ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

KEN FOSTER FARM (FORMER)
SHERWOOD, OREGON

APRIL 3, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

KEN FOSTER FARM (FORMER)
SHERWOOD, OREGON

Prepared by:

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

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Summary

The Environmental Health Assessment Program (EHAP), formerly known as the Superfund Health Investigation and Education Program (SHINE), developed this Public Health Assessment (PHA) to evaluate the public health risk of exposure to contaminants at (Former) Ken Foster Farm (KFF) located in Sherwood, Oregon. EHAP is part of the Oregon Public Health Division (OPHD), and is funded through a cooperative agreement program with the Federal Agency for Toxic Substances and Disease Registry (ATSDR).

The public health implications of exposure to contaminants in soil, sediment, groundwater, and surface water were evaluated for residents living at KFF. EHAP concluded that exposure estimates for incidental ingestion of antimony, chromium, iron, and mercury from soil at KFF do not pose a public health hazard even at the maximum exposure levels. Two sampling locations, however, do present a public health hazard for non-cancer health effects due to lead exposure from incidental ingestion of soil. All other sample locations do not pose a public health risk for incidental ingestion of lead-contaminated soil. EHAP also concluded that lead and other contaminants present at elevated levels in soil at KFF could be potentially taken up into foods grown in those soils and could also adhere to root vegetables grown in the soil such as potatoes and carrots.

EHAP recommends that the geographic extent of the lead levels in soil be characterized at two specific locations that present a health hazard to current and future residents at KFF, especially children. It is important to identify the boundaries of this known health hazard. Appropriate environmental remediation is needed within these boundaries in order to prevent lead exposures. Until remediation takes place, parents should ensure children avoid playing near these two locations. Additionally, if children living anywhere in Ken Foster Farm play outside often and are known to dig in the dirt frequently, it is recommended that they have their blood lead levels checked if parents are concerned that they could have elevated levels (see *the Public Health Action Plan* for resources related to testing blood levels). Additional sampling of soil throughout the entire KFF site is also encouraged to rule out the possibility that other specific locations with elevated lead exist. Gardening should be avoided in the specific locations identified in this report to avoid the uptake of certain metals into foods grown in contaminated soils (see *Public Health Implications* section for additional information about gardening).

Background

The site known as Former Ken Foster Farm (KFF) is located in Sherwood, Oregon, approximately 20 minutes southwest of Portland in Washington County (Figure 1). The 40-acre site was used as agricultural pastureland in the 1960s and 1970s. The private landowner, Ken Foster, began subdividing the property in the 1980s [1]. Today, the site

consists of 17 residential properties that range from 0.9 to 9.95 acres, and there are eight residential homes currently built on the site (Figure 2).

Beginning in the 1960s, Mr. Foster began depositing tannery wastes to the land. The waste was obtained from his employer, the Frontier Leather Company. The purpose of the application was to increase the organic content and nutrients in the soil. DEQ records indicate that the wastes were applied between 1962 and 1971. The specific locations where waste piles were applied are unknown but aerial photographs suggest that applications could have begun as early as 1963 and waste may have been applied to the southern, central, and northeastern portions of the site [1].

Around 1964, the Washington County Health Department began receiving complaints about human health concerns and odors relating to the wastes being applied to the land. Because of these complaints, DEQ's predecessor, the Oregon State Sanitary Authority, inspected the site in 1966. They concluded that the waste did not pose a public health concern but odors were being emitted by waste at the site. The county health department conducted an additional investigation in 1969 because of continuing complaints. At that time, the health department concluded that the onsite dumping was a violation of statutes and they would need to take action if it continued. Mr. Foster was also asked to limit sludge applications to a thickness of six inches or less. By 1971, Frontier Tannery developed onsite methods to treat the process sludge to reduce wastes being applied to the land at KFF [1].

A Preliminary Assessment (PA) by the Oregon Department of Environmental Quality (DEQ) in 2005 indicated that the Frontier Tannery waste that was applied to the land included animal wastes (animal tissue, fat, and hair), chromium-treated animal hides and scraps, and waste water sludge from settling tanks [2]. Calcium oxide (lime) was also applied to the land to minimize odors. In 1969, an inspector from the Oregon State Board of Health estimated that all the waste combined could have covered a four to five acre area at a depth of three to four feet.

The chemicals potentially spread onto Mr. Foster's property were expected to be similar to those used in the tanning process [2]. These included: chromium, a variety of other metals, petroleum hydrocarbons, chlorinated solvents, chlorinated benzene, phthalates, and pesticides.

There is no documentation of investigations at the site until DEQ's PA conducted in October, 2005. The PA raised awareness among residents and caused two homeowners to hire a contractor to conduct site assessments on their properties in March 2006. Soil, sediment, and groundwater samples were collected and the results raised concerns that the soils around the entire KFF property contained elevated levels of total chromium and chromium VI (hexavalent chromium). The PAs by DEQ and the private contractor led to the investigation by the U.S. Environmental Protection Agency (EPA), Superfund Technical Assessment and Response Team (START) in July, 2006. The Environmental Health Assessment Program (EHAP), formerly known as the Superfund Health Investigation and Education Program (SHINE), became involved at the site at the request

of the EPA. They asked EHAP to conduct a health assessment for the site once additional data was available to evaluate whether residents are being exposed to chemicals at levels that presented a health concern.

Currently, there are 22 people living at the site including 13 adults and 9 children. There are plans to develop the site further and add several more homes to the site. Approximately 400 people live within one-quarter of a mile of the site and close to 2000 people live within one-half of a mile of the site.

EHAP staff visited the Ken Foster Farm site in August of 2007. Specifically, staff observed the properties where elevated levels of contaminants have been identified to see if adults or children could be exposed to contaminants detected in those specific locations. There are two houses, one of which is occupied, that currently exist on these two properties. The property where the unoccupied home is, has been divided into several lots for future development. The second home is currently occupied by two adults. There was no indication (i.e. bicycles, toys, ATVs) on either of these properties that they are being used or frequented by children. There was no evidence of gardening taking place in any of the specific locations where levels of contaminants are elevated either.

During the site visit, a meeting was taking place to initiate remediation activities in the area that will be developed. Three homes are planned to be built in addition to the home that already exists on the property. The property owner has entered into an agreement with the ODEQ through the Volunteer Cleanup Program and has received approval by ODEQ to implement an Intermediate Removal Action Measures (IRAM) work plan. The soil in the areas where contaminants are significantly elevated have been identified will be removed and are approved by the ODEQ to be temporarily stored on a nearby parcel.

Figure 1. Proximity of Sherwood, Oregon relative to the Portland metro area.

