Health Consultation

ASTORIA MARINE CONSTRUCTION COMPANY

92134 FRONT ROAD

ASTORIA, OR 97103

EPA FACILITY ID: 0R0002392793

Prepared by
Oregon Health Authority

AUGUST 12, 2016

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

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

The Environmental Health Assessment Program (EHAP) within the Oregon Health Authority, Public Health Division (OHA-PHD) prepared this Health Consultation (HC) report under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to exposures to toxic substances.

ATSDR and its cooperative agreement partners conduct public health assessment activities for every site proposed to or listed on the National Priorities List (the NPL, also known as the Superfund list). In order to prepare an HC report, we review available information about hazardous substances at sites and evaluate whether exposure to them might cause any harm to people. An HC is not the same as a medical exam or a community health study. EHAP prepared this HC in accordance with ATSDR's approved methods, policies and procedures existing at the date of publication. ATSDR has reviewed this document, and based on the information presented, concurs with its findings.

This report evaluates the health risks from contamination at the Astoria Marine Construction Company (AMCCO) site in Astoria, Oregon, and provides recommendations for future investigations. The AMCCO site was proposed for addition to the NPL in March 2011. A deferral from the U.S. Environmental Protection Agency in September 2012 suspended AMCCO's listing on the NPL. Despite the deferral, ATSDR and EHAP are committed to conducting public health assessment activities at this site.

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List of Abbreviations and Acronyms

AMCCO	Astoria Marine Construction Company
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CREG	cancer risk evaluation guide
CSF	cancer slope factor
CV	comparison value
DEQ	Oregon Department of Environmental Quality
EHAP	Oregon Environmental Health Assessment Program
EMEG	environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
HC	health consultation
HOD	health outcome data
HQ	hazard quotient
MCL	maximum contaminant level
µg/dL	microgram per deciliter
µg/L	microgram per liter
mg/kg	milligrams per kilogram
MRL	minimal risk level
NOAEL	no observed adverse effect level
NPL	national priorities list
OHA-PHD	Oregon Health Authority, Public Health Division
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
ppb	parts per billion (also expressed as µg/L or microgram per liter
RBC	Oregon DEQ risk-based concentration
RI	remedial investigation
RMEG	reference dose media evaluation guide
RSL	regional screening level
SI	site investigation
SVOC	semivolatile organic compounds
TPH	total petroleum hydrocarbons
VOC	volatile organic compounds

Summary

Introduction

The Oregon Environmental Health Assessment Program (EHAP) prepared this Health Consultation (HC) on the Astoria Marine Construction Company (AMCCO) as part of its cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). One of ATSDR's goals is to conduct public health assessment activities for all sites proposed for or listed on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL). EHAP prepared this HC in order to meet this goal, and to ensure that people who work at or live near the AMCCO site have the best information possible to safeguard their health.

AMCCO is an active marine shipyard located in Astoria, Oregon, at the confluence of the Lewis and Clark River and Jeffers Slough. The site is located on approximately eight acres of land in a rural residential neighborhood. Industrial activities at AMCCO appear to have contaminated soil, groundwater, and river sediment near the site with heavy metals, organotins, petroleum, and other chemicals. Preliminary investigations by EPA indicate that the heaviest contamination is near a 1,900 square foot pit where debris, solvents, and other materials were burned (1). Other potential contamination sources are two waste piles of sandblasted grit (estimated to be 1,500 and 300 square feet) and petroleum leaks from aboveground oil storage tanks and engines (estimated to cover a total of 400 square feet) (1). The AMCCO site was proposed for addition to the NPL in March 2011. In September 2012, EPA deferred listing AMCCO on the NPL. EPA granted the Oregon Department of Environmental Quality (DEQ) oversight of the site's investigation and cleanup.

For this HC, EHAP evaluated data from a two-phase site investigation that was commissioned by EPA in 2008 and 2009. While these data were sufficient for identifying potential contaminants and sources that could pose threats to public health and the environment, they were not adequate for a comprehensive health assessment. Because of these data limitations, EHAP focused this assessment on identifying major data gaps and providing recommendations for further data collection.

Conclusions

EHAP reached nine conclusions in this HC. These conclusions are based on limited data about the extent of contamination at the AMCCO site. As a result, many of EHAP's conclusions about health risks from the AMCCO site are preliminary. The conclusions in this HC will be reevaluated and updated where appropriate as more data become available.

Pathway 1: Direct contact with contaminated surface soil

> ***Conclusion 1:*** *EHAP concludes that touching or accidentally swallowing arsenic, copper, and lead in surface soil from the burn area on the AMCCO property could be harmful to the health of AMCCO workers.*
>
> *Basis for Decision:* Soil from the burn area on the AMCCO property is contaminated with arsenic, copper, and lead at levels of health concern. If people work at the burn area, they could be

exposed to these chemicals by accidentally swallowing small amounts of soil and dust that stick to their hands.

Conclusion 2: *EHAP cannot conclude whether touching or accidentally swallowing surface soil from other parts of the AMCCO property (outside of the burn area) could harm the health of AMCCO workers.*

Basis for Decision: EHAP does not have enough information on contamination levels in soil in other areas of the site. EHAP also does not know how much time workers spend in these areas.

Conclusion 3: *EHAP concludes that surface soil from the AMCCO property will not harm the general public's health.*

Basis for Decision: The reason for this is that the general public has not been accessing the AMCCO property, and therefore, they have not been touching or accidentally swallowing the surface soil from the property.

Conclusion 4: *EHAP cannot conclude whether touching or accidentally swallowing surface soil that contains dredge spoils on the former Olsen property could harm the health of AMCCO workers, recreationists, or trespassers.*

Basis for Decision: There is evidence that dredged material containing sandblasted waste from AMCCO operations was moved to the former Olsen property, which is directly south of the site. However, no environmental data have been collected from this property. EHAP also does not know if AMCCO workers, recreationists, or trespassers are coming into contact with the dredge spoils on the former Olsen property.

Pathway 2: Direct contact with in-water sediments

Conclusion 5: *EHAP cannot conclude whether touching or accidentally swallowing in-water sediment near the burn area on the AMCCO property could harm the health of AMCCO workers.*

Basis for Decision: One sediment sample was taken from near the burn area. While the concentrations of antimony, arsenic, copper, and lead in this single sample exceeded the environmental screening values, a single sample is insufficient to determine whether the health of workers could be adversely impacted. Additionally, we do not know whether workers come into contact with the sediment in this area.

Conclusion 6: *EHAP cannot conclude whether touching or accidentally swallowing in-water sediment from other parts of the AMCCO property (outside of the burn area) could harm the health of AMCCO workers.*

Basis for Decision: Six sediment samples were taken on the AMCCO site; this does not include the sample taken near the burn area. The contaminant levels found in all of the on-site (Phase I)

sediment samples (except for one sample taken near the burn area) were below environmental screening values. However, six samples are insufficient to determine whether the health of workers could be adversely impacted. Additionally, we do not know how much time workers may be exposed to the in-water sediment.

Conclusion 7: *Based on the data evaluated in this HC, EHAP concludes that touching or accidentally swallowing in-water sediment from the upper Lewis and Clark River is not expected to harm the health of recreationists.*

Basis for Decision: Kayakers, anglers, and other users may occasionally have direct contact with in-water sediment while recreating on the upper Lewis and Clark River. Preliminary data show that the levels of organotins, total petroleum hydrocarbons (TPH), semi-volatile organic compounds (SVOCs), metals, pesticides, and polychlorinated biphenyls (PCBs) in in-water sediment are too low to harm recreationists' health.

Pathway 3: Contact with contaminated groundwater

Conclusion 8: *Based on the data evaluated in this HC, EHAP concludes that ingestion of or dermal contact with groundwater near the AMCCO site is not expected to harm nearby residents' health.*

Basis for Decision: The groundwater on the AMCCO site had levels of contaminants that exceeded the environmental screening values. However, there are no groundwater wells within 0.5 miles of the site, and so people living within this area are not expected to be exposed to the contaminated groundwater. Additionally, it is unlikely that people living more than 0.5 miles from the site with a well are using contaminated groundwater for their domestic water supply since all of the residences in vicinity of the site are on a city water supply.

Pathway 4: Consumption of contaminated fish, shellfish, or marine life

Conclusion 9: *EHAP cannot conclude if eating fish, shellfish, or other marine life caught in the upper Lewis and Clark River could harm people's health.*

Basis for Decision: We do not have information on contaminant levels in fish, shellfish, or other marine life from the Lewis and Clark River or nearby waterways.

Next Steps

EHAP recommends the following actions to protect the health of workers, nearby residents, recreationists, trespassers, and fishermen near the site.

- Workers on the AMCCO site are advised to minimize their contact with soil, dust, and in-water sediment near the burn area of the site. The best way for workers to prevent exposure is to avoid visiting this area. The majority of workers should be able to comply with this recommendation since AMCCO ceased all burning activities in 2007. Additionally, the burn area is located on the periphery of the site and it is unlikely that workers will need to access this area

to perform their regular work activities. If workers need to access the burn area, they are advised to spend as little time as possible there.

- AMCCO is advised to restrict access to the four oil-stained areas on the property until there is more information to determine whether these locations are hazardous to workers' health.
- EHAP recommends that DEQ include the following in the next phase of the site investigation and data collection:
    - Data to evaluate workers' exposures to surface soil and sediment contamination:
        - Additional sampling data on contaminant levels (especially metals, dioxins, and PAH compounds) in surface soil and in-water sediment throughout the site, particularly at and near the burn area and in locations that have not been sampled
        - Speciated chromium data to determine the amount of hexavalent chromium in soil and sediment on the site
        - Information on workers' activities and amount of contact with soil and in-water sediment in different areas of the site
    - Data to evaluate the potential risks from waste material that was disposed on the former Olsen property:
        - Contamination levels for metals, organotins, and other compounds in soil, in-water sediment, and other media on the property
        - Information on the property's land-use designation, and whether people live, work, or recreate on the property
    - Data to evaluate recreationists' exposures to in-water sediment contamination:
        - Additional sampling data on contaminant levels (especially for dioxin-like compounds) in sediment
    - Data to evaluate the potential risks from eating fish, shellfish, or other marine life from the Upper Lewis and Clark River and other nearby water bodies:
        - Contaminant levels and population data on resident fish or shellfish species, especially bottom-feeding and resident predatory species that are more likely to bioaccumulate contaminants in their tissues
        - Characteristics of people who catch and eat fish and shellfish near the AMCCO site, including types of fishers (sports vs. subsistence), types and amounts of fish and shellfish caught, and whether children, pregnant women, or women of child-bearing age eat locally-caught fish and shellfish. While this information would be useful for EHAP's assessment and outreach, we acknowledge that it is difficult to collect this information. Further, this information is not necessary for DEQ's risk assessment and evaluation of clean-up strategies.
    - Confirmatory information that residents or businesses near the site do not use groundwater wells for their domestic water supply or other purposes (e.g., irrigation)

Public Health Action Plan

EHAP will take the following public health actions:

- Participate in DEQ-led meetings and discussions related to the investigation and clean-up of the AMCCO site

- Conduct health education activities such as provide health-based information for AMCCO employees on ways to avoid exposure to site-related contaminants, answer community questions, and provide information about the public health risks associated with the AMCCO site
- Review additional sampling plans and environmental data as they become available
- Provide technical assistance and consultation to DEQ and other stakeholders as needed throughout the cleanup process

For more information

If you have questions about the findings of this report, you can contact the Oregon Environmental Health Assessment Program at 971-673-0977 or toll free at 1-877-290-6767 or via email: ehap.info@state.or.us. You can also call ATSDR at 1-800-CDC-INFO and ask for information on the Astoria Marine Construction Company site in Oregon.

Purpose and Statement of Issues

The Oregon Environmental Health Assessment Program (EHAP) prepared this Health Consultation (HC) to evaluate the health risks from contamination at the Astoria Marine Construction Company (AMCCO) site located at 92134 Front Road in Astoria, Oregon. AMCCO is an active marine shipyard located at the confluence of the Lewis and Clark River and Jeffers Slough. Industrial activities at AMCCO appear to have contaminated soil, groundwater, and river sediment near the site with heavy metals, organotins, petroleum, and other chemicals. The AMCCO site was proposed for addition to the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL; Superfund list) in March 2011, but was deferred from listing on the NPL in September 2012. The Oregon Department of Environmental Quality (DEQ) is currently overseeing site investigation and clean-up activities at AMCCO.

EHAP prepared this HC as part of its cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). One of ATSDR's goals is to conduct public health assessment activities for all sites proposed to or listed on EPA's NPL. EHAP prepared this HC in order to meet this goal, and to ensure that people who work at or live near the AMCCO site have the best information possible to safeguard their health. Currently, there are limited data on the extent of contamination from the AMCCO site. In this HC, we describe our preliminary conclusions about potential health risks at the site and provide recommendations for future investigations (currently being planned by DEQ).

Background

Site Location and History

AMCCO is an active marine shipyard located at 92134 Front Road in Astoria, Oregon. The AMCCO property is located at the confluence of the Jeffers Slough and the Lewis and Clark River (Figure 1). The Lewis and Clark River flows north past the AMCCO site and empties into Youngs Bay. Youngs Bay feeds into the Columbia River, which flows west into the Pacific Ocean. The Columbia River and nearby waterways are important areas for commercial fishing, shipping, transportation, and recreation.

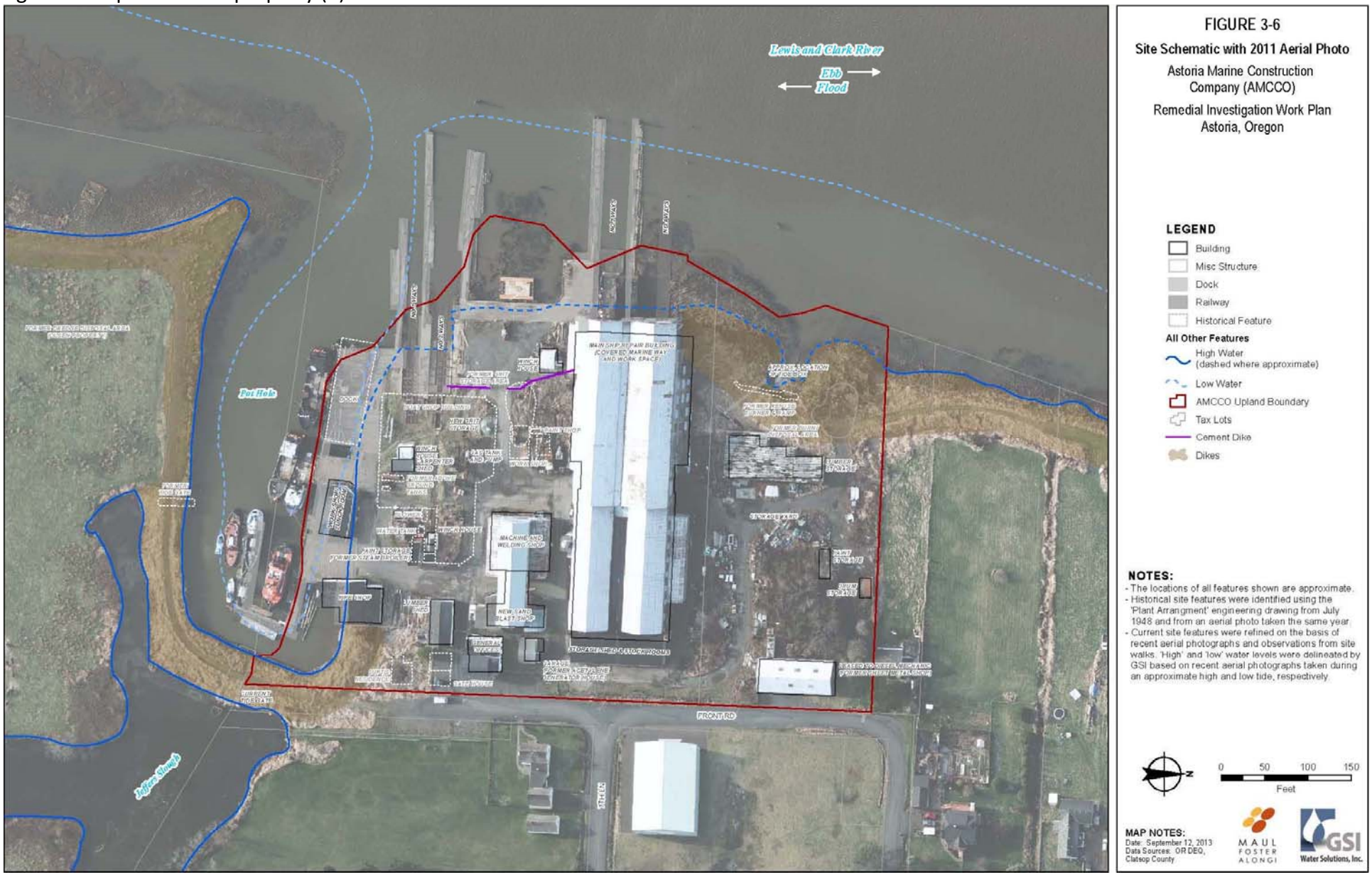
AMCCO is located on approximately eight acres of land in a rural residential neighborhood. There are approximately 15-20 homes and a few businesses within ¼ mile to the east and northeast of the site. The AMCCO property includes a large ship assembly and maintenance building, several storage areas and workshops, a main office, and four marine ways that extend into the Lewis and Clark River (1) (Figure 2). Three of these marine ways are currently used for boat repairs and refurbishment.

