Letter Health Consultation

HOPE IRON AND METAL

HOPE, ARKANSAS

Prepared by
Arkansas Department of Health

APRIL 11, 2017

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

Health Consultation: A Note of Explanation

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

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

You May Contact ATSDR TOLL FREE at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

LETTER HEALTH CONSULTATION

HOPE IRON AND METAL

HOPE, ARKANSAS

Prepared By:

Arkansas Department of Health
Environmental Epidemiology
Under a cooperative agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Arkansas Department of Health

4815 West Markham Street • Little Rock, Arkansas 72205-3867 • Telephone (501) 661-2000
Governor Asa Hutchinson
Nathaniel Smith, MD, MPH, Director and State Health Officer

April 11, 2017

Mr. Nicolas Brescia
Region 6 On-Scene Coordinator
USEPA REGION 6
1445 Ross Avenue, Suite 1200
Mail Code: 6SF
Dallas, TX 75202-2733

RE: Hope Iron and Metal Facility, Hope AR

Dear Mr. Brescia:

This letter is in response to your request that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate whether children could be harmed if exposed to contaminated soil at an abandoned salvage yard in Hope, Arkansas, known as the Hope Iron and Metal Facility. The Arkansas Department of Health (ADH) Environmental Epidemiology Section prepared this health consultation under a cooperative agreement with ATSDR. According to the information you provided:

- Children could be exposed to metals (including antimony, cadmium, and lead), polychlorinated biphenyls (PCBs), and semi-volatile organic compounds (SVOCs) in soil at the site.
- A family with a small child currently lives at the southeast corner of the site within the fenced property line.
- There are other residential properties adjacent to the site.
- The property is partially fenced and accessible to this community.

Our evaluation of the available surface soil samples found that for those who live at or visit the site daily **accidentally ingesting and touching soil contaminated with lead and PCBs at the Hope Iron and Metal Facility could harm children's health and is a current public health hazard.** The remainder of this letter presents the results of the soil evaluation and recommendation aimed at reducing exposures to residents.

Site Description

The site was operated as a metal salvage yard from approximately 1982 until 1992. The salvagers burned insulation materials off copper wiring and drained PCB-containing oil from outdated electrical transformers onto the ground prior to scrapping and selling the metal [1]. The site located at 812 North Main Street in Hope, Hempstead County, Arkansas, is approximately 2.5 acres and is partially fenced [see figures in Appendix A]. Two corrugated metal buildings are located on-site. Building 1 is located in the northwest section of the site and appears to be abandoned. Building 2 is located in the southwest section of the site and is currently operating as a small automotive repair shop. According to the EPA Removal Assessment (RA) Report you provided, the property owner's residence is located at the southeast portion of the property [1]. During our conference call on January 9, 2017, you informed our office that two adults and a five-year-old child live at the southeast corner of the site within the fenced property line. Additional residential areas are located adjacent to the site to the east, south, and west of the property [see figures in Appendix A].

Data Evaluation

In September 2016, 98 composite surface and subsurface soil samples were collected onsite by EPA's contractor, Weston Solutions. Samples were taken from 41, 50-foot by 50-foot sampling grids at depth intervals of 0 to 6 inches (0-6") below ground surface (bgs), 6 to 18 inches bgs, 18 to 24 inches bgs, and 24 to 48 inches bgs. The samples were analyzed for metals, PCBs, and SVOCs [1]. See Figure 2 in Appendix A for the grid locations. We evaluated the 17 samples collected from 0-6" as children are most likely to contact that soil when playing. ADH evaluated the child age group of 2-6 year-olds because of the report that a 5-year-old lives on the property. No offsite sample results were available and therefore have not been evaluated in this health consultation.

The highest level of each potential contaminant of concern (COC) detected in the 0-6" depth soil samples were compared to ATSDR health comparison values to identify the chemicals that require further study as part of this assessment. Based on the results of the health comparison value screening, the COCs evaluated further in this letter health consultation are antimony, cadmium, lead, Aroclor-1242, Aroclor-1254, Aroclor-1260 and benzo[a]pyrene (B[a]P) equivalents. The available soil sample data and the results of the screening evaluation are summarized in Table 1.