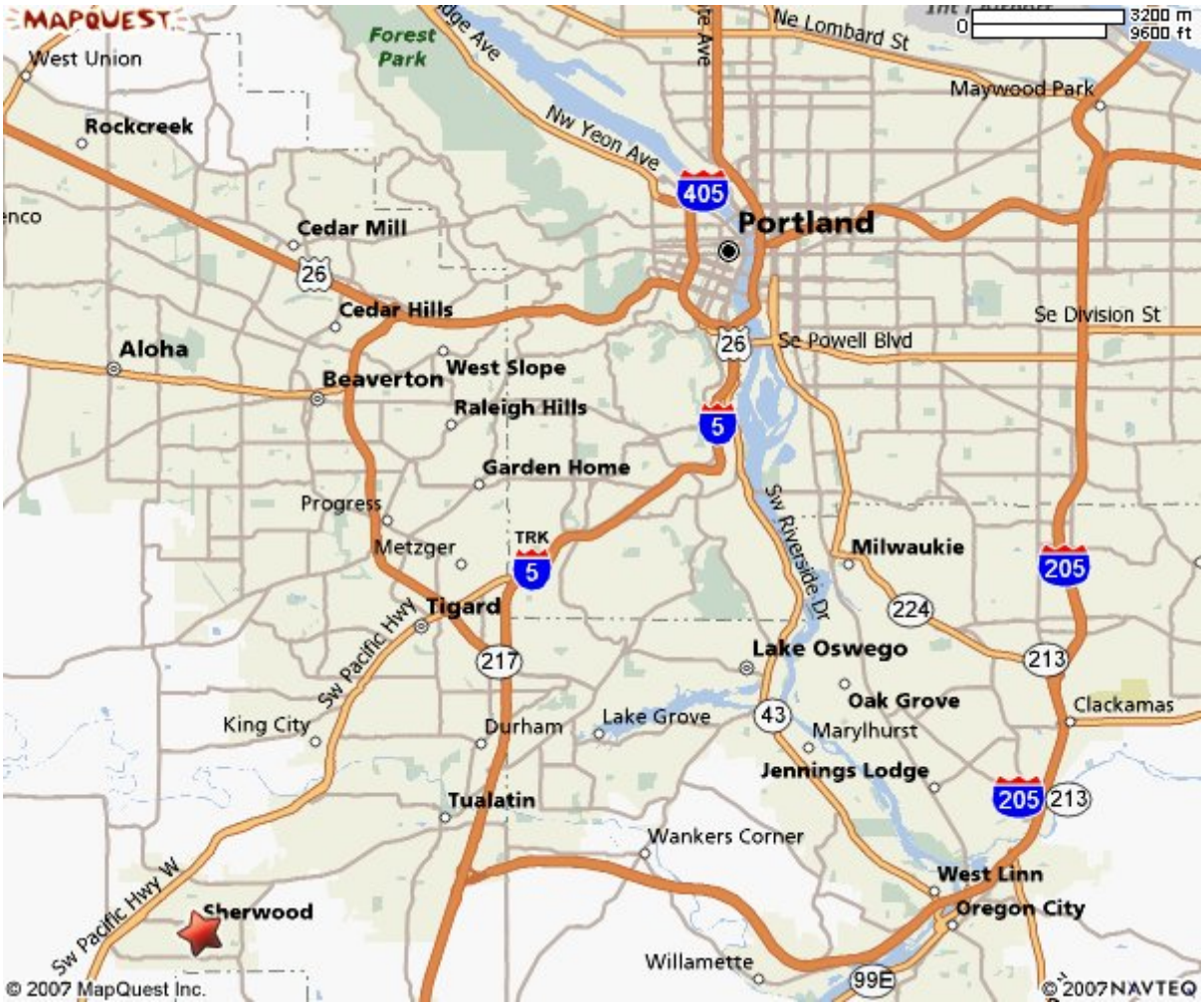
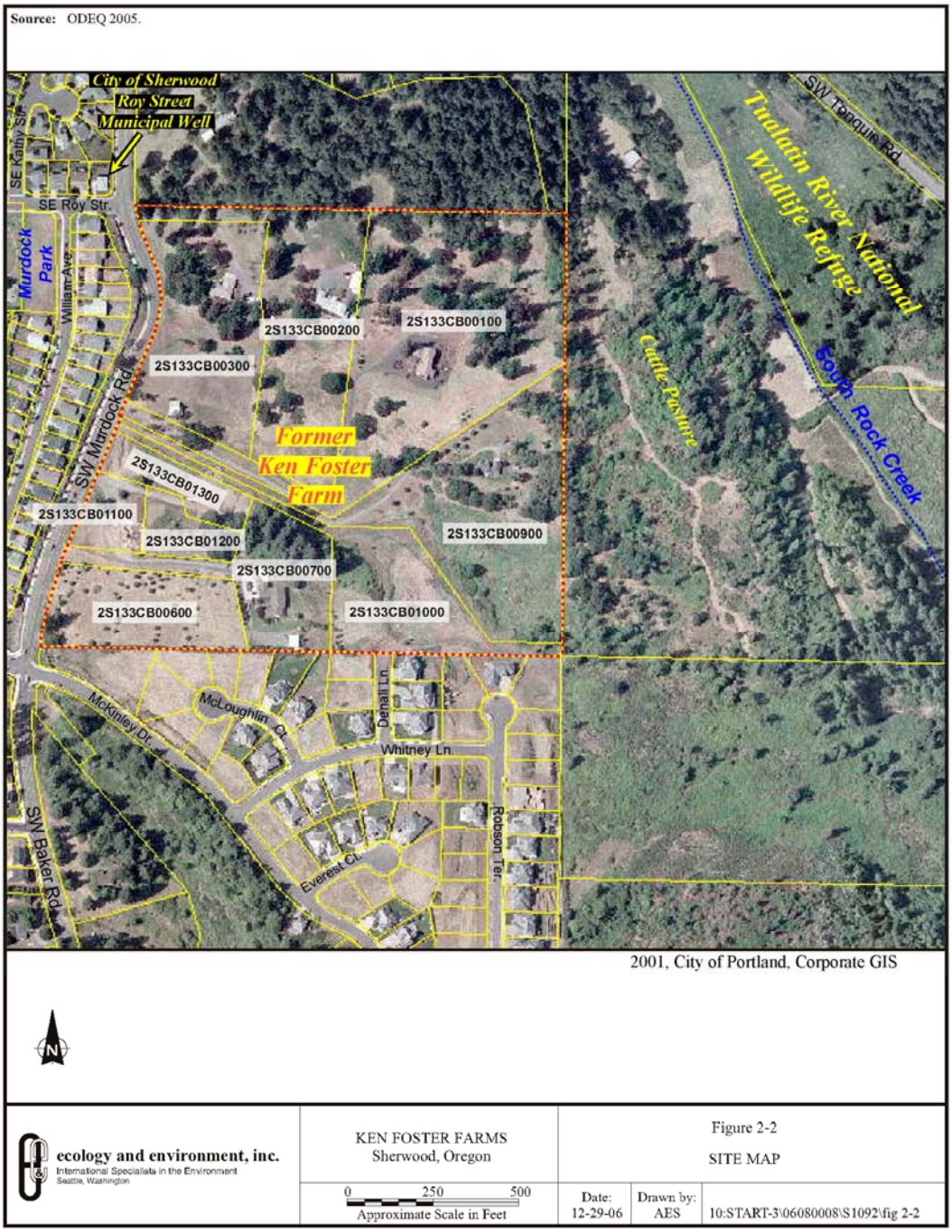


Figure 2. Aerial photograph of property boundaries at the Ken Foster Farms Site (as of spring 2006). (Figure was copied from the EPA START document and developed by Ecology and Environment, Inc.)



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Community Concerns

EHAP collects community concerns to better understand and document the public health concerns and issues related to a site as well as important historic site information. Members of the community often can provide invaluable information regarding behaviors that may be putting adults and children at greater risk of exposures. EHAP gathers this information through participation at public meetings, and interviews with partner agency staff, residents, and local community groups.

Washington County Health received complaints about the site as far back as the 1960s. People were not only concerned about odors, but also that the wastes being applied to the land were hazardous to health and were contaminating local water wells. It was also documented that a neighbor of the property sent a complaint letter to Governor McCall in March 1970 about runoff into South Rock Creek located in the Southeast corner of the property [2]. The neighbor stated that the odors and sludge applications had not decreased since 1962. Correspondence about the application of wastes at KFF continued between the neighbor and Governor McCall through August 1970. The adoption of onsite sludge treatment that began in February 1971 at Frontier Tannery appeared to be spurred by the neighbor's complaints to the Governor.

More recent community concerns have been expressed by residents who now live on the site known as KFF, by developers who own property on the site, and by people living near the site. At two different public meetings in June 2006 and April 2007, land and homeowners were concerned that the recent governmental involvement and sampling activities would have an impact on property values and future development of the site. People also expressed concern for children and families that spend time in Murdock Park, just west of the site and wanted to know whether that area was also contaminated. They asked whether sampling was going to be conducted there to ensure safe use of the park and, as a result, EPA extended sampling to include this area in July 2006. In separate communications, the City of Sherwood staff asked EHAP about the health and safety of workers who could be digging in the soil to connect new homes to sewer and water lines. In talking with community members, EHAP staff learned that gardening activities have taken place on the site in the past. EHAP staff identified former residents and asked them about their potential exposures during that time. Nobody reported health problems or symptoms that they related to environmental exposures at the site.

The Citizens for Smart Growth have communicated several concerns regarding the site. They include concerns about governmental agencies' assessment process, clean-up, and environmental exposures of past and future residents. Below are the specific issues they are concerned about:

- the apparent discrepancy in sampling results
- how well risk assessment activities take into account the exposure to a mixture of chemicals
- level of contamination at greater soil depths than were tested by EPA
- the risk of exposure to families and children, particularly if all Ken Foster Farm properties are cleaned up in a piecemeal way rather than simultaneously

- the need for posted public notifications along Murdock Rd. until the entire area is cleaned, remediated and contaminated soil placed in a permanently secured place
- exposures of past residents and the need for follow up on the health status and concerns of these residents
- potential exposures for future residents

Environmental Contamination

Soil and groundwater samples were first collected in the spring of 2006 on two properties within the KFF site [1]. Two different residents contracted with Creekside Environmental Consulting firm to do the sampling. Forty-one soil samples were collected on one of the properties and 33 samples were collected on the other. The procedures used for sample collection are described in two separate reports released by Creekside [3, 4]. Two groundwater samples were also collected on one of the properties from very shallow auger-dug boreholes. These boreholes were not representative of groundwater that could be used as a drinking water source because they were so shallow and were full of sediment. The results from the Creekside investigation indicated that total chromium, chromium VI, lead and manganese concentrations in soil and sediment were above soil guidelines developed to be protective of human health. However, data discrepancies for chromium VI results were discovered after closer examination by the laboratory. Review of laboratory sample and analysis procedures indicated that chromium VI was likely formed in the lab due to improper analytical controls.