AMCCO was founded in 1924 and incorporated as a business in 1926 (1). Until World War II, the facility manufactured and repaired wooden-hulled fishing boats. During World War II and the Korean War, the U.S. Navy commissioned AMCCO to build mine sweepers and other military craft. When the Navy contract ended in the 1960s, the company went back to repairing fishing and tow boats. The company's workforce decreased from over 1,100 employees in mid-1950s to 15 employees in 1960. In 1962, a group of employees bought the company from the original owner. One of these employees remains as AMCCO's sole owner (1). In recent years, AMCCO has employed between 10-15 workers, and they have primarily focused on repairing and servicing mid-size fishing boats.

Figure 1. Location of AMCCO facility and surrounding area in Astoria, Oregon (3).

Source: GSI Water Solutions, Inc. and Maul Foster Alongi

Figure 2. Map of AMCCO property (3).



Source: GSI Water Solutions, Inc. and Maul Foster Alongi

Potential Sources and Past Investigations

A number of activities at AMCCO appear to have contaminated soil, groundwater, and river sediment near the site. These activities include the following (1) (2):

- Until 1989, AMCCO used copper-based paints that contained organotins, which are chemicals that prevent grass, barnacles, and other marine life from accumulating on a ship's surface. Organotins were banned in 1989 due to their toxicity to marine organisms. These chemicals could have entered the environment from paint spills or leaks on the AMCCO site.
- Until 1997, AMCCO sandblasted old paint off ships and boats and stored the sandblasted grit in waste piles on the site. The paint residues may have contained organotins, copper, lead, chromium, arsenic, and other chemicals. Material from the "former" waste pile, which may have contained hazardous paint residues, was disposed at a landfill in 1997. AMCCO continues to sandblast boats and store waste in the "current" waste pile. They reportedly have stopped sandblasting older materials to minimize the generation of hazardous wastes. The "former" and "current" waste piles are estimated to be 1,500 and 300 square feet, respectively (1).
- AMCCO also sandblasted old paint off the ships and boats in an uncontained manner and some grit accumulated in the Jeffers Slough, reducing the flow of water. As a result, AMCCO reported regularly dredging the slough and disposing of the dredged material off-site at a neighboring property south of the AMCCO site and across from the slough (the former Olsen property) (2).
- Leaks and spills from aboveground oil storage tanks and engines have resulted in petroleum contamination in soil on some parts of the AMCCO property. Four oil-stained areas were identified and each area is estimated to be 100 square feet; the oil-stained areas collectively cover 400 square feet of the site (1). The location of each oil-stained area varies in proximity to the Lewis and Clark River and Jeffers Slough; the closest area is approximately 60 feet from a water body, while the farthest area is about 115 feet (1).
- AMCCO burned lumber, debris, excess solvents, waste petroleum products, and oil-contaminated soil in a burn area on the northwestern side of the property. The burn area is estimated to be 1,900 square feet and approximately 10 feet from the Lewis and Clark River (1). Site history notes indicate that there was also once an incinerator at this location. AMCCO reportedly burned materials in the burn pit as late as 2007.

The earliest environmental investigation at AMCCO was in 1996, when investigators from Oregon DEQ visited the site and collected a few samples to evaluate petroleum leaks and sandblast waste piles (2). DEQ determined that additional investigation was needed to characterize the ecological risks from site contamination (2), and eventually referred the site to EPA. In 1999, EPA commissioned a preliminary assessment to characterize the site's history and identify potential contaminants of concern. In 2007, EPA commissioned a two-phase site investigation (SI) of the AMCCO site that included environmental sampling. The purpose of the Phase I SI was to identify contaminants that could pose threats to public health or the environment, identify potential on-site sources of contamination, and evaluate if the site met criteria for placement on the NPL. The purpose of Phase II was to identify other potential facilities and sources that could contribute to in-water sediment contamination near AMCCO (1) (2).

NPL Proposal and Deferral

The AMCCO site was proposed for addition to the NPL in March 2011. In April 2011, the Clatsop County Board of Commissioners requested that EPA delay its final decision to add AMCCO to the NPL (4). While the Board supported cleaning up the site, they expressed concerns that a Superfund designation could negatively affect AMCCO's viability as a business. They were also concerned that a Superfund designation would be detrimental to the region's economy and image. After several meetings with DEQ and local stakeholders, EPA outlined the key criteria needed to defer AMCCO's listing on the NPL (4). In September 2012, EPA determined that DEQ and AMCCO had met the key criteria and granted a deferral for the AMCCO site. Under this agreement, DEQ is required to conduct the same caliber of investigation, clean-up, and community engagement as an EPA-led Superfund clean-up. AMCCO is financially responsible for all investigation and clean-up related costs.

EHAP Activities

This HC is EHAP's first assessment of the AMCCO site. EHAP staff visited the AMCCO property in June 2012 as part of a coordinated site visit with DEQ, local elected officials, tribal agency staff, representatives from city and county agencies, and other state agency staff. Following the site visit, EHAP staff attended a public meeting hosted by DEQ. The meeting focused on the status of the deferral process and DEQ's plans for community involvement. Approximately 15 people attended the meeting. EHAP is part of the AMCCO Cleanup Partners group convened by DEQ. EHAP staff have participated in several partners' meetings since the group initially met in October 2012.

Discussion

Data Sources and Limitations

The data evaluated in this report were collected during the Phase I and Phase II SIs of the AMCCO site. Phase I sampling took place in spring 2008 and it involved the collection of soil, sediment, and groundwater samples from the AMCCO site. Phase II sample collection was conducted in summer 2009. These samples were used to identify potential sources of sediment contamination in several water bodies near the AMCCO site (1). For the purpose of this HC, EHAP analyzed a subset of the Phase II data, called the Lewis and Clark River Astoria Marine transect, which was collected from the Lewis and Clark River and in closest proximity to the AMCCO site. Additional information about the location and number of samples gathered during Phases I and II is presented in Table 1 and Figures 3 and 4.

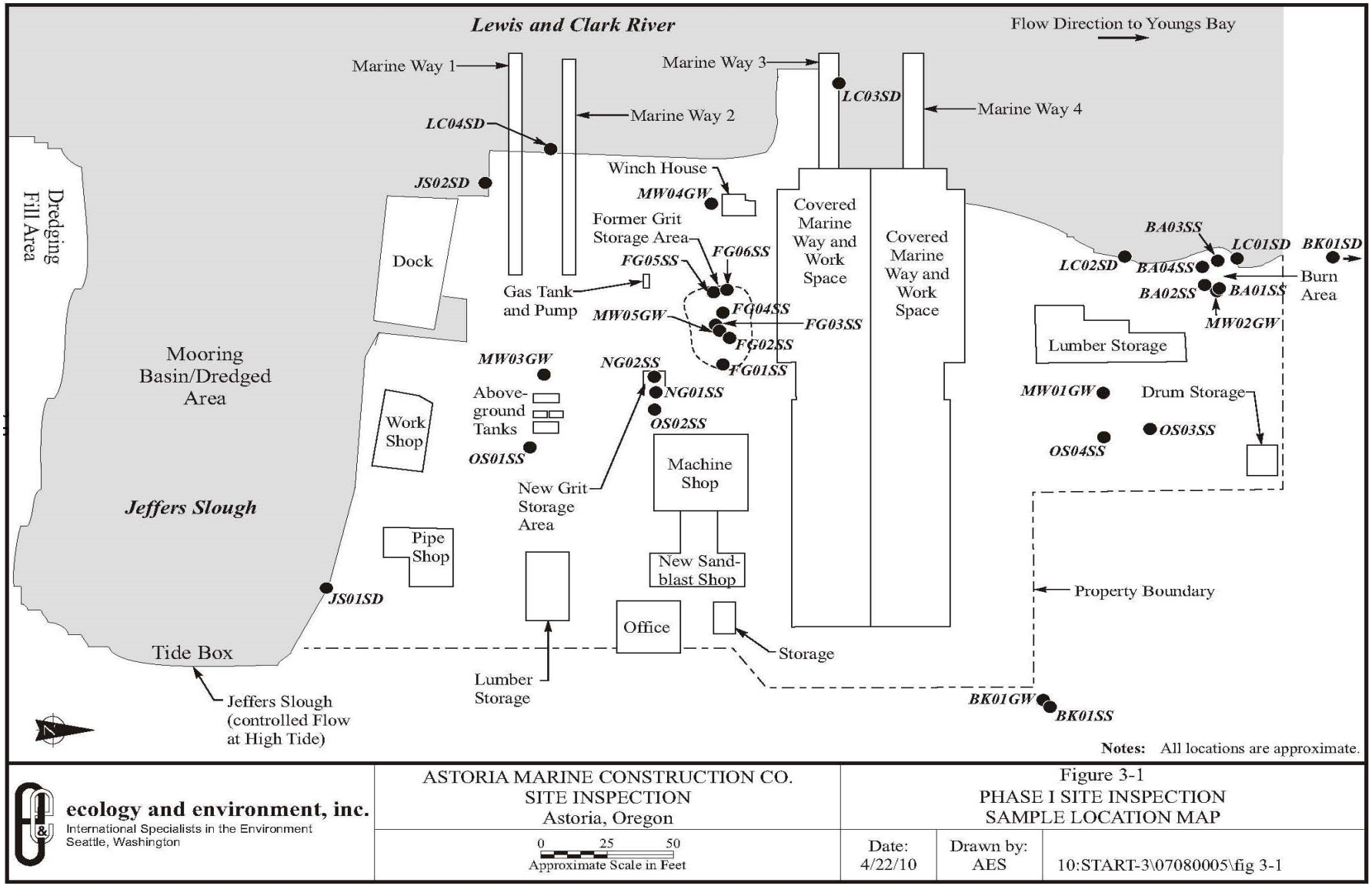
Table 1. Number of Phase I and II samples included in EHAP's analysis by media.

	Surface soil*	Sediment	Groundwater
Phase I	*Total samples n=16* *Burn area n=4* *Former grit pile n=6* *New grit pile n=2* *Oil-stained area n=4*	*Total samples n=7* *Jeffers Slough n=2* *Lewis and Clark River n=5*	*Total samples n=5*
Phase II	No surface soil samples were taken	Total samples n=49 *Lewis and Clark River, AM transect n=15* Lewis and Clark River n=11 Skipanon Waterway n=3 Youngs River n=10 Youngs Bay n=6 Craig Creek n=1 Columbia River, Port of Astoria n=3	No groundwater samples were taken

Abbreviations: AM = Astoria Marine
Italics indicates samples used in this Health Consultation.
*Surface soil samples were collected 0 to 6 inches below the ground surface.

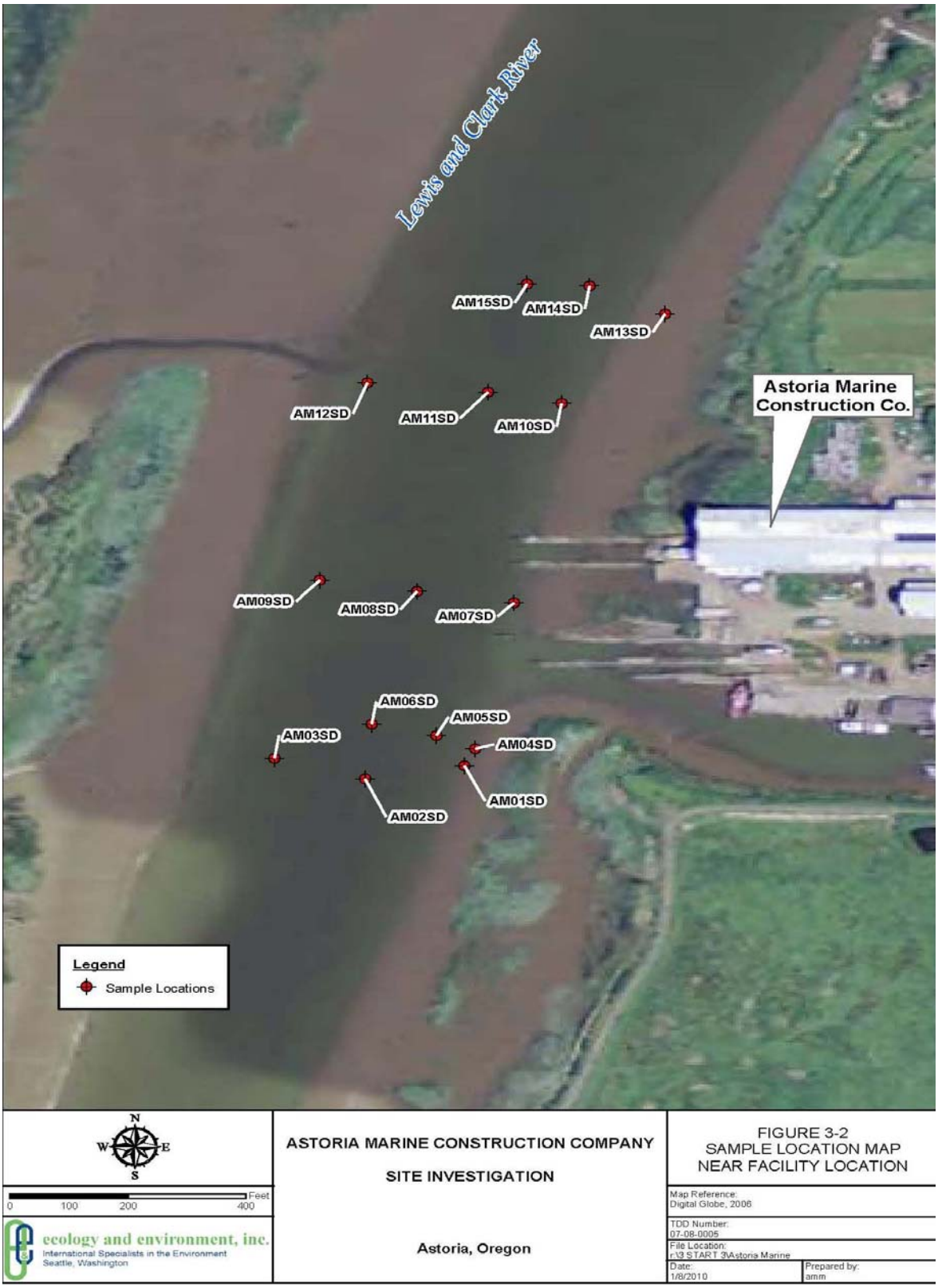
These preliminary investigations collected enough data to identify potential contaminants and sources that could pose threats to public health and the environment. However, these data are not adequate for a comprehensive health assessment. Because of these data limitations, EHAP focused this assessment on identifying major data gaps and providing recommendations for further data collection.

