/03. July 1992.
69. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorobenzene. ATSDR/TP-90/06. December 1990.
70. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Naphthalene. August 1995.
71. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium, Update, Draft for Public Comment. September 1997.
72. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Copper. ATSDR/TP-90/08. December 1990.
73. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Mercury, Update. March 1999.
74. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Antimony. ATSDR/TP-91/02. September 1992.
75. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Beryllium, Update. ATSDR/TP-92/04. April 1993.
76. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Manganese, Update, Draft for Public Comment. September 1997.
77. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Selenium, Update, Draft for Public Comment. August 1994.
78. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Silver. ATSDR/TP-90/24. December 1990.
79. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Thallium. ATSDR/TP-91/26. June 1992.
80. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Vanadium. ATSDR/TP-91/29. July 1992.
81. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlordane, Update. ATSDR/TP-93/03. May 1994.
82. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polychlorinated Biphenyls, Update. September 1997.

83. Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation. Guidance on Including Child Health Issues in Division of Health Assessment and Consultation Documents. July 2, 1998.
84. Allen, C. Survey: Cancer Deaths in Area About Average. The Alpena News. October 23, 1993.
85. Michigan Department of Community Health, Office of the State Registrar and Division of Health Statistics. Cancer Incidence and Mortality, Volume 10, Michigan 1994. August 1996.
86. Environmental Defense Fund. Scorecard World Wide Web site <http://www.scorecard.org/>. Accessed May 6, 1999.
87. National Institute for Occupational Safety and Health. Pocket Guide to Chemical Hazards. June 1990.
88. National Attention Deficit Disorder Association. Website at <http://www.add.org>. Accessed July 23, 1998.
89. National Parkinson's Disease Foundation. Website at <http://www.parkinson.org>. Accessed March 18, 1999.
90. Lupus Foundation of America. Website at <http://www.lupus.org/lupus/index.html>. Accessed July 17, 1998.
91. Mangan, H., MS Foundation. Personal Communication. June 29, 1998.
92. Mayfield, E. Glimmer of Hope for People with ALS. FDA Consumer magazine, **30** (7), September 1996. at <http://www.fda.gov/fdac/features/796_als.html> Accessed November 4, 1998.
93. ALS Association. What is ALS? at <http://www.ALSA.org/WhatIs/> Accessed November 4, 1998.
94. Alpena Public Schools nursing staff. Personal communication. March 23, 1999.
95. Michigan Department of Environmental Quality, Air Quality Division. Unpublished meteorological data, March 6, 1995-March 31, 1996. June 22, 1998.
96. Nauen, C.C. Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products. FAO Fisheries Circular No. 764. Food and Agriculture Organization of the United Nations. Rome, Italy. 1983.
97. Stephens, M., MDEQ. Telephone conversation. September 28, 1999.
98. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Toluene, Update. ATSDR/TP-93/14. May 1994.
99. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Xylenes, Update. August 1995.
100. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Formaldehyde. July 1999.

101. Plume, J., Alpena Municipal Water Plant. Personal communication. September 27, 1999.
102. Unidentified Alpena Municipal Sewage Plant worker. Telephone conversation. September 24, 1999.
103. Hauser, P., J.M. McMillin, V.S. Bhatara. Resistance to Thyroid Hormone: Implications for Neurodevelopmental Research on the Effects of Thyroid Hormone Disruptors. Tox. Ind. Health, **14**(1 / 2), 85-101. 1998.

[1] Or "north" side, by local usage. The left, or northeast, bank of the Thunder Bay River is locally referred to as the "North Side." The streets of Alpena were originally laid out on a rectilinear grid but at an angle of 45° from due north-south and east-west, to conform to the general lay of the shores of Thunder Bay and the Thunder Bay River near the River's mouth (see the Figures) Since the river flows generally from the west to the east, streets running generally parallel to it, southeast-northwest within the city core, are designated east-west. Streets running northeast-southwest, roughly perpendicular to the River and paralell to the Bay shore, are designated north-south. The dividing lines for the street numbering are Second Avenue, which crosses the river closest to the mouth, and Chisholm Street, U.S. 23 north of the city center (Figure 2). Michigan state highway M-32 and the north-south/east-west grids of the streets near Long Lake Road on the North Side and in the southwest part of the city (Figures 1 and 2) were later additions.
[2] As of October 1, 1995, the environmental protection and regulation functions of the Michigan Department of Natural Resources (MDNR) were transferred to the newly-formed Michigan Department of Environmental Quality (MDEQ).
[3] Alpena Township, as a political entity, includes the on-shore portions of 6 townships as designated for survey purposes: Michigan Townships T30N, R8E; T30N, R9E; T31N, R8E (except for those areas incorporated within the City of Alpena); T31N, R9E; T32N, R8E; and T32N, R9E. The Lafarge plant is located in T31N, R8E, Section 24. The Township population is primarily located in T31N, R8E, and T32N, R8E.
[4] "The Census Bureau defines ‘urban' for the 1990 census as comprising all territory, population, and housing units in urbanized areas and in places of 2,500 or more persons outside urbanized areas." (Help Screen, CensusCD software, Reference 7.) "Urbanized areas" by the Census Bureau definition have a population density over 1,000 per square mile and a total population over 50,000.
[5] ATSDR Minimal Risk Levels (MRLs), U.S. EPA Reference Doses (RfDs), and U.S. EPA Reference Concentration (RfCs) are levels of exposure below which toxicologists generally agree that non-cancer adverse health effects are not likely to occur.

[6] Pica behavior is an abnormal consumption of non-food materials, such as soil, most often seen in children between 2 and 5 years of age.
[7] Unlike many other adverse health effects, it is generally assumed that there is no threshold level for cancer. That is, if you are exposed to a carcinogen, no matter how little of the compound or for how short a time, it is assumed that your likelihood of contracting cancer in the future has increased by some finite amount. It is also assumed that this likelihood is proportional to the amount of exposure, related by a constant termed a "slope factor." This analysis of the potential increased cancer risk related to exposure to a chemical in the environment uses slope factors published by the U.S. EPA. These slope factors are derived from the epidemiological and laboratory data with consideration of differences between species and variation within species. The actual increase in rate of cancer occurrence after an exposure is not likely to exceed that calculated from the slope factor and the amount of exposure, and may be much less than the calculated value, even zero. ATSDR's Cancer Risk Evaluation Guides (CREGs) are concentrations at which, if a million people were exposed to the chemical in that medium and at that concentration for their lifetimes, one (1) additional case of cancer would be predicted to occur compared to a similar population not exposed to the chemical. As a comparison, between 1 out of 4 and 1 out of 3 Americans contract cancer in their lifetime.
[8] The MDEQ Industrial and Commercial Clean-Up Criteria for lead were developed using the U.S. EPA Integrated Uptake Biokinetic Model for children, and are equal to the Residential Criteria, 400 ppm. No widely-accepted risk assessment methods are currently available to evaluate lead toxicity in adults.
[9] The 1991 MDNR Michigan Background Soil Survey reported maximum arsenic concentrations of 11 ppm in topsoil samples and 39 ppm in clay samples (15). The MDEQ Generic Clean-up Criteria for Residential Use for arsenic in soil is 6.6 ppm. They also list a Default Background Level of 5.8 ppm (13). Soil containing arsenic concentrations between the Residential Criteria and the above background concentrations is not generally considered to pose a significant health hazard. Although a person might ingest more arsenic from the soil than is generally considered safe, he or she would not be likely to ingest as much as has been observed to cause adverse health effects.
[10] On April 1, 1996, the Michigan Department of Public Health (MDPH) Division of Water Supply was transferred to the Michigan Department of Environmental Quality (MDEQ) Division of Drinking Water and Radiological Protection.
[11] The standard fish analyses used by the MDNR Fish Contaminant Monitoring Program since 1989 includes the following chemicals: aldrin, gamma-BHC (Lindane), alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, oxy-chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, heptachlor, heptachlor

epoxide, heptachlorostyrene, hexachlorobenzene, hexachlorostyrene, mercury, Mirex, octachlorostyrene, pentachlorostyrene, polybrominated biphenyls (PBBs), PCBs, terphenyl, and toxaphene. Chemicals not listed in Tables 20, 21 were not detected in any sample.

[12] The U.S. EPA has proposed new standards for airborne particulate matter less than 2.5 microns in diameter (PM-2.5). The concentrations of particulate matter less than 10 microns (PM-10) measured in Alpena exceeded the proposed daily average standards on a few occasions and consistently exceeded the proposed annual average (Table 13) (23, 24, 50). This does not necessarily mean that the air in Alpena exceeded the new standards. The PM-10 measurement provides an upper bound to the PM-2.5 value; however, it is not possible based on available information to calculate one from the other. The fine particles might pose a health hazard, although more information is needed to evaluate the hazard. The MDEQ is planning to install a meter in Alpena to monitor these fine particle concentrations.

[13] Since 1980, the MDNR has collected fish from 226 of the more than 10,000 inland lakes, impoundments, and reservoirs in the state for their Fish Contaminant Monitoring Program. At least one fish from 155 of these water bodies, 69% of the total, contained a mercury concentration above the MDCH's First Level of Concern. These lakes are distributed throughout the state, regardless of location, human access, or industrial activity. There are believed to be various sources for the mercury, including human activity and natural sources. In 1989, the MDPH issued a general fish consumption advisory for certain predator species of fish taken from any inland lake, impoundment, or reservoir within the state, including Lake Besser. This advisory is summarized in Table 2.

[14] Note 7, page 9

[15] Pica behavior is an abnormal urge to consume non-food substances, such as soil, that most commonly occurs between ages 2 and 5.

[16] The cancer risk from exposure to various carcinogenic polycyclic aromatic hydrocarbons (PAHs), including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene, was estimated using relative risk factors from Reference 66 and the slope factor for benzo(a)pyrene (47).

[17] A child subject to pica behavior (note 6, page 9) might ingest more arsenic from the soil in the city each day, body weight for body weight, than did people who experienced various cardiovascular, neurological, and skin disorders, including cancers of the skin and other organs, after many years of drinking water containing high concentrations of arsenic. Since pica behavior typically lasts for a few years at most, such a child would probably not ingest as much arsenic in total to incur these adverse health effects (28).

[18] 40 CFR 125.62 (b)

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1. ATSDR > Public Health Assessments & Consultations

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

APPENDIX A

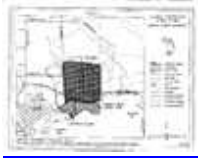

Figure 1. Site Location

Figure 2. Off-Site Sampling Locations

Figure 3. Background Sampling Locations

APPENDIX B

Table 1:

Selected demographic and economic information for populations near the Lafarge Corporation Alpena Plant, from the 1990 U.S. Census.

Radius from Lafarge Plant	**1 Mile**	**3 Miles**
Population	2,592	13,686
Urban	2,592	11,272

Rural	0	2,414
Age		
Average Age (years)	37.3	39.0
Children Ages 0-17	26.5 %	25.1 %
Age 0-4	8.1 %	6.3 %
Age 5-14	14.6 %	14.6 %
Age 15-24	13.2 %	11.6 %
Age 25-34	16.1 %	15.5 %
Age 35-44	11.8 %	13.2 %
Age 45-54	8.3 %	10.3 %
Age 55-64	10.0 %	9.9 %
Age 65+	17.9 %	18.6 %
Race		
White	97.4 %	99.0 %
Black	0.0 %	0.0 %
American Indian	0.7 %	0.5 %
Asian, Pacific	2.0 %	0.5 %
Other	0.0 %	0.0 %
Hispanic (any race)	0.0 %	0.2 %
Major Ethnic Groups		
Polish	33.7 %	20.3 %
German	22.5 %	28.8 %
French (not Basque)	12.9 %	13.7 %
English	10.6 %	9.9 %
Irish	7.7 %	7.4 %
Annual Household Income		
Median	$ 12,138	$ 21,043
Average	$ 21,153	$ 28,251
Population in Poverty (%)	18.5 %	13.3 %

Home Value		
Median	$ 21,625	$ 34,912
Average	$ 30,532	$ 44,174

Reference: 7

Table 2.
MDCH Fish consumption advisories applicable to Thunder Bay, Lake Huron, and the Thunder Bay River, 1999.

Water body	**Species**	**Contaminant(s)**	**General Population**	**Nursing Mothers, Pregnant Women, Women Who Intend to Have Children, and Children under Age 15**
Lake Huron #	Brown Trout	PCBs	shorter than 18 inches, unlimited consumption; longer than 18 inches, 1 meal per week	shorter than 18 inches, 1 meal per month; longer than 18 inches, no consumption
	Burbot	PCBs	unlimited consumption, all sizes	1 meal per week, all sizes
	Chinook Salmon	PCBs	unlimited consumption, all sizes	shorter than 30 inches, 1 meal per month; longer than 30 inches, 6 meals per year
	Coho Salmon	PCBs	unlimited consumption, all sizes	1 meal per month, all sizes
	Lake Trout	PCBs, Chlordane, Dioxins	shorter than 22 inches, 1 meal per week;	no consumption, all sizes

			longer than 22 inches, no consumption	
	Lake Whitefish	PCBs, Dioxins	shorter than 22 inches, unlimited consumption; longer than 22 inches, no consumption	shorter than 18 inches, 1 meal per week; between 18 and 22 inches, 1 meal per month; longer than 22 inches, no consumption
	Rainbow Trout	PCBs	unlimited consumption, all sizes	1 meal per month, all sizes
Thunder Bay #	Carp	PCBs	1 meal per week, all sizes	shorter than 14 inches, 1 meal per month; 14 to 18 inches, 6 meals per year; longer than 18 inches, no consumption
	Walleye	PCBs[(A)]	unlimited consumption, all sizes	shorter than 22 inches, 1 meal per week; longer than 22 inches, 1 meal per month
All Inland Lakes, Reservoirs, and Impoundments (including Lake Besser[(B)] on the Thunder Bay River)	Crappie	Mercury	longer than 8 inches, 1 meal per week	longer than 8 inches, 1 meal per month
	Largemouth Bass	Mercury	1 meal per week, all sizes	1 meal per month, all sizes
	Muskellunge	Mercury	1 meal per week, all sizes	1 meal per month, all sizes
	Northern Pike	Mercury	1 meal per week, all sizes	1 meal per month, all sizes
	Rock Bass	Mercury	longer than 8 inches, 1 meal per week	longer than 8 inches, 1 meal per month

	Smallmouth Bass	Mercury	1 meal per week, all sizes	1 meal per month, all sizes
	Walleye	Mercury[(C)]	1 meal per week, all sizes	1 meal per month, all sizes
	Yellow Perch	Mercury	longer than 8 inches, 1 meal per week	longer than 8 inches, 1 meal per month

Reference: 9
Based on data on edible portions of fish (fillet, with or without skin, depending on the species). No advisory was issued for chub or channel catfish from Thunder Bay because of the small sample size.

Advisories on Lake Huron and Thunder Bay also apply to the Thunder Bay River below the Ninth Street Dam and to other rivers tributary to the water body below their first dams, especially for migratory species.
[A] There is no advisory based on mercury for walleye from Thunder Bay because there was only one fish containing more than 0.5 ppm mercury in the two edible-portion walleye collections in 1989 and 1993. MDCH considered this insufficient data to define a size range where the fish might be expected to exceed the Level of Concern.
[B] There is no advisory on carp from Lake Besser because there was only one fish that exceeded the MDCH Level of Concern for any chemical (0.05 ppm PCBs) in the edible-portion carp collection in 1989. MDCH considered this insufficient data to define a size range where the fish might be expected to exceed the Level of Concern.
[C] There is no advisory based on PCBs for walleye from Lake Besser because there was only one fish containing more than 0.05 ppm PCBs in the edible-portion walleye collection in 1989. MDCH considered this insufficient data to define a size range where the fish might be expected to exceed the Level of Concern.

Table 3.
Chemicals found in the environmental data used in this assessment.