The EPA became involved at the KFF site because of concern about detections of chromium VI during the Creekside investigation. These detections were later determined to be the result of analytical problems. The EPA START program conducted more extensive sampling on all of the properties throughout the KFF site in the summer of 2006. The EPA investigation provided the data used for this public health assessment. The approach and results of the EPA sampling effort are described below.

Sampling and Analysis Methods

EPA began planning their field sampling approach for KFF in June 2006 [1]. All sampling and analysis followed strict quality assurance objectives for the samples and data. The detailed sampling methods used by EPA can be found in the EPA START-3 report for KFF [1].

Samples were collected and analyzed for various chemicals based on concerns that chemicals from the tannery waste leached into soils, surface water, and groundwater. The samples were collected from 10 different on-site properties (Figure 2) along with some off-site locations, including two samples collected from the pond in Murdock Park. The EPA soil, sediment, groundwater, and surface water sampling locations are indicated in Figures 3, 4, and 5.

Soil and sediment samples were gathered from a depth of 0 to 6 inches below the surface. Most samples were randomly distributed and computer software was used to choose these

sample locations. Some sample locations were selected specifically because the historical aerial photographs indicated areas where tannery waste may have been applied. Areas of waste application were determined by the optically bright reflectance believed to be associated with lime application. A limited number of background samples were collected from off-site areas where no contamination was expected to be present. Background samples provided a comparison of the compounds found in soil and water at locations where no application of the tannery waste occurred.

Total chromium concentrations were measured for screening purposes in soil and sediment at 184 locations on-site using an X-ray fluorescence (XRF) direct reading instrument. A direct reading instrument gives an instant reading of specific chemicals in a sample without having to send the sample to a laboratory for analysis. The XRF sampling provided information about total chromium concentrations in soil throughout the entire site. A subset of soil and sediment samples (33 samples) was also sent for laboratory analysis for chromium. All surface water and groundwater samples and a subset of soil and sediment samples, a total of 49 samples, were sent to an off-site laboratory for analysis. Thirty-four soil samples, 2 surface water samples, 9 sediment samples, and 4 groundwater samples were analyzed. Up to 22 metals, including arsenic, chromium, mercury, and lead were measured in each sample. Seven (7) different chlorinated pesticides were also measured in the samples including the breakdown products of DDT.

Following lab analysis, correlation tests were conducted to see if the concentrations of total chromium measured in soil samples analyzed by the lab were consistent with the total chromium results measured by the XRF instrument for soil gathered at the same sampling locations. The correlations between the total chromium concentrations measured in the lab versus the XRF indicated a high level of association ($r^2 = 0.870$). This means that on-site XRF chromium results are reliable estimates of total chromium concentrations.

Sampling Results

Chemicals analyzed for in EPA samples included chromium III and VI other metals such as copper, iron, and lead, and chlorinated pesticides including DDT and dieldrin. A summary of the sampling results for soil, sediment, groundwater, and surface water can be found in Tables 1 through 4. The chemical levels measured in the samples are compared to background levels measured in areas where tannery waste was not applied. Only one background sample was collected for each type of media (i.e. soil, groundwater, etc.) so the background levels may not fully characterize the regional background levels for soil, sediment, groundwater, and surface water surround KFF.

The range of concentrations in soil and sediment for the entire site are summarized in Tables 1 and 2. For soil and sediment, chemical concentrations were expressed in either milligrams per kilogram (mg/kg), which is equivalent to parts-per-million (ppm), or micrograms per kilogram (ug/kg) which is equivalent to parts-per-billion (ppb).

Tables 3 and 4 summarize the entire range of concentrations for groundwater and surface water on or near the KFF site. Of the two surface water samples and four groundwater samples collected by EPA, total chromium was only detected in one sample, WD01SW. Sample WD01SW was collected from the on-site wetland.

Figure 3. Sample locations at the Ken Foster Farms Site (main sampling area)
(Figure was copied from the EPA START document and developed by Ecology and Environment, Inc.)

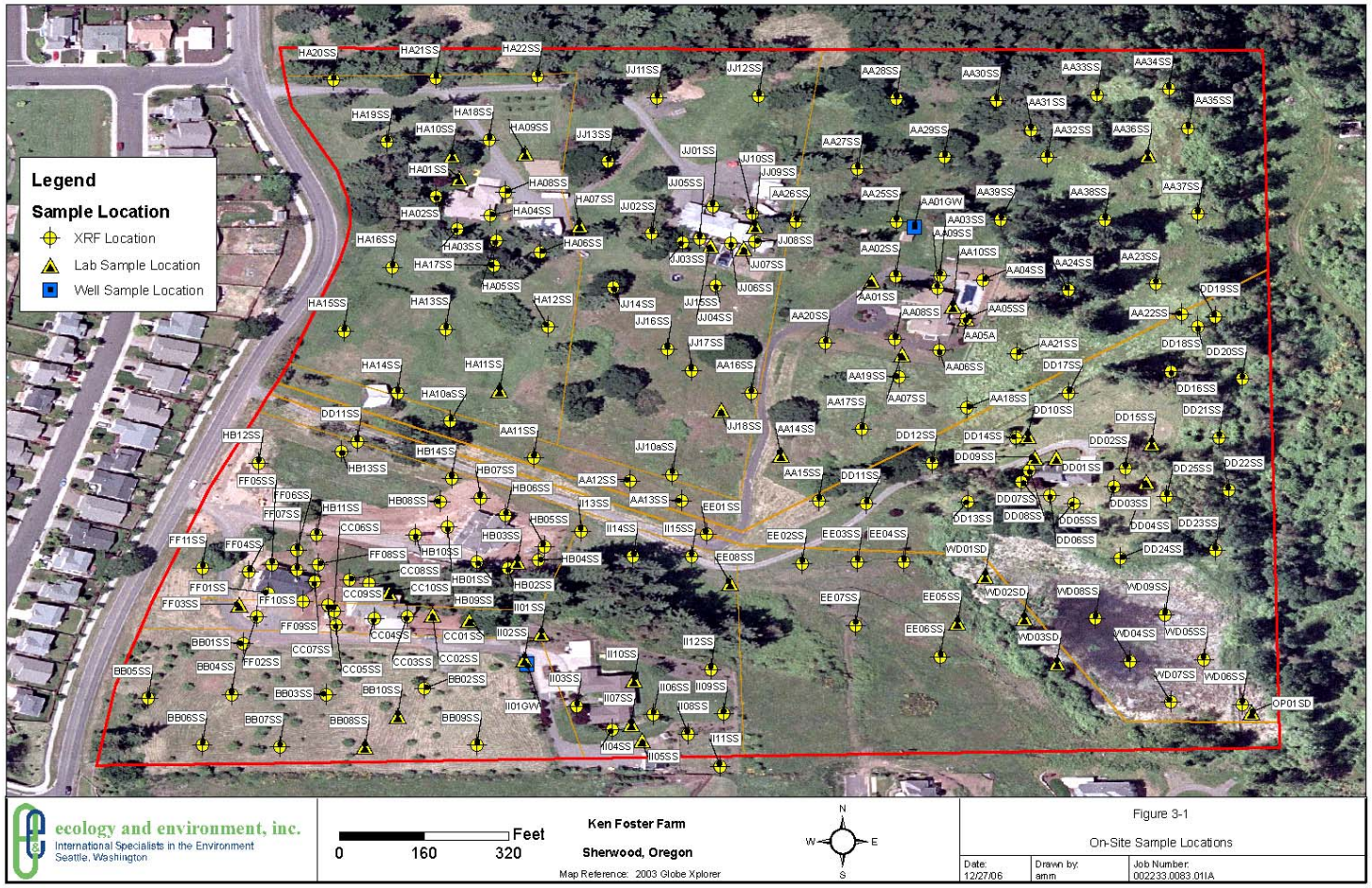

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Figure 4. Sample locations at the Ken Foster Farms Site (Southwest edge of the site).
(Figure was copied from the EPA START document and developed by Ecology and Environment, Inc.)