Figure 3. Map of Phase I site investigation sample locations (from EPA's 2010 Site Investigation Report) (1).



Abbreviations: BA = burn area; BK = background; FG = former grit pile; GW = ground water; JS = Jeffers Slough; LC = Lewis and Clark River; MW = monitoring well; NG = new grit pile; OS = oil stain; SD = sediment; SS = surface soil
Source: Ecology and Environment, Inc.

Figure 4. Map showing the sediment sample locations from the Lewis and Clark River Astoria Marine transect of the Phase II site investigation (from EPA's 2010 Site Investigation Report) (1).



Abbreviations: AM = Astoria Marine; SD = sediment
Source: Ecology and Environment, Inc.

Potential Exposure Pathways

Contamination from the AMCCO site will only pose health risks if people have physical contact with these chemicals in the environment. To determine if, and how, people could be exposed to AMCCO-related contamination, EHAP conducted an exposure pathway analysis by evaluating the following elements:

- A source for the chemicals
- A medium (e.g., water, soil, air) in which the chemicals are found
- A point or location where people come into contact with the chemicals
- A route by which people have physical contact with the chemicals
- A population that comes into contact with the chemicals

In a completed exposure pathway, all five of these elements are present. A completed pathway means there is a strong likelihood that people have been or are currently being exposed to a chemical. In an eliminated exposure pathway, at least one of the five elements is absent. This means that past or current exposure to a chemical is unlikely. In a potential exposure pathway, one or more of the elements may be absent, but additional information is needed before eliminating the pathway.

EHAP identified four potential exposure pathways for the AMCCO site, which are summarized in Table 2. We considered these "potential" pathways primarily because we do not know if people are actually coming into contact with chemicals through these pathways.

Table 2. Potential exposure pathways.

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Potentially Exposed Population	Associated Conclusion(s)
1) Direct contact with contaminated surface soil	Past Current Future	Industrial activities at AMCCO and other properties	Surface soil	Soil and dust on- and off-site (the former Olsen property)	Ingestion, inhalation, dermal contact	AMCCO workers, recreationists, or trespassers	1, 2, 3, 4
2) Direct contact with in-water sediment	Past Current Future	Industrial activities at AMCCO and other properties	In-water sediment	River bottom on-and off-site	Ingestion, dermal contact	AMCCO workers or recreationists	5, 6, 7
3) Contact with contaminated groundwater	Past Current Future	Industrial activities at AMCCO and other properties	Groundwater	Off-site private drinking water wells	Ingestion, dermal contact	Residents living near the AMCCO site with private drinking water wells	8
4) Consumption of contaminated fish	Past Current Future	Industrial activities at AMCCO and other properties	Fish tissue via in-water sediment	Fish tissue	Ingestion	Consumers of locally caught fish (i.e., subsistence and sport fishers, pregnant women, and children)	9

Abbreviation: AMCCO = Astoria Marine Construction Company

Health Screening Evaluation

For each of the four pathways, EHAP identified the relevant environmental data collected during the Phase I and II SIs and compared these data to ATSDR's comparison values (CVs). ATSDR CVs are screening tools to identify contaminants of potential concern at a site. The CVs represent the contaminant levels in soil, water, or air that people could be exposed to on a daily basis and not experience harmful health effects. CVs are not environmental clean-up levels, and chemicals that exceed their CVs will not necessarily pose health risks. If the maximum site contaminant levels are below CVs, they are excluded from further analysis because they are not expected to harm human health. If the maximum contaminant levels are above CVs, they are identified as contaminants of potential concern that require further evaluation. Please refer to Appendix B for more information about the environmental data and CVs that EHAP used for this evaluation.

Note: There were several analytes that were tested in the soil, sediment, and/or groundwater samples from the AMCCO site but did not have CVs (Appendix B). These chemicals include: calcium, magnesium, potassium, and sodium in soil, sediment, and groundwater; iron in groundwater; and methylcyclohexane in soil. If an analyte does not have a CV, usually it is kept for further evaluation. In this case, we did not do that. Calcium, iron, magnesium, potassium, and sodium are essential nutrients with low toxicity, and therefore, they are not considered a health concern at this site. There is little information on the toxicity of methylcyclohexane, and so it cannot be further evaluated. Further, it was detected in only one of four soil samples taken from the burn area and not found outside the burn area.

Health Effects Evaluation

Pathway 1: Direct contact with contaminated surface soil

The first potential exposure pathway is direct contact with contaminants in surface soil (0 to 6 inches below the ground surface) on- and off-site. Workers at the AMCCO site could potentially be exposed to contaminants in surface soil by accidentally swallowing small amounts of contaminated dust or absorbing chemicals through skin contact with soil. In addition, workers, recreationists, or trespassers that come into contact with soil on the former Olsen property could potentially be exposed to contaminants through the same routes. Further, on- and off-site soil contamination could be a source of surface water and in-water sediment contamination, particularly during annual precipitation events that flood parts of the AMCCO property (1).

EHAP only evaluated workers' exposure to soil on the AMCCO site in this HC. It's unlikely that anyone other than workers will access and come into contact with soil from the AMCCO site and so other groups of people (e.g., trespassers, children, etc.) were not evaluated. Additionally, it is an industrial work-site where access is limited by the Lewis and Clark River and Jeffers Slough that border the west and south sides of the property. To assess workers' exposure, we used Phase I soil samples from the burn and oil-stained areas and the former and new grit piles of the AMCCO site. See Figure 3 for more information about the Phase I soil sample locations.

EHAP did not evaluate workers, recreationists, or trespassers' exposure to soil at the former Olsen property. The EPA site investigation did not include the former Olsen property and so there are no data

to evaluate people's exposure to soil at this off-site location. Also, it is unknown whether people access this property.

On-site, workers

During the Phase I investigation, a total of 16 surface soil grab samples were collected at depths between 0-6 inches below ground surface from various locations on the AMCCO property; see Figure 3 for the Phase I sample locations. These samples were tested for organotins, metals, total petroleum hydrocarbons (TPHs), semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). We compared the highest detected level of each contaminant in surface soil to a CV for soil. Since AMCCO is an industrial worksite, we used CVs that are appropriate for adult worker exposures.

Our initial screen of the soil sampling results found seven contaminants at levels that exceeded their CVs (Appendix B, Table 6): arsenic, chromium, copper, lead, TPH-diesel, TPH-motor oil, and benzo(a)pyrene. It is difficult to estimate the risk from these contaminants because of the small number of samples, and because contamination levels varied in different locations on the property. In the following sections, we describe our conclusions about the health risks from surface soil contamination at four locations on the AMCCO property: the burn area (Figure 5), the former grit pile, the new grit pile, and the oil-stained areas.

Figure 5. Map of the former burn & disposal area at the Astoria Marine Construction Company site.

1. Burn Area

During the Phase I site investigation, four samples from the burn area were tested for organotins, metals, SVOCs, and VOCs. The organotin and VOC levels at the burn area were below CVs (Appendix B, Table 7). One sample from the burn area had a benzo(a)pyrene measurement above its CV. However, we did not further evaluate benzo(a)pyrene in

this scenario because the elevated level (0.098 mg/kg) was only found in one sample, and this level only slightly exceeded ATSDR's Cancer Risk Evaluation Guide for benzo(a)pyrene (0.096 mg/kg).[1]

The burn area had higher levels of metal contamination compared to other areas of the property. Four samples exceeded the CV for arsenic, three samples exceeded the CV for copper, and two samples exceeded EPA's screening value for lead at commercial/industrial sites (Appendix B, Table 7), and so we further evaluated workers' exposure to these metals.[2]

The soil samples were also tested for total chromium. Currently, ATSDR does not have a CV for total chromium in soil, but ATSDR does have CVs for trivalent chromium (chromium III) and hexavalent chromium (chromium VI). Chromium VI is significantly more toxic than chromium III. For this assessment, we used the CV for chromium VI as a surrogate for total chromium, and the level of total chromium in one sample exceeded the chromium VI CV.[3] To better assess the potential risk to workers, we used recent speciated site data from the Phase I Remedial Investigation (RI) to calculate the ratio of chromium VI to total chromium and then we estimated the amount of chromium VI in this sample. (These newer data were used in the interest of refining the 2010 data and EHAP has plans to further evaluate the RI data once sampling is complete. These newer data were taken from the same locations as the older data, and there has been no remediation of the area.) The highest chromium VI to total chromium ration was chosen to represent a worst-case scenario. Using this new ratio, the highest estimated concentration of chromium VI in the older samples was 18.19 mg/kg. Since the estimated concentration was below the CV (630 mg/kg), we did not further evaluate it. See Appendix C for a detailed description of the process we used to estimate the concentration of chromium VI.

2. Former Grit Pile

Most of the material from the former grit pile was removed in 1997. However, there is still some residual grit material in that area. Six samples from the former grit pile were tested for organotins and metals. None of the samples contained organotins above ATSDR CVs. However, three samples contained total chromium at levels above the CV for chromium VI. Therefore, we estimated the level of chromium VI using the method described in Appendix C. The highest estimated concentration of chromium VI was 19.35 mg/kg, which was below the CV.

3. New Grit Pile

Two samples were collected from the new grit storage area, which is a partially-enclosed 300 square foot area used to store grit from sandblasted steel. The two samples were tested for organotins and

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[1] Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed during their lifetime. Concentrations greater than CREGs don not necessarily mean that people will develop cancer from exposures, but further evaluation is necessary to assess the risk of cancer.

[2] ATSDR does not have a comparison value for lead, and so we use EPA's screening value for lead at commercial/industrial sites, which is 800 mg/kg.

[3] Typically, chromium III (a relatively non-toxic form of chromium) predominates in surface soils. However, marine terminals and shipyards in the U.S. may have higher levels of chromium VI (which is toxic at low concentrations) in soil because of the industrial nature of work at these facilities. Further, chromium VI has been used as an anti-corrosive agent in paints, plating, and stainless steel used in shipyards.

metals. Neither sample had organotins above ATSDR CVs. However, one sample had levels of total chromium that exceeded the chromium VI CV, and so we estimated the level of chromium VI in the sample. The estimated concentration (15.87 mg/kg) was less than the CV.

4. Oil-Stained Areas

Samples from four visibly oil-stained areas were tested for total petroleum hydrocarbons (TPH in the diesel and motor oil ranges), SVOCs, and metals. The oil-stained areas were relatively small (approximately 100 square feet for each area) and were in different locations on the site. The four samples varied in terms of chemicals detected and levels of contamination. The concentration of total chromium exceeded the CV. Therefore, we estimated the level of chromium VI and it was below the CV. There was one detection of lead and one detection of benzo(a)pyrene above the CV, as well as elevated levels of TPH-Diesel and TPH-Motor Oil (Appendix B, Table 7).

We did not further evaluate the health implications of lead, benzo(a)pyrene, or TPH compounds in soil because these detections were in discrete oil-stained areas and are not representative of site-wide conditions. Further, we do not know if workers are actually coming into contact with soil in these areas. Until we have more information to determine whether the oil-stained areas are hazardous to workers' health, it is prudent for AMCCO to restrict access to these areas.

5. Evaluation of non-cancer and cancer risk in AMCCO workers

Without more information on contaminant levels and workers' activities at the burn and oil-stained areas and the former and new grit piles, it is difficult to estimate the health risks posed by the contamination. However, we used the available data and made conservative assumptions about worker exposure to further evaluate the potential health implications of arsenic and copper at the burn area. We also evaluated workers' exposure to lead at the burn area since this is where the highest concentration that exceeded EPA's screening value for lead at commercial/industrial sites was found.

a) Non-cancer risk of arsenic and copper

EHAP calculated non-cancer risk, the likelihood of a health problem other than cancer, for arsenic and copper. We assumed that AMCCO workers would accidentally swallow 100 mg/day of the most heavily contaminated soil while working in the burn area for 8 hours per day for 5 days per week for 50 weeks per year (or 83.3 days per year) for 25 years. We also assumed that 25% of the arsenic and 100% of the copper in the soil would be absorbed into the bloodstream after ingestion (5). Based on these assumptions, EHAP calculated a non-cancer dose for arsenic and copper (1.0 E-4 and 3.4 E-2 mg/kg, respectively, Table 3).

Next, we calculated a Hazard Quotient (HQ) to better understand the non-cancer risk of arsenic and copper exposure to AMCCO workers. The HQ was produced by dividing the non-cancer dose for each metal by its corresponding health guideline. In this instance, we used ATSDR's Minimal Risk Level (MRL)

as the health guideline.[4] The non-cancer HQs for arsenic and copper are 0.3 and 3.4, respectively (Table 3).

When an HQ is less than or equal to 1.0, it is unlikely that non-cancer health effects will occur. If it is greater than 1.0, an exposed person could experience adverse health effects that are not cancer. Since the HQ for arsenic is below 1.0, we do not expect workers with exposure to arsenic at the burn pile to be at risk for experiencing non-cancer health problems. However, the HQ for copper is greater than 1.0, and so we further evaluated this metal in this assessment.

Appendix D provides additional information about our assumptions and shows the steps we used to calculate a dose and risk for non-cancer health effects.

The estimated dose for copper exceeds ATSDR's MRL. However, it does not necessarily mean that AMCCO workers' health is at risk. ATSDR's health guidelines are conservative estimates that are much lower than the doses that have been shown in scientific studies to result in adverse health effects. In this instance, the MRL is 0.01 mg/kg-day and the no observed adverse effect level (NOAEL) is 0.042 mg/kg-day; the NOAEL is based on gastrointestinal effects in men and women ingesting copper sulfate in drinking water for two months (6). While the estimated dose for copper (0.034 or 3.4 E-2 mg/kg-day) is greater than the health guideline, it is less than the NOAEL. Additionally, EHAP made conservative assumptions that likely overestimated AMCCO workers' actual contact with copper in soil. For instance, we assumed that workers would be exposed to copper for 8 hours per day for 5 days per week for 50 weeks per year over 25 years; this is a conservative estimate of the frequency and duration of exposure. However, EHAP cannot rule out the possibility that contamination at the burn area may pose a risk to workers' health without additional information about workers' exposure to this area.

b) Cancer risk of arsenic

EHAP only calculated workers' cancer risk from arsenic exposure, since copper has not been classified as a human carcinogen (6). To estimate cancer risk, we used many of the same assumptions for non-cancer risk. For instance, we assumed workers would accidently swallow 100 mg/day of the most heavily contaminated soil while working in the burn area for 8 hours per day for 5 days per week for 50 weeks per year (or 83.3 days per year) for 25 years. We also assumed that 25% of the arsenic would be absorbed into the bloodstream after ingestion (5). Additional information about the assumptions used to calculate cancer risk can be found in Appendix D.

EHAP calculated excess cancer risk, the probability of developing an arsenic-related cancer from the AMCCO site over a person's entire lifetime (78 years), by multiplying the dose (3.3 E-5; Table 3) and EPA's cancer slope factor (CSF) for arsenic (5.7 mg/kg-day; Table 3). A CSF is a value used to estimate the risk of cancer associated with exposure to a cancer-causing substance. It is based on the probability of the risk of cancer over a person's lifetime. The lifetime cancer risk from arsenic exposure through accidentally swallowing soil while working near the burn area is approximately 2 in 10,000 (2 E-4; Table

[4] A Minimal Risk Level (MRL) is the daily dose of a chemical, below which scientists consider it unlikely to harm people's health.

