Letter Health Consultation

MULTNOMAH METALS (FORMER) SITE

PORTLAND, OREGON

Prepared by
Oregon Health Authority

JUNE 17, 2014

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

Health Consultation: A Note of Explanation

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

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LETTER HEALTH CONSULTATION

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Public Health Division
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Agency for Toxic Substances and Disease Registry

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March 4, 2014

Scott Manzano
Project Manager
Oregon Department of Environmental Quality
Northwest Regional Office
2020 SW 4th Avenue, Suite 400
Portland, OR 97213

RE: Multnomah Metals (Former) Site, 236 SW Flower Street, Portland, OR and nearby residential properties

Dear Mr. Manzano:

I am writing in response to your request to:

- evaluate and describe the human health implications of recent soil sampling results for the former Multnomah Metals site and nearby properties, and
- describe the available blood lead level data for the southwest Portland neighborhood.

Background/Statement of Issues
The former Multnomah Metals Company operated in southwest Portland from the early-1920s through the mid-1960s. The company operated a secondary lead smelter that melted and recycled lead, solder, and other scrap metals. In 1974, the property was re-zoned for residential use, and the original buildings were demolished the subsequent year. Currently, a residential duplex stands where the former lead smelter existed.

Prior to 2003, there were no investigations to determine if the site or surrounding properties had been contaminated from past operations at the smelting plant. In 2003, at the request of the U.S. Environmental Protection Agency (EPA), the Oregon Department of Environmental Quality (DEQ) collected soil samples from the site. DEQ gathered and tested four surface samples from the eastern and northeastern boundary of the property. The samples showed lead concentrations between 617 and 5,120 mg/kg, which were above EPA's residential screening level of 400 mg/kg. DEQ notified the property owner of the results and recommended that the site undergo further evaluation. However, no further actions were taken at the time.

In 2012, investigators for the newspaper *USA Today* tested soil from the site and nearby properties. This was part of an investigation they were conducting about contamination from former lead smelters throughout the United States. Investigators accessed eleven properties and collected between one and fourteen samples from each property. Forty-one locations from the eleven properties were screened for lead at the ground surface with an XRF analyzer. Also, thirteen soil samples were collected from three of these properties and submitted for lab analysis. They found three of the properties had lead levels that exceeded EPA's screening level for

residential soil. The former Multnomah Metals property was among the three properties with lead levels as high as 7,575 mg/kg.[1,2]

The April 2012 *USA Today* article brought attention to former lead smelters around the nation and the public health risks associated with lead exposure. As a result, state and federal agencies began investigating these sites. In Oregon, DEQ launched an investigation in summer 2012 to evaluate lead contamination at the former Multnomah Metals site and nearby properties.

Discussion

A. Former lead smelter site (236 SW Flower Street)

After the *USA Today* articles were published, the owners of the 236 SW Flower Street property entered into a voluntary cleanup agreement with DEQ. They also secured a contractor to conduct a remedial investigation under DEQ's oversight. In July 2012, the contractor collected eighty-four soil samples at various depths (ground surface[3], shallow subsurface[4], and deeper subsurface[5]). The samples were tested at a state-certified laboratory for lead, arsenic, and other metals.

The Oregon Environmental Health Assessment Program (EHAP) evaluated residents' exposure to lead and arsenic through contact with soil. EHAP compared the environmental sample results for these two contaminants to environmental guidelines to identify whether they should be further evaluated. Environmental data are typically compared to Agency for Toxic Substances and Disease Registry (ATSDR) comparison values. However, when an ATSDR screening value does not exist, other sources may be used for the environmental screening analysis. In this case, ATSDR does not have a comparison value for lead and so a value from EPA was used.

More than half of the samples (48 of 84 samples) taken from the residential property on the former smelter site exceeded the EPA screening value for lead in residential soil of 400 mg/kg (Table 1). The maximum lead concentration found on the site was 58,300 mg/kg, and the average concentration was 3,362 mg/kg.