Metals	U.S. EPA Carcin. Class*	**Volatile Organic Compounds**	U.S. EPA Carcin. Class*	**Polycyclic Aromatic Hydrocarbons**	U.S. EPA Carcin. Class*
aluminum	D	acetone	D	acenaphthene	D

antimony	D	benzene	A	acenaphthylene	D
arsenic	A	bromomethane	D	anthracene	D
barium	D	carbon tetrachloride	B2	benzo(a)anthracene	B2
beryllium	B2	chlorobenzene	D	benzo(a)pyrene	B2
bismuth	D	chlorodibromomethane	C	benzo(b)fluoranthene	B2
cadmium	B1	chloroethane	D	benzo(e)pyrene	D
chromium	A	chloroform	B2	benzo(g,h,i)perylene	D
copper	D	chloromethane	D	benzo(k)fluoranthene	B2
lead	B2	dichlorobromomethane	B2	chrysene	B2
manganese	D	dichlorodifluoromethane	D	dibenzo(a,h)anthracene	B2
mercury	D	1,2-dichloroethane	C	fluoranthene	D
molybdenum	D	ethylbenzene	D	fluorene	D
nickel	D	methylene chloride	B2	indeno(1,2,3-c,d)pyrene	B2
potassium	D	styrene	D	2-methylnaphthalene	D
selenium	D	tetrachloroethylene	UR	naphthalene	D
silver	D	toluene	D	perylene	D
sodium	D	1,1,1-trichloroethane	D	phenanthrene	B2
thallium	D	trichloroethylene	UR	pyrene	D
vanadium	D	trichlorofluoromethane	D	**Other Semi-Volatile Organic Compounds**	
zinc	D	1,1,2-trichloro-1,2,2-trifluoroethane	D		
		trihalomethanes (total)	B2		
		vinyl chloride	A		
		xylene	D	benzyl chloride	B2
				bis(2-ethylhexyl)phthalate	B2
Pesticides, Polychlorinated Biphenyls (PCBs), Chlorinated Dioxins and Furans, and other Chlorinated Organic Compounds				1,2-dichlorobenzene	D
				1,4-dichlorobenzene	D
				1-ethyl-4-methylbenzene	D
alpha-chlordane	B2	heptachlor epoxide	B2	1,2,4-trichlorobenzene	D

gamma-chlordane	B2	heptachlorostyrene	D	1,2,4-trimethylbenzene	D
cis-nonachlor	B2	hexachlorobenzene	B2	1,3,5-trimethylbenzene	D
trans-nonachlor	B2	hexachlorostyrene	D		
oxy-chlordane	B2	octachlorostyrene	D	The concentrations of the shaded chemicals exceeded the ATSDR Comparison Values (or the chemicals were present but no Comparison Value has been established) in at least one environmental medium.	
4,4'-DDD	B2	PCBs	B2		
4,4'-DDE	B2	pentachlorostyrene	D		
4,4'-DDT	B2	toxaphene	B2		
dieldrin	B2				
chlorinated dibenzodioxins and dibenzofurans	B2			*U.S. EPA Carcinogen Class: A Human carcinogen B1, B2 Probable human carcinogen C Possible human carcinogen D Unclassifiable UR Classification Under Review	

Table 4.
Summary of TRI information for Alpena Facilities, 1987-1997.

Facility	Chemical	Reported Releases or Transfers				
		Air	Water	Land	Off-site Transfer	
					POTW	Other
ABT Co. (Abitibi-Price)	ammonia	x	x	—	—	—
	chlorine	x	x	—	—	—
	formaldehyde	x	x	—	—	—
	methanol	x	—	—	—	—
	phenol	x	x	—	—	—
	sodium hydroxide	x	—	—	—	—

	(solution)					
	sulfuric acid	x	x	—	—	—
Fletcher Paper Co.	acetone	x	—	—	—	x
	formaldehyde	x	x	—	x	x
	hydrochloric acid	—	x	—	x	—
	methanol	x	—	—	—	x
	toluene	x	—	—	—	x
Lafarge Corporation (main plant)	acetone	x	—	—	—	—
	ammonium nitrate (solution)	x	—	—	—	—
	benzene	x	—	—	—	x
	n-butyl alcohol	x	—	—	—	—
	tert-butyl alcohol	x	—	—	—	—
	chlorobenzene	x	—	—	—	x
	chromium	x	x	x	—	x
	chromium compounds	x	x	—	—	x
	1,2-dichloroethane	x	—	—	—	—
	dichloromethane*	x	—	—	—	x
	diethanolamine	x	—	—	—	—
	diethyl phthalate	x	—	—	—	—
	dimethyl phthalate	x	—	—	—	—
	2-ethoxyethanol	x	—	—	—	—
	ethylbenzene	x	—	—	—	x
	ethylene glycol	x	—	—	—	—
	Freon 113**	x	—	—	—	—
	glycol ethers	x	—	—	—	x
	hydrochloric acid	x	—	—	—	—
	isopropyl alcohol	x	—	—	—	—
	methanol	x	—	—	—	—
	methyl ethyl ketone	x	—	—	—	x
	methyl isobutyl ketone	x	—	—	—	x
	methyl methacrylate	x	—	—	—	—
	naphthalene	x	—	—	—	—
	phenol	x	—	—	—	—

	polychlorinated biphenyls	—	—	—	—	x
	styrene	x	—	—	—	—
	tetrachloroethylene	x	—	—	—	—
	toluene	x	—	—	—	x
	1,1,1-trichloroethane	x	—	—	—	—
	1,1,2-trichloroethane	x	—	—	—	—
	trichloroethylene	x	—	—	—	—
	vinyl acetate	x	—	—	—	—
	xylene (mixed isomers)	x	—	—	—	x
Lafarge Corp. (M-32 Paxton Quarry)	ammonium nitrate (solution)	x	—	—	—	—
Panel Processing Inc.	acetone	x	—	—	—	x
	n-butyl alcohol	x	—	—	—	x
	certain glycol ethers	x	—	—	—	—
	methyl ethyl ketone	x	—	—	—	x
	methyl isobutyl ketone	x	—	—	—	x
	toluene	x	—	—	—	x
	xylene (mixed isomers)	x	—	—	—	x
Systech Environmental Corp.	acetone	x	—	—	—	x
	benzene	x	—	—	—	x
	dichloromethane*	x	—	—	—	x
	ethylbenzene	x	—	—	—	x
	certain glycol ethers	x	—	—	—	—
	methyl ethyl ketone	x	—	—	—	x
	methyl isobutyl ketone	x	—	—	—	x
	toluene	x	—	—	—	x
	xylene (mixed isomers)	x	—	—	—	x
Thunder Bay Manufacturing	copper	x	—	—	—	—
	methanol	x	—	—	—	x
	nickel	x	—	—	—	—

Reference: 12

x A transfer or release was reported in at least one year's report.

— No transfer or release was reported.

POTW Publicly Owned Water Treatment Works
* Dichloromethane is more commonly called methylene chloride.
** Freon 113 is also known as 1,1,2-trichloro-1,2,2-trifluoroethane.

Table 5. Concentrations of metals in groundwater samples collected from monitoring wells in the vicinity of the cement kiln dust pile at the Lafarge Corporation Alpena Plant during the IRIA, January-July, 1997.

Chemical	Date	Concentration (ppm)			No. of samples exceeding MDEQ Contact Criteria (Ref. 13)	No. of samples exceeding U.S. EPA or MDEQ Drinking Water Standards (Refs. 11, 13)	Comparison Value (ppb)
			Maximum	Median			
acetone	1/97	330		190	0	0	1,000[R]
	7/97	260		ND	0	0	
aluminum	1/97	total	46,000	14,000	0	0	20,000[Ei]
		dissolved	6,500	2,200	0	0	
	7/97	total	48,000	12,000	0	0	
		dissolved	6,400	3,100	0	0	
antimony	1/97	total	5	ND	0	0	3[A]
		dissolved	8	ND	0	1	
	7/97	total	12	ND	0	2	
		dissolved	12	ND	0	1	
arsenic	1/97	total	190	87.5	0	6	3[E], 0.023[C]
		dissolved	140	49	0	3	
	7/97	total	180	89.5	0	8	
		dissolved	180	ND	0	6	

barium	1/97	total	380	ND	0	0	700[R]
		dissolved	ND	ND	0	0	
	7/97	total	1,600	405	0	0	
		dissolved	ND	ND	0	0	
beryllium	1/97	total	2	ND	0	0	4[M], 0.0081[C]
		dissolved	ND	ND	0	0	
	7/97	total	ND	ND	0	0	
		dissolved	ND	ND	0	0	
cadmium	1/97	total	16	2	0	4	2[E], carcinogen
		dissolved	14	3.1	0	3	
	7/97	total	16	ND	0	5	
		dissolved	14	ND	0	4	
chloroform	1/97	ND		ND	0	0	100[E], 5.7[C]
	7/97	1.9		ND	0	0	
chromium	1/97	total	200	ND	0	1	30[R], carcinogen (VI)
		dissolved	100	ND	0	1	
	7/97	total	260	100	0	4	
		dissolved	110	ND	0	1	
copper	1/97	total	190	ND	0	0	1,300[MG]
		dissolved	ND	ND	0	0	
	7/97	total	440	94	0	0	
		dissolved	ND	ND	0	0	
lead	1/97	total	300	32	0	10	15[PL], carcinogen
		dissolved	14	ND	0	4	
	7/97	total	380	37.5	0	12	
		dissolve	ND	ND	0	0	

		d					
manganese	1/97	total	2,100	430	0	5	NA
		dissolved	800	ND	0	2	
	7/97	total	8,900	1,100	0	8	
		dissolved	1,100	ND	0	3	
mercury	1/97	total	2.4	0.95	0	1	2[A]
		dissolved	3.5	ND	0	1	
	7/97	total	2.675	ND	0	1	
		dissolved	2.54	ND	0	1	
nickel	1/97	total	520	83.5	0	2	100[A], carcinogen
		dissolved	330	ND	0	1	
	7/97	total	640	ND	0	2	
		dissolved	510	ND	0	2	
potassium	1/97	total	7,800,000	810,000	0	0	NA
		dissolved	NS	NS	NS	NS	
	7/97	total	9,800,000	2,200,000	0	0	
		dissolved	10,000,000	1,500,000	0	0	
selenium	1/97	total	60	30.5	0	2	50[E]
		dissolved	63	34	0	2	
	7/97	total	65	ND	0	2	
		dissolved	69	ND	0	2	
silver	1/97	total	7.4	ND	0	0	50[R]
		dissolved	11	ND	0	0	
	7/97	total	ND	ND	0	0	
		dissolve	ND	ND	0	0	

		d					
sodium	1/97	total	540,000	190,000	0	6	NA
		dissolved	NS	NS	NS	NS	
	7/97	total	660,000	200,000	0	7	
		dissolved	660,000	200,000	0	7	
thallium	1/97	total	14	ND	0	1	0.4[A]
		dissolved	ND	ND	0	0	
	7/97	total	ND	ND	0	0	
		dissolved	ND	ND	0	0	
trichloroethylene	1/97	1.1		ND	0	0	5[M], 3.2[C]
	7/97	ND		ND	0	0	

Other Parameters	Date	Value (standard units)			No. of samples exceeding MDEQ Contact Criteria (Ref. 14)	No. of samples outside U.S. EPA Drinking Water Standards (Ref. 11)	Comparison Value
		Maximum	Median	Minimum			
pH	1/97	12.8	12.2	7.2	8	9	NA
	7/97	13.3	12.1	6.8	9	10	

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected - for medians, in more than ½ of the samples
NS -- Not Sampled
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs)
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs),calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)
M -- U.S. EPA Maximum Contaminant Level (11)

MG -- U.S. EPA Maximum Contaminant Level Goal (11)
A -- U.S. EPA Drinking Water Lifetime Health Advisory (11)
PL -- U.S. EPA Proposed Action Level for Lead in Drinking Water (11)

Table 6. Concentrations of metals in samples of cement kiln dust collected from a pile on the lakeshore behind the Lafarge Corporation Alpena plant by the MDNR (March 1993, August 1993) and during the IRIA (December 1996).

Chemical	Date	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
		Maximum	Median			
antimony	3/31/93	NS	NS	NS	NS	0.8[R]
	8/93	NS	NS	NS	NS	
	12/96	0.52	ND	0	0	
arsenic	3/31/93	27.1	23.2	0	3	0.6[E], 0.47[C]
	8/93	65	60.5	0	2	
	12/96	32	12	0	9	
barium	3/31/93	70	68	0	0	140[R]
	8/93	160	157	0	0	
	12/96	100	82	0	0	
beryllium	3/31/93	NS	NS	NS	NS	10[R], 0.16[C]
	8/93	0.4	0.35	0	0	
	12/96	1.6	0.52	0	0	
cadmium	3/31/93	0.6	0.52	0	0	0.4[E], carcinogen
	8/93	ND	ND	ND	ND	
	12/96	2.8	1.1	0	0	
chromium	3/31/93	15	15	0	0	6[R], carcinogen (VI)
	8/93	36	33	0	0	
	12/96	21	15	0	0	

copper	3/31/93	18	16	0	0	NA
	8/93	45	43	0	0	
	12/96	26	18	0	0	
lead	3/31/93	51	36	0	0	carcinogen
	8/93	125	108.5	0	0	
	12/96	180	64	0	0	
manganese	3/31/93	NS	NS	NS	NS	NA
	8/93	NS	NS	NS	NS	
	12/96	260	210	0	0	
mercury	3/31/93	0.121	ND	0	0	NA
	8/93	2.4	1.27	0	0	
	12/96	ND	ND	ND	ND	
molybdenum	3/31/93	NS	NS	NS	NS	10^{R}
	8/93	23	21.5	0	0	
	12/96	NS	NS	NS	NS	
nickel	3/31/93	NS	NS	NS	NS	40^{R}, carcinogen
	8/93	31	30	0	0	
	12/96	26	19	0	0	
selenium	3/31/93	3.15	2.65	0	0	10^{E}
	8/93	7.1	6.35	0	0	
	12/96	4.3	2.6	0	0	
silver	3/31/93	0.2	0.2	0	0	10^{R}
	8/93	NS	NS	NS	NS	
	12/96	0.51	ND	0	0	
thallium	3/31/93	NS	NS	NS	NS	NA
	8/93	NS	NS	NS	NS	
	12/96	6.2	2.9	0	0	
titanium	3/31/9	NS	NS	NS	NS	NA

	3					
	8/93	1,100	1,100	0	0	
	12/96	NS	NS	NS	NS	
vanadium	3/31/93	NS	NS	NS	NS	6[Ei]
	8/93	67	62.5	0	0	
	12/96	NS	NS	NS	NS	
zinc	3/31/93	134	115	0	0	600[E]
	8/93	350	345	0	0	
	12/96	NS	NS	NS	NS	

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected - for medians, in more than ½ of the samples
NS -- Not Sampled or Not Analyzed for
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
Ei -- ATSDR Environmental Media Evaluation Guides (EMEGs), intermediate-duration exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 7. Concentrations of metals in soil samples collected at two residences in Alpena by the MDNR, June-July 1992.

Chemical	Date - Depth	Concentration (ppm)				No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
		Residence A		Residence B				
		Maximum	Median	Maximum	Median			
arsenic	6/92 - 6"	2.9	2.1	5.8	3.8	0	2	0.6[E], 0.47[C]

	7/92 - 1"	2.6	2.2	5	3.2	0	0	
cadmium	6/92 - 6"	ND (2)	ND (2)	ND (2)	ND (2)	0	0	0.4[E], carcinogen
	7/92 - 1"	ND (2)	ND (2)	ND (2)	ND (2)	0	0	
chromium	6/92 - 6"	7.9	7.1	7.5	6.45	0	0	6[R], carcinogen (VI)
	7/92 - 1"	9	7	6	5	0	0	
copper	6/92 - 6"	15	9	24	20	0	0	NA
	7/92 - 1"	24	13	19	11	0	0	
lead	6/92 - 6"	219	141	287	209	0	0	carcinogen
	7/92 - 1"	221	172	218	110	0	0	
mercury	6/92 - 6"	ND	ND	0.12	ND	0	0	NA
	7/92 - 1"	ND	ND	0.25	ND	0	0	
nickel	6/92 - 6"	ND	ND	7.5	ND	0	0	40[R], carcinogen
	7/92 - 1"	13	9.45	ND	ND	0	0	
zinc	6/92 - 6"	190	100	200	190	0	0	600[E]
	7/92 - 1"	170	130	160	130	0	0	

References: 18
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected (with detection level) - for medians, in more than ½ of the samples
-- = Not relevant, only one sample collected
Note: The MDEQ Industrial and Commercial Clean-Up Criteria for lead were developed using the U.S. EPA Integrated Uptake Biokinetic Model for children, and are equal to the Residential Criteria, 400 ppm. No risk assessment methods are

currently available to evaluate lead toxicity in adults.
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 8. Concentrations of metals in surface soil samples collected at residences, school yards, and parks in Alpena by the MDNR (June-August 1992), the Alpena Public Schools (November-December 1992), and Encotec (1996).