3). This probability represents the number of additional cancer cases in a population where everyone would get the same dose of a chemical for a certain period of time. The estimated risk slightly exceeds EPA's target risk range of one additional cancer case in 10,000 and one additional cancer case in 1,000,000. However, this cancer risk value is a conservative estimate and we will be able to calculate a more realistic value when we have more environmental data and information about worker exposure.

The steps we took to calculate cancer dose and risk for arsenic are shown in Appendix D.

Table 3. Arsenic and copper dose and risk calculations for AMCCO workers.

Non-cancer dose and risk				
Chemical	Maximum concentration (mg/kg)	Estimated dose (mg/kg-day)	Non-cancer health guideline (mg/kg-day)	Hazard Quotient
Arsenic	1,450	1.0 E-4	0.0003 [a]	0.3
Copper	118,000	3.4 E-2	0.01 [b]	3.4
Cancer dose and risk‡				
Chemical	Cancer slope factor $(mg/kg\text{-}day)^{-1}$	Estimated dose (mg/kg-day)	ATSDR cancer risk guideline	Cancer risk
Arsenic	5.7	3.3 E-5	1.0 E-4	2 E-4

See Appendix D for detailed calculations. All values are rounded; however, complete numbers were used in all calculations.
Abbreviations: AMCCO = Astoria Marine Construction Company; mg/kg = milligrams per kilogram; ATSDR = Agency for Toxic Substances and Disease Registry
‡ We did not calculate cancer risk for copper since they have not been classified as human carcinogens (6) (7).
[a] ATSDR Chronic Oral Minimal Risk Level (8)
[b] ATSDR Intermediate Oral Minimal Risk Level (6)

c) Lead

EHAP evaluated AMCCO workers' exposure to lead through soil ingestion. Earlier, we compared the soil lead concentration to EPA's screening value for commercial/industrial sites (800 mg/kg) since ATSDR does not have a comparison value for lead. Typically, 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 known safe level of blood lead. Instead, we used EPA's Adult Lead Methodology to estimate a range of blood lead concentrations for workers exposed to soil and dust at the site and compared this range to the Centers for Disease Control and Prevention's (CDC's) adult case definition for elevated blood lead levels (9).

To calculate the range of blood lead levels, we made conservative assumptions about workers' exposure. We assumed workers would be exposed to the maximum soil lead concentration (10,100 mg/kg) while working in the burn area for 8 hours per day for 5 days per week for 50 weeks per year

(or 83.3 days per year) for 25 years. We also assumed that they would accidently ingest the soil and dust at a rate of 100 mg/day.

Based on these assumptions, AMCCO workers would be expected to have blood lead concentrations between 12.1 and 12.6 µg/dL (Table 4). The estimated blood lead levels exceed the CDC's case definition for elevated adult blood lead levels, which is greater than or equal to 10 µg/dL (≥10 µg/dL) of whole blood (10). It is recommended that workers avoid contact with soil, dust, and in-water sediment near the burn area of the site. However, if workers need to access the burn area, they are advised to limit their time there.

EHAP reviewed adult blood lead level data reported to OHA-PHD's Lead Program from 1991, when the program began collecting these data, to the present. In order to find any blood lead tests that may be related to the site, we queried the database by the company's name. There are no blood lead tests for AMCCO workers in the program's database based on this search criterion. However, we cannot be completely certain of this. While CDC's case definition for an elevated adult blood lead level is ≥10 µg/dL of whole blood, OHA-PHD's Lead Program only has resources to investigate cases that are ≥25 µg/dL. As a result, employer information is rarely known and captured in the program's database when a blood lead test is less than 25 µg/dL (<25 µg/dL).

Table 4. Comparison of workers' estimated blood lead concentration from soil lead exposure to CDC's blood lead guideline.

Chemical	Maximum concentration in soil (mg/kg)	Estimated blood lead level	Non-cancer health guideline
Lead	10,100	12.1 – 12.6 µg/dL [a]	10 µg/dL [b]

All values are rounded; however, complete numbers were used in all calculations.
Abbreviations: mg/kg = milligrams per kilogram; µg/dL = micrograms per deciliter; ATSDR = Agency for Toxic Substances and Disease Registry
[a] For lead, ATSDR recommends estimating the blood lead level. We used the Environmental Protection Agency's Adult Lead Methodology in this assessment (9).
[b] The Centers for Disease Control and Prevention's adult case definition for elevated blood lead levels (10).

Off-site (former Olsen property), workers, recreationists, or trespassers

According to a DEQ site assessment report, AMCCO performed sandblasting activities in an uncontained manner and grit accumulated in Jeffers Slough (2). To ensure the flow of water in Jeffers Slough was not compromised, AMCCO regularly dredged it and disposed of the spoils at an off-site property, south of the AMCCO facility and across from the Slough – this property is referred to as the former Olsen property. According to AMCCO's owner, the dredged material accumulated to a depth of 3 feet and covered an acre of the property (2). To evaluate the risk to people that might come into contact with the soil on the former Olsen property, EHAP would need the following information:

- Surface soil data – To date, there have not been any samples collected from the former Olsen property. This information would enable EHAP to evaluate the magnitude or extent of contamination on this off-site property.
- Information about people's contact with the soil on the former Olsen property – It is completely unknown if people access the former Olsen property and are exposed to the soil. If people access the property, we also need information about the activities they perform on the property and the amount of time they spend doing them.

Pathway 2: Direct contact with in-water sediments

The second potential exposure pathway is direct contact with contaminated sediment at the bottom of the Lewis and Clark River and Jeffers Slough. People could be exposed by absorbing chemicals from sediment that sticks to their skin or accidentally swallowing sediment that sticks to their hands. The people who could have this type of contact are workers who enter the water during boat repair and maintenance activities and recreational users (such as anglers and kayakers) on the Lewis and Clark River.

We evaluated these two groups separately since it's unlikely that workers and recreational users will equally access and become exposed to in-water sediment from all of the sampled areas. EHAP used the Phase I samples to evaluate workers' exposure to in-water sediment since they were collected from locations on the AMCCO site where workers have the greatest potential for exposure. To assess recreational users' exposure to in-water sediment, we used the Astoria Marine transect samples from the Phase II site investigation. These data were collected from the Lewis and Clark River where the public is most inclined to access and come into contact with sediment. See Figures 3 and 4 for more information about the Phase I and II sediment sample locations.

On-site, workers

During the Phase I site investigation, seven sediment samples were collected near the AMCCO property from the Lewis and Clark River and Jeffers Slough; see Figure 3 for the Phase I sample locations. These samples were tested for organotins, TPHs, heavy metals, SVOCs, and VOCs. We used the results to evaluate workers' exposures to sediment contamination. We compared the highest measured contaminant levels found in these seven samples to CVs for soil. Since AMCCO is an industrial worksite, we used CVs that are appropriate for adult worker exposures.

No VOCs or SVOCs were detected in the Phase I sediment samples. The organotin and TPH levels in these samples were below CVs (Appendix B, Table 8). Our initial screen of the Phase I sediment data found antimony, arsenic, copper, and lead levels exceeded CVs. A closer examination of the data found that these elevated levels were from one sample that had particularly high levels of metal contamination. This sample (LC01SD) was collected from the Lewis and Clark River near the burn area on the northwestern corner of the AMCCO property. The antimony, arsenic, copper, and lead levels in the other six sediment samples were below their respective CVs.

We did not further evaluate the public health implications of the antimony, arsenic, copper, and lead contamination in sediment for two key reasons. First, we only have data from one sample. This single data point is not sufficient to understand the actual sediment contamination levels near the burn area

or how this contamination could affect people's health. Second, we do not know if workers are actually coming into contact with sediment near the burn area. Based on our observations during a 2012 site visit, the burn area does not appear to be accessed by workers on a regular basis, and the owners do not burn materials any longer. Even if workers do come in contact with in-water sediment in this area, their levels of exposure are likely to be infrequent and low (especially if they wear clothing that limits their contact with in-water sediment). If additional data become available for the burn area or future use of the site changes, then EHAP will be available for further evaluation of this area.

Off-site, recreationists

During the Phase II site investigation, 15 sediment samples were collected from the Lewis and Clark River. The samples were collected at roughly equal intervals that extend from the shoreline (near the facility) to the center of the river; see Figure 4 for the Phase II sample locations. These samples were tested for organotins, TPH, SVOCs, metals, pesticides, and polychlorinated biphenyls (PCBs).

During EHAP's site visit in June 2012, an AMCCO representative stated that he occasionally saw kayakers, anglers, or other recreational users in the upper Lewis and Clark area. Therefore, we used the results to evaluate adult recreational users' exposures to sediment contamination near the facility. It is unlikely that children recreate in the river near the facility because it is not easily accessible by land (i.e., there are no visible beaches or access points), and the river is too deep for children and adults to safely swim or wade.

We compared the highest measured contaminant levels found in these 15 samples to adult CVs for soil. No pesticide, PCB, or TPH compounds were detected in the 15 samples (1) (11) (12).[5] The organotin, SVOC, and metal levels in these samples were below their CVs (Appendix B, Table 9).

The measured contaminant levels in the upper Lewis and Clark River are too low to pose any health risks to potential recreational users. However, because the sediment was tested for a limited number of contaminants during the Phase II investigation, we do not know if the sediment contains other contaminants from the AMCCO site (e.g., dioxins or furans) that could pose a risk to recreational users. If new data become available for the upper Lewis and Clark River and include dioxins and furans, there can be further evaluation of recreational users' exposure to in-water sediment.

Pathway 3: Contact with contaminated groundwater

The third potential exposure pathway is contact with contaminated groundwater from private domestic wells. (Ingestion is the most important route of exposure, however, dermal contact is another route of exposure that can contribute some to the overall dose.) In May 2008, one background and five on-site groundwater samples were collected and evaluated for site-related contaminants; the background sample was collected outside the property's northeast boundary. The samples were tested

[5] The Phase II sediment samples were tested for pesticides/PCBs using EPA laboratory method SOM01.2 (10) and for TPH compounds using the NWTPH-Dx method (11). These methods have detection limits that are below ATSDR's CVs for the tested compounds. In other words, if these sediment samples had any undetected PCB, pesticide, or TPH contamination, the levels were below ATSDR's or other agencies' comparison values.

for organotins, metals, and VOCs, but there was not sufficient water volume for TPH or SVOC analyses (1).

We compared the highest detected level of each contaminant in groundwater to a drinking water CV (Appendix B, Table 10). The limited sampling results indicate that the groundwater at AMCCO has elevated levels of aluminum, arsenic, chromium, copper, lead, manganese, nickel, vanadium, and zinc. The other metals tested did not exceed CVs, but they were elevated compared to background levels. One sample had tributylin and VOCs above background levels, but these contaminants were below CVs.

Off-site, residents

According to the 2010 SI report, 139 groundwater wells serve an estimated 320 people within four miles of the AMCCO site (1). The nearest wells are located between 0.5 – 1 mile of the site.
AMCCO and nearby residences receive their water supply from the Youngs River Lewis & Clark Water District. According to the 2010 SI report, there are no groundwater wells within 0.5 miles of the site, which includes several homes north, northeast, and east of the site (1). Since there are no groundwater wells in this area, EHAP does not expect people living within 0.5 miles of the site to be exposed to contaminated groundwater. While there are groundwater wells more than 0.5 miles from the AMCCO site, DEQ does not believe that people living close to the site use groundwater wells for their domestic water supply. If people are connected to and use city water, they will not be exposed to the metals that exceed background levels in groundwater by drinking or cooking with the water. However, EHAP needs additional information about the location of the groundwater wells near the AMCCO site and about whether people are using them for domestic or other purposes (e.g., irrigation water).

Pathway 4: Consumption of contaminated fish, shellfish, or marine life

The fourth potential pathway is exposure through the consumption of contaminated fish, shellfish, or other marine life. The Lewis and Clark River, Youngs River, Youngs Bay, and the mouth of the Columbia River provide opportunities for sport and commercial fishing and crab harvesting (1). The main fish species caught in these water bodies are salmon and steelhead (Table 5). The most recent sport catch data from the Oregon Department of Fish and Wildlife indicate that very few sturgeon have been caught in these water bodies in recent years (13). However, these data are self-reported and may not reflect actual catch and consumption patterns in the Lewis and Clark River and Youngs Bay.

Salmon and steelhead are anadromous fish that are born and spawn in fresh water but spend most of their life-cycle at sea. Because they spend little time feeding in local water bodies, they will not be affected by local contamination levels (14). Non-migratory bottom-feeding fish (such as sturgeon) and shellfish are more likely to accumulate local toxins in their tissues (14).

Currently, there are no fish or shellfish tissue data to evaluate the potential risks from eating fish or shellfish caught near the AMCCO site. While there are methods to estimate risk based on sediment contamination levels, OHA-PHD requires actual measurements of contaminant levels in fish tissue. To evaluate the risks from consuming fish and shellfish caught near the AMCCO site, EHAP would need the following information:

- Types and amounts of fish or shellfish caught and eaten – Bottom-feeding and resident predatory species (e.g., sturgeon or crab) are more likely to bioaccumulate contamination than migratory species (14).
- Contaminants and contaminant levels in fish and shellfish tissue – Certain chemicals are known to bioaccumulate in the food chain, including dioxins and dioxin-like compounds (including PCBs), mercury, and organotins (14).
- Characteristics of people who catch and eat fish near the AMCCO site – Sports fishers are expected to have lower rates of fish consumption than subsistence fishers and may catch and consume different species of fish. Since sports and subsistence fishers may provide fish to their families or community members, it is important to know if children, pregnant women, or women of child-bearing age consume fish caught near the AMCCO site.

EHAP acknowledges that some of this information (particularly data on types and amounts of fish eaten and characteristics of people who fish near the site) may be difficult to collect. While this information is useful for EHAP's risk assessment and health education activities, it is not necessary for DEQ's risk assessment and clean-up process. EHAP and OHA-PHD's Healthy Waters Unit are available for consultation during the design and implementation of any fish and shellfish tissue studies conducted at the AMCCO site.

Table 5. Sport catch statistics for the Lewis and Clark River and Youngs River and Bay, 2008-2012.

Water Body	Year	Number of fish by type						
		Coho Salmon	Fall Chinook Salmon	Spring Chinook Salmon	Summer Steelhead	Winter Steelhead	Green Sturgeon	White Sturgeon
Lewis and Clark River	2008	0	39	4	8	0	0	0
	2009	0	31	0	4	0	0	0
	2010	7	15	46	0	0	0	0
	2011	3	107	41	0	0	0	0
	2012*	5	78	28	10	5	0	0
Youngs River and Youngs Bay	2008	0	63	4	0	0	0	5
	2009	20	39	12	0	4	0	0
	2010	33	141	74	11	0	0	0
	2011	41	186	24	0	4	0	0
	2012*	15	131	46	3	3	0	0

Data Source: Oregon Department of Fish and Wildlife Sport Catch Statistics for 2008-2012 (13) (accessed 3/25/2014).
*2012 values are preliminary

Data Gaps

- Some areas of the AMCCO property are likely to have contaminated soil, sediment, or water but have not been sampled. There are visible waste piles below the pipe and workshops located at the mouth of Jeffers Slough on the southern end of the property. However, samples have not been collected to evaluate the nature and extent of contamination in these areas. Similarly, samples have not been collected to evaluate if spills or leaks have impacted soil or groundwater near a former drum storage area located on the northern border of the property. EHAP cannot fully characterize the potential risks to human health without additional sampling data from these and other locations on the AMCCO site.
- In DEQ's initial site assessment report, AMCCO's owners stated that sandblasted waste from the site would accumulate and occasionally block Jeffers Slough (2). AMCCO workers would dredge Jeffers Slough and dispose of the waste material on the property directly south of AMCCO, also known as the former Olsen property. To date, there have not been any samples collected to evaluate the magnitude or extent of contamination on the former Olsen property. EHAP considers this an important data gap to address in future investigations.
- Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/PCDFs or dioxins) were likely formed during the burning of waste materials on-site. However, the environmental samples collected during EPA's site investigations were not evaluated for these contaminants. Dioxins are known to cause a number of health effects, including development problems, effects to the immune, endocrine, and reproductive systems, and increased cancer risks. These chemicals are also highly persistent in the environment and bioaccumulate in the food chain. Therefore, future investigations should consider testing for dioxin-like compounds in environmental media and fish tissue samples.
- The SI report notes that the Phase I and II sediment samples were tested for SVOCs, which included several PAHs (1). Like dioxins, PAHs are persistent in the environment, bioaccumulate in the food chain, and were likely produced during the burning of waste on the property. Future investigations should consider additional testing for PAHs in environmental media and fish tissue samples (especially from shellfish, which do not metabolize PAHs (15) (16)).
- The soil and sediment samples collected for the Phase I and II SI were tested for total chromium. Currently, there is no CV for total chromium in soil, but there are CVs for chromium III and chromium VI. We used the chromium VI CV and compared the levels of total chromium to it. None of the sediment samples evaluated in this HC were above this CV. However, six of the soil samples were greater than the chromium VI CV. Next, we used site specific data to calculate the ratio of chromium VI to total chromium and estimated the amount chromium VI in the six soil samples. While all of the estimated concentrations were below the CV, we recommend speciation be conducted on future samples so health risk is not assessed using total chromium or estimated chromium VI concentrations.