Table 1. Summary of Surface Soil Data and ATSDR Health Comparison Value (CV) Screening Results [1]

Contaminant of Concern	Range of Detections (mg/kg)	Average Concentration (mg/kg)	Health Comparison Value (CV) (mg/kg)	Health CV Reference	Number of Grids Above Health CV
Metals					
Antimony	1.19 - 238	27	23	Chronic RMEG child	20 (49%)
Cadmium	0.24 - 41.7	10	5.7	Chronic EMEG child	15 (37%)
Lead	40.5 - 3,180	803	NA	NA	21 (51%)*
Polychlorinated Biphenyls (PCBs)					
Aroclor-1242	0.01 - 5.29	1	0.19	PCB CREG	27 (66%)
Aroclor-1254	0.24 - 245	17	0.19	PCB CREG	
Aroclor-1260	0.24 - 1,640	100	0.19	PCB CREG	
Semi-Volatile Organic Compounds (SVOCs)					
B[a]P Equivalents[α]	ND - 3.09	0.45	0.12	B[a]P CREG	25 (61%)

*Since there is no CV for lead, this percentage was calculated using EPA's residential soil screening level for lead of 400 mg/kg
[α]A mathematical method called toxicity equivalence is used to evaluate exposure to this mixture of PAHs based on the toxicity information available for B[a]P. (See Appendix B).
mg/kg - milligrams per kilogram
NA - Not Available. There is no health comparison value available for lead.
ND - Not detected
CREG - cancer risk evaluation guide
EMEG - environmental media evaluation guide
RMEG - reference dose media evaluation guide

Soil ingestion can occur from getting soil on hands or food items, or mouthing of soil-contaminated objects. All children mouth or ingest non-food items to some extent [2]. For the Hope Iron and Metal Facility, soil ingestion was identified as the completed exposure pathway for both residents and visitors; the most likely exposure scenario is young children living at or visiting the site to play. For this assessment, children (ages 2-6) were assumed to be exposed to chemicals in soil each day through ingestion and direct skin (or dermal) contact. As children at this site are expected to have the highest exposures, any conclusions made for children's exposures would be protective of exposures to others in this community, including adults.

For COCs that exceeded screening levels, further evaluation of site-specific information on exposures was used to derive a daily exposure dose and cancer risk estimates, when applicable. Equations and exposure parameters utilized in this assessment are presented in Appendix B; Technical Supporting Information. A summary of the non-cancer and cancer risk evaluation is presented in Table 2.

Public Health Implications

ADH conducted an evaluation of non-cancer health effects and cancer. Ingestion and dermal dose calculations and exposure parameters are presented in Appendix B. Exposure doses were calculated in accordance with ATSDR's Exposure Dose Guidance for soil ingestion and dermal contact [3]. We used available site-specific information and standard default exposure assumptions. Because a child lives at the site, we assumed they were exposed to soil daily. For cancer risk estimates, we conservatively assumed that children were exposed from age 2 until adulthood (21 years of age; equal to 19 years of exposure).

Table 2. Summary of Doses, Non-Cancer Evaluation and Cancer Risk Estimates

Contaminant of Concern	Average Concentration (mg/kg)	Ingestion and Dermal Exposure Dose mg/kg/day	Non-Cancer Health Guideline mg/kg/day	Non-Cancer Health Guideline Source	Hazard Quotient	Excess Cancer Risk (Children Exposed from age 2-21)[α]
Metals						
Antimony	27	3.6E-04	4.0E-04	EPA RfD	0.9	NA
Cadmium	10	1.3E-04	1.0E-04	ATSDR MRL	**1.3**	NA
Lead [β]	803	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)						
Aroclor-1242	1.0	1.6E-05	2.0E-05	ATSDR MRL	0.78	4.3E-06
Aroclor-1254	17	2.7E-04	2.0E-05	ATSDR MRL	**13**	7.3E-05
Aroclor-1260	100	1.6E-03	2.0E-05	ATSDR MRL	**78**	4.3E-04
Semi-Volatile Organic Compounds SVOCs)						
B[a]P Equivalents	0.45	6.7E-06	3.00E-04	EPA RfD	0.02	1.9E-05

[α]Cancer risk estimates were calculated using the EPA oral cancer slope factors of 2E+00(mg/kg/day)-1 for PCBs and 1.0E+00 (mg/kg/day)-1 for B[a]P equivalents [4,5].