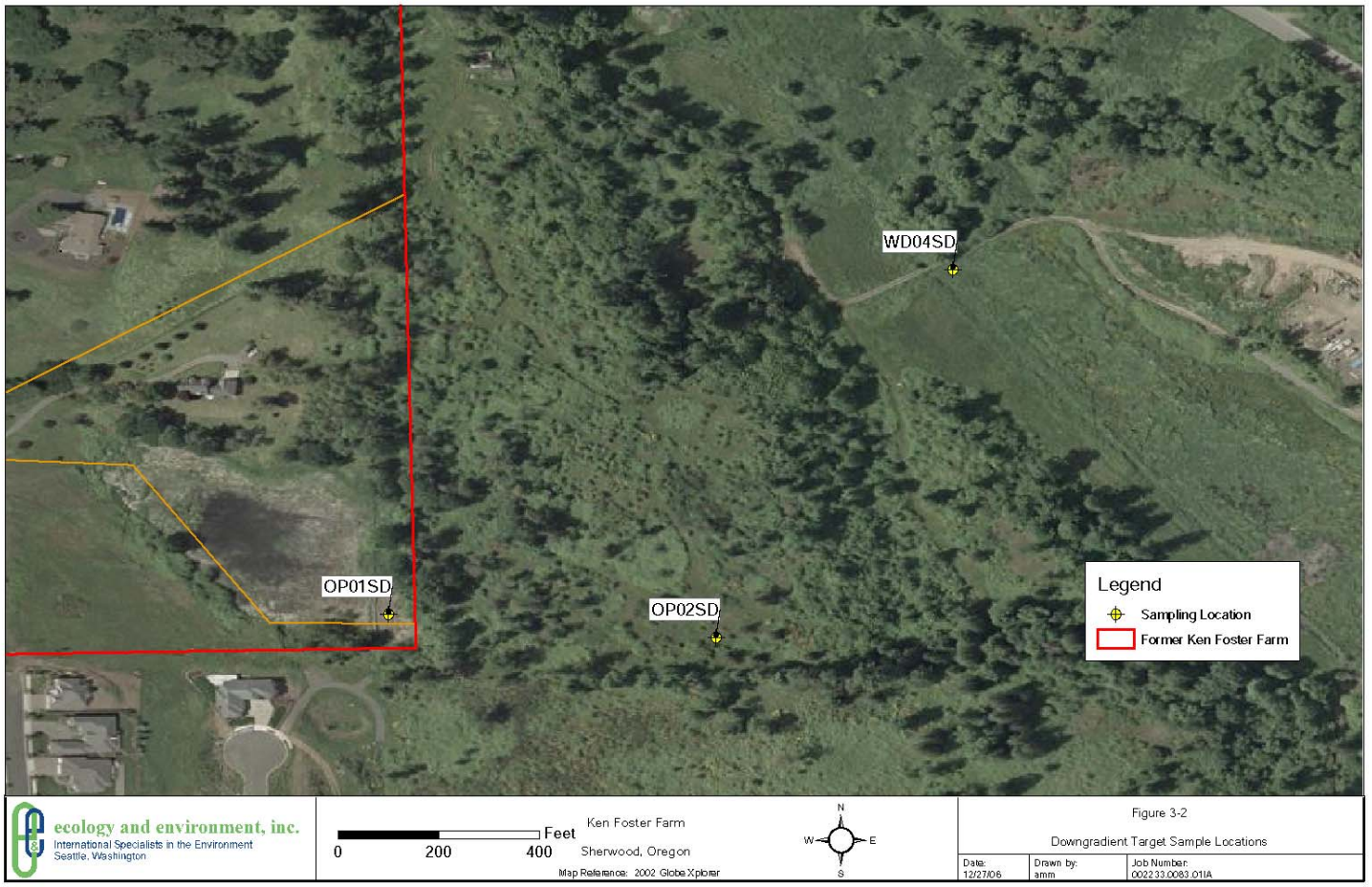

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Figure 5. Sample locations at the Ken Foster Farms Site (Northeast edge of the site).
(Figure was copied from the EPA START document and developed by Ecology and Environment, Inc.)

Discussion

Exposure Pathway Analysis

EHAP completed an exposure pathway analysis to determine how people could be exposed to chemicals at the former Ken Foster Farm site.

Five elements of an exposure pathway were evaluated to determine whether people are being exposed to the contaminants in soil, sediment, or groundwater. If all five elements exist for a pathway, then the exposure pathway is considered "completed." The five elements that need to be present for a completed exposure pathway to exist are:

- A contaminant source or release into the environment;
- A way for the contamination to move through air, soil, or water;
- An exposure point, which is an area where people can come in contact with the contaminated air, soil, or water;
- A route of exposure or a way by which people physically contact environmental contamination, such as drinking contaminated water or breathing contamination in air;
- And, a population that comes in contact with the contaminant.

If an exposure pathway is complete it means that people can be exposed to a chemical present at the site by a specific pathway and route of exposure. When a pathway is incomplete it indicates that people can not be exposed to contaminants by that specific pathway and route of exposure. The pathway analysis is used to identify past, current, or future exposure pathways that need to be further evaluated in the public health assessment.

Completed Exposure Pathways at KFF

There are currently homes on the KFF site and residents can come in contact with contaminated soil. *Soil exposure is a completed exposure pathway* for children and adults.

We know that people can accidentally swallow small amounts of soil each day (incidental ingestion). Children are especially prone to incidental ingestion of soil because they frequently place their hands in their mouths and they play outside frequently. Dermal exposure to contaminants in soil will also be considered if contaminants of concern are identified that pass through the skin into the body. Some of the soil on the site is covered by driveways or vegetation and the climate is wet much of the year, which would reduce the dispersion of contaminants into air in dust. Former residents grew vegetables on the site and new gardens could be established in the future. Some of the contaminants could be taken up into food grown in contaminated soil, so *ingesting food grown on-site is a potential exposure pathway*. The incidental ingestion route of soil exposure will be evaluated quantitatively, and other routes of exposure to soil, such as vegetables grown on-site, will be considered qualitatively in further evaluations in the next section.

Exposure to groundwater is a completed exposure pathway. There are drinking water wells that access an aquifer that runs under the site, and therefore exposure to groundwater is a completed exposure pathway. Surface water is not used as a source of drinking water. However, resident's skin may come in to contact with surface water, if wetlands are used for recreational purposes.

Contaminants of Concern

The maximum concentrations for each chemical in soil, sediment, surface water, or groundwater were compared to the available background data as well as health-based comparison values to determine which chemicals should be evaluated further for their potential impacts on human health.

Health-based comparison values are chemical concentrations in various environmental media, for example soil or water, that are used to identify contaminants of concern (COC) for further evaluation. Comparison values are based on standard, generic exposure scenarios and are calculated to be very protective. Appendix A provides a more detailed explanation of the various types of comparison values used to identify COCs at this site. COCs were identified by considering the following criteria:

- Comparison of maximum contaminant concentrations with background levels,
- Comparison of maximum contaminant concentrations with health-based comparison values (CVs) provided by ATSDR. Preliminary remediation goals (PRGs) set by EPA were used when ATSDR comparison values were not available.

If a chemical is present at a concentration above a screening value, it does not necessarily mean that a health threat exists, but that risks from exposure to that chemical need further evaluation. Contaminants of concern are carried through a second evaluation that more fully considers site-specific exposures.

Soil & Sediment

Tables 1 and 2 summarize the range of concentration of chemicals found in soil and sediment throughout the KFF site. The concentrations are compared with background concentrations, ATSDR comparison values, or EPA's PRGs in the tables. During the identification of COCs, both soil and sediment samples were compared to the same screening values. Standard comparison values are not available for sediment, but exposure to sediment is expected to be less frequent than to soil, so use of the soil values provides a screen for sediments that is protective of public health.

In this assessment, antimony, total chromium, iron, lead, and mercury were found to be COCs for soil, based on the available data from EPA. Concentrations of COCs were not uniform throughout the entire site, but rather were a concern at specific locations. The levels of health concern were only found at one location for total chromium, iron, lead, and mercury in soil and two locations for antimony in soil. All lead levels are below the

lead comparison values except at one location on property 2S133CB00900 (Figures 1 and 2, Sample location DD15SS) where the lead level reached 14,600 ppm. An additional location where lead concentrations are elevated is evident in the earlier data from the Creekside investigation and is discussed in later sections of this public health assessment. Chromium was identified as a COC based on the total chromium concentration (91,300 ppb) measured by the XRF instrument for one location in parcel 2S133CB00100 (Figures 2 and 3, Sample location AA14SS).

In sediment, antimony and iron are COCs based on the available data. The maximum concentrations of antimony and iron in sediment exceeded the limited information available on background levels and health-based screening values (for soil).

The presence of antimony, chromium, iron, lead, and mercury in soil and sediments measured at the KFF site will be evaluated further for their potential public health impacts in the *Exposure Evaluation* and *Public Health Implications* sections of this report.

Groundwater

The levels of various chemicals in groundwater along with comparisons with screening values are summarized in Table 3. Of the chemicals EHAP evaluated in groundwater wells on and off-site at KFF, only Chromium VI was present at levels that exceeded health-based screening values. Chromium VI exceeded the ATSDR health-based screening value for children.

Chromium was scrutinized closely. The laboratory analyzed groundwater samples for both total chromium and chromium VI. Total chromium captures all forms of chromium combined, whereas chromium VI represents one specific form of chromium. Total chromium levels in groundwater were all reported as non-detect because they were lower than the reporting limit of 20 ppb. However, the reports showed chromium VI levels in those same wells were higher than total chromium levels. The chromium VI levels should be represented in the total chromium levels. Therefore, the total chromium levels should be higher than the chromium VI levels for the same sampling location. These results indicate that some analytical problem may have occurred with these samples because it is not plausible that chromium VI levels are higher than total chromium levels for the same sample.