Evaluation of Health Outcome Data

The Superfund law requires ATSDR and its cooperative agreement partners to consider if health outcome (i.e., mortality and morbidity) data (HOD) should be evaluated in a HC (17). The main requirements for evaluating HOD are: the presence of a completed human exposure pathway; a known time period of exposure; a quantified population that was (or is being) exposed; sufficient contaminant

levels and time to result in health effects; and the availability of systematically collected HOD for the health outcomes associated with chemicals in the pathway (17).

The AMCCO site does not meet the requirements for including an evaluation of HOD in this HC. The main reason we did not evaluate HOD in this HC is because we do not know how many people have been (or are being) exposed to chemicals from the site. We also do not have enough environmental data to know which chemicals are of health concern at this site, or if they are at levels that could cause observable health effects. Finally, we lack systematically collected HOD on the health outcomes that are potentially associated with chemicals at this site.

Children's Health Considerations

EHAP and ATSDR recognize that infants and children may be more vulnerable than adults to exposures in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas
- Children are shorter, resulting in a greater likelihood to breathe airborne particles from indoor dust and soil, and heavy vapors close to the ground
- Children are smaller, resulting in higher doses of chemical exposure per body weight
- Children are more likely to mouth soil and contaminated objects and swallow more water and soil compared to adults
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages

Because children depend on adults for risk identification and management decisions, EHAP and ATSDR are committed to evaluating their special interests at and around the AMCCO site. Since AMCCO is an industrial work-site, it is unlikely that children will have regular access to on-site contamination in soil or to sediment contamination near the facility. However, there are several residences near the facility that may have young children present. Children could potentially be affected by site-related contamination in the following scenarios:

- Contact with contaminants in groundwater through private wells
- Consumption of contaminated fish from nearby water bodies
- Contact with soil, dirt, or waste that has moved or been disposed of off the AMCCO site (i.e., former Olsen property)

Additional information and investigation is needed to evaluate children's health risks in these scenarios. This HC's recommendations were developed to ensure a high level of protection for children and other potentially vulnerable groups.

Community Concerns

EHAP identified some key community concerns by reviewing newspaper articles related to AMCCO's proposal for the NPL (18) (19) (20), talking with stakeholders during a June 2012 site visit, and listening

to community questions and comments during a June 2012 public meeting hosted by DEQ. To date, the major community concerns include the following:

- There is strong community support for AMCCO as a business and concern about the future viability of the company. The company has been in operation for decades and has provided local jobs and services to support the local economy. AMCCO specializes in servicing mid-size fishing boats, which is a relatively niche market, and there are few other locations on the Oregon and Washington coast that can service these boats. During the public meeting, several community members expressed concern that the cost of clean-up would affect AMCCO's financial viability.
- There were concerns that a "Superfund" designation would harm AMCCO's reputation and the image of the local region and economy. Superfund sites are often viewed as heavily polluted areas, and there is concern that AMCCO and nearby communities will be stigmatized if the site is listed on the NPL.
- County and state elected officials support EPA's deferral of the site, which was granted in September 2012. The deferral allows DEQ to oversee the investigation and clean-up and may result in a faster and less costly clean-up.
- There is support for cleaning up environmental contamination from the site. However, concerns about health and environmental impacts appear to be secondary to economic concerns.

Conclusions

EHAP reached nine conclusions in this HC. These conclusions are based on limited data about the extent of contamination at the AMCCO site. As a result, many of EHAP's conclusions about health risks from the AMCCO site are preliminary. The conclusions in this HC will be reevaluated and updated where appropriate as more data become available.

Pathway 1: Direct contact with contaminated surface soil

Conclusion 1: *EHAP concludes that touching or accidentally swallowing arsenic, copper, and lead in surface soil from the burn area on the AMCCO property could be harmful to the health of AMCCO workers.* Soil from the burn area on the AMCCO property is contaminated with arsenic, copper, and lead at levels of health concern. If people work at the burn area, they could be exposed to these chemicals by accidentally swallowing small amounts of soil and dust that stick to their hands.

Conclusion 2: *EHAP cannot conclude whether touching or accidentally swallowing surface soil from other parts of the AMCCO property (outside of the burn area) could harm the health of AMCCO workers.* EHAP does not have enough information on contamination levels in soil in other areas of the site. EHAP also does not know how much time workers spend in these areas.

Conclusion 3: *EHAP concludes that surface soil from the AMCCO property will not harm the general public's health.* The reason for this is that the general public has not been accessing the

AMCCO property, and therefore, they have not been touching or accidentally swallowing the surface soil from the property.

Conclusion 4: *EHAP cannot conclude whether touching or accidentally swallowing surface soil that contains dredge spoils on the former Olsen property could harm the health of AMCCO workers, recreationists, or trespassers.* There is evidence that dredged material containing sandblasted waste from AMCCO operations was moved to the former Olsen property, which is directly south of the site. However, no environmental data have been collected from this property. EHAP also does not know if AMCCO workers, recreationists, or trespassers are coming into contact with the dredge spoils on the former Olsen property.

Pathway 2: Direct contact with in-water sediments

Conclusion 5: *EHAP cannot conclude whether touching or accidentally swallowing in-water sediment near the burn area on the AMCCO property could harm the health of AMCCO workers.* One sediment sample was taken from near the burn area. While the concentrations of antimony, arsenic, copper, and lead in this single sample exceeded the environmental screening values, a single sample is insufficient to determine whether the health of workers could be adversely impacted. Additionally, we do not know whether workers come into contact with the sediment in this area.

Conclusion 6: *EHAP cannot conclude whether touching or accidentally swallowing in-water sediment from other parts of the AMCCO property (outside of the burn area) could harm the health of AMCCO workers.* Six sediment samples were taken on the AMCCO site; this does not include the sample taken near the burn area. The contaminant levels found in all of the on-site (Phase I) sediment samples (except for one sample taken near the burn area) were below environmental screening values. However, six samples are insufficient to determine whether the health of workers could be adversely impacted. Additionally, we do not know how much time workers may be exposed to the in-water sediment.

Conclusion 7: *Based on the data evaluated in this HC, EHAP concludes that touching or accidentally swallowing in-water sediment from the upper Lewis and Clark River is not expected to harm the health of recreationists.* Kayakers, anglers, and other users may occasionally have direct contact with in-water sediment while recreating on the upper Lewis and Clark River. Preliminary data show that the levels of organotins, total petroleum hydrocarbons (TPH), semi-volatile organic compounds (SVOCs), metals, pesticides, and polychlorinated biphenyls (PCBs) in in-water sediment are too low to harm recreationists' health.

Pathway 3: Contact with contaminated groundwater

Conclusion 8: *Based on the data evaluated in this HC, EHAP concludes that ingestion of or dermal contact with groundwater near the AMCCO site is not expected to harm nearby residents' health.* The groundwater on the AMCCO site had levels of contaminants that exceeded the environmental screening values. However, there are no groundwater wells within 0.5 miles of the

site, and so people living within this area are not expected to be exposed to the contaminated groundwater. Additionally, it is unlikely that people living more than 0.5 miles from the site with a well are using contaminated groundwater for their domestic water supply since all of the residences in vicinity of the site are on a city water supply.

Pathway 4: Consumption of contaminated fish, shellfish, or marine life

Conclusion 9: *EHAP cannot conclude if eating fish, shellfish, or other marine life caught in the upper Lewis and Clark River could harm people's health.* We do not have information on contaminant levels in fish, shellfish, or other marine life from the Lewis and Clark River or nearby waterways.

Recommendations

Based on EHAP's review of the available environmental data for the AMCCO site, we recommend the following actions to protect the health of workers, nearby residents, recreationists, trespassers, and fishermen near the site:

- Workers on the AMCCO site are advised to minimize their contact with soil, dust, and in-water sediment near the burn area of the site. The best way for workers to prevent exposure is to avoid visiting this area. The majority of workers should be able to comply with this recommendation since AMCCO ceased all burning activities in 2007. Additionally, the burn area is located on the periphery of the site and it is unlikely that workers will need to access this area to perform their regular work activities. If workers need to access the burn area, they are advised to spend as little time as possible there.
- AMCCO is advised to restrict access to the four oil-stained areas on the property until there is more information to determine whether these locations are hazardous to workers' health.
- EHAP recommends that DEQ include the following in the next phase of the site investigation and data collection:
    - Data to evaluate workers' exposures to surface soil and sediment contamination:
        - Additional sampling data on contaminant levels (especially metals, dioxins, and PAH compounds) in surface soil and in-water sediment throughout the site, particularly at and near the burn area and in locations that have not been sampled
        - Speciated chromium data to determine the amount of hexavalent chromium in soil and sediment on the site
        - Information on workers' activities and amount of contact with soil and in-water sediment in different areas of the site
    - Data to evaluate the potential risks from waste material that was disposed on the former Olsen property:
        - Contamination levels for metals, organotins, and other compounds in soil, in-water sediment, and other media on the property
        - Information on the property's land-use designation, and whether people live, work, or recreate on the property

- Data to evaluate recreationists' exposures to in-water sediment contamination:
  - Additional sampling data on contaminant levels (especially for dioxin-like compounds) in sediment
- Data to evaluate the potential risks from eating fish, shellfish, or other marine life from the Upper Lewis and Clark River and other nearby water bodies:
  - Contaminant levels and population data on resident fish or shellfish species, especially bottom-feeding and resident predatory species that are more likely to bioaccumulate contaminants in their tissues
  - Characteristics of people who catch and eat fish and shellfish near the AMCCO site, including types of fishers (sports vs. subsistence), types and amounts of fish and shellfish caught, and whether children, pregnant women, or women of child-bearing age eat locally-caught fish and shellfish. While this information would be useful for EHAP's assessment and outreach, we acknowledge that it is difficult to collect this information. Further, this information is not necessary for DEQ's risk assessment and evaluation of clean-up strategies.
- Confirmatory information that residents or businesses near the site do not use groundwater wells for their domestic water supply or other purposes (e.g., irrigation)

Public Health Action Plan

A Public Health Action Plan describes the specific actions EHAP will take to implement the recommendations outlined in this HC, with the goal of preventing and reducing people's exposure to hazardous substances in the environment. EHAP will implement this action plan in collaboration with community members, partner agencies, and other stakeholders at the AMCCO site.

Public Health Actions completed

To date, EHAP has taken the following actions:

- Reviewed and provided feedback on DEQ's community involvement plan for the AMCCO site
- Participated in a coordinated site visit in June 2012
- Attended a public meeting hosted by DEQ in June 2012
- Participated in the October 2012 AMCCO Cleanup Partners Meeting convened by DEQ

Public Health Actions planned

EHAP will take the following public health actions:

- Participate in DEQ-led meetings and discussions related to the investigation and clean-up of the AMCCO site
- Conduct health education activities such as provide health-based information for AMCCO employees on ways to avoid exposure to site-related contaminants, answer community questions, and provide information about the public health risks associated with the AMCCO site
- Review additional sampling plans and environmental data as they become available

- Provide technical assistance and consultation to DEQ and other stakeholders as needed throughout the cleanup process

References

1. Ecology and Environment Inc. *Astoria Marine Construction Company Site Inspection Report.* Seattle, WA : s.n., 2010.

2. Oregon Department of Environmental Quality. *DEQ Site Assessment for Astoria Marine Construction Co.* Portland, OR : s.n., 1997.

3. GSI Water Solutions, Inc. and Maul Foster Alongi. *Remedial Investigation Work Plan: Astoria Marine Construction Company Facility, Astoria, Oregon, ECSI No. 1898.* Portland, OR : s.n., 2013.

4. United States Environmental Protection Agency. *Re: Deferral Criteria for final NPL Listing of the Astoria Marine Construction Company.* Seattle, WA, WA : s.n., 2011.

5. *Measurement of arsenic bioavailability in soil using a primate model.* Roberts, Stephen M, et al. June 2002, Toxicological Sciences, Vol. 67(2), pp. 303-10.

6. Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Copper.* Atlanta, GA : United States Department of Health and Human Services, 2004.

7. —. *Toxicological Profile for Lead.* Atlanta, GA : United States Department of Health and Human Services, 2007.

8. —. *Toxicological Profile for Arsenic.* Atlanta, GA : United States Department of Health and Human Services, 2007.

9. United States Environmental Protection Agency. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.* Technical Review Workgroup for Lead. Washington DC : United States Environmental Protection Agency, 2003.

10. Centers for Disease Control and Disease Prevention. Lead, Elevated Blood Levels. *National Notifiable Diseases Surveillance System (NNDSS).* [Online] [Cited: March 5, 2013.] http://wwwn.cdc.gov/NNDSS/script/casedef.aspx?CondYrID=742&DatePub=1/1/2010%2012:00:00%20AM.

11. Oregon Department of Environmental Quality. DEQ Laboratory Analytic Methods, Northwest Total Petroleum Hydrocarbon-Dx: Semi-Volatile Petroleum Products Method for Soil and Water. *Oregon Department of Environmental Quality.* [Online] [Cited: March 14, 2013.] http://www.deq.state.or.us/lab/techrpts/docs/nwtphDx.pdf.

12. United States Environmental Protection Agency. SOM01.2 Pesticides/Aroclors Target Compound List and Corresponding CRQLs. *United States Environmental Protection Agency.* [Online] [Cited: March 4, 2013.] http://www.epa.gov/superfund/programs/clp/som-ptarget.htm.

13. Oregon Department of Fish and Wildlife. Sport Catch Statistics - Salmon, Steelhead & Sturgeon. *Oregon Department of Fish and Wildlife.* [Online] [Cited: August 20, 2012.] http://www.dfw.state.or.us/resources/fishing/sportcatch.asp.

14. Oregon Health Authority. *Fish Monitoring Standard Operating Guidance.* Health Waters Fish Advisory Program. Portland, OR : s.n., 2010.

15. Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons.* Atlanta, GA : United States Department of Health and Human Services, 1995.

16. *Bioaccumulation and biomagnification of polycyclic aromatic hydrocarbons in aquatic organisms.* D'Adamo R, Pelosi S, Trotta P, Sansone G. February 1997, Marine Chemisty, Vols. 56(1-2), pp. 45-49.

17. Agency for Toxic Substances and Disease Registry. *Public Health Assessment Guidance Manual.* Atlanta, GA : United States Department of Health and Human Services, 2005.