[β] IEUBK model evaluated.

Bold values indicate the Hazard Quotient is greater than 1.0 and further non-cancer health effects evaluation is needed.

EPA RfD – Environmental Protection Agency Reference Dose

ATSDR MRL - Agency for Toxic Substances and Disease Registry Minimum Risk Level

NA - Not Applicable

mg/kg - milligrams per kilogram

Antimony

Antimony is a metal found in the earth's surface. It is mixed into alloys and used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, and pewter. The exposure dose for children (2-6 year olds) that live or visit the site was calculated at 3.6E-04 mg/kg/day for antimony. This site-specific dose does not exceed the health guideline (EPA's RfD) of 4.0E-04 mg/kg/day, based on hematological impacts. Non-cancer health effects from exposure are not likely. Antimony has not been classified as a carcinogen [6].

Cadmium

Cadmium is also a naturally occurring metal that is used in batteries, pigments and plating. It is extracted as a byproduct during the production of other metals such as zinc, lead, or copper. The exposure dose for children (2-6 year olds) that live or visit the site was calculated at 1.3E-04 mg/kg/day for cadmium. This site-specific dose just slightly exceeds the health guideline (ATSDR's Minimum Risk Level, or MRL) of 1.0E-04 mg/kg/day that was derived from studies that relate bone effects (osteomalacia, osteoporosis and increased bone fractures) and renal dysfunction to environmentally exposed populations in Japan [7]. Further evaluation indicates that doses for children at this site do not approach the levels associated with health effects. Therefore, non-cancer health effects from cadmium exposures at Hope Iron and Metal are unlikely. Cadmium has not been found to be carcinogenic via the oral route of exposure.

Lead

Lead is a naturally occurring metal found in soil throughout Arkansas. Lead has been used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead in paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. Prior to 1955, there were no limits on lead in paint; after 1978, the industrial limits were lowered considerably. Still today, older homes with lead-based paint and contaminated dust are the most widespread and dangerous high-dose source of lead exposure for young children [8].

Children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may contain lead particles. In some cases, children swallow non-food items such as paint chips. Dust and soil that contain lead may get on skin, but only a small portion of the lead will pass through skin and enter someone's blood if it is not washed off. However, a person can accidentally swallow lead that is on their hands when they eat, drink, or smoke. Breathing in or swallowing airborne dust and dirt is another way someone can be exposed to lead [8].

The effects of lead are the same whether it enters the body through breathing or swallowing. The main target for lead toxicity is the nervous system, in both adults and children. Children are more sensitive to the health effects of lead than adults. Children with high blood lead levels do not always have specific symptoms. There is no known safe blood lead level in children. Lead affects children in different ways depending on how much lead a child swallows or breathes. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe "stomach ache"), muscle weakness, and brain damage [8].

Repeated contact with lead that causes a measured blood lead level in young children can:

- slow growth and development;
- damage hearing; and
- affect ability to pay attention and learn.

Neither ATSDR nor the EPA has developed a health-based guideline (i.e., an ATSDR MRL or EPA MRL) to evaluate exposures to lead. Therefore, ATSDR cannot use the usual approach of estimating human exposure to an environmental contaminant and then comparing that dose to a health guideline to evaluate health effects. Instead, lead is evaluated using a biological model that predicts blood lead concentrations that could result from human exposure to environmental lead contamination. ATSDR uses EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) model to predict the risk of elevated blood lead levels in children from 6 months to 7 years of age. The model is only used as a predictor of potential population-based lead concentrations in the blood; therefore, ADH uses the model as a screening tool for identifying children that are at risk of higher blood lead levels and making recommendations to reduce their exposures, as necessary.

Using the mean soil lead concentration (803 mg/kg), the IEUBK Model estimates that young children who regularly play at the site have a high probability (nearly 90%; children 2-3 years of age) that their blood lead levels may be above the Centers for Disease Control and Prevention (CDC)'s reference level of 5 µg/dL which may harm children's health.