When contaminant levels exceed environmental comparison values, EHAP calculates a dose and compares that value to appropriate health guidelines. While we can calculate a dose for lead exposure at this site, we cannot compare that dose to a health guideline; neither ATSDR nor EPA has established a health guideline for lead since there is no risk-free level of exposure. Instead, we used EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) model to predict blood lead concentrations for children exposed to soil and dust from the site. The 95% upper confidence limit for lead surface soil samples (12,478 mg/kg; Table 1) was used to calculate the blood lead concentrations for children at several age groups (0.5-1, 1-2, 2-3, 3-4, 4-5, 5-6, and 6-7).

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[1] Young, Alison. (2012, April 19). Long –gone lead factories leave poisons in nearby yards. *USA Today*. Retrieved from http://usatoday30.usatoday.com/news/nation/story/2012-04-19/smelting-lead-contamination-government-failure/54399578/1

[2] Young, Alison and Peter Eisler. (2012, April 20). Some neighborhoods dangerously contaminated by lead fallout. *USA Today*. Retrieved from http://usatoday30.usatoday.com/news/nation/story/2012-04-20/smelting-lead-contamination-soil-testing/54420418/1

[3] Ground surface samples were taken between 0 and 0.5 feet below ground surface

[4] Shallow subsurface samples were taken between 1.0 and 1.5 feet below ground surface

[5] Deeper subsurface samples were taken between 2.5 and 3.0 feet below ground surface

Based on the IEUBK model, children exposed to lead contaminated soil and dust from the former smelter site would be expected to have blood lead concentrations between 37.2 and 53.2 µg/dL. Modeled results above 30 µg/dL should not be considered reliable since there are limitations with the IEUBK model when high soil lead concentrations yield these results.[6,7] However, if the predicted blood lead concentrations for children at this site are greater than 30 µg/dL, these values are much higher than Centers for Disease Control and Prevention's (CDC's) reference value of 5 µg/dL which is based on the 97.5 percentile of child blood lead concentrations in the National Health and Nutrition Examination Survey (NHANES). More importantly, the predicted blood lead concentrations may exceed levels where CDC recommends medical exams (20-44 µg/dL) and/or medical treatment (45-69 µg/dL).

High levels of arsenic were also detected in soil. Ten of the eighty-four samples tested exceeded ATSDR's comparison value for arsenic of 15 mg/kg (Table 1); the maximum level of arsenic detected at the site was 145 mg/kg. The 95% upper confidence limit of the average arsenic concentration was 17 mg/kg. Since the levels of arsenic at the former smelter site exceeded ATSDR's environmental guideline, EHAP further evaluated residents' exposure to this contaminant through soil ingestion.

[6] US Environmental Protection Agency. 2002. Reference manual: Documentation of updates for the integrated exposure uptake biokinetic model for lead in children (IEUBK). OSWER #9285.7-44. Office of Solid Waste and Emergency Response. Washington, DC.
[7] US Environmental Protection Agency. 2002. Short sheet: Overview of the IEUBK model for lead in children. EPA #PB 99-9635-8, OSWER #9285.7-31. Office of Solid Waste and Emergency Response. Washington, DC.

Table 1. Soil test results for the former lead smelter site (236 SW Flower Street)

Lead					
Chemical	Number of samples >CV/ Total samples	Maximum level detected (mg/kg)	Average level detected (mg/kg)	Comparison value (mg/kg)	95% Upper confidence limit (mg/kg)
All samples	48/84	58,300	3,362	400 [a]	7,819
Surface samples	33/42	58,300	4,591	400 [a]	12,478
Subsurface samples	15/42	29,700	2,133	400 [a]	8,008
Arsenic					
Chemical	Number of samples >CV/ Total samples	Maximum level detected (mg/kg)	Average level detected (mg/kg)	Comparison value (mg/kg)	95% Upper confidence limit (mg/kg)
All samples	10/84*	145	12†	15 [b]	17†
Surface samples	8/42**	145	15†	15 [b]	23†
Subsurface samples	2/42***	106	9†	15 [b]	13†

*Among the 84 samples, 38 were not detected at concentrations above the laboratory Minimal Reporting Limit (MRL) and 46 were detected above the laboratory MRL.
**Among the 42 samples, 14 were not detected at concentrations above the laboratory Minimal Reporting Limit (MRL) and 28 were detected above the laboratory MRL.
***Among the 42 samples, 24 were not detected at concentrations above the laboratory Minimal Reporting Limit (MRL) and 18 were detected above the laboratory MRL.
†According to Pro-UCL 5.0 the arsenic data were not normal, gamma, or lognormal distributed. Therefore, Pro-UCL 5.0 used the Kaplan-Meier survival analysis (a nonparametric method) to estimate a mean and 95% upper confidence level using the full range of data, both detect and non-detect.
Abbreviations: mg/kg = milligrams per kilogram; CV = comparison value
Comparison Value sources: a) EPA Regional Screening Level for lead in residential soil—this value is used because ATSDR does not have a comparison value for lead in soil, and b) ATSDR August 2012 Child Chronic Environmental Media Evaluation Guide.