18. EPA eyes Astoria shipyard site for cleanup. *The Daily Astorian.* March 9, 2011.

19. Graf, Tyler. Dry-dock facility might be listed as a Superfund site. *The Daily Astorian.* December 6, 2011.

20. —. DEQ works to keep ship repair company off Superfund status. *The Daily Astorian.* June 20, 2012.

21. Florida Department of Environmental Protection. *Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.* Gainesville, FL : Florida Department of Environmental Protection, 2005.

22. United States Environmental Protection Agency. *Toxicological Review of Ingested Inorganic Arsenic, O.o.R.a. Development, Editor.* Washington DC : United States Environmental Protection Agency, 2005.

23. —. *Issue Paper: Inorganic Arsenic Cancer Slope Factor, O.o.R.a. Development, Editor.* Washington DC : United States Environmental Protection Agency, 2005.

24. Agency for Toxic Substances and Disease Registry. *Exposure dose guidance for soil ingestion (4/23/2012).* Atlanta, GA : United States Department of Health & Human Services, 2012.

25. —. *Dose estimate guidance: Determining life expectancy and exposure factor to estimate exposure doses.* Atlanta, GA : United States Department of Health & Human Services, 2012.

26. United States Environmental Protection Agency. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation. Supplemental Guidance "Standard Default Exposure Factors" Interim Final. OSWER Directive: 9285.6-03.* Washington DC : United States Environmental Protection Agency, 1991.

27. —. *Exposure Factors Handbook 2011 Edition.* Washington DC : United States Environmental Protection Agency, 2011.

28. Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Chromium.* Atlanta, GA : United States Department of Health and Human Services, 2012.

Report Preparation

This Health Consultation for the Astoria Marine Construction Company 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, and 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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Appendix A: Maps of the Astoria Marine Construction Company site

Astoria Marine Construction Company

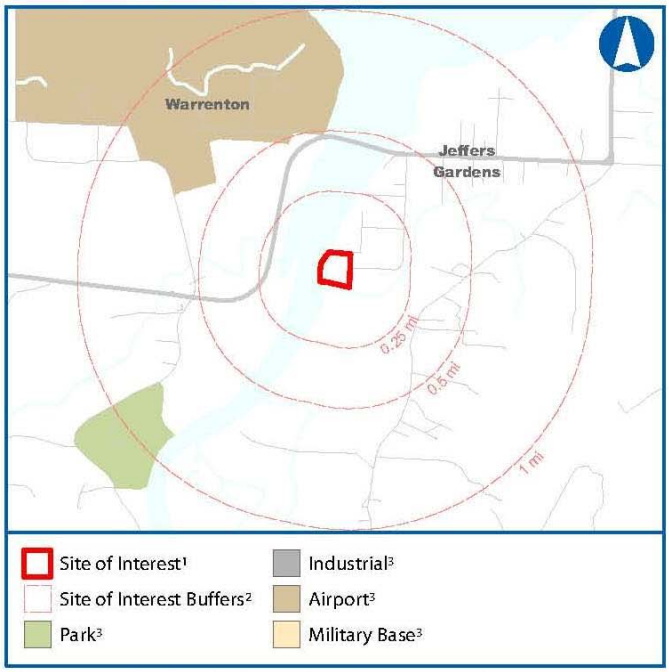
Astoria, Clatsop County, OR

GENERAL SITE PROFILE

EPA FACILITY ID OR0002392793

INTRODUCTORY MAP SERIES

Site Vicinity Map



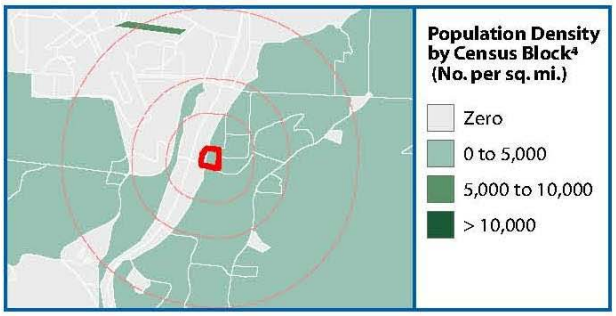
The **General Site Profile Map** depicts the hazardous waste site of interest, highlights locations of other environmental hazards and community gathering points, and provides community demographic and housing statistics.

Demographic Statistics[4,5]

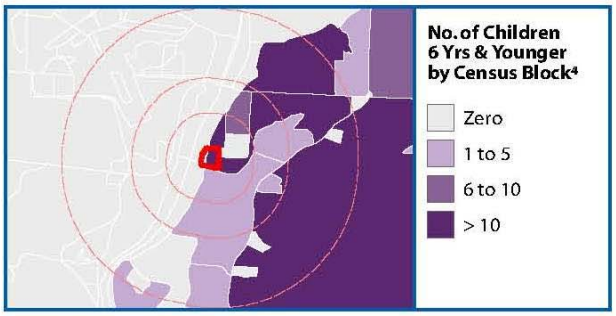
Within 1 mile buffer of site boundary

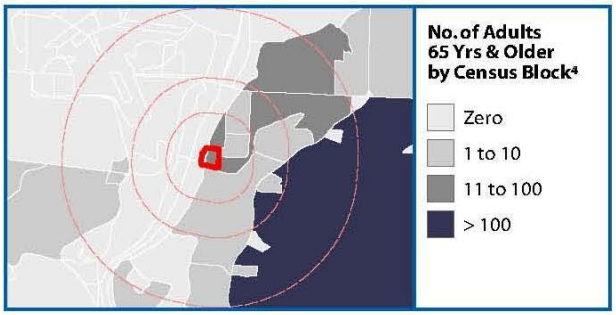
Measure	2000	2010	Change
Total Population	553	645	+16%
White Alone	539	578	+7%
Black Alone	1	5	+400%
Am. Indian & Alaska Native Alone	4	10	+150%
Asian Alone	1	7	+600%
Native Hawaiian & Other Pacific Islander Alone	1	1	+0%
Some Other Race Alone	3	19	+533%
Two or More Races	5	26	+420%
Hispanic or Latino[6]	13	46	+253%
Children Aged 6 and Younger	40	40	+0%
Adults Aged 65 and Older	91	82	-9%
Females Aged 15 to 44	89	85	-4%
Housing Units	246	244	+0%
Housing Units Pre 1950	49	37	-24%

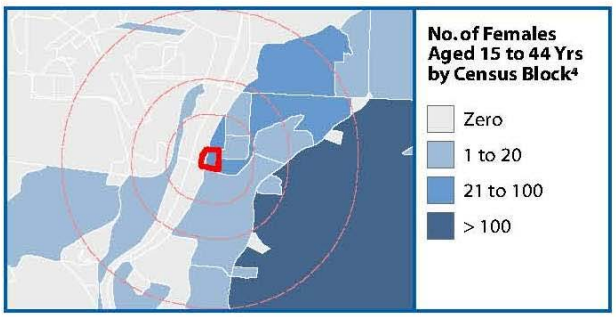
General Population Density



Sensitive Populations







Data Sources: ¹ATSDR GRASP Hazardous Waste Site Boundary Database (2012). ²ATSDR GRASP. ³TomTom International BV (2012). ⁴US Census 2010.
Notes: ⁵Calculated using area-proportion spatial analysis method. ⁶Individuals identifying origin as Hispanic or Latino may be of any race.
Projection: Projection used for all map panels is NAD 1983 StatePlane Oregon North FIPS 3601 Feet.

PRJ 04496 WMJ4 6/26/14

GRASP

Agency for Toxic Substances and Disease Registry

Division of Toxicology and Human Health Sciences

ATSDR

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Appendix B: Environmental Sampling Data and Comparison to Environmental Comparison Values

The tables in this appendix show the environmental data used in this HC. All data were obtained from the 2010 Site Investigation Report (1) for the AMCCO facility. The following comparison values (CVs) were used to evaluate these data:

Environmental Media Evaluation Guides (EMEGs)

EMEGs are an estimate of contaminant concentrations low enough that ATSDR would not expect people to have a negative, non-cancerous health effect. EMEGs are based on ATSDR Minimal Risk Levels and conservative assumptions about the public's contact with contaminated media, such as how much, how often, and for how long someone may be in contact with the contaminated media. EMEGs also account for body weight and length of exposure; chronic EMEGs are used for exposures lasting more than 365 days, intermediate EMEGs for exposures between 14 and 364 days, and acute EMEGs for exposures less than 14 days. In this assessment, we used adult EMEGs to evaluate contact with on-site surface soil and sediment and child EMEGs for contact with groundwater.

Cancer Risk Evaluation Guides (CREGs)

CREGs are an estimate of contaminant concentrations that are low enough that ATSDR would expect no more than one excess cancer case in a million (10^{-6}) persons exposed during their lifetime. ATSDR's CREGs are calculated from EPA's "cancer slope factors" (CSFs) used for oral exposures (swallowing a contaminant). For inhalation exposures (breathing in a contaminant), ATSDR uses EPA's "unit risk values." These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure. Note that the CREG for arsenic in soil/sediment is 0.47 mg/kg. Since this is below background levels, ATSDR recommends using 15 mg/kg as a screening value for arsenic.

Reference Dose Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses, which are developed based on EPA evaluations. RMEGs represent chemical concentrations in water or soil at which daily human contact is not likely to cause negative, non-cancerous health effects. In this assessment, we used adult RMEGs to evaluate contact with on-site surface soil and sediment and child RMEGs for contact with groundwater.

Maximum Contaminant Levels (MCL)

MCLs are derived by EPA as enforceable standards for municipal water systems. These standards are not strictly health-based but are set as close to the maximum contaminant level goals (MCLGs) as is feasible. MCLs are based on considerations of health, available treatment technologies, costs (affordability), and other feasibility factors, such as the availability of analytical methods, treatment technology and costs for achieving various levels of removal.

Minimal Risk Levels (MRLs)

An ATSDR MRL is an estimate of daily human exposure - by a specified route and length of time - to a dose of a chemical that is likely to be without a measurable risk of negative, noncancerous effects. Acute MRLs are designed to evaluate exposures lasting 14 days or less. Intermediate MRLs are designed to evaluate exposures lasting from 15-364 days. Chronic MRLs are designed to evaluate

exposures lasting for 1 year or longer. Oral exposures (swallowing the contaminant) are measured in milligrams per kilogram per day [mg/kg/day] and inhalation exposures (breathing the contaminant) are measured in parts per billion [ppb] or micrograms per cubic meter [$\mu g/m^3$].

Regional Screening Levels (RSLs)

RSLs are contaminant concentrations in soil, water, or air, below which any adverse health effects would be unlikely. RSLs are derived by EPA's Regions 3, 6, and 9 Offices using EPA's reference doses (RfDs) and Cancer Slope Factors (CSFs). RSLs take into account both non-cancer and cancer risks. EHAP used RSLs developed for composite workers to evaluate workers' exposures to on-site soil and sediment. EPA defines a composite worker as "a full time employee working on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, and landscaping) typically involve on-site exposures to surface soils. The composite worker combines the most protective exposure assumptions of the outdoor and indoor workers. The only difference between the outdoor worker and the composite worker is that the composite worker uses the more protective exposure frequency of 250 days/year from the indoor worker scenario."[6] RSLs are available online at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

Oregon DEQ Risk Based Concentrations (RBCs)

The Oregon Department of Environmental Quality (DEQ) uses risk-based concentrations (RBCs) to screen environmental contaminants in soil, water, and air. RBCs are typically based on EPA toxicity factors for carcinogens and non-carcinogens. DEQ's RBCs are available online at: http://www.deq.state.or.us/lq/rbdm.htm.

[6] http://epa-prgs.ornl.gov/radionuclides/comworksoilimage.html

Table 6. Surface soil sampling results from AMCCO site (used for Pathway 1: Workers' exposures to surface soil).

Contaminant Type	Contaminant	Detects/ Total Samples	Background Levels (mg/kg)	Maximum Concentration Detected (mg/kg)	Comparison Value (mg/kg)	Contaminant of Potential Concern?
Organotins	Butyltin Trichloride*	12/12	0.091	2.9	210 [a]	No
	Dibutyltin Dichloride	12/12	0.065	3.3	3,500 [b]	No
	Tetrabutyltin*	7/12	<0.005	0.036	210 [a]	No
	Tributyltin Chloride*	12/12	0.038	1.5	210 [a]	No
Total Petroleum Hydrocarbons	TPH-Diesel	2/4	<4.2	18,000	9,700 [c]	Yes
	TPH-Motor Oil	3/4	97	110,000	9,700 [c]	Yes
Metals	Aluminum	16/16	6,220	12,600	700,000 [a]	No
	Antimony	5/16	<4.5	40.2	280 [d]	No
	Arsenic**	14/16	2.2	1,450	0.47 [e]/15	Yes
	Barium	16/16	39.5	3,400	140,000 [a]	No
	Cadmium	14/16	0.49	18.4	70 [a]	No
	Calcium	16/16	3,500	37,400	None	No
	Chromium***	16/16	144	1,500	630 [a]	No‡
	Cobalt	16/16	16.9	61.9	7,000 [b]	No
	Copper	16/16	95.3	118,000	7,000 [b]	Yes
	Iron	16/16	30,200	66,500	715,000 [f]	No
	Lead	16/16	116	10,100	800 [f]	Yes
	Magnesium	16/16	7,250	47,500	None	No
	Manganese	16/16	411	3,350	35,000 [d]	No
	Nickel	16/16	71.2	1,570	14,000 [d]	No
	Potassium	16/16	807	2,190	None	No
	Silver	6/16	<1.1	8.7	3,500 [d]	No
	Sodium	11/16	370	3,590	None	No
	Vanadium	16/16	90.5	95.5	7,000 [b]	No
	Zinc	16/16	423	17,000	210,000 [a]	No

Contaminant Type	Contaminant	Detects/ Total Samples	Background Levels (mg/kg)	Maximum Concentration Detected (mg/kg)	Comparison Value (mg/kg)	Contaminant of Potential Concern?
Volatile Organic Compounds	1,4-Dioxane†	N/A	N/A	N/A	7 [e]	No
	Ethylbenzene	1/4	<0.0037	1.2	27 [f]	No
	m,p-Xylenes€	1/4	<0.0037	43	140,000 [a]	No
	Methylcyclohexane	1/4	<0.0037	7.1	None	No
	o-Xylene€	1/4	<0.0037	23	140,000 [a]	No
	Toluene	4/4	<0.0037	58	14,000 [b]	No
Semivolatile Organic Compounds	Acetophenone	5/8	<0.180	1.1	70,000 [d]	No
	Naphthalene	1/8	<0.180	0.57	14,000 [d]	No
	N-Nitrosodiphenylamine	2/8	<0.180	0.19	140 [e]	No
	Pentachlorophenol	1/8	<0.350	1.5	1.8 [e]	No
	Phenanthrene ¥	4/8	0.099	0.71	21,000 [d]	No
	Fluoranthene	6/8	0.26	1	28,000 [d]	No
	Pyrene	7/8	0.28	0.85	21,000 [d]	No
	Butylbenzylphthalate	1/8	<0.180	0.67	140,000 [d]	No
	Benzo(a)anthracene	2/8	0.12	0.33	2 [f]	No
	Chrysene	3/8	0.2	0.44	211 [f]	No
	Bis(2-ethylhexyl)phthalate	5/8	<0.180	2.1	123 [f]	No
	Benzo(b)fluoranthene	2/8	0.16	0.37	2 [f]	No
	Benzo(k)fluoranthene	2/8	0.14	0.27	21 [f]	No
	Benzo(a)pyrene	2/8	0.19	0.28	0.096 [e]	Yes
	Indeno(1,2,3-cd)pyrene	2/8	0.18	0.21	2 [f]	No
	Benzo(g,h,i)perylene ¥	2/8	0.24	0.24	21,000 [d]	No

Abbreviations: mg/kg = milligrams per kilogram; CV = comparison value; < = Less than; TPH = Total Petroleum Hydrocarbons; N/A = not applicable; ATSDR = Agency for Toxic Substances and Disease Registry; EPA = U.S. Environmental Protection Agency; DEQ = Oregon Department of Environmental Quality

Comparison value sources: a) ATSDR March 2013 Adult Chronic Environmental Media Evaluation Guide; b) ATSDR March 2013 Adult Intermediate Environmental Media Evaluation Guide; c) Oregon DEQ Generic Gasoline TPH Risk Based Concentration (for construction workers); d) ATSDR March 2013 Adult Reference Dose Media Evaluation Guide; e) ATSDR March 2013 Cancer Risk Evaluation Guide; and f) EPA Regional Screening Level for composite workers

*There is no CV for butyltin trichloride, tetrabutyltin, and tributyltin chloride and so we used the CV for tributyltin oxide.