Chemical	Date	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
		Maximum	Median			
antimony	1996	0.1	ND	0	0	0.8[R]
arsenic	6-8/92	33	3.2	0	7	0.6[E], 0.47[C]
	11/30/92	9.2	1.2	0	2	
	12/22/92	15	1.7	0	4	
	1996	5.3	1.4	0	0	
barium	1996	79	32	0	0	140[R]
beryllium	1996	0.5	ND	0	0	10[R], 0.16[C]
cadmium	6-8/92	ND (2)	ND (2)	0	0	0.4[E], carcinogen
	1996	2.6	0.85	0	0	
chromium	6-8/92	16	7	0	0	6[R], carcinogen (VI)
	1996	13	5.7	0	0	
copper	6-8/92	42	13	0	0	NA
	1996	11	6.5	0	0	
lead	6-8/92	595	64	1	1	carcinogen
	11/30/9	1,150	13.3	1	1	

	2					
	12/22/92	2,600	62.2	4	4	
	1996	150	19	0	0	
manganese	1996	1,400	160	0	0	NA
mercury	6-8/92	0.33	ND	0	0	NA
	1996	ND	ND	0	0	
nickel	6-8/92	19	7.25	0	0	40[R], carcinogen
	1996	13	4.2	0	0	
zinc	6-8/92	800	84.2	0	0	600[E]
	1996	140	53	0	0	

Reference: 18, 19, 21
Shaded chemicals exceeded ATSDR Comparison Values
These statistics include data also presented in Tables 7 and 10.
ND -- Not Detected - for medians, in more than ½ of the samples
Note: The MDEQ Industrial and Commercial Clean-Up Criteria for lead were developed using the U.S. EPA Integrated Uptake Biokinetic Model for children, and are equal to the Residential Criteria, 400 ppm. No risk assessment methods are currently available to evaluate lead toxicity in adults.
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 9. Concentrations of metals in subsurface soil samples collected at residences, school yards, and parks in Alpena by the MDNR, June-August 1992, and Encotec (1996).

Chemical	Date	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
		Maximum	Median			

antimony	1996	2.2	ND	0	0	0.8[R]
arsenic	6-8/92	8.2	2	0	4	0.6[E], 0.47[C]
	1996	5	1.3	0	0	
barium	1996	94	23	0	0	140[R]
beryllium	1996	0.3	ND	0	0	10[R], 0.16[C]
cadmium	6-8/92	ND (2)	ND (2)	0	0	0.4[E], carcinogen
	1996	1.8	0.7	0	0	
chromium	6-8/92	15.5	6.3	0	0	6[R], carcinogen (VI)
	1996	10	6.1	0	0	
copper	6-8/92	36	17.5	0	0	NA
	1996	35	4.55	0	0	
lead	6-8/92	451	134	1	1	carcinogen
	1996	260	8.4	0	0	
manganese	1996	240	140	0	0	NA
mercury	6-8/92	0.12	ND	0	0	NA
	1996	ND	ND	ND	ND	
nickel	6-8/92	20	ND	0	0	40[R], carcinogen
	1996	8.2	4.5	0	0	
thallium	1996	2.3	ND	0	0	NA
zinc	6-8/92	350	100	0	0	600[E]
	1996	210	24	0	0	

Reference: 18, 21
Shaded chemicals exceeded ATSDR Comparison Values
These statistics include data also presented in Table 7.
ND -- Not Detected - for medians, in more than ½ of the samples
Note: The MDEQ Industrial and Commercial Clean-Up Criteria for lead were developed using the U.S. EPA Integrated Uptake Biokinetic Model for children, and are equal to the Residential Criteria, 400 ppm. No risk assessment methods are currently available to evaluate lead toxicity in adults.
(VI) -- For chromium(VI)

NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 10. Concentrations of metals in surface soil samples collected at Ella White and Lincoln Elementary schools in Alpena by the MDNR (June-August 1992) and contractors for the Alpena Public Schools (November-December 1992).

Chemical	Date	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
		Maximum	Median			
Ella White						
arsenic	8/25/92	23	--	0	1	0.6[E], 0.47[C]
	11/30/92	0.9	0.7	0	0	
	12/22/92	15	1.2	0	1	
chromium	8/25/92	16	--	0	0	6[R], carcinogen (VI)
copper	8/25/92	42	--	0	0	NA
lead	8/25/92	115	--	0	0	carcinogen
	11/30/92	17	9.11	0	0	
	12/22/92	83	15.2	0	0	
nickel	8/25/92	6.9	--	0	0	40[R], carcinogen
zinc	8/25/92	250	--	0	0	600[E]
Lincoln						

arsenic	6/9/92	6.1	3.35	0	1	0.6[E], 0.47[C]
	11/30/92	9.2	5.2	0	2	
	12/22/92	7.8	2.85	0	3	
chromium	6/9/92	7	5.5	0	0	6[R], carcinogen (VI)
copper	6/9/92	21	10.75	0	0	NA
lead	6/9/92	161	43	0	0	carcinogen
	11/30/92	1,150	41.3	1	1	
	12/22/92	2,600	186	4	4	
nickel	6/9/92	9.9	5.75	0	0	40[R], carcinogen
zinc	6/9/92	210	90.5	0	0	600[E]

Reference: 18, 19
Shaded chemicals exceeded ATSDR Comparison Values
These statistics include data also presented in Table 8.
ND -- Not Detected - for medians, in more than ½ of the samples
-- = Not Relevant - only one sample collected.
Note: The MDEQ Industrial and Commercial Clean-Up Criteria for lead were developed using the U.S. EPA Integrated Uptake Biokinetic Model for children, and are equal to the Residential Criteria, 400 ppm. No risk assessment methods are currently available to evaluate lead toxicity in adults.
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Next Section **Table of Contents**

1. ATSDR > Public Health Assessments & Consultations

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

APPENDIX B

Table 11. Concentrations of metals in fly ash samples collected in Alpena by the MDNR (October 1991 - June 1992).

Chemical	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
	Maximum	Median			
arsenic	31.2	15.6	0	5	0.6[E], 0.47[C]
barium	517	288.5	0	0	140[R]
cadmium	0.08	ND	0	0	0.4[E], carcinogen
chromium	13	11	0	0	6[R], carcinogen
copper	70	38	0	0	NA
lead	81	25	0	0	carcinogen
mercury	1.07	ND	0	0	NA
nickel	25	19	0	0	40[R], carcinogen
selenium	5.9	2.6	0	0	10[E]
silver	3	ND	0	0	10[R]
zinc	190	70	0	0	600[E]

Reference: 22
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected - for medians, in more than ½ of the samples
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available

Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 12. Concentrations of chemicals in air samples collected in the Alpena area by a Lafarge contractor, March 1995-March 1996, May 1997-June 1998.

Parameter	Date	Concentration ($\mu g/m^3$)						Comparison Value ($\mu g/m^3$)
		Besser School (1995-6)/Immanuel Lutheran School (1997-8)		Lincoln School (1995-6)/Sunrise Center (1997-8)		North Point		
		Maximum	Median	Maximum	Median	Maximum	Median	
acenaphthene	95-96	0.0037	0.0012	0.0047	0.0015	0.002	0.00029	NA
acenaphthylene	95-96	0.0078	0.00059	0.011	0.0018	0.0084	0.000097	NA
anthracene	95-96	0.0018	0.00034	0.0065	0.00081	0.002	0.00011	NA
barium	95-96	0.06	0.02	0.07	0.02	0.06	0.015	NA
benzene	95-96	10.1	0.650	6.50	1.53	3.58	ND	13^{Ei}, 0.12^{C}
	97-98	2.1	1.2	3.4	1.25	2	ND	
benzo(a)anthracene	95-96	0.00054	0.00005	0.001	0.000056	0.00042	ND	carcinogen
benzo(a)pyrene	95-96	0.00044	0.000054	0.00077	0.000062	0.00055	0.000025	carcinogen
benzo(b)fluoranthene	95-96	0.0011	0.00016	0.0018	0.00019	0.0012	0.000045	carcinogen
benzo(e)pyrene	95-	0.0003	0.0000	0.001	0.0000	0.0006	0.00002	carcinog

	96	8	95		89	6	7	en
benzo(g,h,i)perylene	95-96	0.00048	0.0001	0.0013	0.00013	0.00069	0.0000255	NA
benzo(k)fluoranthene	95-96	0.00044	0.000063	0.00095	0.000076	0.00042	0.000018	carcinogen
benzyl chloride	95-96	4.26	ND	1.05	ND	1.16	ND	carcinogen
bromomethane	95-96	19.0	ND	10.3	ND	21.3	ND	19[E]
	97-98	ND	ND	0.73	ND	ND	ND	
carbon tetrachloride	95-96	0.703	ND	1.09	ND	3.32	ND	320[Ei], 0.07[C]
	97-98	1.1	0.81	1.1	0.81	0.92	0.77	
chlorobenzene	95-96	1.68	ND	ND	ND	ND	ND	NA
	97-98	ND	ND	ND	ND	ND	ND	
chloroethane	95-96	ND	ND	ND	ND	ND	ND	10,000[R]
	97-98	ND	ND	2.7	ND	0.57	ND	
chloroform	95-96	2.98	ND	ND	ND	ND	ND	98[E], 0.04[C]
	97-98	0.66	ND	1.3	ND	ND	ND	
chloromethane	95-96	2.94	1.28	2.52	1.27	3.57	1.26	100[E]
	97-98	4.4	1.9	15	2.1	5.4	1.9	
chrysene	95-96	0.001	0.00016	0.002	0.00018	0.0014	0.000053	carcinogen
dibenzo(a,h)anthracene	95-96	0.000056	0.000008	0.00028	ND	0.000093	ND	carcinogen
1,2-	95-	6.72	ND	3.79	ND	22.6	ND	NA

dichlorobenzene	96							
	97-98	ND	ND	1.9	ND	ND	ND	
1,4-dichlorobenzene	95-96	3.36	ND	ND	ND	7.33	ND	600[Ei], carcinogen
	97-98	ND	ND	ND	ND	ND	ND	
dichlorodifluoromethane	95-96	4.48	2.87	4.33	2.97	7.04	2.82	NA
	97-98	6.3	3.9	6.1	4.1	4.9	3.85	
1,2-dichloroethane	95-96	1.03	ND	ND	ND	ND	ND	830[E], 0.04[C]
	97-98	ND	ND	ND	ND	ND	ND	
dioxins and furans (total)	95-96	--	--	0.000032	6.7E-07	--	--	7.7E-08[C]
2,3,7,8-TCDD	95-96	--	--	2.6E-08	ND	--	--	
TEQ	95-96	--	--	2.07E-07	2.96E-09	--	--	
1-ethyl-4-methylbenzene	95-96	ND	ND	3.44	ND	ND	ND	NA
ethylbenzene	95-96	2.87	ND	3.18	ND	1.68	ND	870[Ei]
	97-98	1.4	ND	2	ND	ND	ND	
fluoranthene	95-96	0.0042	0.00097	0.0043	0.0011	0.0035	0.00022	NA
fluorene	95-96	0.0069	0.0019	0.0078	0.0031	0.0057	0.0008	NA
indeno(1,2,3-c,d)pyrene	95-96	0.00038	0.000072	0.00081	0.0001	0.0005	0.000021	carcinogen
mercury particulate	95-96	0.00042	0.000021	0.00035	0.000015	0.00017	0.000013	0.14[E]
mercury vapor	95-	0.013	0.0025	0.0077	0.0025	0.0071	0.0020	

	96							
methylene chloride	95-96	1.48	ND	24.7	ND	3.14	ND	100[Ei], 2.5[C]
	97-98	11	0.97	3.1	1.1	1.6	0.91	
2-methylnaphthalene	95-96	0.06	0.015	0.85	0.024	0.036	0.0045	NA
naphthalene	95-96	0.26	0.054	0.42	0.097	0.15	0.024	10[E]
nickel	95-96	0.03	ND	ND	ND	ND	ND	0.2[E], carcinogen
perylene	95-96	0.00019	0.000024	0.00091	0.000022	0.000082	ND	NA
phenanthrene	95-96	0.012	0.0039	0.017	0.0059	0.01	0.00091	NA
pyrene	95-96	0.0043	0.00067	0.0048	0.00095	0.004	0.00016	NA
styrene	95-96	13.4	ND	3.64	ND	ND	ND	60[E]
	97-98	1.9	ND	1.7	ND	ND	ND	
1,1,2,2-tetrachloroethane	95-96	ND	ND	ND	ND	ND	ND	2,800[Ei], 0.02[C]
	97-98	ND	ND	0.6	ND	ND	ND	
tetrachloroethylene	95-96	1.58	ND	1.79	ND	ND	ND	270[E], 2[C]
	97-98	5	ND	39	0.285	5.1	ND	
toluene	95-96	21.4	2.14	203	3.79	13.8	0.651	3,800[E]
	97-98	14	2.5	51	3.4	5.2	0.735	
1,1,2-trichloro-1,2,2-	95-96	ND	ND	0.935	ND	1.01	ND	NA

trifluoroethane								
1,2,4-trichlorobenzene	95-96	11.9	ND	ND	ND	ND	ND	NA
	97-98	ND	ND	ND	ND	ND	ND	
1,1,1-trichloroethane	95-96	0.777	ND	3.44	ND	1.11	ND	3,800[Ei]
	97-98	1.9	0.54	0.7	0.565	0.8	0.515	
trichloroethylene	95-96	16.4	ND	5.24	ND	5.02	ND	540[Ei], 0.59[C]
	97-98	1.1	ND	8.4	ND	3.2	ND	
trichlorofluoromethane	95-96	2.06	ND	7.99	1.54	2.68	1.54	NA
	97-98	3.3	2.1	3.2	2.3	2.9	2	
1,2,4-trimethylbenzene	95-96	13.8	ND	7.86	ND	3.88	ND	NA
	97-98	8.9	ND	8.1	ND	0.86	ND	
1,3,5-trimethylbenzene	95-96	3.39	ND	1.13	ND	12.8	ND	NA
	97-98	1.6	ND	1.9	ND	ND	ND	
vinyl chloride	95-96	0.598	ND	ND	ND	ND	ND	77[Ei], 0.012[C]
	97-98	ND	ND	3	ND	ND	ND	
xylenes (total)	95-96	7.98	ND	17.2	1.12	8.07	ND	430[E]
	97-98	7.6	0.72	13.9	1.3	2.93	ND	
zinc	95-96	0.06	0.02	0.25	0.02	0.09	0.01	NA

Reference: 23, 24
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected, for medians, in more than 50% of the samples
-- = Not Analyzed for
6.7E-07 = $6.7 \times 10^{-7} = 0.00000067$
NA -- None available
carcinogen -- Known, possible, or probable human carcinogen, but no CREG available
Comparison Value Bases
E -- ATSDR Environmental Media Exposure Guide/Minimal Risk Level -- chronic exposure
Ei -- ATSDR Environmental Media Exposure Guide/Minimal Risk Level -- intermediate-term exposure
R -- U.S. EPA Reference Concentration
C -- ATSDR Cancer Risk Evaluation Guide

Table 13. Concentrations of suspended particulate matter in air samples collected in the Alpena area by a Lafarge contractor, March 1995-March 1996, May 1997-June 1998.