Model results indicate that the mean blood lead could range from as high as 9.7 µg/dL (child age 1 to 2 years) to 5.2 µg/dL (child 6 to 7 years) [see Appendix B; Technical Supporting Information]. The CDC's reference level of 5 micrograms per deciliter (µg/dL) represents the blood lead level that is above most children's levels. The reference level is based on the highest 2.5% of the U.S. population of children ages 1-5 years. That level is currently 5 µg/dL and based on the 2009-2010 National Health and Nutrition Examination Survey (NHANES). The current (2011-2012) geometric mean level for that age group is 0.97 (µg/dL), and CDC will periodically update the reference level.

PCBs (Aroclors-1242,-1254, and -1260)

PCBs are a group of synthetic organic chemicals, including Aroclor-1242, -1254 and -1260) that have been associated with several types of harmful effects, including cancer. Use of PCBs was banned in the U.S. in the late 1970's. There are no known natural sources of PCBs in the environment. Older products that may contain PCBs that may have been salvaged at this site include electrical devices, appliances, transformers, and old hydraulic oil. Once in the environment, PCBs do not readily break down and may remain for very long periods of time.

The Aroclor-1242, -1254 and -1260 exposure doses for children (2-6 year olds) that live or visit the site was calculated at 1.6E-05 mg/kg/day, 2.7E-04 mg/kg/day and 1.6E-03 mg/kg/day, respectively. To evaluate the non-cancer health effects of Aroclor compounds, the ATSDR MRL for Aroclor-1254 of 2.0E-05 mg/kg/day was used. This site-specific dose for Aroclor-1242 does not exceed the ATSDR MRL. Site-specific doses for Aroclor-1254 of 2.7E-04 exceed the ATSDR MRL. Calculated doses for Aroclor-1260 (1.6E-03 mg/kg/day) were considerably higher than the MRL and are near the levels that have been associated with health effects in animal studies. **Further evaluation of the site-specific doses for Aroclors indicates that children who live and play in contaminated soil at the site may be at risk for non-cancer health effects.**

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage [9]. The ATSDR MRL is based on an animal study that noted immune effects (e.g. reduction in antibodies and lymphocytes) based on exposures to Aroclors-1254 [9].

PCBs have been classified as a probable human carcinogens due to the association between exposure and the production of liver tumors in animal studies [4]. **Exposures to Aroclors at the Iron Hope Mine Site may increase the risk of developing cancer for children who are exposed throughout their childhood (ages 2 to 21 years of age).** While we do not have information indicating that these exposures have occurred and actual cancer cases are expected, site-specific cancer risk estimates are used to make the recommendation that childhood exposures to soil be reduced as soon as possible, as ongoing exposures to Aroclors at the levels found on the site may harm children's health.

B[a]P Equivalents

B[a]P is a polycyclic aromatic hydrocarbon that is formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances and has been classified by EPA as carcinogen to humans [5].

The exposure dose for children (2-6 year olds) that live at or visit the site daily was calculated at 6.7E-06 mg/kg/day. This site-specific dose does not exceed the health guideline (EPA's RfD) of 3.0E-04 mg/kg/day, based on neurological impacts in animal studies [10]. Therefore, non-cancer health effects from B[a]P exposure are not likely. As B[a]P has been associated with several cancer types with the strongest evidence for gastrointestinal cancers in humans and animals, a cancer evaluation of B[a]P was conducted. Our cancer evaluation concludes that B[a]P exposures at this site present a low risk of cancer for children that have ongoing, daily exposure to soil throughout their childhood.

Limitations

Every attempt was made to accurately and conservatively assess the potential impact of children's exposures to onsite contaminants, however, there are inherent uncertainties in the public health assessment process. ADH incorporated site-specific information, when available, and made health-protective exposure assumptions to minimize uncertainties in this evaluation.

Conclusion

Per EPA's request, ADH evaluated current childhood exposure to the metals, PCBs, and B[a]P equivalents in the surface soil at the Hope Iron and Metal Facility. **Based on our evaluation, ADH and ATSDR conclude that exposure (accidentally ingesting and touching) soil contaminated with lead and PCBs (particularly Aroclor-1254 and -1260) at Hope Iron and Metal could harm children's health and is a current public health hazard.**

Recommendations
For prudent public health and safety, ADH recommends the following:

For EPA

- Take immediate actions to reduce exposures and determine if the extent of contamination continues offsite.
- Inform residents about the exposures on the site and recommend that they keep children away from contact with contaminated soil.