**The ATSDR March 2013 Cancer Risk Evaluation Guide for arsenic (0.47 mg/kg) is below background levels and so ATSDR's recommended CV for arsenic in soil is 15 mg/kg.

***There is no CV for total chromium and so we used the CV for hexavalent chromium, which is lower and more conservative than the CV for trivalent chromium.

‡While the maximum concentration detected for total chromium exceeded the CV, we were able to rule this contaminant out as a potential hazard by estimating the level of hexavalent chromium for this sample. Where the total chromium concentration was 1,500 mg/kg, the estimated level of hexavalent chromium was 19.35 mg/kg. This concentration was below the CV.
†The results for 1,4-dioxane are R-qualified, which means they were rejected for data quality reasons.
€There is no CV for m,p-xylenes and o-xylene and so we used the CV for total xylenes.
¥There is no CV for phenanthrene and benzo(g,h,i)perylene and so we used the CV for pyrene (21).
Contaminants whose maximum concentrations exceed their comparison value are shaded.

Table 7. Surface soil sampling results from specific areas of AMCCO site (used for Pathway 1: Workers' exposures to surface soil).

Contaminant Type	Contaminant	Comparison Value (mg/kg)	Burn area			Former grit pile			New grit pile			Oil-stained areas		
			Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples
Organotins	Butyltin Trichloride*	210 [a]	0.53	No	0/4	2.9	No	0/6	0.011	No	0/2	-	-	-
	Dibutyltin Dichloride	3,500 [b]	0.61	No	0/4	3.3	No	0/6	0.007	No	0/2	-	-	-
	Tetrabutyltin*	210 [a]	0.036	No	0/4	0.011	No	0/6	<0.005	No	0/2	-	-	-
	Tributyltin Chloride*	210 [a]	0.63	No	0/4	1.5	No	0/6	0.004	No	0/2	-	-	-
Total Petroleum Hydrocarbons	TPH-Diesel	9,700 [c]	-	-	-	-	-	-	-	-	-	**18,000**	**Yes**	**1/4**
	TPH-Motor Oil	9,700 [c]	-	-	-	-	-	-	-	-	-	**110,000**	**Yes**	**2/4**
Metals	Aluminum	700,000 [a]	12,600	No	0/4	6,200	No	0/6	2,250	No	0/2	6,520	No	0/4
	Antimony	280 [d]	40.2	No	0/4	12.9	No	0/6	<8.2	No	0/2	28.8	No	0/4
	Arsenic**	0.47 [e]/15	**1,450**	**Yes**	**4/4**	5.2	No	0/6	<1.1	No	0/2	10.6	No	0/4
	Barium	140,000 [a]	3,400	No	0/4	59.2	No	0/6	37	No	0/2	69.9	No	0/4
	Cadmium	70 [a]	18.4	No	0/4	0.82	No	0/6	<0.53	No	0/2	1.3	No	0/4
	Calcium	None	37,400	No	0/4	2,420	No	0/6	1,450	No	0/2	4,020	No	0/4
	Chromium***	630 [a]	1,410	No‡	1/4	1,500	No‡	3/6	1,230	No‡	1/2	959	No‡	1/4
	Cobalt	7,000 [b]	61.9	No	0/4	27.6	No	0/6	23.1	No	0/2	26.6	No	0/4
	Copper	7,000 [b]	**118,000**	**Yes**	**3/4**	793	No	0/6	25.3	No	0/2	769	No	0/4
	Iron	715,000 [f]	66,500	No	0/4	35,600	No	0/6	29,100	No	0/2	42,000	No	0/4
	Lead	800 [f]	**10,100**	**Yes**	**2/4**	206	No	0/6	18.1	No	0/2	**1,020**	**Yes**	**1/4**
	Magnesium	None	47,500	No	0/4	42,500	No	0/6	42,900	No	0/2	38,200	No	0/4
	Manganese	35,000 [d]	3,350	No	0/4	538	No	0/6	441	No	0/2	631	No	0/4
	Nickel	14,000 [d]	1,570	No	0/4	985	No	0/6	956	No	0/2	620	No	0/4
	Potassium	None	2,190	No	0/4	671	No	0/6	526	No	0/2	1,590	No	0/4
	Silver	3,500 [d]	8.7	No	0/4	0.22	No	0/6	<1.1	No	0/2	0.35	No	0/4
	Sodium	None	3,590	No	0/4	267	No	0/6	<526	No	0/2	568	No	0/4
	Vanadium	7,000 [b]	42.1	No	0/4	29.5	No	0/6	11	No	0/2	95.5	No	0/4
	Zinc	210,000 [a]	17,000	No	0/4	508	No	0/6	654	No	0/2	1,060	No	0/4

Contaminant Type	Contaminant	Comparison Value (mg/kg)	Burn area			Former grit pile			New grit pile			Oil-stained areas		
			Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples	Maximum Concentration Detected (mg/kg)	Contaminant of Potential Concern?	# of Samples>CV/ Total Samples
Volatile Organic Compounds	1,4-Dioxane†	7 [e]	N/A	N/A	N/A	-	-	-	-	-	-	-	-	-
	Ethylbenzene	27 [f]	1.2	No	0/4	-	-	-	-	-	-	-	-	-
	m,p-Xylenes€	140,000 [a]	43	No	0/4	-	-	-	-	-	-	-	-	-
	Methylcyclohexane	None	7.1	No	0/4	-	-	-	-	-	-	-	-	-
	o-Xylene€	140,000 [a]	23	No	0/4	-	-	-	-	-	-	-	-	-
	Toluene	14,000 [b]	58	No	0/4	-	-	-	-	-	-	-	-	-
Semivolatile Organic Compounds	Acetophenone	70,000 [d]	1.1	No	0/4	-	-	-	-	-	-	0.7	No	0/4
	Naphthalene	14,000 [d]	0.57	No	0/4	-	-	-	-	-	-	<0.270	No	0/4
	N-Nitrosodiphenylamine	140 [e]	<0.330	No	0/4	-	-	-	-	-	-	0.19	No	0/4
	Pentachlorophenol	1.8 [e]	<0.640	No	0/4	-	-	-	-	-	-	1.5	No	0/4
	Phenanthrene ¥	21,000 [d]	0.19	No	0/4	-	-	-	-	-	-	0.71	No	0/4
	Fluoranthene	28,000 [d]	0.41	No	0/4	-	-	-	-	-	-	1	No	0/4
	Pyrene	21,000 [d]	0.36	No	0/4	-	-	-	-	-	-	0.85	No	0/4
	Butylbenzylphthalate	140,000 [d]	<0.330	No	0/4	-	-	-	-	-	-	0.67	No	0/4
	Benzo(a)anthracene	2 [f]	0.12	No	0/4	-	-	-	-	-	-	0.33	No	0/4
	Chrysene	211 [f]	0.19	No	0/4	-	-	-	-	-	-	0.44	No	0/4
	Bis(2-ethylhexyl)phthalate	123 [f]	2.1	No	0/4	-	-	-	-	-	-	0.88	No	0/4
	Benzo(b)fluoranthene	2 [f]	0.13	No	0/4	-	-	-	-	-	-	0.37	No	0/4
	Benzo(k)fluoranthene	21 [f]	0.093	No	0/4	-	-	-	-	-	-	0.27	No	0/4
	Benzo(a)pyrene	0.096 [e]	**0.098**	**Yes**	**1/4**	-	-	-	-	-	-	**0.28**	**Yes**	**1/4**
	Indeno(1,2,3-cd)pyrene	2 [f]	0.086	No	0/4	-	-	-	-	-	-	0.21	No	0/4
	Benzo(g,h,i)perylene ¥	21,000 [d]	0.1	No	0/4	-	-	-	-	-	-	0.24	No	0/4

Abbreviations: mg/kg = milligrams per kilogram; # = number; CV = comparison value; > = Greater than; < = Less than; TPH = Total Petroleum Hydrocarbons; N/A = not applicable; ATSDR = Agency for Toxic Substances and Disease Registry; EPA = U.S. Environmental Protection Agency; DEQ = Oregon Department of Environmental Quality

Comparison value sources: a) ATSDR March 2013 Adult Chronic Environmental Media Evaluation Guide; b) ATSDR March 2013 Adult Intermediate Environmental Media Evaluation Guide; c) Oregon DEQ Generic Gasoline TPH Risk Based Concentration (for construction workers); d) ATSDR March 2013 Adult Reference Dose Media Evaluation Guide; e) ATSDR March 2013 Cancer Risk Evaluation Guide; and f) EPA Regional Screening Level for composite workers

*There is no CV for butyltin trichloride, tetrabutyltin, and tributyltin chloride and so we used the CV for tributyltin oxide.

**The ATSDR March 2013 Cancer Risk Evaluation Guide for arsenic (0.47 mg/kg) is below background levels and so ATSDR's recommended CV for arsenic in soil is 15 mg/kg.

***There is no CV for total chromium and so we used the CV for hexavalent chromium, which is lower and more conservative than the CV for trivalent chromium.

‡While the maximum concentration detected for total chromium exceeded the CV, we were able to rule this contaminant out as a potential hazard by estimating the level of hexavalent chromium for this sample. Where the total chromium concentration was 1,500 mg/kg, the estimated level of hexavalent chromium was 19.35 mg/kg. This concentration was below the CV.
†The results for 1,4-dioxane are R-qualified, which means they were rejected for data quality reasons.
€There is no CV for m,p-xylenes and o-xylene and so we used the CV for total xylenes.
¥There is no CV for phenanthrene and benzo(g,h,i)perylene and so we used the CV for pyrene (21).
Text shown in bold indicates the maximum concentration exceeds the CV.
A cell without text (-) means that the lab did not test the samples from the area for a specific contaminant.

Table 8. Phase I sediment sampling results from AMCCO site (used for Pathway 2: Workers' exposures to sediment).

Contaminant Type	Contaminant	Detects/ Total Samples	Background Levels (mg/kg)	Maximum Concentration Detected (mg/kg)	Comparison Value (mg/kg)	Contaminant of Potential Concern?
Organotins	Butyltin Trichloride*	7/7	<0.006	0.56	210 [a]	No
	Dibutyltin Dichloride	7/7	<0.0069	3.1	3,500 [b]	No
	Tetrabutyltin*	4/7	<0.0046	0.006	210 [a]	No
	Tributyltin Chloride*	7/7	<0.004	0.7	210 [a]	No
Total Petroleum Hydrocarbons	TPH-Diesel	6/7	<6.8	450	9,700 [c]	No
	TPH-Motor Oil	7/7	<14	2,200	9,700 [c]	No
Metals	Aluminum	7/7	14,200	17,900	700,000 [a]	No
	Antimony	1/7	<11.3	300	280 [d]	Yes
	Arsenic**	7/7	6.6	42.8	0.47 [e]/15	Yes
	Barium	7/7	119	249	140,000 [a]	No
	Cadmium	7/7	0.54	2.6	70 [a]	No
	Calcium	7/7	3,610	25,500	None	No
	Chromium***	7/7	12.9	284	630 [a]	No
	Cobalt	7/7	14.5	31.6	7,000 [b]	No
	Copper	7/7	21.2	10,300	7,000 [b]	Yes
	Iron	7/7	34,600	104,000	715,000 [f]	No
	Lead	7/7	8.3	1,080	800 [f]	Yes
	Magnesium	7/7	5,000	6,680	None	No
	Manganese	7/7	339	1,850	35,000 [d]	No
	Nickel	7/7	17.9	215	14,000 [d]	No
	Potassium	7/7	1,220	2,400	None	No
	Silver	2/7	1.9	7.1	3,500 [d]	No
	Sodium	7/7	559	2,970	None	No
	Vanadium	7/7	62.9	68.9	7,000 [b]	No
	Zinc	7/7	85	1,650	210,000 [a]	No

Abbreviations: mg/kg = milligrams per kilogram; CV = comparison value; TPH = Total Petroleum Hydrocarbons; < = Less than; ATSDR = Agency for Toxic Substances and Disease Registry; EPA = U.S. Environmental Protection Agency; DEQ = Oregon Department of Environmental Quality

Comparison value sources: a) ATSDR March 2013 Adult Chronic Environmental Media Evaluation Guide; b) ATSDR March 2013 Adult Intermediate Environmental Media Evaluation Guide; c) Oregon DEQ Generic Gasoline TPH Risk Based Concentration (for construction workers); d) ATSDR March 2013 Adult Reference Dose Media Evaluation Guide; e) ATSDR March 2013 Cancer Risk Evaluation Guide; and f) EPA Regional Screening Level for composite workers

*There is no CV for butyltin trichloride, tetrabutyltin, and tributyltin chloride and so we used the CV for tributyltin oxide.
**The ATSDR March 2013 Cancer Risk Evaluation Guide for arsenic (0.47 mg/kg) is below background levels and so ATSDR's recommended CV for arsenic in soil is 15 mg/kg.
***There is no CV for total chromium and so we used the CV for hexavalent chromium, which is lower and more conservative than the CV for trivalent chromium.
Contaminants whose maximum concentrations exceed their comparison value are shaded.

Table 9. Phase II sediment sampling results from AMCCO site (used for Pathway 2: Recreational users' exposures to sediment).

Contaminant Type	Contaminant	Detects/ Total Samples	Background Levels (mg/kg)	Maximum Concentration Detected (mg/kg)	Comparison Value (mg/kg)	Contaminant of Potential Concern?
Organotins	Butyltin Trichloride*	1/15	<0.006	0.026	210 [a]	No
	Dibutyltin Dichloride	3/15	<0.0069	0.05	3,500 [b]	No
	Tributyltin Chloride*	2/15	<0.004	0.072	210 [a]	No
Metals	Aluminum	15/15	14,200	15,200	700,000 [a]	No
	Arsenic**	15/15	6.6	10.4	0.47 [c]/15	No
	Barium	15/15	119	77.4	140,000 [a]	No
	Calcium	15/15	3,610	4,910	None	No
	Chromium***	15/15	12.9	20.6	630 [a]	No
	Cobalt	15/15	14.5	16.6	7,000 [b]	No
	Copper	15/15	21.2	52	7,000 [b]	No
	Iron	15/15	34,600	34,400	715,000 [d]	No
	Lead	15/15	8.3	13.9	800 [d]	No
	Magnesium	15/15	5,000	6,460	None	No
	Manganese	15/15	339	359	35,000 [e]	No
	Mercury†	8/15	<0.18	0.5	307 [d]	No
	Nickel	15/15	17.9	25.4	14,000 [e]	No
	Potassium	15/15	1,220	2,360	None	No
	Sodium	15/15	559	3,380	None	No
	Vanadium	15/15	62.9	75.4	7,000 [b]	No
	Zinc	15/15	85	118	210,000 [a]	No
Semivolatile Organic Compounds	Di-n-butylphthalate	12/15	<340	390	70,000 [e]	No

Abbreviations: mg/kg = milligrams per kilogram; CV = comparison value; < = Less than; ATSDR = Agency for Toxic Substances and Disease Registry; EPA = U.S. Environmental Protection Agency

Comparison value sources: a) ATSDR March 2013 Adult Chronic Environmental Media Evaluation Guide; b) ATSDR March 2013 Adult Intermediate Environmental Media Evaluation Guide; c) ATSDR March 2013 Cancer Risk Evaluation Guide; d) EPA Regional Screening Level for composite workers; and e) ATSDR March 2013 Adult Reference Dose Media Evaluation Guide

*There is no CV for butyltin trichloride and tributyltin chloride and so we used the CV for tributyltin oxide.