Parameter		Concentration (µg/m^3)							
		Besser School (1995-6)/Immanuel Lutheran School (1997-8)		Lincoln School (1995-6)/Sunrise Center (1997-8)		North Point		Lafarge Plant	
	Date	Maximum	Median	Maximum	Median	Maximum	Median	Maximum	Median
Total	95-96	96.4	23.1	121.0	28.2	56.2	15.8	NS	NS
Under 10 microns (PM-10)	95-96	47.5	12.6	78.2	17.3	34.5	8.3	82.3	18.9
	97-98	115.0	15.1	54.4	20.1	38.8	9.1	98.0	27.8

References: 23, 24
NS -- Not Sampled.

U.S. EPA's health-based national air quality standards for PM-10 are 50 µg/m^3 (measured as an annual average) and 150 µg/m^3 (measured as a daily average)

(49). The U.S. EPA has recently proposed a new standard for particles less than 2.5 microns in diameter, 15 $\mu g/m^3$ (measured as an annual average) and 65 $\mu g/m^3$ (measured as a daily average) (50).

Table 14. Concentrations of metals (total) in surface water samples collected offshore from the cement kiln dust pile at the Lafarge Corporation Alpena Plant during the IRIA, January-September, 1997.

Chemical	Date	Concentration (ppb)			No. of samples exceeding MDEQ Contact Criteria (Ref. 13)	No. of samples exceeding U.S. EPA or MDEQ Drinking Water Standards (Refs. 11, 13)	Comparison Value (ppb)
		Maximum		Median			
aluminum	1/23/97	total	4,300	655	0	0	20,000[Ei]
		dissolved	850	170	0	0	
	7/2/97	total	180,000	8,900	0	0	
		dissolved	1,300	ND	0	0	
	9/3/97	total	NS	NS	NS	NS	
arsenic	1/23/97	ND		ND	0	0	3[E], 0.023[C]
	7/2/97	190		ND	0	2	
	9/3/97	ND		ND	0	0	
barium	1/23/97	ND		ND	0	0	700[R]
	7/2/97	1,600		ND	0	0	
	9/3/97	ND		ND	0	0	
beryllium	1/23/97	ND		ND	0	0	4[M], 0.0081[C]
	7/2/97	10		ND	0	1	
	9/3/97	ND		ND	0	0	
cadmium	1/23/97	ND		ND	0	0	2[E], carcinogen
	7/2/97	28		ND	0	2	
	9/3/97	ND		ND	0	0	
chromium	1/23/97	ND		ND	0	0	30[R], carcinogen
	7/2/97	230		ND	0	1	

	9/3/97	ND	ND	0	0	(VI)
copper	1/23/97	ND	ND	0	0	1,300[MG]
	7/2/97	290	ND	0	0	
	9/3/97	ND	ND	0	0	
lead	1/23/97	8	ND	0	3	15[PL], carcinogen
	7/2/97	1,800	53.5	0	6	
	9/3/97	5	ND	0	1	
manganese	1/23/97	20	ND	0	0	NA
	7/2/97	3,300	ND	0	2	
	9/3/97	ND	ND	0	0	
mercury	1/23/97	ND	ND	0	0	2[A]
	7/2/97	0.825	0.0351	0	0	
	9/3/97	0.00471	0.00155	0	0	
nickel	1/23/97	ND	ND	0	0	100[A], carcinogen
	7/2/97	260	ND	0	1	
	9/3/97	ND	ND	0	0	
selenium	1/23/97	ND	ND	0	0	50[E]
	7/2/97	87	ND	0	1	
	9/3/97	ND	ND	0	0	
thallium	1/23/97	ND	ND	0	0	0.4[A]
	7/2/97	83	ND	0	2	
	9/3/97	ND	ND	0	0	

Other Parameters	Date	Maximum	Median	Minimum	No. of samples exceeding MDEQ Contact Criteria (Ref. 14)	No. of samples outside U.S. EPA Drinking Water Standards (Ref. 11)	Comparison Value
pH	1/23/97	8.7	8.2	7.9	0	1	NA
	7/2/97	11.2	9.2	8.7	0	8	

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
Note: Only Aluminum was detected in any of the filtered (dissolved metals)

samples.
ND -- Not Detected - for medians, in more than ½ of the samples
NS -- Not Sampled
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs)
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)
M -- U.S. EPA Maximum Contaminant Level (11)
MG -- U.S. EPA Maximum Contaminant Level Goal (11)
A -- U.S. EPA Drinking Water Lifetime Health Advisory (11)
PL -- U.S. EPA Proposed Action Level for Lead in Drinking Water (11)

Table 15. Concentrations of metals (total) in surface water samples collected from Squaw Bay and Misery Bay (see Figure 3) during the IRIA, October 1-2, 1997.

Chemical	Concentration (ppb)				No. of samples exceeding MDEQ Contact Criteria (Ref. 13)	No. of samples exceeding U.S. EPA or MDEQ Drinking Water Standards (Refs. 11, 13)	Comparison Value (ppb)
	Squaw Bay		Misery Bay				
	Maximum	Median	Maximum	Median			
aluminum	360	140	130	ND	0	0	20,000[Ei]
potassium	870	860	980	940	0	0	NA
thallium	4	ND	ND	ND	0	1	0.4[A]

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
Note: Only Aluminum was detected in any of the filtered (dissolved metals) samples.
ND -- Not Detected - for medians, in more than ½ of the samples
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:

A -- U.S. EPA Drinking Water Lifetime Health Advisory (11)

Table 16. Schedule of MDEQ monitoring of Alpena Municipal Water.

Analysis	Schedule	Latest analysis
partial chemical analysis (nitrates, nitrites, fluoride, chloride, hardness, iron, sulfate, and sodium)	annual	June 15, 1999
volatile organic chemicals	annual	June 15, 1999
pesticides and other synthetic organic chemicals	every 3 years	July 30, 1998
trihalomethanes and haloacetic acids (from 4 locations in distribution system)	quarterly	December 20, 1999
metals	every 3 years	June 15, 1999
radiological contaminants	every 4 years	October 26, 1998

Reference: 26, 27

The sampling dates in Table 17 do not necessarily agree with the schedule described here. Special samples might be collected at any time at a specific request. Analysis of samples collected this year might not be complete as of this writing.

Table 17. Concentrations of chemicals in water samples collected from the Alpena City water system during routine or investigative sampling by the MDPH and MDEQ, March 1995-December 1999.

Chemical	Date	Range of Concentrations (ppb)		MCL (Ref. 11) (ppb)
		Plant Tap	Public Distribution	
chlorodibromomethane	3/22/95	1.3	NS	
	6/15/95	0.8	trace	
	8/31/95	NS	ND	
	12/15/95	NS	ND	
	1/12/96	2	NS	
	5/30/96	0.4	NS	
	6/13/96	NS	trace	

	9/4/96	ND	NS	
	3/20/97	0.6	NS	
	4/23/97	trace	NS	
	6/13/97	1.5	0.6	
	6/16/98	NS	1.3	
	7/29/98	1.4	NS	
	2/8/99	NS	trace	
	2/23/99	NS	0.4-0.5	
	5/25/99	NS	0.6	
	6/15/99	trace	NS	
	8/23/99	NS	0.9-1.4	
	11/22/99	NS	0.6-0.9	
	12/20/99	0.4	0.4	
chloroform	3/22/95	109	NS	
	6/15/95	15.8	19	
	8/31/95	NS	44.9	
	12/15/95	NS	7.7	
	1/12/96	60.6	NS	
	5/30/96	43.9	NS	
	6/13/96	NS	40.7	
	9/4/96	3.5	NS	
	3/20/97	NS	26.4	
	4/23/97	13.9	NS	
	6/13/97	68.6	23.3	
	6/16/98	NS	23.1	
	7/29/98	15.9	NS	
	2/8/99	NS	14.5	
	2/23/99	NS	10.7-14.6	
	5/25/99	NS	2.2-3	
	6/15/99	2.1	NS	
	8/23/99	NS	15.1-19.1	
	11/22/99	NS	6.8-8.1	
	12/20/99	8.2	9.2	

dichlorobromomethane	3/22/95	11.6	NS	
	6/15/95	5.4	2.6	
	8/31/95	NS	4	
	12/15/95	NS	1.8	
	1/12/96	9.6	NS	
	5/30/96	5.4	NS	
	6/13/96	NS	4.8	
	9/4/96	0.5	NS	
	3/20/97	NS	5	
	4/23/97	3	NS	
	6/13/97	10.4	4.3	
	6/16/98	NS	7.3	
	7/29/98	6.7	NS	
	2/8/99	NS	3.1	
	2/23/99	NS	3.2-4	
	5/25/99	NS	0.6-1.1	
	6/15/99	0.5	NS	
	8/23/99	NS	3.7-4.6	
	11/22/99	NS	2.6-3	
	12/20/99	2.5	2.6	
Total trihalomethanes	3/22/95	122	NS	100
	6/15/95	22	21.6	
	8/31/95	NS	48.9	
	12/15/95	NS	9.5	
	1/12/96	72.2	NS	
	5/30/96	49.7	NS	
	6/13/96	NS	45.5	
	9/4/96	4	NS	
	3/20/97	NS	32	
	4/23/97	16.9	NS	
	6/13/97	80.5	28.2	
	6/16/98	NS	31.7	
	7/29/98	24	NS	

	2/8/99	NS	17.6	
	2/23/99	NS	14.3-19.1	
	5/25/99	NS	3.7-4.7	
	6/15/99	2.6	NS	
	8/23/99	NS	19.7-24.6	
	11/22/99	NS	10-12	
	12/20/99	11.1	12.2	
arsenic	6/15/95	1.2	NS	50
	11/02/95	ND	NS	
	5/30/96	ND	NS	
	6/15/99	ND	NS	
barium	6/15/95	ND	NS	2,000
	11/02/95	30	NS	
	5/30/96	ND	NS	
	6/15/99	ND	NS	
chromium	6/15/95	ND	NS	100
	11/02/95	ND	NS	
	5/30/96	1	NS	
	6/15/99	ND	NS	
sodium	6/15/95	ND	NS	160,000[A]
	5/30/96	6,000	NS	
	7/29/98	5,000	NS	
	6/15/99	5,000	NS	
bis(2-ethylhexyl)phthalate	12/15/95	0.7	NS	6
dibromoacetic acid	2/23/99	NS	ND	60[B]
	5/25/99	NS	trace	
	8/31/99	NS	ND	
	11/22/99	NS	ND	
dichloroacetic acid	2/23/99	NS	3-5	60[B]
	5/25/99	NS	ND	
	8/31/99	NS	trace	
	11/22/99	NS	trace	
trichloroacetic acid	2/23/99	NS	6-8	60[B]

	5/25/99	NS	trace	
	8/31/99	NS	3	
	11/22/99	NS	3-5	
gross alpha radiation (pCi/L)	10/26/98	1	NS	15

Reference: 25
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected
NS -- Not Sampled
trace -- Detected, but the concentration was not quantifiable

Table 18. Concentrations of metals in sediment samples collected from Thunder Bay off the cement kiln dust pile behind the Lafarge Corporation Alpena Plant during the IRIA, September-October 1997.

Chemical	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
	Maximum	Median			
arsenic	53	4	0	15	0.6^{E}, 0.47^{C}
barium	170	29	0	0	140^{R}
beryllium	2.2	0.21	0	0	10^{R}, 0.16^{C}
bismuth	2.1	ND	0	0	NA
chromium	34	5.3	0	0	6^{R}, carcinogen (VI)
copper	40	5.6	0	0	NA
lead	150	11	0	0	carcinogen
manganese	480	200	0	0	NA
mercury	0.23	ND	0	0	NA
nickel	49	12	0	0	40^{R}, carcinogen
selenium	7.9	ND	0	0	10^{E}
silver	2.5	ND	0	0	10^{R}

thallium	9.7	0.5	0	0	NA

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected - for medians, in more than ½ of the samples
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Next Section **Table of Contents**

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

APPENDIX B

Table 19. Concentrations of metals in sediment samples collected from Squaw Bay and Misery Bay (see Figure 3) during the IRIA, September-October 1997.

Chemical	Concentration (ppm)		No. of samples above MDEQ Industrial/Commercial Criteria (Ref. 13)	No. of samples above MDEQ Residential Criteria (Ref. 13)	Comparison Value (ppm)
	Maximum	Median			
arsenic	1.2	1	0	0	0.6^{E}, 0.47^{C}
barium	3.2	3.2	0	0	140^{R}
beryllium	ND	ND	ND	ND	10^{R}, 0.16^{C}

bismuth	ND	ND	ND	ND	NA
chromium	ND	ND	ND	ND	6[R], carcinogen (VI)
copper	1.1	ND	0	0	NA
lead	1.6	1.2	0	0	carcinogen
manganese	48	27	0	0	NA
mercury	0.11	ND	0	0	NA
nickel	3.7	2	0	0	40[R], carcinogen
selenium	ND	ND	ND	ND	10[E]
silver	ND	ND	ND	ND	10[R]
thallium	ND	ND	ND	ND	NA

Reference: 3
Shaded chemicals exceeded ATSDR Comparison Values
ND -- Not Detected - for medians, in more than ½ of the samples
(VI) -- For chromium(VI)
NA -- None Available
carcinogen -- Carcinogen (proven, probable, or possible) but no CREG available
Comparison Value Bases:
E -- ATSDR Environmental Media Evaluation Guides (EMEGs), chronic exposure
R -- ATSDR Reference Dose Media Evaluation Guides (RMEGs), calculated from U.S. EPA Reference Dose
C -- ATSDR Cancer Risk Evaluation Guides (CREGs)

Table 20. Concentrations of contaminants in fish collected from Thunder Bay by the MDNR, 1983-1998.

Species	Chemical	Date	Sample type	Concentration (ppm)		Reference	MDCH First Level of Concern (ppm)
				Maximum	Median		
alewife	alpha-chlordane	6/13/93	W	0.013	0.012	36	
	gamma-chlordane	6/13/93	W	0.004	0.004	36	
	cis-nonachlor	6/13/93	W	0.022	0.018	36	
	trans-nonachlor	6/13/93	W	0.028	0.023	36	0.3[A]

	oxy-chlordane	6/13/93	W	0.003	0.003	36	
	total chlordane	6/13/93	W	0.062	0.059	36	
	4,4'-DDD	6/13/93	W	0.007	0.007	36	
	4,4'-DDE	6/13/93	W	0.131	0.118	36	
	4,4'-DDT	6/13/93	W	0.014	0.013	36	
	total DDT	6/13/93	W	0.152	0.137	36	5[A]
	dieldrin	6/13/93	W	0.025	0.024	36	0.3[A]
	heptachlor epoxide	6/13/93	W	0.006	0.005	36	0.3[A]
	hexachlorobenzene	6/13/93	W	0.003	0.003	36	0.2-0.5[B]
	mercury	6/13/93	W	0.06	0.05	36	0.5[C]
	PCBs (total)	6/13/93	W	0.264	0.264	36	0.05[D]
	toxaphene	6/13/93	W	0.15	0.138	36	10[A]
brown trout	alpha-chlordane	10/10/85	F	0.04	0.04	37	
		10/15/90	F	0.023	0.014	38	
		6/19/91	F	0.029	0.015	39	
		6/1/92	F	0.013	0.010	35	
		8/12-25/93	F	0.017	0.012	36	
	gamma-chlordane	10/10/85	F	0.02	0.01	37	
		10/15/90	F	0.017	ND	38	
		6/19/91	F	0.012	0.004	39	
		6/1/92	F	0.004	0.003	35	
		8/12-25/93	F	0.004	ND	36	
	cis-nonachlor	10/10/85	F	0.02	0.02	37	
		10/15/90	F	0.058	0.024	38	
		6/19/91	F	0.026	0.017	39	0.3[A]

		6/1/92	F	0.036	0.026	35	
		8/12-25/93	F	0.033	0.029	36	
	trans-nonachlor	10/10/85	F	0.05	0.05	37	
		10/15/90	F	0.068	0.053	38	
		6/19/91	F	0.068	0.046	39	
		6/1/92	F	0.081	0.061	35	
		8/12-25/93	F	0.054	0.044	36	
	oxy-chlordane	10/10/85	F	0.04	0.04	37	
		10/15/90	F	0.015	0.009	38	
		6/19/91	F	0.011	0.009	39	
		6/1/92	F	0.014	0.009	35	
		8/12-25/93	F	0.014	0.011	36	
	total chlordane	10/10/85	F	0.17	0.16	37	
		10/15/90	F	0.171	0.101	38	
		6/19/91	F	0.146	0.087	39	
	total chlordane	6/1/92	F	0.144	0.109	35	
		8/12-25/93	F	0.151	0.093	36	
	copper	7/23/86	F	5.7	0.6	40	10-100[B]
	4,4'-DDD	10/10/85	F	ND	ND	37	
		10/15/90	F	0.043	0.029	38	
		6/19/91	F	0.034	0.023	39	
		6/1/92	F	0.041	0.025	35	
		8/12-	F	0.027	0.023	36	5[A]