Since there are discrepancies in the data, data for chromium cannot be adequately interpreted in this public health assessment. However, the maximum level of chromium VI reported in the current data exceeds the comparison value for children's exposure. EHAP will evaluate groundwater further in the future if additional data become available and it is confirmed that chromium VI levels are above the child-based comparison values for drinking water.

Surface Water

None of the chemicals detected in surface water are identified as COCs. For a chemical to be considered a COC in surface water, it was first compared to the limited information

available on background levels. Contaminants exceeding background were next compared to CVs for groundwater and to a value that was 10 times (10x) higher than the comparison values. The reasoning behind including the higher screening values is that the health-based values for CVs for drinking water are meant to protect people who will drink the water on a daily basis over an extended period of time. People living at and around KFF may have incidental contact with surface water. Using a value 10 times higher than comparison values used for drinking water addresses the health implications for people who incidentally ingest up to approximately 1.5 liters of water weekly.

Table 1. Range of chemical concentrations in soil and comparisons to screening values. **(See Appendix A for the definitions of various comparison values)**

Soil Summary	Range in Soil		Background in Soil (FF03SS)	Comparison Value Children/Adults	Contaminant of Concern (COC) for further evaluation?
Compounds	[ppm]	Sample Number	[ppm]	ATSDR [ppm]	[yes/no]
Chromium					
Chromium (Total)	24.8 - 58900	33	32.3	80,000/1,000,000[1]	no
Chromium (Total) XRF	57-**91300**	172	Less than LOD	80,000/1,000,000[1]	**yes**
Chromium (VI)	ND	6		200/2,000[2]	no
Metals					
Aluminum	7410 - 44300	33	29100.0	100,000/1,000,000[2]	no
Antimony	0.9 - **112**	25	1.6	20/300[3]	**yes**
Arsenic	0.6 - 3.8	33	1.9	20/200[4]	no
Barium	89 - 593	33	299.0	30,000/40,000[4]	no
Beryllium	0.2 - 1.2	33	1.1	100/1,000[4]	no
Cadmium	2.1	5	0.58*	10/100[4]	no
Calcium	2120 - 235000	33	3210.0	-	no
Chromium	23.4 -58900	33	31.3	80,000/1,000,000[1]	no
Cobalt	3.3 - 38.3	33	30.1	500/7,000[2]	no
Copper	16.1 - 254	33	27.4	500/7,000[2]	no
Iron	2710 - **101000**	33	47900.0	-	**yes**
Lead	3.4 - **14600**	33	7.8	-	**yes**
Magnesium	1030 - 4590	33	2270.0	-	no
Manganese	383 - 1990	33	1300.0	3,000/40,000[3]	no
Mercury	0.1 - **118**	33	0.12*	20/200[3,5]	**yes**
Nickel	6.1 - 43.8	33	11.3	1,000/100,000[3]	no
Potassium	283 - 1980	33	1080.0	-	no
Silver	0.08 - 1.7	10	1.2*	300/4,000[3]	no
Sodium	1040 - 1040	6	307.0	-	no
Thallium	0.6 - 11.9	16	2.1	-	no
Vanadium	33.8 - 194	33	138.0	200/2,000[2]	no
Zinc	40.7 - 843	33	75.5	20,000/200,000[4]	no
Chlorinated Pesticides					
4,4'-DDE	0.00016 - 0.018	11	0.0038	2[6]	no
4,4'-DDD	0.021 - 0.021	5	0.0038	3[6]	no
4, 4'-DDT	0.0015 - 0.023	18	0.0038	30/400[3], 2[6]	no
alpha-chlordane	0.047	5	0.002	30,400[4], 2[6]	no
delta-BHC	0.0038 - 0.0061	3	0.002	-	**yes**
Dieldrin	0.00016 - 0.014	23	0.053	3/40[4], 0.04[6]	no
Endosulfan II	0.0027 - 0.016	5	0.00065	100/1000[4]	no
Endrin aldehyde	0.004 - 0.042	2	0.0038	-	**yes**
gamma-Chlordane	0.0013 - 0.015	15	0.002	30,400[4], 2[6]	no

1 Based on chromium III Reference Dose Media Evaluation Guide (RMEG) - child/adult
2 Intermediate Environmental Media Evaluation Guide (EMEG)- child/adult
3 Chronic Reference Dose Media Evaluation Guide (RMEG) - child/adult
4 Chronic Environmental Media Evaluation Guide (EMEG) - child/adult
5 Based on mercuric chloride Reference Dose Media Evaluation Guide (RMEG)
6 Cancer Risk Evaluation Guide (CREG)
7 EPA Preliminary Remediation Goal (PRG)
ND = Non-detect
LOD= Limit of Detection
ppm = parts per million
* Values are considered non-detect (ND) because they are less than the reporting limits

Table 2. Range of chemical concentrations in sediment and comparisons to screening values. (See Appendix A for the definitions of various comparison values)

Sediment Summary	Range in Sediment		Backround in Sediment (BG01SD)	Comparison Value Children/Adults	Contaminant of Concern (COC) for further evaluation?
Compounds	[ppm]	Sample Number	[ppm]	ATSDR [ppm]	[yes/no]
Target Metals					
Aluminum	8740 - 30800	8	20000	100,000/1,000,000[1]	no
Antimony	1 - **89.3**	8	rejected	20/300[2]	**yes**
Arsenic	0.71 - 2.32	8	6.5*	20/200[3]	no
Barium	151 - 601	8	217	30,000/40,000[3]	no
Beryllium	0.23 - 1	8	0.92	100/1,000[3]	no
Calcium	2880 - 66200	8	4070	-	no
Chromium	18.4 - 63000	8	27.8	80,000/1,000,000[4]	no
Cobalt	2.9 - 26.9	8	9.3	500/7,000[1]	no
Copper	16.7 - 94	8	19	500/7,000[1]	no
Iron	12000 - **52700**	8	17300	23,000[7]	**yes**
Lead	7.6 - 230	8	15.5	400[7]	no
Magnesium	973 - 2920	8	1690	-	no
Manganese	132 - 2580	8	338	3,000/40,000[2]	no
Mercury	0.48 - 14.6	8	0.74*	20/200[2,5]	no
Nickel	5.4 -12.8	8	11	1,000/100,000[2]	no
Potassium	331 - 923	8	822	-	no
Thallium	0.94 - 80.1	8	16.3*	-	no
Vanadium	80.1 - 211	8	112	200/2,000[1]	no
Zinc	55.2 - 313	8	76.2	20,000/200,000[3]	no
Chlorinated Pesticides					
4,4'-DDE	0.0056 - 0.0056	3	4.1*	2[6]	no
Semivolatile Organic Compounds					
Bis(2-ethylhexyl)phthalate	0.051 - 1.2	8	1.4*	50[6]	no
3,3-Dichlorobenzidine	ND	7	1.4*	-	-
4-Chloroaniline	ND	7	1.4*	-	-
Hexachlorocyclopentadiene	ND	7	1.4*	-	-

1 Based on chromium III Reference Dose Media Evaluation Guide (RMEG) - child/adult
2 Intermediate Environmental Media Evaluation Guide (EMEG)- child/adult
3 Chronic Reference Dose Media Evaluation Guide (RMEG) - child/adult
4 Chronic Environmental Media Evaluation Guide (EMEG) - child/adult
5 Based on mercuric chloride Reference Dose Media Evaluation Guide (RMEG)
6 Cancer Risk Evaluation Guide (CREG)
7 EPA Preliminary Remediation Goal (PRG)
ND = Non-detect
LOD= Limit of Detection
ppm = parts per million
* Values are considered non-detect (ND) because they are less than the reporting limits

Table 3. Range of chemical concentrations in groundwater and comparisons to screening values. (See Appendix A for the definitions of various comparison values)

Groundwater Summary	Range in Groundwater		Background in Groundwater	Comparison Value Children/Adults	Contaminant of Concern (COC) for further evaluation?
Compounds	[ppb]	Sample Number	ATSDR [ppb]	ATSDR [ppb]	yes/no
Chromium					
Chromium, Total	ND[†]	1	-	20,000/50,000[1]	no
Chromium VI	ND - 51	3	23	30/100[1]	**yes***
Target Metals					
Calcium	20900 - 34700	3	13100	-	no
Magnesium	7580 - 9070	3	5160	-	no
Manganese	2.3 - 36.5	3	15	500/2,000[1]	no
Sodium	6310 - 57500	3	5960	-	no
SVOCs					
Bis(2-ethylhexyl)phthalate	0.0000	3	0.83	-	no

1 Chronic Reference Dose Media Evaluation Guide (RMEG)
ND = Non-detect
ppb = parts per billion
* Chromium VI levels should be less than total chromium levels, see text for explanation
[†] All total chromium cocentrations were considered non-detect (ND) because they are below the reporting limit of 20 ppb

Table 4. Range of chemical concentrations in surface water and comparisons to screening values. **(See Appendix A for the definitions of various comparison values)**