For Residents and/or Visitors

- Reduce exposures immediately. Suggestions include:
  - Avoid direct contact with the soil.
  - Avoid digging.
  - Avoid tracking soil into the house on shoes, clothing, and by household pets. Ask family members to remove their shoes by the door, and frequently bathe pets as they could also track contaminated soil into the home.
  - Regularly conduct damp mopping and damp dusting of indoor surfaces. Dry sweeping and dusting could increase the amount of lead-contaminated dust in the air.
  - Keep children's hands clean by washing periodically before coming inside and before eating.
  - Change and launder any dirty clothes after playing outside.
- Test blood for lead. People living or routinely visiting the Hope Iron and Metal Facility property who are:
  - pregnant
  - wanting to become pregnant, or
  - a child less than six years of age (who has not had a blood test for lead in the past 6 to 12 months) should get a blood test for lead as soon as practical. Any local doctor can perform this test.

ADH and ATSDR will continue to assist EPA with public health evaluation and community needs, such as offering a list of local doctors who can conduct the blood lead test and other outreach and health education within the community surrounding the Hope Iron and Metal site, as requested.

If there are any questions, I can be reached by phone at 501-614-5227, or by email at Chris.Hemann@arkansas.gov.

Sincerely,

Chris C. Hemann, M.S.
ADH Environmental Epidemiologist
ATSDR Cooperative Agreement Health Assessor

cc: Lori Simmons, M.S., Branch Chief, Epidemiology, ADH
Ashley Whitlow, M.S., CPM, ATSDR Principal Investigator, Environmental Epidemiology Supervisor, ADH
Carrie Poston, MPH, MCHES, ATSDR Cooperative Agreement Health Outreach Coordinator, ADH
Ashley Mason, Lead-Based Paint Epidemiologist, ADH
Rob Robinson, M.B.A., Division of Community Health Investigations (DCHI), Technical Project Officer, ATSDR

References

[1] Weston Solutions. Removal Assessment Report for Hope Iron and Metal Assessment. November 2016.

[2] Agency for Toxic Substances and Disease Registry (ATSDR). Public Health Assessment Guidance Manual (Update), Appendix G: Calculating Exposure Doses; January 2005.

[3] Agency for Toxic Substances and Disease Registry. 2014. Exposure Dose Guidance for Soil and Sediment Ingestion. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. November 2014.

[4] U.S. Environmental Protection Agency. 1994. Integrated Risk Information System (IRIS). Polychlorinated Biphenyls (PCBs). https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=294

[5] U.S. Environmental Protection Agency. 2017. Integrated Risk Information System (IRIS). Benzo[a]pyrene. https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=136

[6] Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Antimony. Available at: https://www.atsdr.cdc.gov/toxprofiles/tp23.pdf

[7] Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Cadmium. Available at: https://www.atsdr.cdc.gov/toxprofiles/tp5.pdf

[8] U.S. Centers for Disease Control and Prevention (CDC 2009). Lead (web page). Last Updated June 1, 2009. Available online@ http://www.cdc.gov/nceh/lead/tips/sources.htm

[9] Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Polychlorinated Biphenyls (PCBs). Available at: https://www.atsdr.cdc.gov/toxprofiles/tp17.pdf

[10] Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs). Available at: https://www.atsdr.cdc.gov/toxprofiles/tp69.pdf

[11] California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. Guidance Manual for Preparation of Health Risk Assessments, Appendix G. February 2015. Available at: https://oehha.ca.gov/media/downloads/crnr/2015gmappendicesgj.pdf

[12] Integrated Exposure Uptake Biokinetic (IEUBK) Available at: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals

Appendix A:

Site Figures

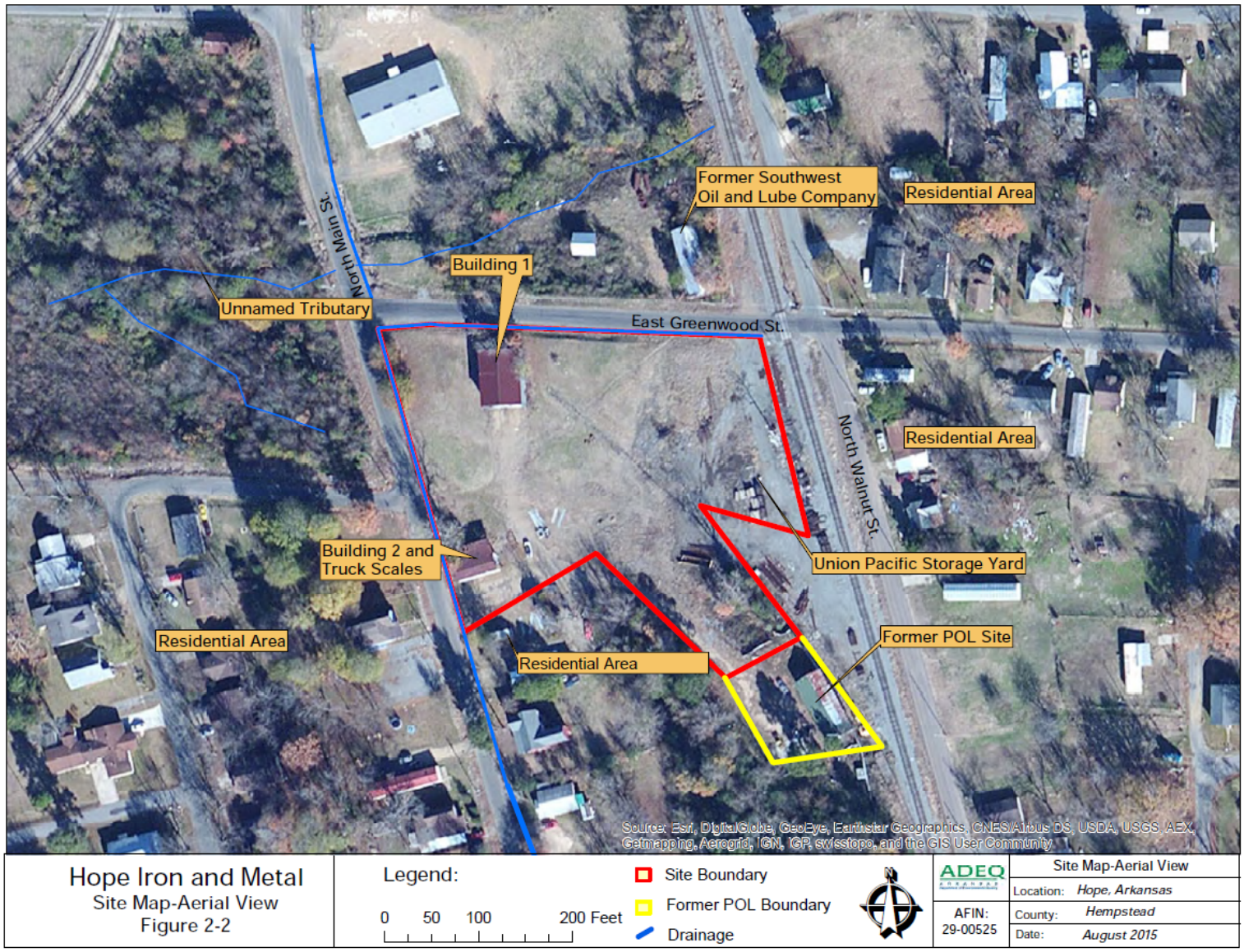

Figure 1. Aerial View Map
Weston Solutions. Removal Assessment Report for Hope Iron and Metal Assessment. November 2016.

Figure 2. Soil Sample Location Map
Weston Solutions. Removal Assessment Report for Hope Iron and Metal Assessment. November 2016.