		25/93					
	4,4'-DDE	10/10/85	F	0.27	0.25	37	
		10/15/90	F	0.362	0.198	38	
		6/19/91	F	0.260	0.175	39	
		6/1/92	F	0.283	0.243	35	
		8/12-25/93	F	0.313	0.275	36	
	4,4'-DDT	10/10/85	F	0.04	0.03	37	
		10/15/90	F	0.042	0.029	38	
		6/19/91	F	0.078	0.025	39	
		6/1/92	F	0.038	0.031	35	
		8/12-25/93	F	0.033	0.027	36	
	total DDT	10/10/85	F	0.30	0.28	37	
		10/15/90	F	0.447	0.263	38	
		6/19/91	F	0.371	0.226	39	
		6/1/92	F	0.351	0.296	35	
		8/12-25/93	F	0.367	0.329	36	
	dieldrin	10/10/85	F	0.05	0.03	37	0.3[A]
		10/15/90	F	0.039	0.033	38	
		6/19/91	F	0.054	0.047	39	
		6/1/92	F	0.040	0.032	35	
		8/12-25/93	F	0.055	0.049	36	
	heptachlor epoxide	10/15/90	F	0.011	0.007	38	0.3[A]

		6/19/91	F	0.013	0.010	39	
		6/1/92	F	0.011	0.007	35	
		8/12-25/93	F	0.013	0.011	36	
	hexachlorobenzene	10/15/90	F	0.006	0.004	38	0.2-0.5[B]
		6/19/91	F	0.006	0.005	39	
		6/1/92	F	0.016	0.004	35	
		8/12-25/93	F	0.006	0.005	36	
	mercury	7/23/86	F	0.17	0.14	40	0.5[C]
		10/15/90	F	0.17	0.1	38	
		6/19/91	F	0.12	0.1	39	
		6/1/92	F	0.16	0.13	35	
		8/12-25/93	F	0.17	0.13	36	
	octachlorostyrene	10/15/90	F	0.003	0.002	38	NA
		6/19/91	F	0.003	0.001	39	
		6/1/92	F	0.011	0.003	35	
		8/12-25/93	F	0.005	0.003	36	
	PCBs (total)	10/10/85	F	1.61	1.49	37	0.05[D]
		7/23/86	F	2.77	1.94	40	
		10/15/90	F	0.884	0.595	38	
		6/19/91	F	0.790	0.460	39	
		6/1/92	F	0.944	0.675	35	
		8/12-25/93	F	0.855	0.764	36	
	toxaphene	10/15/90	F	0.425	0.25	38	10[A]
		6/19/91	F	0.5	0.25	39	

		6/1/92	F	0.3	0.2	35	
		8/12-25/93	F	0.325	0.3	36	
	zinc	7/23/86	F	7.0	5.0	40	30-1,000[B]
carp	alpha-chlordane	6/29/89	Fs	0.050	0.027	41	
		6/4/92	W	0.016	0.008	35	
		6/14/93	Fs	0.034	0.015	36	
		6/27/94	W	0.054	0.025	36	
		6/16/95	W	0.016	0.013	42	
	gamma-chlordane	6/29/89	Fs	0.023	0.011	41	
		6/4/92	W	0.006	ND	35	
		6/14/93	Fs	0.008	0.005	36	
		6/27/94	W	ND	ND	36	
		6/16/95	W	0.005	0.005	42	
	cis-nonachlor	6/29/89	Fs	0.045	0.020	41	
		6/4/92	W	0.038	0.032	35	
		6/14/93	Fs	0.040	0.025	36	
		6/27/94	W	0.023	0.018	36	
		6/16/95	W	0.023	0.017	42	
	trans-nonachlor	6/29/89	Fs	0.058	0.028	41	
		6/4/92	W	0.111	0.038	35	
		6/14/93	Fs	0.059	0.034	36	
		6/27/94	W	0.084	0.044	36	
		6/16/95	W	0.042	0.026	42	
	oxy-chlordane	6/29/89	Fs	0.021	0.007	41	
		6/4/92	W	0.014	0.004	35	
		6/14/93	Fs	0.020	0.007	36	
		6/27/94	W	0.015	0.005	36	
		6/16/95	W	0.009	0.003	42	
	total chlordane	6/29/89	Fs	0.187	0.103	41	
		6/4/92	W	0.161	0.094	35	
		6/14/93	Fs	0.151	0.093	36	0.3[A]
		6/27/94	W	0.136	0.080	36	

		6/16/95	W	0.087	0.064	42	
	4,4'-DDD	6/29/89	Fs	0.179	0.109	41	
		6/4/92	W	0.120	0.062	35	
		6/14/93	Fs	0.098	0.063	36	
		6/27/94	W	0.065	0.051	36	
		6/16/95	W	0.050	0.041	42	
	4,4'-DDE	6/29/89	Fs	1.016	0.541	41	
		6/4/92	W	1.020	0.203	35	
		6/14/93	Fs	1.290	0.465	36	
		6/27/94	W	0.682	0.456	36	
		6/16/95	W	0.714	0.363	42	
	4,4'-DDT	6/29/89	Fs	0.046	0.007	41	
		6/4/92	W	0.050	0.017	35	
		6/14/93	Fs	0.047	0.015	36	
		6/27/94	W	0.048	0.011	36	
		6/16/95	W	0.074	0.020	42	
	total DDT	6/29/89	Fs	1.241	0.658	41	
		6/4/92	W	1.146	0.264	35	
		6/14/93	Fs	1.405	0.534	36	
		6/27/94	W	0.749	0.510	36	5[A]
		6/16/95	W	0.826	0.431	42	
	dieldrin	6/29/89	Fs	0.027	0.010	41	0.3[A]
		6/4/92	W	0.033	0.019	35	
		6/14/93	Fs	0.041	0.015	36	
		6/27/94	W	0.023	0.015	36	
		6/16/95	W	0.028	0.019	42	
	heptachlor epoxide	6/29/89	Fs	0.018	0.006	41	0.3[A]
		6/4/92	W	0.013	0.004	35	
		6/14/93	Fs	0.021	0.008	36	
		6/27/94	W	0.014	0.008	36	
		6/16/95	W	0.010	0.004	42	
	heptachlorostyrene	6/29/89	Fs	ND	ND	41	NA
		6/4/92	W	ND	ND	35	

		6/14/93	Fs	0.003	ND	36	
		6/27/94	W	ND	ND	36	
		6/16/95	W	ND	ND	42	
	hexachlorobenzene	6/29/89	Fs	0.006	0.003	41	0.2-0.5[B]
		6/4/92	W	0.004	0.002	35	
		6/14/93	Fs	0.009	0.003	36	
		6/27/94	W	0.003	0.002	36	
		6/16/95	W	0.004	0.002	42	
	hexachlorostyrene	6/29/89	Fs	ND	ND	41	NA
		6/4/92	W	ND	ND	35	
		6/14/93	Fs	0.002	ND	36	
		6/27/94	W	ND	ND	36	
		6/16/95	W	ND	ND	42	
	mercury	6/29/89	Fs	0.19	0.12	41	0.5[C]
		6/4/92	W	0.17	0.11	35	
		6/14/93	Fs	0.41	0.17	36	
		6/27/94	W	0.13	0.045	36	
		6/16/95	W	0.16	0.13	42	
	octachlorostyrene	6/29/89	Fs	0.013	0.003	41	NA
		6/4/92	W	0.006	0.001	35	
		6/14/93	Fs	0.034	0.007	36	
		6/27/94	W	0.006	0.004	36	
		6/16/95	W	0.006	0.002	42	
	PCBs (total)	6/29/89	Fs	3.76	1.41	41	0.05[D]
		6/4/92	W	2.15	0.590	35	
		6/14/93	Fs	3.19	1.695	36	
		6/27/94	W	3.12	2.09	36	
		6/16/95	W	1.89	1.125	42	
	pentachlorostyrene	6/29/89	Fs	ND	ND	41	NA
		6/4/92	W	ND	ND	35	
		6/14/93	Fs	0.012	0.005	36	
		6/27/94	W	ND	ND	36	
		6/16/95	W	ND	ND	42	

	toxaphene	6/29/89	Fs	0.3	0.15	41	10[A]
		6/4/92	W	0.5	ND	35	
		6/14/93	Fs	0.125	ND	36	
		6/27/94	W	ND	ND	36	
		6/16/95	W	ND	ND	42	
channel catfish	alpha-chlordane	6/29/89	Fs	0.020	--	41	
		10/12/93	Fs	0.123	0.081	36	
	gamma-chlordane	6/29/89	Fs	0.009	--	41	
		10/12/93	Fs	0.054	0.034	36	
	cis-nonachlor	6/29/89	Fs	0.019	--	41	
		10/12/93	Fs	0.125	0.085	36	
	trans-nonachlor	6/29/89	Fs	0.022	--	41	
		10/12/93	Fs	0.294	0.199	36	
	oxy-chlordane	6/29/89	Fs	0.005	--	41	
		10/12/93	Fs	0.033	0.025	36	
	total chlordane	6/29/89	Fs	0.075	--	41	
		10/12/93	Fs	0.629	0.423	36	0.3[A]
	4,4'-DDD	6/29/89	Fs	0.064	--	41	
		10/12/93	Fs	0.348	0.204	36	
	4,4'-DDE	6/29/89	Fs	0.229	--	41	
		10/12/93	Fs	2.340	1.357	36	
	4,4'-DDT	6/29/89	Fs	0.021	--	41	
		10/12/93	Fs	0.096	0.067	36	
	total DDT	6/29/89	Fs	0.314	--	41	
		10/12/93	Fs	2.784	1.628	36	5[A]

	dieldrin	6/29/89	Fs	0.032	--	41	0.3[A]
		10/12/93	Fs	0.070	0.066	36	
	heptachlor epoxide	6/29/89	Fs	0.008	--	41	0.3[A]
		10/12/93	Fs	0.016	0.015	36	
	hexachlorobenzene	6/29/89	Fs	0.004	--	41	0.2-0.5[B]
		10/12/93	Fs	0.009	0.008	36	
	mercury	6/29/89	Fs	0.09	--	41	0.5[C]
		10/12/93	Fs	0.51	0.34	36	
	octachlorostyrene	6/29/89	Fs	0.005	--	41	NA
		10/12/93	Fs	0.032	0.019	36	
	PCBs (total)	6/29/89	Fs	1.4	--	41	0.05[D]
		10/12/93	Fs	31.8	16.6	36	
	toxaphene	6/29/89	Fs	0.25	--	41	10[A]
		10/12/93	Fs	0.75	0.513	36	
chub	alpha-chlordane	6/22-23/93	Fs	0.016	0.015	36	
		6/23/93	W	0.030	0.020	36	
	gamma-chlordane	6/22-23/93	Fs	0.005	0.005	36	
		6/23/93	W	0.010	ND	36	
	cis-nonachlor	6/22-23/93	Fs	0.019	0.016	36	
		6/23/93	W	0.020	0.015	36	
	trans-nonachlor	6/22-23/93	Fs	0.029	0.025	36	
		6/23/93	W	0.035	0.024	36	
	oxy-chlordane	6/22-23/93	Fs	0.012	0.010	36	0.3[A]

		6/23/93	W	0.008	0.006	36	
	total chlordane	6/22-23/93	Fs	0.081	0.071	36	
		6/23/93	W	0.103	0.069	36	
	4,4'-DDD	6/22-23/93	Fs	0.014	0.011	36	
		6/23/93	W	0.012	0.010	36	
	4,4'-DDE	6/22-23/93	Fs	0.113	0.102	36	
		6/23/93	W	0.169	0.107	36	
	4,4'-DDT	6/22-23/93	Fs	0.014	0.014	36	
		6/23/93	W	0.034	0.024	36	
	total DDT	6/22-23/93	Fs	0.141	0.127	36	
		6/23/93	W	0.215	0.141	36	5[A]
	dieldrin	6/22-23/93	Fs	0.046	0.041	36	0.3[A]
		6/23/93	W	0.034	0.025	36	
	heptachlor epoxide	6/22-23/93	Fs	0.016	0.014	36	0.3[A]
		6/23/93	W	0.019	0.013	36	
	hexachlorobenzene	6/22-23/93	Fs	0.002	0.002	36	0.2-0.5[B]
		6/23/93	W	0.001	ND	36	
	mercury	6/22-23/93	Fs	0.08	0.08	36	0.5[C]
		6/23/93	W	0.04	0.04	36	
	octachlorostyrene	6/22-23/93	Fs	ND	ND	36	NA
		6/23/93	W	0.004	ND	36	
	PCBs (total)	6/22-23/93	Fs	0.234	0.207	36	0.05[D]
		6/23/93	W	0.301	0.193	36	
	toxaphene	6/22-	Fs	0.175	0.163	36	10[A]

		23/93					
		6/23/93	W	0.275	0.188	36	
lake trout	alpha-chlordane	6/4/92	W	0.059	0.043	35	
		6/14/93	F	0.056	0.034	36	
		6/27/94	W	0.067	0.034	36	
		6/16/95	W	0.061	0.041	42	
		6/26/96	F	0.038	0.022	42	
		8/22/98	W	0.047	0.017	43	
	gamma-chlordane	6/4/92	W	0.021	0.011	35	
		6/14/93	F	0.020	0.010	36	
		6/27/94	W	0.025	0.010	36	
		6/16/95	W	0.025	0.014	42	
		6/26/96	F	0.014	0.007	42	
		8/22/98	W	0.013	0.003	43	
	cis-nonachlor	6/4/92	W	0.081	0.059	35	
		6/14/93	F	0.070	0.054	36	
		6/27/94	W	0.084	0.049	36	
		6/16/95	W	0.068	0.043	42	
		6/26/96	F	0.046	0.026	42	
		8/22/98	W	0.057	0.028	43	
	trans-nonachlor	6/4/92	W	0.199	0.131	35	
		6/14/93	F	0.148	0.112	36	
		6/27/94	W	0.132	0.086	36	
		6/16/95	W	0.125	0.078	42	
		6/26/96	F	0.081	0.048	42	
		8/22/98	W	0.113	0.048	43	
	oxy-chlordane	6/4/92	W	0.032	0.027	35	
		6/14/93	F	0.024	0.020	36	
		6/27/94	W	0.030	0.014	36	
		6/16/95	W	0.024	0.015	42	
		6/26/96	F	0.013	0.008	42	
		8/22/98	W	0.020	0.009	43	0.3[A]
	total chlordane	6/4/92	W	0.376	0.281	35	

		6/14/93	F	0.305	0.193	36	
		6/27/94	W	0.301	0.191	36	
		6/16/95	W	0.278	0.180	42	
		6/26/96	F	0.177	0.110	42	
		8/22/98	W	0.228	0.109	43	
	4,4'-DDD	6/4/92	W	0.088	0.055	35	
		6/14/93	F	0.053	0.036	36	
		6/27/94	W	0.050	0.032	36	
		6/16/95	W	0.053	0.034	42	
		6/26/96	F	0.036	0.024	42	
		8/22/98	W	0.040	0.024	43	
	4,4'-DDE	6/4/92	W	0.890	0.489	35	
		6/14/93	F	0.611	0.438	36	
		6/27/94	W	0.618	0.438	36	
		6/16/95	W	0.723	0.419	42	
		6/26/96	F	0.487	0.236	42	
		8/22/98	W	0.527	0.315	43	
	4,4'-DDT	6/4/92	W	0.118	0.078	35	
		6/14/93	F	0.075	0.062	36	
		6/27/94	W	0.090	0.060	36	
		6/16/95	W	0.104	0.049	42	
		6/26/96	F	0.068	0.041	42	
		8/22/98	W	0.077	0.033	43	
	total DDT	6/4/92	W	1.096	0.613	35	
		6/14/93	F	0.712	0.488	36	
		6/27/94	W	0.758	0.527	36	
		6/16/95	W	0.853	0.515	42	5[A]
		6/26/96	F	0.582	0.306	42	
		8/22/98	W	0.628	0.367	43	
	dieldrin	6/4/92	W	0.136	0.088	35	0.3[A]
		6/14/93	F	0.092	0.056	36	
		6/27/94	W	0.124	0.059	36	
		6/16/95	W	0.128	0.063	42	