	BG01SW	WD01SW	Comparison Value for Surface water† Children/Adults	Contaminant of Concern (COC) to be evaluated further?
Compounds [ppb]	Background	On-site wetland	ATSDR [ppm]	[yes/no]
Chromium (ug/L = ppb)				
Chromium (Total)	4	73	100	no
Chromium (VI)	10*	51	30/100	no
Target Metals (ug/L = ppb)				
Aluminum	10600	1760	20,000/70,000	no
Barium	249	407	6,000/20,000	no
Calcium	22500	47800	-	no
Chromium	10.8	81.1	100	no
Iron	20000	12400	-	no
Magnesium	7510	5220	-	no
Manganese	1510	1360	500/2000	no
Sodium	7230	10300	-	no
Vanadium	66.7	25	30/100	no
			-	
SVOCs (ug/L = ppb)				
4-Methylphenol	5*	120	-	no

*Below Detection Limit (DL), values less than DL were not included in the mean and maximum calculations
†For a concentration in the wetland to be considered a COC, it must be 10 times greater than the Comparison Value for drinking water (see comparison values in

1 EPA MCL (maximum contaminant level)
2 Chronic Reference Dose Media Evaluation Guide (RMEG) - child/adult
3 EPA Maximum Contaminant Level/Preliminary Remediation Goal (MCL/PRG)
4 Intermediate Environmental Media Evaluation Guide (EMEG) - child/adult
5 Chronic Environmental Media Evaluation Guide (EMEG) - child/adult
ug/L= microgram/Liter
ppm = parts per million
ppb = parts per billion

Public Health Implications

This section summarizes the public health implications of exposure to COCs through completed pathways. The public health implications are evaluated by calculating exposure doses for site-specific scenarios and then comparing estimated exposures with established doses that are not expected to result in adverse health effects. The exposure levels at which health effects have been observed in human and animal studies are also considered and compared to estimated doses for the site to determine the likelihood that an adverse health effect could occur. See Appendix A, tables 5 through 8 to see summaries of how exposure estimates were calculated and how public health risks were evaluated for this assessment.

In this section, the public health implications will be evaluated quantitatively for incidental ingestion of antimony, chromium, iron, lead, and mercury in soil and sediment.

Potential exposure to COCs taken up into vegetables grown in contaminated, on-site soil is discussed qualitatively. Incidental exposure to surface water was considered earlier during screening for contaminants of concern.

In public health assessments, cancer and non-cancer effects are evaluated differently. For non-cancer effects, it is assumed there is a threshold below which no health effect will occur. For cancer, it is assumed there is no dose below which there is no cancer risk, which is a very health protective assumption. Cancer risk is expressed as the excess risk level of developing cancer following a chemical exposure above the risk that would be expected in the absence of that exposure. Exposure risks for all of the COCs at KFF will be evaluated for non-cancer effects. Lead is the only COC that is listed as a probable carcinogen by the EPA [15]. The other metals, chromium III, iron, mercury, and antimony, are either unclassified as to their carcinogenicity or they are not believed to be carcinogenic (Appendix B). Cancer risks of exposure to lead can not be quantified in this report because there are no health guidelines (specifically, no slope factor) available to calculate the estimated risk.

Soil

Incidental ingestion of soil was evaluated for the KFF site. All of the COCs are metals, which do not pass through the skin easily into the body, so exposure through the dermal route is minimal. COCs at KFF were found at only a few locations rather than uniformly distributed across the entire site. Therefore two scenarios were considered. First contaminant concentrations were averaged across the entire site and used to estimate site-specific exposure levels for residents living at the site. (The means were only calculated for samples with concentrations above the detection limits). Exposure estimates were also calculated based on maximum contaminant concentrations to ensure evaluation of risks for the most highly exposed, sensitive individuals. This assessment assumed that exposure to soil occurs for 350 days a year for several years. This is a health protective assumption. If a health protective exposure estimate indicates there is no health hazard, it is a very good indication that the chemicals at a site do not pose a health hazard. EHAP has included a worst case scenario to evaluate risk at KFF as a health protective approach because homes are located close to hot spot areas with very high levels of certain chemicals. Another important consideration at KFF is that there is the potential that the home sites will be subdivided in the near future, increasing the potential for many more people to come in contact with soil at the site.

The soil exposure estimates for KFF were used as a surrogate for exposure to sediments. The maximum concentrations of COCs in soil are higher than any of the sediment concentrations measured for COCs and exposures are likely to be more frequent with soils than sediment. Therefore, exposure estimates for contaminants in soil should over-estimate exposure to contaminants in sediment at and around KFF. If a contaminant posed a risk in soil, the levels in sediment were examined further. If exposure to a contaminant is soil did not pose a risk, the chemical was not considered a hazard in sediment.

The solubility of metals is an important consideration in determining how likely the chemical is to be absorbed by the gut once ingested (bioavailability). Metals persist in soil and the toxicity can depend on the form of the chemical present. The different forms of metals present in soil at KFF are unknown. It is likely that many of them have formed inorganic complexes in the soils, which are less soluble and not easily absorbed by the gut. Health protective, conservative bioavailability factors were used in this assessment to account for the uncertainty about which form is present in soil. There is more scientific information about bioavailability for some metals than for others and this was also considered when establishing bioavailability factors for this site. A bioavailability factor of 100% was used for chromium, iron, and lead to ensure that estimates were health protective and to account for uncertainty about absorption of these metals. Inorganic and elemental forms of mercury are not readily absorbed by the body so a bioavailability factor of 30% was used as a conservative, protective factor based on the available scientific studies [16]. Based on animal experiments, it is known that trivalent antimony salts are not well absorbed by the gut with an estimated bioavailability factor for antimony less than 10% [7], so 10% was used in this assessment.

Antimony, Chromium (total), Iron, and Mercury

Exposure estimates for incidental ingestion of antimony, total chromium, iron, and mercury from soil at KFF do not pose a public health risk even at the maximum exposure levels. For antimony, total chromium and mercury, the exposure estimates were well below non-cancer health guidelines indicating that no health effect is expected for daily exposure over an exposure period of many years. The estimate for children's exposure to iron through incidental ingestion slightly exceeded the EPA's reference dose (RfD). However, the exposure estimates assume that children are playing specifically at the locations where levels of contaminants are elevated every day for several years, so it is very unlikely that actual exposures will exceed the RfD. Because iron exposure from soils at KFF are unlikely to cause an increased risk of developing adverse health effects, iron levels in soil are not considered a health hazard.

Lead

Based on EPA data, lead levels in soil at KFF are below screening values except at one location on the property and therefore the majority of sampling locations do not present a public health hazard. However, on property 2S133CB00900 at sample location DD15SS (Figures 2 and 3), the lead concentration is 14,900 ppm while the recommended health-based action level for lead in residential soil is 400 ppm. One other sample location tested by Creekside Environmental on tax lot 100 (S-30, located in northeast corner of the property) was found to contain lead at 2310 ppm [1, 3] which is also well above the recommended action level. These locations are limited in scope, but it is unknown how far out from the sample locations the contamination extends.

These locations present a risk because children are very susceptible to the effects of lead and they tend come in frequent contact with soil while playing and digging outside. Children 6 years of age and younger are especially vulnerable. In the scientific literature there are clear associations between blood lead levels and health effects. Screening levels for lead in soil provide guidance to assess whether lead levels in soil are likely to result in

an increase in blood lead levels in children exposed to the soil. A multi-site study showed that lead concentrations in soil greater than 500 mg/kg were associated with average increase in blood lead levels to above 10 μg/dL in children ages 6 months to 5 years [19].

The geographic extent of the elevated lead levels in soil around 2S133CB00900 at sampling location **DD15SS** (Figure 3) and location **S-30** should be characterized further since these specific locations pose a health hazard in the past, and to current, and future residents at KFF. It is important to identify the boundaries of this known health hazard. Appropriate environmental remediation is needed within these boundaries in order to prevent lead exposures. Until remediation takes place, parents should ensure children avoid playing near these two locations. If parents are concerned because their children often play outside at Ken Foster Farms and are known to dig in the dirt frequently, blood lead levels can be checked (See *Public Health Action Plan* for additional resources related to testing blood levels). Additional sampling of soil throughout the entire KFF site is also encouraged to rule out the possibility that other potential locations of elevated lead levels exist.

<u>On-site Gardening</u>

Past residents ate vegetables grown on the site. Contaminated soils can adhere to the surfaces of vegetables grown in the soil, especially to root vegetables such as carrots. Lead contaminated soil could also be tracked into the home on shoes, clothing, or tools from gardening activities. It is also known that lead and chromium III can be taken up into food grown in contaminated soils.