**The ATSDR March 2013 Cancer Risk Evaluation Guide for arsenic (0.47 mg/kg) is below background levels and so ATSDR's recommended CV for arsenic in soil is 15 mg/kg.

***There is no CV for total chromium and so we used the CV for hexavalent chromium, which is lower and more conservative than the CV for trivalent chromium.

†The EPA Regional Screening Level for mercuric chloride was used.
Contaminants whose maximum concentrations exceed their comparison value are shaded.
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Table 10. Groundwater sampling results from AMCCO site (used for Pathway 4: Exposure to groundwater).

Contaminant Type	Contaminant	Detects/ Total Samples	Background Levels (ppb)	Maximum Concentration Detected (ppb)	Comparison Value (ppb)	Contaminant of Potential Concern?
Organotins	Tributyltin	4/5	0.015	0.082	3 [a]	No
Metals	Aluminum	5/5	1,840	31,500	10,000 [a]	Yes
	Arsenic	5/5	<10	35	0.023 [b]	Yes
	Barium	5/5	<200	382	2,000 [a]	No
	Calcium	5/5	35,800	86,700	None	No
	Chromium	5/5	5.2	140	100 [c]	Yes
	Cobalt	5/5	<50	63.4	100 [d]	No
	Copper	5/5	<25	847	100 [d]	Yes
	Iron	5/5	18,700	132,000	None	No
	Lead	5/5	<10	224	15 [c]	Yes
	Magnesium	5/5	72,600	140,000	None	No
	Manganese	5/5	672	3,760	500 [e]	Yes
	Nickel	5/5	<40	970	200 [e]	Yes
	Potassium	5/5	18,600	27,600	None	No
	Sodium	5/5	377,000	695,000	None	No
	Vanadium	5/5	<50	256	100 [d]	Yes
	Zinc	5/5	53.9	9,850	3,000 [a]	Yes
Volatile Organic Compounds	1,4-Dioxane*	-	-	-	0.35 [b]	No
	Toluene	1/5	<5	18	200 [d]	No
	m,p-Xylenes†	1/5	<5	5.3	2,000 [a]	No

Abbreviations: ppb = parts per billion (also expressed as µg/L or microgram per liter); CV = comparison value; < = Less than; ATSDR = Agency for Toxic Substances and Disease Registry; EPA = U.S. Environmental Protection Agency
Comparison value sources: a) ATSDR March 2013 Child Chronic Environmental Media Evaluation Guide; b) ATSDR March 2013 Cancer Risk Evaluation Guide; c) EPA Drinking Water Maximum Contaminant Level; d) ATSDR March 2013 Child Intermediate Environmental Media Evaluation Guide; e) ATSDR March 2013 Child Reference Dose Media Evaluation Guide
*The results for 1,4-dioxane are R-qualified, which means they were rejected.
†There is no CV for m,p-xylenes and we used the CV for total xylenes.
Contaminants whose maximum concentrations exceed their comparison value are shaded.

Appendix C: Chromium VI estimates in soil

More recent soil data for the AMCCO site became available in July 2014. These data are from the Phase I Remedial Investigation (RI) and they include results for total chromium and hexavalent chromium (chromium VI). We used this new information to estimate the levels of chromium VI in soil collected during the 2010 EPA SI for two reasons: 1) No speciated data were available for the 2010 sampling; 2) We felt it was important to assess a realistic exposure scenario for chromium that is specific to this site. This appendix describes our process for estimating the concentration of chromium VI in soil.

The 2014 Phase I RI data show 58 surface soil samples (composited from a depth of 0 to 1 foot below the ground surface) from 46 locations were analyzed for total chromium. Among these samples, seven of them were also analyzed for chromium VI. After identifying all of the total chromium and chromium VI samples, EHAP matched the chromium VI sample identification numbers to the total chromium sample identification numbers; this process resulted in a total of seven samples.

The seven samples that were analyzed for total chromium and chromium VI were collected from various parts of the AMCCO site including the burn area (n=3), marine way 3 (n=1), general storage area (n=2), and former above ground storage tanks (n=1). The levels of total chromium ranged from 248 to 1,000 mg/kg and the levels varied across the site. The concentrations of chromium VI ranged between 0.029 to 9.3 mg/kg. The chromium VI levels also varied across the site, but they did not follow the same pattern as the total chromium concentrations. See Table 11 for the Phase I RI total chromium and chromium VI data.

Table 11. Phase I Remedial Investigation total chromium and chromium VI data in surface soil.

Sample area	Sample identification	Concentration of total chromium from the Phase I RI (mg/kg)	Concentration of chromium VI from the Phase I RI (mg/kg)	Percent of chromium VI
Burn area	SB-11B	268	0.029	0.01%
	SB-12	341	0.096	0.03%
	SB-13	1,000	9.3	0.93%
Marine way 3	SB-06	646	0.26	0.04%
General storage area	MW-03	846	0.17	0.02%
	SB-37	774	3.6	0.47%
Former above ground storage tanks	SB-18	394	5.1	1.29%

Abbreviations: RI = Remedial Investigation; mg/kg = milligrams per kilogram; chromium VI = hexavalent chromium

For each sample from the new dataset, the concentration of chromium VI was divided by the level of total chromium. This yielded the percent of chromium VI in each sample; the percentages ranged from 0.01 to 1.29% (Table 11). To estimate the amount of chromium VI in the EPA SI samples, we used the highest (maximum) percentage (1.29%) since it would generate the most conservative values. Additionally, we used the highest percentage since there was no discernable pattern among and between the concentrations of total chromium and chromium VI and the sample locations. Then, each

concentration of total chromium from EPA's SI was multiplied by 1.29% to yield an estimated chromium VI soil concentration (Table 12).

$$Estimated\ concentration\ of\ chromium\ VI = Concentration\ of\ total\ chromium\ x\ 1.29\%$$

Table 12. Actual and estimated concentrations of total chromium and chromium VI in surface soil (from EPA's 2010 Site Investigation Report) (1).

Sample area	Sample identification	Concentration of total chromium from EPA's SI (1) (mg/kg)	Estimated concentration of chromium VI (mg/kg)
Burn Area	BA01SS	1,410	18.19
	BA02SS	596	7.69
	BA03SS	384	4.95
	BA04SS	433	5.59
Former Grit Pile	FG01SS	410	5.29
	FG02SS	370	4.77
	FG03SS	459	5.92
	FG04SS	769	9.92
	FG05SS	1,500	19.35
	FG06SS	984	12.69
New Grit Pile	NG01SS	411	5.30
	NG02SS	1,230	15.87
Oil-Stained Areas	OS01SS	451	5.82
	OS02SS	959	12.37
	OS03SS	198	2.55
	OS04SS	201	2.59

Abbreviations: mg/kg = milligrams per kilogram; EPA = U.S. Environmental Protection Agency; SI = site investigation; chromium VI = hexavalent chromium

Appendix D: Dose calculations for worker contact with soil

This appendix describes the equations and assumptions used to calculate a dose and risk for cancer and non-cancer health effects.

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

Risk calculations

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

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 slope factor

Assumptions
These doses are estimates of workers' exposure to arsenic and copper at the burn area on the AMCCO site. We assumed that workers would accidentally swallow 100 mg/day of the most heavily contaminated soil while working in the burn area for 8 hours per day for 5 days per week for 50 weeks per year (or 83.3 days per year) for 25 years. We also assumed that 25% of the arsenic and 100% of the copper in soil would be absorbed into the bloodstream after ingestion (5).[7]

See Table 13 for a complete list of values used to estimate a non-cancer and cancer dose and risk.

Arsenic was the only known carcinogenic contaminant of potential concern at the AMCCO site for which EHAP calculated a cancer risk. EHAP did not calculate cancer risk for copper because it has not been classified as to its human carcinogenicity (6) (7).

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 (22) (23).

[7] It is unlikely that all of the arsenic, copper, or other metals in soil at the AMCCO site would actually be absorbed after ingestion. The relative bioavailability of metals in soil depends on a number of factors, including the chemical's solubility and chemistry, and the soil's particle size and structure. We assumed 100% relative bioavailability in this risk assessment because we currently lack site-specific information to determine appropriate bioavailability factors for this site.

Table 13. Exposure factors for arsenic and copper dose calculations for adult workers.

Parameter		Value		Unit	Source
Term	Description	Arsenic	Copper		
C	= contaminant concentration	1,450	118,000	mg/kg	Maximum levels measured at burn area (1)
IR	= intake rate	100	100	mg/day	The intake rate is taken from Table 1 of ATSDR's Exposure dose guidance for soil ingestion (4/23/2012) (24).
BAF	= bioavailability factor	0.25	1.00	unitless	We assumed that 25% of the arsenic and 100% of the copper in soil would be absorbed into the bloodstream after ingestion. The bioavailability factor for arsenic is derived from a study in monkeys (5).
CF	= conversion factor	0.000001	0.000001	kg/mg	---
F	= frequency of exposure	83.3 (8 hours/day x 5 days/week x 50 weeks/year)	83.3 (8 hours/day x 5 days/week x 50 weeks/year)	days/year	We assumed workers access the burn area no more than 8 hours per day for 5 days per week for 50 weeks per year. The frequency parameters are taken from ATSDR's Dose estimate guidance: Determining life expectancy and exposure factor to estimate exposure doses and EPA's Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation. Supplemental Guidance "Standard Default Exposure Factors" Interim Final. OSWER Directive: 9285.6-03 (25) (26).
ED	= exposure duration	25	25	years	The exposure duration is taken from ATSDR's Dose estimate guidance: Determining life expectancy and exposure factor to estimate exposure doses and EPA's Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation. Supplemental Guidance "Standard Default Exposure Factors" Interim Final. OSWER Directive: 9285.6-03 (25) (26).
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 (27).
AT	= averaging time	---	---	days	---
Adult lifetime		78	78	years	The value for adult lifetime is taken from Table 18-1 of the EPA Exposure Factor Handbook 2011 (27).
Health guideline		0.0003	0.01	mg/kg/day	The health guideline for arsenic is ATSDR's MRL for chronic oral exposure (8). The health guideline for copper is ATSDR's MRL for intermediate oral exposure (6).

Cancer slope factor	5.7	---	$(mg/kg/day)^{-1}$	The EPA Science Advisory Board Arsenic Review Panel recommends using a cancer slope factor of 5.7 $(mg/kg/day)^{-1}$ for arsenic. While this value differs from the cancer slope factor in EPA's Integrated Risk Information System of 1.5 $(mg/kg/day)^{-1}$, EHAP chose this value since it reflects more recent evaluations by EPA staff. Additionally, this value is based on the combined risk of lung and bladder cancer, which are more serious endpoints than skin cancer (22) (23).

Appendix E: Glossary of Terms

This appendix defines words used in this Health Consultation (HC). It is not a complete dictionary of environmental health terms. If you have questions or comments, call the Centers for Disease Control and Prevention's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Absorption:	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Acute exposure:	Contact with a substance that occurs once or for only a short time (up to 14 days).
Adverse health effect:	A change in body function or cell structure that might lead to disease or health problems.
Averaging time (AT):	The period over which the exposure is averaged to arrive at a time-weighted exposure factor. For assessing cancer risks, AT is averaged over a lifetime (78 years); for assessing non-cancer risks, AT is averaged over the exposure duration (years), which may or may not be a lifetime.
Background level:	An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.
Cancer:	Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.
Cancer risk:	A theoretical risk for getting cancer if exposed to a substance every day for 78 years (a lifetime exposure). The true risk might be lower.
Cancer slope factor (CSF):	A value used to estimate the risk of cancer associated with exposure to a cancer-causing substance. It is based on the probability of the risk of cancer over a person's lifetime (78 years).
Carcinogen:	A substance that causes cancer.
Chronic exposure:	Contact with a substance that occurs over a long time (more than 1 year).
Comparison value (CV):	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway:	See exposure pathway.
Composite worker:	This is a long-term receptor exposed during the work day who is a full time employee working on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposures to surface soils. The composite worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, external radiation from contaminants in soil, inhalation of fugitive dust. The composite worker combines the most protective exposure assumptions of the outdoor and indoor workers. The only difference between the outdoor worker and the composite worker is that the composite worker uses the more protective exposure frequency of 250 days/year from the indoor worker scenario.
Concentration:	The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.
Contaminant:	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal contact:	Contact with (touching) the skin (see route of exposure).
Detection limit:	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Dose:	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental media:	Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants. Environmental media is the second part of an exposure pathway.

Exposure:	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).
Exposure duration (ED):	The number of years that an exposure occurred.
Exposure pathway:	The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: 1) a source of contamination, 2) an environmental media, 3) a point of exposure, 4) a route of exposure, and 5) a receptor population. When all five parts are present, the exposure pathway is termed a completed exposure pathway.
Frequency of exposure (F):	How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.
Health Consultation (HC):	A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.
Health guideline:	See Minimal Risk Level (MRL).
Hazard quotient (HQ):	A value used to quantify non-cancer risk where an exposure dose is compared to a health guideline. Specifically, the value is the result of dividing an exposure dose by a health guideline. When an HQ is less than or equal to 1.0 (the exposure dose is lower than or equal to the health guideline), it is unlikely that non-cancer health effects will occur. If the HQ is greater than 1.0 (the exposure dose is higher than the health guideline), an exposed person could experience adverse health effects that are not cancer.
Ingestion:	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).

Ingestion rate (IR):	The amount of soil, sediment, or water that is swallowed in a day. It is usually expressed as liters per day or L/day for water and grams/day or g/day for soil and sediment.
Inhalation:	The act of breathing. A hazardous substance can enter the body this way (see route of exposure).
Intermediate duration exposure:	Contact with a substance that occurs for more than 14 days and less than a year.
kg	Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
Maximum Contaminant Level (MCL):	An MCL is the maximum permissible level of a contaminant in water which is delivered to any user of a public water system. MCLs are derived by EPA as enforceable standards for public water systems. These standards are not strictly health-based, but they are set as close to the maximum contaminant level goals (MCLGs) as is feasible. MCLs are based on considerations of health, available treatment technologies, costs (affordability), and other feasibility factors, such as the availability of analytical methods, treatment technology and costs for achieving various levels of removal. There are MCLs for about 88 contaminants.
µg	Microgram or 1 millionth of 1 gram. Usually used here as part of the concentration of contaminants in water (µg/liter).
mg	Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
Minimal Risk Level (MRL):	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects.
No observed adverse effect level (NOAEL):	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

National Priorities List (NPL):	A list kept by the U.S. Environmental Protection Agency of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people cab be exposed to chemicals from the site.
Point of exposure:	The place where someone can come into contact with a substance present in the environment (see exposure pathway).
Population:	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Potential exposure pathway:	See exposure pathway.
Reasonable maximum exposure (RME):	RME refers to people who are at the high end of the exposure distribution (approximately the 95th percentile). The RME scenario is intended to assess exposures that are higher than average, but are still within a realistic range of exposure. The RME scenario is derived using both high end and average exposure factors.
Receptor population:	People who could come into contact with hazardous substances (see exposure pathway).
Risk:	The probability that something will cause injury or harm.
Route of exposure:	The way people come into contact with a hazardous substance. The three routes of exposure are: 1) breathing (inhalation), 2) eating or drinking (ingestion), and 3) contact with the skin (dermal contact).
Source (of contamination):	The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.
Special populations:	People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Substance:	A chemical.

Superfund	See National Priorities List (NPL).