EHAP calculated non-cancer and cancer risk for arsenic using values that reflect high (maximum) and moderate (central tendency) exposure to this contaminant on the former smelter site (Table 2). All calculations are based on adult residential exposure to the 95% upper confidence limit for arsenic surface soil samples (23 mg/kg) through the chronic ingestion of soil. Additional information about the assumptions and the dose and risk calculations is provided in section C of Appendix A.

The non-cancer Hazard Quotients (HQs) for the high and moderate exposure scenarios are less than 1 (0.1 and 0.002, respectively; Table 2) which means adult residents with past exposure to arsenic at the site are not at risk of experiencing non-cancer health problems.

Cancer risk is expressed as a probability, which can be thought of in terms of additional cancer cases in a population where everyone would get the same dose of the same chemical every day over their entire lifetime (78 years). EHAP considers 1 additional case of cancer out of 10,000 people exposed every day for an entire lifetime to be a low risk. A cancer risk of 1 additional case out of 100,000 people would be a very low risk, and a cancer risk of 1 additional case out of 1,000,000 people would be a negligible risk.

The estimated cancer risk for the high and moderate exposure scenarios is 8 in 100,000 (8 E-5) and 5 in 10,000,000 (5 E-7), respectively (Table 2). The risk estimated for both high and moderate exposures is within EPA's target risk (1 in 10,000 to 1 in 1,000,000).

Table 2. Arsenic dose and risk calculations for adult residents at the former lead smelter site (236 SW Flower Street)

Non-cancer dose and risk			
	Dose (mg/kg-day)	MRL (mg/kg-day)	HQ
Maximum	2.9 E-5	0.0003 mg/kg-day	0.1
Central tendency	6.0 E-7	0.0003 mg/kg-day	0.002
Cancer dose and risk			
	Dose (mg/kg-day)	Cancer slope factor $(mg/kg\text{-}day)^{-1}$	Cancer risk
Maximum	1.4 E-5	5.7	8 E-5
Central tendency	9.2 E-8	5.7	5 E-7

All values are rounded; however, complete numbers were used in all calculations.
Abbreviations: mg/kg-day = milligrams per kilogram per day; MRL = Minimal Risk Level; HQ = Hazard Quotient

EHAP determined that the high lead levels found at the 236 SW Flower Street property warranted immediate outreach to the residents living at the property. EHAP made several attempts to contact the property owners and residents by phone. On September 5, 2012, EHAP staff visited the property and observed that the ground was landscaped with grass covering, with no observable areas of bare soil. EHAP spoke with an adult resident of one rental unit on the property, who stated she did not have much contact with bare soil. EHAP staff provided this resident with information about blood lead testing. EHAP staff left a letter at the other rental unit stating that we recommended they have a blood lead test given the high soil lead levels found at the property. To our knowledge, there are no children living in either of the rental units on this property. To date, EHAP has not received any follow-up health-related questions or information from residents at this property.

The 236 SW Flower Street property was remediated in December 2012 to meet DEQ's residential risk-based concentrations for lead and arsenic. The implemented remedy included:

- removing highly concentrated lead-contaminated soil 15 inches below ground surface from the northeast side of the residence, treating and disposing of the excavated soil offsite, and filling this area with clean topsoil;
- removing soil 12 inches below ground surface from the north-central section of the site and select parking strips, disposing of the excavated soil offsite, and filling these areas with clean topsoil; and
- grading, demarcating, and capping with hardscape materials all other areas of the site, including parking strips.

DEQ also required an Easements and Equitable Servitude (EES) be recorded with the property deed. The EES outlines the protective measures at the site, prohibitions regarding the site's use, and DEQ's inspection and maintenance requirements related to the site protective cover.