EHAP recommends that gardening be avoided around locations DD15SS, due to lead (14,600 ppm), and at AA14SS due to total chromium (91,300 ppm). Sampling location DD15SS also contains the maximum levels of mercury (118 ppm) and iron (101,000 ppm) detected on-site, the second highest concentration of antimony (110 ppm), and intermediate levels of chromium (59,700 ppm). The highest level of antimony detected on-site (112 ppm) was found at location AA14SS. The detection of elevated levels for multiple COCs at these two sampling locations further justifies the recommendation to avoid gardening in soil near them. Gardening around sample location S-30 (tested by Creekside Environmental) located in the northeast corner of tax lot 100 should also be avoided due to elevated levels of lead (2310 ppm). Gardening near these locations should be avoided until environmental remediation is complete. Because it is uncertain how far out around these locations the contamination extends, it is difficult to assign a specific distance around the sampling locations that residents should avoid gardening or that children should avoid playing. However, residents can use information about other sampling locations to determine where safer places exist for adult and child activities.

Summary of Public Health Implications

Contaminant of Concern (COC)	Soil and Sediment	Locations where contaminant levels present potential concern	Public Health Recommendations*
Total Chromium	Not a public health concern	AA14SS;	Avoid gardening near this location
Antimony	Not a public health concern	AA14SS and DD15SS	Avoid gardening near these two locations
Iron	Not a public health concern	DD15SS	Avoid gardening near this location
Lead	**Health hazard at DD15SS and S-30,**	**DD15SS and S-30**	**Adults and children should avoid activities near these locations**
Mercury	Not a public health concern	DD15SS	Avoid gardening near this location

*These are precautionary measures that residents can take to prevent exposure to soil contaminants.

Figure 6. Areas at KFF where gardening should be avoided until soil removal occurs.

Children's Health Considerations

EHAP and ATSDR recognize that infants and children may be more vulnerable to exposures than adults 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, put their hands in their mouths, and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- 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, ATSDR is committed to evaluating their special interests at sites such as Ken Foster Farm where their behaviors or sensitivity to contaminants could put them at greater risk. Since children have a greater hand-to-mouth tendency and they may spend a significant amount of time digging and playing in soil, their activity in yards throughout the Ken Foster Farm site and in nearby wetlands should be monitored by an adult to minimize exposures to contaminated soils.

Children under the age of six are particularly sensitive to the effects of lead so it is important that they avoid playing in areas where lead levels are elevated in soils at the KFF site. This is specifically the case around sampling location DD15SS (Figure 3). Children are more easily exposed to lead than adults and when lead enters a child's body, it is absorbed more easily than it is for adults. Due to children's behaviors that increase their exposures to lead, their increased sensitivity to the health effects of lead, and the elevated levels of lead in soil at KFF, parents may want to consider having their children's blood lead levels tested for lead. See the *Recommendations and Action Plan* section for resources available regarding lead exposure and testing blood lead levels.

Conclusions

Antimony, chromium, iron or mercury levels in soil at KFF pose *no apparent public health hazard.* EHAP does not expect adverse health effects to result from maximum exposures.

Sampling locations, DD15SS and S-30 present a *public health hazard* for non-cancer health effects due to lead exposure from incidental ingestion of soil (Figure 6). Lead-contaminated soil at all other sample locations does not pose a public health risk.

Exposure to metals through gardening activities and the consumption of home-grown foods is of potential concern at three specific locations. Contamination in the soil could adhere to vegetables grown in the soil as well as be taken up into foods grown in the

contaminated soil. Dirt from shoes, clothes, and gardening tools could also be tracked into homes after gardening. Gardening is a potential concern at three specific locations. Soil sample location AA14SS is a potential concern for chromium and antimony. Soil sample location DD15SS is a potential concern for iron, lead, and mercury, and S-30 is a potential concern for lead (Figure 6). Residents who have consumed food grown on-site may have been exposed to chromium and lead. However, EHAP does not have information on the levels of contaminants that were taken up by the produce or the amount of home-grown produce consumed. Therefore, EHAP can not determine whether people were exposed to contaminants at levels of concern when they ate produce grown on the site.

Since there are apparent discrepancies in the data, data for chromium VI in groundwater cannot be adequately interpreted in this health assessment. EHAP will evaluate the groundwater pathway further if additional data becomes available.

Soil samples were collected from a depth of 0-6 inches. Utility or other workers may excavate soil at greater depth and may be exposed to soil that is contaminated to a greater (or lesser) extent than surface soil. No information is available to EHAP to evaluate this exposure pathway.

Public Health Recommendations

EHAP has outlined below the steps that residents, property owners, and environmental agencies can take to protect public health at this site.

- The geographic extent of the elevated lead levels in soil at sample locations DD15SS and S-30 should be characterized further. It is important to identify the boundaries of this known health hazard. Appropriate environmental remediation is needed within these boundaries in order to prevent lead exposures. Until remediation takes place, parents should ensure children avoid playing near these two locations.

- Residents should avoid gardening near sampling locations DD15SS, S-30, and AA14SS. This is due to elevated levels of lead, as well as antimony, iron, and mercury at DD15SS, elevated levels of lead at S-30 and elevated levels of total chromium and antimony at AA14SS. If residents would like to garden, they should select areas where sampling has shown lower levels of contaminants.

- Thirty-four soil samples from the 40-acre KFF were analyzed for lead. Two locations were identified where levels of lead are elevated. Additional sampling of soil is encouraged to rule out the possibility that other locations with elevated lead exist.

- Since it is unknown if other locations with elevated levels of contaminants exist on the site, steps should also be taken to minimize tracking on-site soil into homes. This could include: taking off shoes in the house, wiping pets' feet, and washing hands after coming into contact with the dirt.

- EHAP recommends that children living at KFF who play outside often or dig in the dirt frequently, have their blood lead levels checked if parents are concerned that they could have elevated levels (see *the Public Health Action Plan* for additional resources related to testing blood levels).

- Groundwater samples should be retested for total chromium and chromium VI to confirm that levels of chromium VI is groundwater are not elevated. EHAP supports the local water district's plan to include Chromium VI in their routine testing.

- If utility or other workers excavate soil at depths greater than 6 inches, additional soil samples gathered from greater depth will be needed to assess potential health hazards.

Public Health Action Plan

The following public health actions have been taken at KFF:

- EPA and Creekside Environmental completed soil sampling for many different metals and chlorinated solvent in soil, sediment, groundwater, and surface water throughout the properties at KFF. The data provided during this sampling provided the information needed to conduct this health assessment.
- EHAP has attended public meetings related to the site held in June 2006 and April 2007 to hear community concerns and answers questions related to public health as needed.
- EHAP sent a letter to residents and stakeholders to inform them of upcoming public health assessment activities and contacted individuals by telephone to invite input on health concerns at the site.
- EHAP staff conducted a site visit in August 2007.
- In August 2007, DEQ approved for implementation an Intermediate Removal Action Measure plan to remediate soil on property 2S133CB00900.
- EHAP developed a fact sheet on the KFF health assessment results which was released at the same time as the draft report and distributed at public meeting in November 2007. The fact sheet is available on the EHAP website (www.healthoregon.org/superfund).
- In 2006 and 2007, DEQ notified property owners of the results from sampling conducted on their respective properties.
- In 2007, EHAP contacted owners of the properties that contained sampling locations DD15SS and S-30. EHAP provided them information about lead levels at those locations and how to reduce or prevent exposures to lead-contaminated soil.
- In November 2007, EHAP hosted a public availability session in Sherwood to address community questions and concerns.

The public health actions to be implemented include the following:

- DEQ will continue to work with the site developer and oversee remediation of the area where high lead levels were detected.
- EHAP and ATSDR will continue to provide assistance to the community and to regulatory agencies during any additional sampling or planning for site cleanup.
- In response to a request from the community, EHAP will develop a fact sheet directed to potential purchasers of property at Ken Foster Farms to inform them of EHAP's findings.
- DEQ continues to collect additional data on Chromium VI in soil.
- DEQ will work with the local water district to implement testing of chromium in the drinking water.

Resources regarding exposure to lead and information about testing blood lead levels can be found at the following website: http://www.oregon.gov/DHS/ph/lead/leadsafefam.shtml

Certification

The Environmental Health Assessment Program of the Oregon Department of Human Services prepared the Ken Foster Farm (Former), Sherwood, Oregon Public Health Assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This document is in accordance with approved methodology and procedures.

Alan S. Crawford, REHS/RS
Technical Project Officer for Oregon, CAPEB, DHAC

I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.

Alan Yarbrough, M.S.
Leader, Cooperative Agreement Team, CAPEB, DHAC

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Response to Comments

Comment:
The area is part of the formal SE Sherwood Master plan and calls for a build out of upwards of 100 houses with approximately 4-500 people living in the area. The development also calls for extensive public use of the area via park strips and public walking and biking paths. In addition the area will be frequented by another 500-1000 household members once the build out continues along a bluff in front of Sherwood View Estates.

Such a build out and access template makes it difficult to secure access to any of the areas your report indicates is a health concern to human beings, or an environmental concern, without the total area being remediated before build-out commences.