Appendix B:

Technical Supporting Information

Toxicity Equivalence Factors for Polycyclic Aromatic Hydrocarbons or Derivatives

Polycyclic Aromatic Hydrocarbons (PAH) or derivative	Toxicity Equivalence Factor (TEF)
benzo[a]pyrene (index compound)	1
benz[a]anthracene	0.1
benzo[b]fluoranthene	0.1
benzo[j]fluoranthene	0.1
benzo[k]fluoranthene	0.1
dibenz[a,j]acridine	0.1
dibenz[a,h]acridine	0.1
7H-dibenzo[c,g]carbazole	1
dibenzo[a,e]pyrene	1
dibenzo[a,h]pyrene	10
dibenzo[a,i]pyrene	10
dibenzo[a,l]pyrene	10
indeno[1,2,3-cd]pyrene	0.1
5-methylchrysene	1
1-nitropyrene	0.1
4-nitropyrene	0.1
1,6-dinitropyrene	10
1,8-dinitropyrene	1
6-nitrochrysene	10
2-nitrofluorene	0.01
chrysene	0.01

Reference: California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. Guidance Manual for Preparation of Health Risk Assessments, Appendix G. February 2015. Available at: https://oehha.ca.gov/media/downloads/crnr/2015gmappendicesgj.pdf

Exposure Dose Equation for Incidental Ingestion of Soil from Hope Iron & Metal

Calculations for the evaluation of non-cancer effects from ingestion [3]:

Ingestion ED = (C x IR x EF x CF) / BW

Ingestion ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
C = Contaminant Concentration (milligram per kilogram (mg/kg)
IR = Intake Rate of Contaminated Soil
EF = Exposure Factor (unitless)
CF = Conversion Factor
BW = Body Weight (kilograms, kg)

Receptor Scenario Variables:
C = (from table below) mg/kg
IR =200 mg/day
CF = 1E-6
EF = 1; 365 days a year; residential exposure
BW = 17.4 kg (children ages 2-6 years old)

Calculations for the evaluation of non-cancer effects from dermal contact [3]:

Dermal ED = (C x EF x CF x AF x ABS_d x SA) / BW

Dermal ED = Exposure Dose (mg/kg/day)
C = Contaminant Concentration (milligram per kilogram (mg/kg)
EF = Exposure Factor (unitless)
CF = Conversion Factor
AF = Adherence Factor of Soil/Sediment to Skin (mg/cm^2/event)
ABS_d = Dermal Absorption Fraction for Soil and Sediment
SA = Surface Area Available for Contact (cm^2)
BW = 17.4 kg (children ages 2-6 years old)

Calculation of the Hazard Quotient for Total Doses (Ingestion and Dermal Contact):

HQ = Total ED / EPA RfD or ATSDR MRL

HQ = Hazard Quotient (unitless)
Total ED = Total Dose from Ingestion and Dermal Exposures (milligrams per kilogram per day, mg/kg/day)
EPA RfD = EPA Reference Dose (milligrams per kilogram per day, mg/kg/day)
ATSDR MRL = ATSDR Minimal Risk Level (mg/kg/day)

Calculation for the evaluation of excess cancer risk (for Aroclors and B[a]P equivalents):

LCR = Child Age-Specific ED x CSF x (estimated exposure years / 78 years lifetime)*

LCR = Theoretical Excess Cancer Risk (unitless)
ED = Age-Specific Exposure Dose (milligrams per kilogram per day, mg/kg/day); using body weight and exposure duration estimates for childhood age groups (ages 2 to 21 years of age; assumes 19 years of exposure during childhood).
CSF = Cancer Slope Factor (1/milligrams per kilogram per day, $mg/kg/day^{-1}$)
*As B[a]P is a mutagen, ADAF factors were applied to cancer risk estimates to account for early-life susceptibility.

Integrated Exposure Uptake Biokinetic (IEUBK) Model Results

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11
User Name: Chris C. Hemann
Date: 02/09/2017
Site Name: Hope Iron and Metal
Operable Unit:
Run Mode: Research

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 572.100 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	803.000	572.100
1-2	803.000	572.100
2-3	803.000	572.100
3-4	803.000	572.100
4-5	803.000	572.100
5-6	803.000	572.100
6-7	803.000	572.100

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	0.942	0.000	0.333
1-2	0.034	0.791	0.000	0.808
2-3	0.062	0.884	0.000	0.863
3-4	0.067	0.867	0.000	0.901
4-5	0.067	0.872	0.000	0.984
5-6	0.093	0.935	0.000	1.058
6-7	0.093	1.024	0.000	1.088

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	14.367	15.664	8.3
1-2	22.110	23.744	9.7
2-3	22.716	24.524	9.0
3-4	23.269	25.103	8.7
4-5	18.147	20.071	7.1
5-6	16.655	18.742	6.0
6-7	15.897	18.103	5.2