B. Nearby properties

DEQ evaluated lead contamination in soil at twenty-one nearby properties in July 2012. Property owners near the former smelter site voluntarily participated in the investigation and granted DEQ access to their properties.

DEQ screened for lead at ten or more locations at each property at the ground surface using an XRF analyzer. DEQ collected data at the most reasonable locations for outdoor residential exposure, including gardens, play areas, and parking strips. At the two locations on each property where ground surface lead levels were highest, DEQ took two readings at six inches below ground surface. DEQ also collected soil samples for lab analysis at ten percent of the XRF screening locations where concentrations were greater than 200 mg/kg to confirm the accuracy of the XRF data.

EHAP evaluated residents' exposure to lead through soil ingestion and compared the sample results to EPA's risk-based soil screening value.

The 95% upper confidence limit of the average lead concentration for the twenty-one properties was 507 mg/kg.

Among the twenty-one properties tested, five properties had lead concentrations above 400 mg/kg. Two of these five properties (properties 1 and 2 in Table 3) had two sampling locations with soil lead levels over 400 mg/kg. These properties are located north of the former site on SW Kelly Avenue.

The other three properties are in closer proximity to the 236 SW Flower Street property and had higher levels of lead as compared to properties 1 and 2. The average concentration for each lot ranged from 779 to 1,272 mg/kg with maximum concentrations of 1,373, 3,729, and 5,190 mg/kg.

Table 3. Soil lead results for the five nearby properties with lead concentrations over 400 mg/kg

Location	Number of soil lead samples >CV/ Total samples	Maximum soil lead level detected (mg/kg)	Average soil lead level detected (mg/kg)	Comparison value (mg/kg)
Property 1	2/12	511	259	400 [a]
Property 2	2/13	509	267	400 [a]
Property 3	9/12	3,729	1,272	400 [a]
Property 4	10/10	1,373	779	400 [a]
Property 5	9/12	5,190	939	400 [a]

Abbreviations: mg/kg = milligrams per kilogram; CV = comparison value
Comparison Value source: a) EPA Regional Screening Level for lead in residential soil—this value is used because ATSDR does not have a comparison value for lead in soil

When contaminant levels exceed the environmental comparison value, EHAP usually performs a health guideline comparison. However, for lead, this comparison is not possible since neither ATSDR nor EPA has established a health guideline for this contaminant. Consequently, EHAP

used EPA's IEUBK model to predict blood lead concentrations for children exposed to contaminated soil and dust from the nearby properties. The 95% upper confidence limit for lead detected among the twenty-one nearby properties (507 mg/kg) was used to calculate a range of blood lead concentrations for children less than eight years old. According to the IEUBK model, children exposed to soil and dust from these offsite properties would be expected to have blood lead concentrations between 3.7 and 6.8 µg/dL. The model predicted that children 6 months to 5 years old would have blood lead levels greater than or equal to 5 µg/dL, which is the CDC's reference value.

EHAP staff contacted the owners and renters at properties 3, 4, and 5 by phone in August 2012. The residents at properties 3 and 5 are adults, and no children have lived on these properties for many years. The residents stated that they have very limited contact with the bare soil on their properties. EHAP provided these residents with information on adult health risks from lead exposure, measures that can be taken to reduce potential exposure, and adult blood lead testing. Neither resident felt that they needed to be tested for lead exposure.

Property 4 is a rental property with two units. Both units are occupied by families with children. EHAP was able to contact one family by phone. The adult resident had her child's blood lead level tested. EHAP obtained a copy of the child's blood lead test, which showed the child's blood lead level was 0 µg/dL. EHAP has not been able to contact the family living in the other unit. However, the landlord and the other renter stated that they would encourage the family to have their children tested for lead exposure.

DEQ and EPA have continued their investigation of nearby properties that had lead concentrations above 400 mg/kg. In November 2012, EPA conducted additional soil sampling and they are planning to do an area-wide cleanup in summer 2013. An update on DEQ and EPA's work with the nearby properties is provided in Appendix B.