		6/26/96	F	0.059	0.050	42	
		8/22/98	W	0.077	0.043	43	
	dioxins and furans (total)	1983-88	W	0.000141	0.000069	35	
		6/4/92	W	0.000064	0.000052	42	
		6/14/93	F	0.000057	0.000040	44	
		6/27/94	W	0.000061	0.000039	44	
		8/22/98	W	0.000060	0.000045	43	
	2,3,7,8-TCDD	1983-88	W	0.000015	0.000010	35	
		6/4/92	W	0.000008	0.000005	42	
		6/14/93	F	0.000005	0.000004	44	
		6/27/94	W	0.000005	0.000004	44	
		8/22/98	W	0.000004	0.000003	43	
	TEQ	1983-88	W	0.000038	0.000026	35	
		6/4/92	W	0.000022	0.000013	42	
		6/14/93	F	0.000017	0.000012	44	
		6/27/94	W	0.000018	0.000013	44	0.000010[B]
		8/22/98	W	0.000016	0.000012	43	
	heptachlor epoxide	6/4/92	W	0.038	0.019	35	0.3[A]
		6/14/93	F	0.023	0.013	36	
		6/27/94	W	0.033	0.015	36	
		6/16/95	W	0.028	0.014	42	

		6/26/96	F	0.012	0.010	42	
		8/22/98	W	0.014	0.007	43	
	hexachlorobenzene	6/4/92	W	0.011	0.009	35	0.2-0.5[B]
		6/14/93	F	0.009	0.006	36	
		6/27/94	W	0.011	0.006	36	
		6/16/95	W	0.061	0.008	42	
		6/26/96	F	0.006	0.004	42	
		8/22/98	W	0.006	0.005	43	
	mercury	6/4/92	W	0.17	0.13	35	0.5[C]
		6/14/93	F	0.30	0.19	36	
		6/27/94	W	0.28	0.165	36	
		6/16/95	W	0.22	0.145	42	
		6/26/96	F	0.28	0.14	42	
		8/22/98	W	0.19	0.14	43	
	octachlorostyrene	6/4/92	W	0.007	0.003	35	NA
		6/14/93	F	0.004	0.003	36	
		6/27/94	W	0.005	0.003	36	
		6/16/95	W	0.004	0.003	42	
		6/26/96	F	0.002	0.002	42	
		8/22/98	W	0.003	0.002	43	
	PCBs (total)	6/4/92	W	2.04	1.19	35	0.05[D]
		6/14/93	F	1.39	1.024	36	
		6/27/94	W	1.80	1.335	36	
		6/16/95	W	1.68	1.09	42	
		6/26/96	F	1.20	0.637	42	
		8/22/98	W	1.22	1.003	43	
	toxaphene	6/4/92	W	2.0	1.2	35	10[A]
		6/14/93	F	0.475	0.350	36	
		6/27/94	W	0.775	0.413	36	
		6/16/95	W	0.70	0.50	42	
		6/26/96	F	0.525	0.338	42	
		8/22/98	W	0.55	0.35	43	
lake	alpha-chlordane	6/1/92	F	0.017	0.014	35	0.3[A]

whitefish		6/26/96	F	0.023	0.008	42	
		8/20/98	F	0.009	0.006	43	
	gamma-chlordane	6/1/92	F	0.009	0.007	35	
		6/26/96	F	0.010	0.004	42	
		8/20/98	F	0.005	ND	43	
	cis-nonachlor	6/1/92	F	0.019	0.016	35	
		6/26/96	F	0.036	0.015	42	
		8/20/98	F	0.026	0.014	43	
	trans-nonachlor	6/1/92	F	0.061	0.034	35	
		6/26/96	F	0.083	0.041	42	
		8/20/98	F	0.064	0.022	43	
	oxy-chlordane	6/1/92	F	0.017	0.011	35	
		6/26/96	F	0.018	0.010	42	
		8/20/98	F	0.014	0.008	43	
	total chlordane	6/1/92	F	0.104	0.086	35	
		6/26/96	F	0.145	0.083	42	
		8/20/98	F	0.110	0.059	43	
	4,4'-DDD	6/1/92	F	0.021	0.016	35	
		6/26/96	F	0.022	0.014	42	
		8/20/98	F	0.018	0.01	43	
	4,4'-DDE	6/1/92	F	0.255	0.110	35	
		6/26/96	F	0.246	0.158	42	
		8/20/98	F	0.262	0.118	43	
	4,4'-DDT	6/1/92	F	0.037	0.031	35	
		6/26/96	F	0.061	0.033	42	
		8/20/98	F	0.051	0.028	43	
	total DDT	6/1/92	F	0.312	0.156	35	
		6/26/96	F	0.329	0.203	42	
		8/20/98	F	0.32	0.156	43	5[A]
	dieldrin	6/1/92	F	0.109	0.067	35	0.3[A]
		6/26/96	F	0.049	0.032	42	
		8/20/98	F	0.047	0.014	43	
	dioxins and furans (total)	8/20/98	F	0.000064	0.000032	43	0.000010[E]

	2,3,7,8-TCDD	8/20/98	F	0.000004	0.000002	43	
	TEQ	8/20/98	F	0.000017	0.000008	43	
	heptachlor epoxide	6/1/92	F	0.046	0.025	35	0.3[A]
		6/26/96	F	0.021	0.014	42	
		8/20/98	F	0.018	0.005	43	
	hexachlorobenzene	6/1/92	F	0.022	0.006	35	0.2-0.5[B]
		6/26/96	F	0.005	0.004	42	
		8/20/98	F	0.004	0.003	43	
	mercury	6/1/92	F	0.07	0.05	35	0.5[C]
		6/26/96	F	0.17	0.08	42	
		8/20/98	F	0.17	0.085	43	
	octachlorostyrene	6/1/92	F	0.003	ND	35	NA
		6/26/96	F	0.001	ND	42	
		8/20/98	F	0.002	ND	43	
	PCBs (total)	6/1/92	F	0.403	0.235	35	0.05[D]
		6/26/96	F	0.620	0.293	42	
		8/20/98	F	0.738	0.265	43	
	toxaphene	6/1/92	F	0.25	0.2	35	10[A]
		6/26/96	F	0.25	0.15	42	
		8/20/98	F	0.175	0.1	43	
spottail shiner	cis-nonachlor	9/15/95	W	0.005	0.004	42	0.3[A]
	trans-nonachlor	9/15/95	W	0.010	0.007	42	
	total chlordane	9/15/95	W	0.012	0.010	42	
	4,4'-DDD	9/15/95	W	0.010	0.009	42	5[A]
	4,4'-DDE	9/15/95	W	0.025	0.025	42	
	total DDT	9/15/95	W	0.035	0.034	42	
	mercury	9/15/95	W	0.03	0.03	42	0.5[C]
	PCBs (total)	9/15/95	W	0.110	0.093	42	0.05[D]
walleye	alpha-chlordane	6/29/89	F	0.021	0.003	41	0.3[A]
		6/25/91	W	0.087	0.041	39	
		6/14/93	F	0.012	ND	36	
		6/16/95	W	0.055	0.015	42	

		9/15/95	W	0.106	0.027	42	
		8/22/98	W	0.055	0.026	43	
	gamma-chlordane	6/29/89	F	0.006	ND	41	
		6/25/91	W	0.030	0.012	39	
		6/14/93	F	0.003	ND	36	
		6/16/95	W	0.016	0.005	42	
		9/15/95	W	0.035	0.010	42	
		8/22/98	W	0.015	0.007	43	
	cis-nonachlor	6/29/89	F	0.022	0.003	41	
		6/25/91	W	0.091	0.034	39	
		6/14/93	F	0.016	ND	36	
		6/16/95	W	0.061	0.014	42	
		9/15/95	W	0.133	0.036	42	
		8/22/98	W	0.069	0.036	43	
	trans-nonachlor	6/29/89	F	0.034	0.006	41	
		6/25/91	W	0.231	0.121	39	
		6/14/93	F	0.032	0.010	36	
		6/16/95	W	0.124	0.038	42	
		9/15/95	W	0.198	0.073	42	
		8/22/98	W	0.153	0.063	43	
	oxy-chlordane	6/29/89	F	0.006	ND	41	
		6/25/91	W	0.024	0.014	39	
		6/14/93	F	0.004	ND	36	
		6/16/95	W	0.015	0.004	42	
		9/15/95	W	0.036	0.010	42	
		8/22/98	W	0.015	0.008	43	
	total chlordane	6/29/89	F	0.089	0.013	41	
		6/25/91	W	0.463	0.213	39	
		6/14/93	F	0.063	0.016	36	
		6/16/95	W	0.271	0.071	42	
		9/15/95	W	0.508	0.140	42	
		8/22/98	W	0.306	0.141	43	
	4,4'-DDD	6/29/89	F	0.020	0.005	41	5[A]

		6/25/91	W	0.128	0.058	39	
		6/14/93	F	0.012	ND	36	
		6/16/95	W	0.053	0.018	42	
		9/15/95	W	0.345	0.077	42	
		8/22/98	W	0.08	0.044	43	
	4,4'-DDE	6/29/89	F	0.216	0.028	41	
		6/25/91	W	1.45	0.485	39	
		6/14/93	F	0.138	0.044	36	
		6/16/95	W	0.755	0.227	42	
		9/15/95	W	1.080	0.458	42	
		8/22/98	W	0.873	0.424	43	
	4,4'-DDT	6/29/89	F	0.038	0.005	41	
		6/25/91	W	0.148	0.044	39	
		6/14/93	F	0.019	ND	36	
		6/16/95	W	0.087	0.021	42	
		9/15/95	W	0.201	0.050	42	
		8/22/98	W	0.081	0.036	43	
	total DDT	6/29/89	F	0.274	0.038	41	
		6/25/91	W	1.73	0.558	41	
		6/14/93	F	0.168	0.050	39	
		6/16/95	W	0.895	0.248	36	
		9/15/95	W	1.626	0.588	42	
		8/22/98	W	1.034	0.500	43	
	dieldrin	6/29/89	F	0.020	0.006	41	0.3[A]
		6/25/91	W	0.067	0.048	39	
		6/14/93	F	0.011	0.006	36	
		6/16/95	W	0.041	0.017	42	
		9/15/95	W	0.075	0.040	42	
		8/22/98	W	0.03	0.02	43	
	heptachlor epoxide	6/29/89	F	0.004	ND	41	0.3[A]
		6/25/91	W	0.013	0.010	39	
		6/14/93	F	0.004	ND	36	
		6/16/95	W	0.006	ND	42	

		9/15/95	W	0.018	0.012	42	
		8/22/98	W	0.006	0.003	43	
	hexachlorobenzene	6/29/89	F	0.002	ND	41	0.2-0.5[B]
		6/25/91	W	0.009	0.006	39	
		6/14/93	F	0.001	ND	36	
		6/16/95	W	0.005	0.003	42	
		9/15/95	W	0.017	0.006	42	
		8/22/98	W	0.004	0.003	43	
	mercury	6/29/89	F	0.51	0.155	41	0.5[C]
		6/25/91	W	0.82	0.205	39	
		6/14/93	F	0.36	0.16	36	
		6/16/95	W	0.31	0.16	42	
		9/15/95	W	0.53	0.22	42	
		8/22/98	W	0.57	0.36	43	
	octachlorostyrene	6/29/89	F	0.002	ND	41	NA
		6/25/91	W	0.010	0.005	39	
		6/14/93	F	0.001	ND	36	
		6/16/95	W	0.004	0.001	42	
		9/15/95	W	0.080	0.008	42	
		8/22/98	W	0.008	0.004	43	
	PCBs (total)	6/29/89	F	0.577	0.094	41	0.05[D]
		6/25/91	W	3.93	1.695	39	
		6/14/93	F	0.310	0.117	36	
		6/16/95	W	1.93	0.677	42	
		9/15/95	W	7.74	1.32	42	
		8/22/98	W	3.121	1.403	43	
	toxaphene	6/29/89	F	0.35	0.063	41	10[A]
		6/25/91	W	1.1	0.475	39	
		6/14/93	F	0.125	0.05	36	
		6/16/95	W	0.75	0.238	42	
		9/15/95	W	1.24	0.40	42	
		8/22/98	W	0.600	0.375	43	

Shaded chemicals exceeded MDCH Levels of Concern
ND -- Not Detected - for medians, in more than ½ of the samples

NA -- None Available
-- = Not Relevant - only one sample collected.
W -- Whole fish samples
Fs -- Skin-off fillet samples
F -- Skin-on fillet samples
[A] U.S. FDA Tolerance Level
[B] International range of legal limits in fish (96). No MDCH or U.S. FDA Level of Concern.
[C] U.S. FDA Tolerance Level = 1.0 ppm
[D] U.S. FDA Tolerance Level = 2.0 ppm
[E] U.S. FDA Tolerance Level = 0.000025 ppm = 25 parts per trillion (ppt)

Table 21. Concentrations of contaminants in fish collected from Lake Besser on the Thunder Bay River by the MDNR, 1989-1993.

Species	Chemical	Date	Sample type	Concentration (ppm)		Reference	MDCH First Level of Concern (ppm)
				Maximum	Median		
carp	4,4'-DDD	6/29/89	Fs	0.037	0.010	41	
		10/15/93	W	0.078	0.051	45	
	4,4'-DDE	6/29/89	Fs	0.122	0.012	41	
		10/15/93	W	0.156	0.119	45	
	4,4'-DDT	6/29/89	Fs	ND	ND	41	
		10/15/93	W	0.006	ND	45	
	Total DDT	6/29/89	Fs	0.159	0.022	41	
		10/15/93	W	0.222	0.162	45	5[A]
	hexachlorobenzene	6/29/89	Fs	ND	ND	41	0.2-0.5[B]
		10/15/93	W	0.002	ND	45	
	mercury	6/29/89	Fs	0.14	ND	41	0.5[C]

		10/15/93	W	0.13	0.07	45	
	PCBs	6/29/89	Fs	0.065	ND	41	0.05[D]
		10/15/93	W	0.307	0.108	45	
redhorse sucker	4,4'-DDD	6/29/89	F	0.009	--	41	
	4,4'-DDE	6/29/89	F	0.017	--	41	
	4,4'-DDT	6/29/89	F	ND	--	41	
	Total DDT	6/29/89	F	0.026	--	41	5[A]
	hexachlorobenzene	6/29/89	F	ND	--	41	0.2-0.5[B]
	mercury	6/29/89	F	0.14	--	41	0.5[C]
	PCBs	6/29/89	F	ND	--	41	0.05[D]
smallmouth bass	4,4'-DDD	6/29/89	F	ND	ND	41	
	4,4'-DDE	6/29/89	F	0.008	0.005	41	
	4,4'-DDT	6/29/89	F	ND	ND	41	
	Total DDT	6/29/89	F	0.008	0.005	41	5[A]
	hexachlorobenzene	6/29/89	F	ND	ND	41	0.2-0.5[B]
	mercury	6/29/89	F	0.71	0.31	41	0.5[C]
	PCBs	6/29/89	F	ND	ND	41	0.05[D]
walleye	4,4'-DDD	6/29/89	F	0.007	ND	41	
	4,4'-DDE	6/29/89	F	0.038	0.016	41	
	4,4'-DDT	6/29/89	F	ND	ND	41	
	Total DDT	6/29/89	F	0.045	0.016	41	5[A]
	hexachlorobenzene	6/29/89	F	ND	ND	41	0.2-0.5[B]
	mercury	6/29/89	F	0.86	0.42	41	0.5[C]
	PCBs	6/29/89	F	0.067	ND	41	0.05[D]

Shaded chemicals exceeded MDCH Levels of Concern
ND -- Not Detected - for medians, in more than ½ of the samples
NA -- None Available
-- = Not Relevant - only one sample collected.
W -- Whole fish samples

Fs -- Skin-off fillet samples
F -- Skin-on fillet samples
[A] U.S. FDA Tolerance Level
[B] International range of legal limits in fish (96). No MDCH or U.S. FDA Level of Concern.
[C] U.S. FDA Tolerance Level = 1.0 ppm
[D] U.S. FDA Tolerance Level = 2.0 ppm
Next Section **Table of Contents**

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN

RESPONSIVENESS SUMMARY

The MDCH released a draft of this Public Health Assessment for public comment on April 27, 1999. The Public Comment Period lasted until May 27, 1999. The MDCH received extensive comments from an Alpena resident. Our responses to these comments are given below. Page numbers refer to the draft reviewed, and may have changed in this current draft.