C. Analysis of blood lead levels

EHAP reviewed child and adult blood lead level data reported to the Oregon Health Authority's (OHA's) Lead Program between January 2004 and August 2012 from the neighborhood surrounding the 236 SW Flower Street property. Among 33 adult and child blood lead tests reviewed, 20 of the tests were from children less than 6 years of age. All of the individuals included in this analysis had blood lead levels below 5 µg/dL, except for one child living several blocks from the former smelter site. The child at this property had a blood lead level between 5 and 9 µg/dL.

Of the twenty-one properties tested in DEQ's investigation, only one household was included in OHA's Lead Program database. The child from that home had a blood lead level below 5 µg/dL.

Conclusions

EHAP reached four conclusions about the former Multnomah Metals site and nearby properties:

EHAP concludes that past contact with lead in surface and subsurface soil at the 236 SW Flower Street property could potentially harm people's health. Before the property was remediated in December 2012, the property had elevated levels of lead in the soil. Regardless of whether

residents had a little or a lot of past contact with soil at this property, there is no known level of lead exposure that is without health risk.

EHAP concludes that past contact with arsenic in surface and subsurface soil at the 236 SW Flower Street property is not expected to harm people's health. Adult residents that were exposed to contaminated soil are not expected to experience non-cancer health problems or have an increased risk of cancer.

EHAP concludes that current and future contact with lead and arsenic in surface and subsurface soil at the 236 SW Flower Street property is not expected to harm people's health. This is because the 236 SW Flower Street property was remediated in December 2012. The remedy included removing and appropriately disposing of approximately 20 tons of highly contaminated soil and putting in place a hardscape cover over the entire site. Also, an EES was recorded with the property deed to prevent future exposure to any residual contamination.

EHAP concludes that past, current, or future contact with lead in surface and subsurface soil at twenty-one nearby properties could potentially harm people's health. Among the twenty-one properties tested, sixteen properties had lead concentrations below 400 mg/kg and five had concentrations above this screening value. Regardless of whether soil lead levels were above or below the screening value, lead was present in the yards of all twenty-one residences. Adults and children that come into contact with this soil may have been or be exposed to lead and their health could be impacted.

Recommendations

There are several possible sources of child lead exposure. The most common sources of exposure include lead-based paint and lead-contaminated indoor dust. Consequently, EHAP recommends that any child at risk for these exposures have their blood lead tested by a health care provider to determine if they have been in contact with unhealthy levels of lead. Specifically, it is prudent to test children less than 6 years of age living at the three nearby properties (properties 3, 4, and 5) with the highest soil lead levels.

To minimize current and future risks from unhealthy levels of lead in the soil, EHAP recommends that DEQ and/or EPA identify and test other nearby properties that they suspect might have lead contamination from the former lead smelter. If unhealthy levels are found, we recommend taking steps to reduce exposure.

Public Health Action Plan

To date, EHAP has taken the following actions:

- reviewed and provided comment on DEQ's plan to test soil samples from properties surrounding 236 SW Flower Street,
- reviewed child and adult blood lead level data reported to the OHA's Lead Program,
- reviewed DEQ's soil sampling results for 236 SW Flower Street and twenty-one other properties,

- recommended that residents of the 236 SW Flower Street property have their blood tested by a health care provider to determine if they had been in contact with unhealthy levels of lead,
- reviewed the proposed remediation plan for the 236 Flower Street property,
- coordinated meetings and shared resources with DEQ, OHA's Lead Program, and Multnomah County Health Department's Lead Program,
- attended two neighborhood association meetings in June and October 2012 and one DEQ public meeting about the investigation in October 2012,
- contacted six households at the four properties with elevated lead levels by phone and/or letter and talked with the residents at these properties about their environmental sampling results, the potential health risks from lead exposure, and their options for getting blood lead tests, and
- answered residents' questions about gardening, blood lead tests, and risks from past exposures to lead in soil.

EHAP will take the following public health actions:

- share this letter health consultation with DEQ,
- attend future neighborhood association and DEQ public meetings relevant to this site,
- continue to respond to residents' questions about past, current, or future risks to lead in soil and blood lead testing, and
- review additional soil sampling data and remediation plans for nearby properties upon request.

If you have any questions, please contact Lauren Karam at 971-673-0974 or lauren.karam@state.or.us.