General Comments:

Comment: *A complete examination and statistical analysis of death certificates of Alpena County would provide a considerable measure of confidence for the health assessment. I have reviewed Alpena County death certificates for 1975, 1989, 1990, and 1991. I am not a statistician.*

My review showed that about 42% of cement plant workers, who died in the years 1989, 1990, and 1991 died with cancer of one kind or another. I included leukemia as a cancer. Please note that I counted all WITH cancer at death. Some of these had another cause of death, but listed a cancer also. Most had cancer as the primary cause of death.

Response: In general, one type of cancer is associated with an exposure to a known or suspected carcinogen. For example, an increase in one type of cancer could

suggest exposures to certain known or suspected carcinogens that have been associated with the cancer type. Similarly, an exposure to a known or suspected carcinogen could lead to surveillance of certain cancer types that have been associated with the carcinogen. The MDCH statistical analysis did not find obvious elevations in the number of cancer cases and deaths for the 20 major anatomical categories of cancer (cancer categories) for Alpena County and zip code 49707.
Comment: *About 7% of all City of Alpena and Township of Alpena residents who died in 1989, 1990, and 1991, died of some form of lung cancer. This included one case of mesothelioma.*
Response: Cancer cases and deaths for each of the 20 cancer categories that occurred from 1985 through 1995 were investigated for both Alpena County and the zip code (49707) that contains the City of Alpena. Specific histological cancer types were not investigated. Statistical analyses of specific histological cancer types are conducted when numbers of cases or deaths of specific cancer categories remain elevated over time as compared with the entire State of Michigan. The numbers of lung and bronchus cancer cases and deaths in Alpena County and zip code 49707 were not elevated as compared with the entire State of Michigan.
Comment: *I chose 1975 as a date prior to Lafarge, hydrogen chloride and hazardous waste. The unborn and young children had a worse time of it then. For all persons in Alpena Township and the City of Alpena, death with cancer was about 25%. Among cement plant workers, the death with cancer rate was about 25%. From this it appears that the rate of cancer at least among cement plant workers has increased from 1975 to 1990.*
`Response: The Michigan Cancer Registry was started in 1985 and accurate time trends for the number of cancer cases and incidence rates cannot be studied before 1985. Consequently, the MDCH conducted statistical analyses of cancer cases and deaths for the 20 major anatomical categories of cancer (cancer categories) for Alpena County and zip code 49707 beginning with 1985 cases. Cancer deaths before 1985 were not included in the analysis because DVRHS conducts paired cancer cases and cancer deaths analyses for each cancer category.
Comment: *Based on my amateur statistics, I ask that the MDCH review the last twenty years of Alpena County death certificates on a township and city basis. I ask this so that for each year, every cause of death and any other health conditions are counted and tabulated. Also a break down for each major employer should be given. I chose twenty years, because trends of increase or decrease in a health condition could be seen. We have a small population, so more years of data might be needed to give a complete picture.*
Please do not refuse to do this based on ideas that different doctors list causes of death differently, or some death certificates are not explicit about who a person's employer was. I would say that if you do the best you can with the available

records, and then let the public have all the tabulated findings, then people would be impressed with the presentation of the information. It is easy to find out where persons in Alpena worked. If the MDCH wants that information complete, all they have to do is make a list of names with residence addresses at death and give the list to our county committee. We can find out fast.
More than anything else the MDCH could do, this kind of complete review of death certificates and fetal deaths would be appreciated. All the possible work that might study contamination levels would cost much more than this statistical analysis of death certificates. Contamination and toxic release studies are quite speculative given our present level of knowledge.
One reason to do a review of death certificates is to compare them with the state health registry to see if they agree. I think that the state registry is missing some information.
Response: The Michigan Resident Death Files (MRDF) have a high degree of reporting completeness. Therefore, manual tabulation of death certificate data is not necessary. Workplace location is not part of the MRDF database. Data quality could be a problem with other sources of workplace location information.
Comment: p. 1. *Rather than writing that Lafarge has recently begun using hazardous waste, please put the date in. It has been more than ten years.*
Response: The date has been added.
Besides being in consistent violation of a Consent Order regarding hydrogen chloride emissions, Lafarge has hundreds of other environmental violations. Reported violations greatly reduced during 1997 through the present.
Response: Thank you for the information.
Levels of benzene and carbon tetrachloride surprise me. Where do these come from?
Response: Both benzene and carbon tetrachloride are ubiquitous in the environment, from various industrial, commercial, and residential releases. Carbon tetrachloride does not readily degrade, so the environmental load is steadily increasing. Since carbon tetrachloride is also volatile, it can be carried vast distances from its source. The carbon tetrachloride concentrations found in Alpena air were comparable to those found in rural locations (55).
In urban areas benzene might come from gasoline stations, but Alpena has a lower population. So, there are fewer gas stations, and less gas is pumped.
Response: Alpena has the population density of a urban area, by U.S. Census Bureau definition (Help Screen, CensusCD software, Reference 7). The maximum concentration found in Alpena's air is on the low side of the range found in urban areas (Reference 46, Table 5-2).

Could the benzene come from Lafarge's crushing operations? Several years ago, the MDEQ discussed requiring Lafarge to burn off its VOC emissions from its rock crushing operations. Was this ever implemented?
Response: We do not know whether that specific remedy was ever implemented. However, the VOC emissions no longer pose a problem. The high VOC emissions occurred when the company used oil-containing shale as fuel, and some of the organic material within the rock volatilized during the crushing operation. Lafarge has since changed its raw material mix, no longer using the oil-containing shale, and those emissions have been lowered dramatically (97).
Throughout the report levels of contaminants are referred to as being at levels typically found in urban areas. Does this mean that levels found in urban areas are safe or desirable?
Response: If a contaminant is found at levels comparable to those typically found in urban areas, there are likely to be multiple sources for the chemical besides the facility under investigation. In addition, health effects from exposure to that chemical are not likely to occur more often in the target community than in another city.
Also, while perhaps benzene is found at this level in urban areas, do the same urban areas also have the methanol, formaldehyde, toluene, diethanolamine, xylene and other contaminants all in close proximity?
Response: Although the specific chemicals present vary widely, the air in any urban industrialized area contains a mixture of various chemicals. As for the specific chemicals you mention, benzene, toluene, and xylene are components of gasoline, and therefore are frequently found together in urban environments. The toluene and xylene concentrations in the air in Alpena are well within the range found in urban and even some rural areas (98, 99). Many household, industrial, and commercial products contain formaldehyde. Formaldehyde has been found in the ambient air in many cities (100). The U.S. EPA Toxic Chemicals Release Inventory for 1997 contains records of hundreds of facilities nationwide that reported releases of diethanolamine, formaldehyde, methanol, or more than one of the chemicals (12).
Comment: p. 2. *The former quarry site is sometimes referred to as "Pike's Peak." It might be good to give it this label. Discussion of the three CKD disposal sites gets a little confused at points in the draft, because two of the sites are quarries.*
Response: The text has been revised to cite this name and the name by which the MDEQ refers to the property, the Wessel Road Quarry.
Comment: p. 3. *It would be helpful to note that recent health studies have found that metallic particulate matter inflames human lungs and has been linked to some respiratory illnesses.*

Response: A paragraph discussing the health effects from airborne particulate matter has been added to the assessment.

Also note that 2.5-micron size particles are absorbed into the blood stream from the lungs during respiration. And note that Lafarge releases metallic particulate matter at 2.5 microns and smaller.

Response: Thank you for the suggestion. The U.S. EPA has proposed new air quality standards for particulate matter less than 2.5 microns in diameter (50). However, in the absence of data on airborne particulate matter in this size range in Alpena, any statement about the possibility of health effects from this cause would be very speculative. The MDEQ is planning to install a monitor to measure particulate matter smaller than 2.5 microns in Alpena.

While some believe that chloride is released from limestone and other raw material, please note that Lafarge has been cited for exceeding its chloride feed limits. Chloride is fed into the mix as an additive to reduce the levels of magnesium and potassium in the cement product. The chemicals are deleterious to cement.

Response: Thank you for the information.

Comment: p. 4. *A "physician" should be changed to chiropractor.*

Response: The text has been changed to indicate the branch of medicine the petitioner practices.

Comment: p. 6. *Note the high level of poverty among the most exposed to pollution population. Because they have less money, they have less access to health care, and so their health problems are less likely to be medically identified and recorded.*

Response: MDCH shares your concern about the disproportionate effect of environmental pollution on the less affluent members of the population.

How close is the City of Alpena rain water discharge to the city water intake?

Response: There is a storm sewer discharge within 1,000 feet of the city water intake. The Michigan Department of Transportation recently installed the discharge to take runoff from U.S. 23 south (101). The Alpena city storm sewers discharge into the Thunder Bay River, approximately 1 mile from the city water intake (102).

What does federal law require as a separation between the two?

Response: Federal regulations do not appear to specify such separation. Under the U.S. EPA's National Pollutant Discharge Elimination System (NPDES), which regulates at least some storm sewers (see 40 CFR 122.26):

(b) Impact of discharge on public water supplies.

(1) The applicant's modified discharge must allow for the attainment or maintenance of water quality which assures protection of public water supplies.

(2) The applicant's modified discharge must not:

(I) Prevent a planned or existing public water supply from being used, or from continuing to be used, as a public water supply; or
(ii) Have the effect of requiring treatment over and above that which would be necessary in the absence of such discharge in order to comply with local and EPA drinking water standards.[(18)]
Comment: p. 12. *Why is the source of the dioxin not known? There has been stack testing at Lafarge for dioxins. If dioxins are released from Lafarge, can't the report say that at least some of the dioxin is coming from Lafarge?*
Response: There have been several documented other incidents of releases of dioxin into the environment within the watershed of Lake Huron. Large predator fish such as lake trout and whitefish range widely within the lake. The text has been changed to make it clear that Lafarge is also a source of dioxin.
Comment: p. 13. *"Reasonably conservative assumptions," is hard to believe. Do these assumptions account for exposure to kiln upsets? Have there ever been any studies of how often kiln upsets occur, and what amounts and kinds of pollution are released during kiln upsets?*
Response: MDCH is not aware of any studies of kiln upsets, their frequency, or the nature of the emissions during them. MDCH is working with the available environmental data and is in the process of acquiring additional data on HCl.
Please refer to Internet web site http://www.scorecard.org for Environmental Defense Fund information about the contaminants in Alpena, as to amounts, kinds and health end points. Has the assessment included contaminants that are known to affect some persons more than other persons? What about the most sensitive persons exposed to toluene?
Response: The standards used for selecting chemicals for detailed evaluation were developed to account for and protect the most sensitive human populations.
Comment: p. 15. *Releases of pollution are not the same as the chemicals used by industry. For instance, Fletcher Paper releases toluene, even though it buys none, and ABTCO releases formaldehyde even though it does not add it to the product. These are byproducts made in the manufacturing process.*
Response: MDCH agrees that the U.S. EPA's Toxic Chemical Release Inventory (TRI) is not necessarily a complete listing of all chemicals released into the environment, one shortcoming being the problem you cite. It is indeed possible that a facility might release a large amount of some toxic chemical while never using, manufacturing, or processing enough of any chemicals on the TRI's list to be required to file reports with the TRI. The passage commented upon was intended to describe one limitation of the TRI.
The Paxton Quarry is no longer used. There are concerns that the water pumped out of the quarry may be diverted into a nearby stream , thus giving it a strong yellow color.

Response: Thank you for the information. MDCH has discussed your concerns with the MDEQ.

Comment: p. 16. *I hope the MDCH issues some kind of warning that ground water near Pike's Peak and privately taken water from some places in Thunder Bay should be tested before human consumption. It is conceivable that residences may drill wells near Pike's Peak. That area is developing*.

Response: Until now, the MDCH has not seen any data indicating that the groundwater in the "Pike's Peak" a.k.a. Wessel Road Quarry area is contaminated. The MDEQ started an investigation of the area in September 1999. The MDEQ and MDCH share your concern that the CKD in the Wessel Road Quarry probably impacts the groundwater in much the same way as the CKD does under the lakeshore CKD pile. The MDEQ investigation will include investigation of the groundwater as resources permit (4, 5).

Comment: p. 19. *"None of the arsenic concentrations was outside the range found in Michigan background soils." It is not clear to me that the levels of arsenic are safe or not safe throughout the draft.*

Response: Exposure to background concentrations of arsenic in soil has not caused any documented adverse health effects, or at least, will not cause more adverse effects in one locality more than another. Certain risk calculations do indicate that there is some risk of adverse health effects from exposure to soils containing the background levels of arsenic found in pristine natural soils; however, these calculations include assumptions that are not necessarily realistic. For example, as mentioned in footnote 17 on page 30, a child subject to pica behavior might ingest as much of the metal as has been observed to cause an adverse health effect after chronic exposure. However, pica is a short-lived behavior, and the resultant dose estimates should properly be compared only with exposure doses connected with health effects upon short-term exposure. The documented health effects were from exposures through drinking water; however, experiments indicate that arsenic is from 3.5 to 10 times less readily absorbed from soil than from water. Cancer risks are generally estimated assuming that any exposure results in some finite increase of risk, proportional to the dose, though a very small dose might result in an increased cancer incidence only in a very large population. However, there is evidence that the published proportionality constant might overestimate the actual increased cancer risk, to the point that low doses of arsenic might actually pose no increased cancer risk at all (28).

Comment: p. 24. *It is troublesome that the draft indicates that there is a source of dioxin and that in the draft it says that some readings are above levels of concern, and yet there is no recommendation that someone find the source of dioxin. If there is a level of concern, why not address it? (And Page 31).*

Response: The appropriate agencies are already investigating to find and eliminate the source of the dioxins in the air and the fish.
Comment: p. 31. *Why are there no dioxin advisories for fish in Thunder Bay?*
Response: There are advisories due to dioxin in place for lake trout and lake whitefish from Lake Huron, including Thunder Bay.
Comment: p. 32. *The first sentence of section D means almost nothing. All it says is that if some other city has the same kind of pile of CKD Alpena has, then the two piles pose the same risk to both cities. This says nothing about what the risk is, or is not. Wherever the risk is, it is the same risk, so what is the point of the sentence? Is the risk acceptable? DO other cities with comparable industrial facilities have something to worry about?*
Response: There are physical hazards in any city, including automobile accidents, household accidents, workplace accidents, and tripping and falling on uneven terrain. These hazards are almost completely determined by the population density and surface topography of an area, and nearly independent of the specific industrial or commercial activity within the area. Most residents of a city have implicitly accepted the level of such risks inherent to the area.
Comment: p. 34. *Does the fact that many cities have similar concentrations of many (although not all) of these chemicals make these levels safe or desirable?*
Response: As mentioned above, if a contaminant is found at levels comparable to those typically found in urban areas, there are likely to be multiple sources for the chemical besides the facility under investigation. In addition, health effects from exposure to that chemical are not likely to occur more often in the target community than in another city.
Comment: p. 35. *How can we believe that since these chemicals are found in CKD and the CKD was released without environmental controls for decades, that we do not know where the levels of lead, arsenic, and other metals come from? To the extent that CKD was scattered over Alpena, it has contributed to the existing levels.*
Response: The soil throughout Alpena is most likely part CKD because of the historic air transport of the material from what is now the Lafarge plant. However, there is no way to determine how much of the metals in the soil came from the CKD. There have not been any studies on most of the metals similar to the isotope study on lead. It can also be noted that, if you compare the CKD analysis in Table 6 with the concentrations found in the soils in the city in Tables 7, 8, 9, the lead concentration in the CKD is lower than that in the city. On the other hand, the concentrations of arsenic, chromium, zinc, and other metals in the CKD are frequently higher, sometimes much higher, than those in the city. The contribution from the airborne CKD to the soil in the city appears to be small.

The sentences, "The pile presents little to attract trespass. Any access to the pile is not likely to be frequent or prolonged," are questionable statements about human behavior. While the authors of the draft may see little to attract trespass, can the authors point to any studies that demonstrate these sentences reflect human behavior?

Response: The text has been changed to reflect the documented activity that does occur on the pile. We stand by our judgment that there is not likely to be frequent or prolonged access to the pile. There is no evidence that there is a lot of trespassing on the pile.

Comment: p. 36. *I think employees and contractors should be mentioned as persons who might be exposed to dust from the pile.*

Response: A paragraph has been added addressing this issue.

Comment: p. 37. "*There is no available evidence to connect this contamination with the CKD pile." Does this mean it should not be investigated? Does this mean that the existing evidence indicates that there is no connection?*

Response: The statement quoted does not say and is not meant to imply anything about investigating the fish or the existence of evidence that there is no connection. The problem of contamination in the fish in Lake Huron is much broader than can be addressed in this Public Health Assessment, and is being addressed by the MDEQ, the Ontario Ministry of Energy and the Environment, the U.S. EPA, and other appropriate agencies.

Might the fish in our bay be better than other Michigan fish were it not for this pile and the other Alpena pollution? It seems dubious to set standards at whatever generally prevails.

Response: Regarding the fish in Thunder Bay, those fish that stay within the bay might contain somewhat less contaminants than other fish in Lake Huron if there was no pollution from Alpena, and other fish in the lake might contain less contaminants than they do now. The problem of contamination in the fish in Lake Huron is much broader than can be addressed in this Public Health Assessment, and is being addressed by the MDEQ, the Ontario Ministry of Energy and the Environment, the U.S. EPA, and other appropriate agencies.

In the groundwater section, naming one pile the lake shore pile and the other Pike's Peak might make this discussion clearer.

Response: See our response to the earlier comment to page 2 (page RS-4).

Do groundwater and well-drilling authorities know about this contamination?

Response: The MDEQ and the District Health Department, the existing groundwater and well- permitting authorities, know very much about this contamination.

[pile misspelled as "plie."]

Response: The error has been corrected.

Comment: p. 41. *Does the MDCH know the leukemia rate for Alpena?*
Response: The observed numbers of leukemia cases were not significantly elevated in Alpena County and zip code 49707 from 1985 through 1995 for all years combined and for each individual year in comparison with the entire State of Michigan. The observed numbers of leukemia deaths were not significantly elevated in Alpena County from 1985 through 1997 and zip code 49707 from 1989 through 1997 for all years combined and for each individual year in comparison with the entire State of Michigan.
Does the benzene level in Alpena exceed what one might expect from the population size and the number of cars located here?
Response: The data necessary to make any such judgment is not readily available.
Benzene causes leukemia and so does cadmium. We get it twice in Alpena. Here the death certificate study would be helpful.
Response: See our response on page RS-2 to the general comments regarding a manual tabulation of death certificates.
Comment: p. 43. *How does the MDCH know that persons in Alpena receive only a brief exposure to dioxins and furans?*
Response: That is what the currently available ambient air monitoring data shows. There was a fairly constant low background of certain relatively low-toxicity dioxins and furans, but the more toxic congeners such as 2,3,7,8-TCDD were only detected on a few days during the year.
Can a single exposure to dioxin or furan affect an unborn child?
Response: According to one theory, yes, especially at high doses. However, the chain of events thought to be involved in producing a health effect from an exposure is fairly complex and more likely to occur after a high exposure or a long series of exposures.
Comment: p. 47. *Please have a professional sanitarian and a nutritionist review the assessment. Some of the statements on this page and elsewhere in the assessment might be changed based on a review by persons in these areas of study.*
Response: Thank you for the suggestion. The assessment has been reviewed by professionals in all appropriate disciplines.
Does the MDCH know how the flow of the river affects the water coming to the city intake? How forceful is the flow of the river, and for what distance into the bay? Might it swirl and bring contaminants to the intake?
Response: According to a manager at the city water plant, the National Oceanic and Atmospheric Administration (NOAA) once attempted to chart the currents in Thunder Bay, but came up with very inconclusive results. The paths of the buoys NOAA used were very dependent on wind direction even though they were designed to be more affected by water currents. The manager said his experience tended to agree with that. When the wind is out of the northeast, the plant will pull

river water into the intake. When the wind is from the northwest, water from the bay is pushed into the lake. The latter is the prevailing condition (101).
What are the results of the water testing taken at the intake? Bob Wagner or John Vick can provide water testing for samples taken near the intake.
Response: The water is sampled and tested for metals annually, and nothing indicating contamination from the CKD pile has been seen (101).
Comment: p. 48. *"Is not likely to result in any apparent increased risk of contracting cancer." What does apparent mean here? Maybe "appreciable" was meant.*
Response: "No Apparent Risk" is ATSDR's preferred designation for a certain level of increased risk of contracting cancer, between their "No Risk" threshold of 1 additional cancer case in one million people exposed and their "Low Risk" range.
The last sentence on page 48 and continuing on to page 49 is confusing. It would be better to separate the ideas in this sentence into at least two sentences. "A child subject to pica behavior would not be likely to ingest or absorb through the skin enough arsenic in a day from soil in some residential areas of Alpena to exceed the amounts that have been observed to cause adverse health effects in documented exposures of less than 10 years." It is the last part of the sentence I cannot make sense of. Does a child subject to pica behavior have an increased chance of changes in the cardiovascular system or skin? Whatever the answer to this question is, I would make a separate sentence.
Response: The passage has been revised to present the message more clearly.
What are the levels of prostate cancer and leukemia in Alpena? I think that a review of death certificates would find more prostate cancer than has been reported to the state registry. This is based on my own review, but I am not a professional statistician.
Response: See above response to the comment on page 41 concerning leukemia. The observed numbers of prostate cancer cases were not significantly elevated in Alpena County and zip code 49707 from 1985 through 1995 for all years combined and for each individual year in comparison with the entire State of Michigan. The observed numbers of prostate cancer deaths were not significantly elevated in Alpena County from 1985 through 1997 for all years combined and for each individual year in comparison with the entire State of Michigan. The observed number of prostate cancer deaths was significantly elevated in zip code 49707 from 1989 through 1997 for all years combined in comparison with the entire State of Michigan. However, the observed numbers of prostate cancer deaths were not significantly elevated in zip code 49707 for any individual year from 1989 through 1997 in comparison with the entire State of Michigan.
Comment: p. 52. *"The MDCH and the district health department serving Alpena have programs in place to address the potential health problems from childhood*

lead exposure." Are these programs receiving adequate funding to meet the needs of Alpena? The health district has had its budget cut in the last several years.
Response: Such questions are best addressed to the relevant sections of the MDCH and the District Health Department.
Comment: p. 53. *What about birth defects from mercury compounds? Minamata.*
Response: The discussion includes all documented adverse health effects related to exposure to mercury, as listed in ATSDR's Toxicological Profile for the element, including birth defects from prenatal exposure through the mother's diet, at both Minamata, Japan, and another incident in Iraq (73). If a health effect was not mentioned in the toxicological discussion, the estimated exposure was less than that which has been associated with the health effect.
The birth defect survey done so far in the assessment is for only three years. Does this avoid the neural tube defects in the most recent five years? I am not satisfied that a 3-year review is enough to find possible birth defects which are related to pollution.
Response: Since MDCH issued the draft, we have analyzed additional birth defect data for 1995 and 1996. As mentioned in the text, the Michigan Birth Defect Registry was established in 1992, and the most recent data available is that for 1996. The analysis of birth defect data from Alpena County from 1992 through 1996 showed no elevation in the numbers or rates of congenital abnormalities as compared with the entire State of Michigan. Because the overall rates and numbers showed no increase, MDCH did not analyze the birth defect data for specific major congenital anomalies, including spinal abnormalities, for the years 1995 through 1996.
["Lungs" misspelled as "lings"]
Response: The error has been corrected.
The draft's fish advisory table does not include the mercury contamination in Lake Besser.
Response: A discussion of the available Lake Besser fish data and existing advisories has been added to the text.
Comment: p. 54. *"No one is likely to spend so much time on the cement kiln dust pile east of Lafarge ..." What about employees and contractors?*
Response: No one is working on the CKD pile on the lake shore at the present time.
What about Pike's Peak, which is a large elevated field near a residential area? Pike's Peak has had two grass fires so far this Spring.
Response: To date, there has been no data indicating that "Pike's Peak" posed any health risks beyond the physical risks posed by any equivalent hill. The cover placed over the CKD when the quarry was filled and closed should have protected the population from exposure to the CKD. Unfortunately, a recent MDEQ

inspection revealed that the cover has eroded away in places. The MDEQ has collected samples of soil, sediment, and surface water from the area, however, the data on the analysis of these samples is not available as of this writing (4, 5). MDCH is very interested in evaluating this data for possible health hazards when it is available.

Comment: p. 58. *I am not satisfied that a 3-year review is enough to find possible birth defects which are related to pollution.*

Response: See the response to the similar comment to page 53.

There is nothing about PCB's and the studies linking PCBs to Attention Deficit Disorder and similar conditions.

Response: Neither the ATSDR in the Toxicological Profile for PCBs (82) or the National Attention Deficit Disorder Association (88) mention any link between PCB exposure and Attention Deficit Hyperactivity Disorder. The hypothesis has been made that since a genetic syndrome called Resistance to Thyroid Hormones (RTH) has been linked to ADHD and that Dioxin-Like Chemicals (DLCs) (including Dioxins and PCBs) can interfere with the actions of thyroid hormones, exposure to DLCs might be linked to ADHD. The available evidence is equivocal. Studies of the children of Great Lakes fisheaters found hypoactivity, while studies of Taiwanese who ate rice oil tainted with a mixture of dioxins, PCBs, and other DLCs found hyperactivity. More research is required before the hypothesis can be even provisionally accepted (103).

What of a child who eats PCB tainted fish and then has lead and mercury in his body? [and pages 62 and 63]

Response: PCBs, lead, and mercury, although their effects are similar, act on the body through different mechanisms. The effects of exposure to one of these chemicals are not likely to be affected by the child's exposure to another, although each could have its own separate health effects.

Comment: p. 61. *How does the MDCH know that Alpena colon and rectal, and cervical cancers were* [mis]*diagnosed? Because the rates were elevated is it assumed that it was due to misdiagnosis? Or is there another reason?*

Response: The Division for Vital Records and Health Statistics (DVRHS) compiled cancer cases from the Michigan Cancer Registry and cancer deaths from the Michigan Resident Death Files for Alpena County and the zip code (49707) that contains the City of Alpena. In addition, DVRHS conducted a records review and determined that rectal cancers were falsely elevated due to misdiagnosis in 1986 and 1987, which were the two individual years with the highest SIRs for rectal cancer. DVRHS is currently conducting a records review of rectal cancers for the other nine years in the 11-year period. Colon cancers are commonly misdiagnosed as rectal cancers and the two cancers are often combined into one category for investigation and cancer monitoring purposes. DVRHS also

conducted a records review for cervix uteri cancers and determined that the number of cases was falsely elevated due to misdiagnosis in 1985 and 1988. Pre-invasive cervix uteri disease is frequently misdiagnosed a cervix uteri cancer. If you would like a more detailed explanation of how DVRHS determined that errors in reporting occurred, please contact Brendan Boyle of MDCH at 1-800-647-6942.
We in Alpena can even supply some lifestyle information on persons who died years ago; things like whether they smoked or were overweight. We can make these records very good. Time trends and incidence can be determined if the MDCH wants to do it.
Response: Demographic, lifestyle and mortality information for the City of Alpena and zip code 49707 residents would be helpful if demographic, lifestyle and mortality information is also collected from a comparison population to identify differences.
Comment: p. 63. *What about miscarriages and still births? Were they as expected?*
Response: The incidence of miscarriages is unknown because most miscarriages occur before the woman recognizes her pregnancy. An analysis of stillbirths in Alpena County was not conducted.
Comment: p. 70. *Melody Jaskolski reported that several dogs, including her own, in her State Street neighborhood had seizures.*
Response: We have considered that report, in consultation with veterinarians, and came to no conclusion regarding environmental hazards and seizures in dogs.
Comment: p. 72. *What is the other known source of dioxin in the Lake Huron watershed?*
Response: There have been many documented dioxin contamination events in the Lake Huron watershed, associated with chemical and automotive plants along the Saginaw and Tittabawassee Rivers and paper mills along the Escanaba River and the Menominee River.
Also the way this sentence is worded it sounds like Lafarge is a source of dioxin and there is another one. Is Lafarge a source of dioxin or not?
Response: Monitoring data shows that Lafarge's stack gas has contained some dioxins, although not in excess of the limits in their discharge permit from the MDEQ.
Comment: *In a few places it seems to say that a finding of a contaminant in soil, water, or air is explainable in some way. For instance, that the lead in the soil is from leaded gasoline, or that the benzene in the air is from gasoline stations. If it is the case that this is what the report is saying, that nationwide benzene levels in the air are elevated from gasoline stations or that nationwide elevated levels of lead tend to be from leaded gasoline, then the draft should say that.*

The way these are worded now, it seems to imply that in Alpena, the MDCH has done a study and determined that the levels of lead and benzene found in Alpena can be fully explained by these sources. I do not believe that the MDCH has done such a study. Someone on your staff would have had to estimate the level of benzene attributable to the number of gas stations, and the frequency of activities at the gas stations, and then determined if this level represents the level found in Alpena. And so forth for lead in the soil.

Response: Our mentioning of some specific alternate sources, other than emissions from the Lafarge plant, was not meant to exclude other potential sources, such as leaded paint and home use of benzene-containing solvents. We did not and cannot describe the proportional contribution from all possible sources.

During the MDCH Availability Session on May 4, 1999, several Alpena residents made comments about the draft Public Health Assessment to the MDCH. These comments and the MDCH responses are summarized below.

Comment: *How is the classification "urban" (vs. rural) made? Why is Alpena considered urban?*

Response: The urban/rural classification in Table 1 was made by the CensusCD software which analyzed the data, using the U.S. Census Bureau definitions, which include, "The Census Bureau defines 'urban' for the 1990 census as comprising all territory, population, and housing units in urbanized areas and in places of 2,500 or more persons outside urbanized areas." (Help Screen, CensusCD software, Reference 7.) An "urbanized area" according to the Census Bureau definition has a minimum population density of 1,000 per square mile and a total population of at least 50,000. Alpena has the density (1,335 per square mile overall) but not the total population to be classified as an "urbanized area." However, it is a "place of 2,500 or more persons," and it is therefore considered urban.

Comment: *If Alpena has the same rates of cancer as the rest of the state, why is the hospital building a $6 million cancer center?*

Response: Any questions about the decision-making process and the exact criteria used are best directed to the hospital administration. One consideration is that cancer of all sorts occurs more commonly in older people, and the average age of Alpena area residents has been rising (39 years), compared to the state (34.8). An older population will have more cancer cases than a younger one, even with the same "age-adjusted" rates in both. In addition, if there is to be a cancer center within a reasonable driving distance of people in northeast Michigan, Alpena's central location, Alpena General Hospital itself, and the infrastructure of the largest city in the area would make the city a logical site for it.

Comment: *Why are there no dioxin advisories for fish in Thunder Bay?*

Response: See the above response to the comment to page 31.

Table of Contents

PETITIONED PUBLIC HEALTH ASSESSMENT
LAFARGE CORPORATION - ALPENA PLANT
ALPENA, ALPENA COUNTY, MICHIGAN
EPA FACILITY ID: MID981200835
March 15, 2000
Prepared by:
Michigan Department of Community Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

TABLE OF CONTENTS

Next Section