Sincerely,

Lauren Karam, MPH
Program Coordinator/Health Assessor
Environmental Health Assessment Program
Oregon Health Authority, Public Health Division

Appendix A. Dose and risk calculations

This appendix describes the equations and assumptions used to calculate a dose and risk for cancer and non-cancer health effects from chronic arsenic exposure. All estimates assume ingestion of contaminated soil by adult residents living at the former Multnomah Metals site.

A. Dose calculations

The formula used to calculate an exposure dose is as follows:

$$D = \frac{C \times IR \times BAF \times CF \times F \times ED}{BW \times AT}$$

Where:

Parameter	
Term	Description
D	= exposure dose
C	= contaminant concentration
IR	= intake rate of contaminated soil
BAF	= bioavailability factor
CF	= conversion factor
F	= frequency of exposure
ED	= exposure duration
BW	= body weight
AT	= averaging time

Non-cancer and cancer doses

The method for generating non-cancer and cancer exposure doses is identical except for the way in which the averaging time (AT) is calculated. For non-cancer, the *exposure duration* or ED is used to calculate the AT. For cancer, adult lifetime (78 years) is used to calculate the AT.

Non-cancer	Cancer
AT = ED x 365 days/year	AT = adult lifetime x 365 days/year

B. Risk calculations

1. Non-cancer

The formula used to calculate non-cancer risk is as follows:

$$HQ = \frac{D}{\text{Health guideline}}$$

Where:

Parameter	
Term	Description
HQ	= hazard quotient
D	= exposure dose

2. Cancer
The formula used to calculate cancer risk is as follows:

$$\text{Cancer risk} = D \times CSF$$

Where:

Parameter	
Term	Description
D	= exposure dose
CSF	= cancer slop factor

C. Assumptions
EHAP calculated doses that reflect high (maximum) and moderate (central tendency) exposure to arsenic at the former smelter site. All calculations are based on adult residential exposure to the 95% upper confidence limit for arsenic surface soil samples from on the site (23 mg/kg) through the chronic ingestion of soil. We also assumed that adult residents would have accidentally ingested 100 mg/day of the most heavily contaminated soil.

To calculate the maximum exposure dose, EHAP assumed adult residents would be exposed 365 days per year for 37 years, which is from 1975 when the smelter was demolished through 2012 when the site was remediated. We also assumed that 100% of the metal in the soil would be absorbed into the bloodstream after ingestion.

The central tendency was estimated by assuming that adult residents spent 120 minutes per day engaged in outdoor activities on dirt. We also presumed that adults lived at the property for an average of 12 years. There is evidence in the peer-reviewed literature that a fraction of arsenic is absorbed into the bloodstream when bound to soil and so EHAP used a bioavailability factor of 25% to estimate the central tendency.

See Table A-1 for a complete list of values used to estimate the maximum and central tendency doses.

To estimate the cancer risk from exposure to arsenic in soil, EHAP used EPA staff's recommended cancer slope factor (CSF) of 5.7 per mg/kg-day instead of the current Integrated Risk Information System (IRIS) CSF for arsenic (1.5 per mg/kg-day). The IRIS CSF is based on

the risk for developing skin cancer while the new CSF is based on the risk for lung and bladder cancer. We chose to use the higher CSF since it is based on more serious endpoints.[8,9]

Conservative assumptions were made to calculate both the non-cancer and cancer maximums and central tendencies and they may overestimate the actual risk to adult residents in both instances. However, the maximum assumes residents were exposed to the greatest amount of arsenic possible at the site, whereas the central tendency includes values that are more realistic and are more likely to match residents' true exposure.

Table A-1. Exposure factors for dose calculations

Parameter		Value		Unit	Source/rationale
Term	Description	Maximum for adult residential scenarios	Central tendency for adult residential scenarios		
C	= contaminant concentration	23	23	mg/kg	95% upper confidence limit for arsenic surface soil samples from the former lead smelter site (236 SW Flower Street)
IR	= intake rate of contaminated soil	100	100	mg/day	The intake rate is taken from Table 1 of ATSDR's Exposure dose guidance for soil ingestion. Agency for Toxic Substances and Disease Registry. 2012. Exposure dose guidance for soil ingestion (4/23/2012). United States Department of Health and Human Services, Atlanta, GA.
BAF	= bioavailability factor	1.00	0.25	unitless	The central tendency bioavailability factor is derived from the peer-reviewed literature. Roberts, S.M., et al., Measurement of arsenic bioavailability in soil using a primate model. Toxicol Sci. 2002. 67(2): p. 303-10.
CF	= conversion factor	0.000001	0.000001	kg/mg	---
F	= frequency of exposure	365	30.42 (120 minutes/day)	days/year	This is the 95th percentile value for "playing on dirt" for 18 to <65 year olds. This value is taken from Table 16-1 of the EPA Exposure Factor Handbook 2011. United States Environmental Protection Agency. 2011. Exposure Factors Handbook: 2011 Edition. United States Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.
ED	= exposure duration	37	12	years	The maximum value is the period of time between the year the property was rezoned for residential use (1975) and the year the property was remediated (December 2012). The central tendency is the mean number of years for residential occupancy. This value is taken from Table 16-5 of the EPA Exposure Factor Handbook 2011. United States Environmental Protection Agency. 2011. Exposure Factors Handbook: 2011 Edition. United

[8] United States Environmental Protection Agency. 2005. Toxicological review of ingested inorganic arsenic, O.o.R.a. development, Editor. United States Environmental Protection Agency, Washington, DC Issue paper: Inorganic arsenic cancer slope factor. United States Environmental Protection Agency, Washington, DC.
[9] United States Environmental Protection Agency. 2005. Issue paper: Inorganic arsenic cancer slope factor, O.o.R.a. development, Editor. United States Environmental Protection Agency, Washington, DC.

					States Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.
BW	= body weight	80	80	kg	This is the mean body weight for adults. This value is taken from Table 8-1 of the EPA Exposure Factor Handbook 2011. United States Environmental Protection Agency. 2011. Exposure Factors Handbook: 2011 Edition. United States Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.
AT	= averaging time	---	---	days	---
Adult lifetime		78	78	years	The value for adult lifetime is taken from Table 18-1 EPA Exposure Factor Handbook 2011. United States Environmental Protection Agency. 2011. Exposure Factors Handbook: 2011 Edition. United States Environmental Protection Agency, Washington, DC. Available online at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.
Health guideline		0.0003	0.0003	mg/kg/day	This is ATSDR's MRL for chronic oral exposure to arsenic. Agency for Toxic Substances and Disease Registry. 2007. Toxicological Profile for Arsenic. US Department of Health and Human Services, Atlanta, GA. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf.
Cancer slope factor		5.7	5.7	$(mg/kg/day)^{-1}$	This is the EPA Science Advisory Board Arsenic Review Panel's recommended cancer slope factor for arsenic. This differs from the cancer slope factor in EPA's Integrated Risk Information System of 1.5 mg/kg/day. EHAP chose the value 5.7 mg/kg/day because it reflects more recent evaluations by the EPA staff. Additionally, this value is based on the combined risk of lung and bladder cancer, which are more serious endpoints than skin cancer. United States Environmental Protection Agency. 2005. Toxicological Review of Ingested Inorganic Arsenic, O.o.R.a. Development, Editor. United States Environmental Protection Agency, Washington, DC. United States Environmental Protection Agency. 2005. Issue Paper: Inorganic Arsenic Cancer Slope Factor, O.o.R.a. Development, Editor. United States Environmental Protection Agency, Washington, DC.

Appendix B. Update on nearby residential properties

In July 2012, DEQ investigated offsite contamination from the former smelter. Among the twenty-one properties that they tested for elevated soil lead levels, they referred four of these properties to EPA for additional evaluation. In addition to the four properties DEQ referred to EPA, EPA identified three properties they suspected to have high concentration of soil lead.

EPA conducted a removal assessment of the seven properties in October and November 2012. A total of eighty-four soil samples were taken and screened soil for lead, arsenic, chromium, and other metals using incremental sampling methods. Among the seven properties, four properties had soil lead levels greater than 400 mg/kg and one property had levels between 350 and 399 mg/kg. EPA established a cleanup level of 350 mg/kg at the site and so they decided to pay to have the five properties remediated.

In summer 2013, the remedy was implemented; 2,000 tons of contaminated soil was removed and new landscape was put into place at the five properties.

REPORT PREPARATION

This Letter Health Consultation for the Multnomah Metals (Former) Site was prepared by the Oregon Environmental Health Assessment Program under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

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