It is our contention that the State of Oregon and the City of Sherwood ought to strongly recommend, advise and call for a collaborative remediation model where the entire area is remediated and secured before any build-out starts.

We realize that current state, DEQ funding, City and public regulations make this a challenge for developers and the public agencies, however, after reviewing the report, we believe total remediation along the lines of a Brown Field total remediation, encapsulation and storage is doable with city and state collaboration.

Response:
The specific information related to the development plans at Ken Foster Farm is helpful and is noted. Your concern that the areas of public health concern may be more accessible once plans for development are completed is noted. We believe that our recommendation to clean up those areas addresses the public health concern we have identified.

We note your comment that total remediation, encapsulation and storage are preferable and doable. We are forwarding this comment to the DEQ.

Comment:
[If total remediation] is not implemented, we urge your agency to develop a proper fact sheet for new residents and purchasers of any portion of property in the area; consumers do not, under current regulations, have an assured format for being made aware of the conditions of the environment in the area without such a fact sheet.

Response: We are glad to work with SCSG to develop a fact sheet that informs new residents and purchasers of our findings related to the Ken Foster Farm site.

Comment:
We are, additionally, concerned with the requirement for ongoing testing of soil at depths greater than 6" as development proceeds; the original data does not contain adequate

testing results of ground sedimentation at depth, or the quality of ground water tables. We suggest that your agency strongly recommends such testing before NFAs are issued on any parcel.

Response:
This health consultation is based on soil samples conducted from 0”-6” soil depths. We have recommended (See Recommendations section) that the soil at depths greater than 6” be tested before excavation or work is done at these depths.

We will forward this comment onto DEQ for their consideration. DEQ is responsible for issuing NFAs.

Comment:
Your verbal comments indicate that you have satisfied public requirements for historical health data of families that have lived in the area for a number of years, now and in the years since the contamination took place; we have a concern that this data may not be formalized and available for public examination, and that no assurance is stated directly in the report.

Response:
We have added language to the report (See Community Concerns section) to address this comment. We have spoken to current and past residents in this area and nobody has reported that they are experiencing health problems or symptoms that they relate to exposures at the site. No public data is available for such a small population. Because it is not possible to discuss details of the conversations we have had with residents without revealing identifying information, we can only state generally what we learned.

Comment:
Your report follows the traditional format of examining exposure on the basis of test data from individual contaminants, and we are concerned about the aggregate health effect represented by the mixture of the many contaminants over a long period of time for new residents and public; we urge your agency to call for public health advisory signs to be posted unless the entire area is completely remediated before any build out occurs.

Response:
ATSDR agrees that exposure to chemical mixtures is an important toxicological issue. The agency has an extensive program to develop toxicological profiles for chemical mixtures based on currently available information, and has a research program to develop methods and guidance to more adequately address the issue in the future. Information on the objectives of the ATSDR Chemical Mixtures Program can be found on the ATSDR web site. At this time, toxicological information is available to address only a limited number of chemical mixtures. As a result, qualitative approaches that incorporate protective assumptions were used as the basis for the recommended public health actions for this site.

Appendix A. - Explanation of Chemical of Concern Screening Process and Evaluation of Public Health Implications

Screening Process

In evaluating these data, EHAP used health-based comparison values (CVs) from ATSDR to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific media (soil or water) that are unlikely to result in a health hazard and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone could inhale or ingest each day. There are both child-based and adult-based CVs. When ATSDR CVs are not available, EHAP used EPA preliminary remediation goals (PRGs) or maximum contaminant levels. PRGs are used to determine the levels to which a chemical should be cleaned for a particular media. MCLs are levels are designed to be safe drinking water levels.

As health-based guidelines, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included. They are also based on the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one in a million excess cancer risk for an adult eating contaminated soil or drinking contaminated water every day for 70 years. Exceeding a CV does not mean that health effects will occur—just that more evaluation is needed.

CVs used in this document are listed below:

Environmental Media Evaluation Guides (EMEGs) are estimated contaminant concentrations in a media where non-carcinogenic health effects are unlikely. The EMEG is derived from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk level (MRL).

Remedial Media Evaluation Guides (RMEGs) are estimated contaminant concentrations in a media where non-carcinogenic health effects are unlikely. The RMEG is derived from the Environmental Protection Agency's (EPA's) reference dose (RfD).

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in 1 million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs).

Preliminary Remediation Goals (PRGs) are the estimated contaminant concentrations in a media where carcinogenic or non-carcinogenic health effects are unlikely. The PRGs used in this public health assessment were derived using provisional reference doses or cancer slope factors calculated by EPA's Region 9 toxicologists.

Evaluation of Public Health Implications

Estimation of Exposure Dose

The step in evaluating public health implication sis to compare contaminant levels to CVs. The next step is to take those contaminants that are above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for site-specific exposure scenarios, using site-specific assumptions about who goes on the site and how often they contact the site contaminants. An exposure dose is an estimate of the amount of a contaminant that gets into a person's body.

Non-cancer Health Effects

The calculated site-specific exposure doses are then compared to an appropriate health guideline for that chemical. Health guidelines are considered safe doses; that is, health effects are unlikely below this exposure level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, the use of the lowest adverse effect level, or a combination of all three. For non-cancer health effects, the following health guideline values are used:

Minimal Risk Level (MRLs) - developed by ATSDR
An estimate of daily human exposure—by a specified route and length of time—to a dose of chemical that is likely to be without a measurable risk of adverse, non-cancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

Reference Dose (RfD) - developed by EPA
An estimate, with safety factors built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. The RfDs can be found at http://www.epa.gov/iris/.

After a site-specific exposure dose is calculated, a hazard quotient can be calculated. This is equal to the estimated dose divided by the RfD or MRL. If the estimated exposure dose for a chemical is less than the health guideline value (hazard quotient less than 1), then the exposure is unlikely to cause a non-carcinogenic health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline (hazard quotient greater than 1), further evaluation is required. When the hazard quotient is greater than 1, the exposure dose is compared to toxicological data for that chemical and is discussed in more detail in the public health assessment (see Discussion Section). In this case then, a direct comparison of site-specific exposure and doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely or not.

The tables below (Tables 5 – 8) summarize the assumptions used in calculating exposure doses for the incidental ingestion of soil at Ken Foster Farms (KFF) along with the calculated exposure estimates and comparison to non-cancer health guidelines (MRLs and RfDs). The equation used to estimate exposure doses for non-cancer health risks to incidental ingestion of soil is provided below.

Table 5. Assumptions Used to Estimate Exposure

Exposure Factor	Symbol	Value			Source/Notes
		Young Child - less than 5-years-old	Older Child - less than 12-years-old	Adult	
Body Weight [kg]	BW_{yc}	15	40	70	A, Adult weight = default value
Exposure Frequency - Residential	EF_{Res}	350	350	350	B; Away for 2 weeks per year
Exposure Duration	ED	6	10	30	B
[days]	AT_{nonc}	2190	3650	10950	B
Soil Ingestion Rate [g/day]	SIR	200	200	100	C
Oral Bioavailable Fraction - Lead, Chromium, and Iron [%]	BV_a	1	1	1	D
Oral Bioavailable Fractoion - Mercury [%]	BV_m	0.3	0.3	0.3	E
Oral Bioavailable Fractoion - Antimony [%]	BV_a	0.1	0.1	0.1	F
Conversion Factor	CF	0.000001	0.000001	0.000001	Converts contaminant mass from milligrams (mg) to kilograms (kg)
Drinking Water Ingestion Rate [2 L/day]	DIR	1		2	G
Conversion Factor for water	CF_{water}	0.001	0.001	0.001	Converts ug to mg
Inhalation Rate [m^3/day]	IR	8.3	14	20	A, H

A = EPA Child-specific exposure factors hanbook (Sections 7 and 11)

B = DEQ Deterministic HHRA Guidance, Appendix B

C = Estimate based on daily use during summer months

C= DEQ Risk Based Decision Making, Appendix C - Child and Adult

D = These fractions were assumed to be 100%

E = Mercury Toxicological Profile (ATSDR) - Not sure which form of mercury present so the upper end of the BV for mercury chloride was used

F = Antimony Toxicological Profile (ATSDR)

G = ATSDR Health Assessment Guidance Manual

H = EPA IRIS default inhalation rate

Table 6. COC Concentrations and Health Guidelines

Compounds	Soil & Sediment ppm		Groundwater ppb		Health Guidelines - non-cancer
	Mean	Maximum	Median	Maximum	MRL/RfD**
Chromium (mg/kg = ppm)					*note:
Chromium (Total)	n/a	91300*		ND	1.50
Metals (mg/kg = ppm)					
Antimony	14.5	112.0	-	-	4.00E-04
Iron	29563	101,000	-	-	3.00E-01
Lead	468.1	14600.0	-	-	No MRL or RfD
Mercury	9.3	118.0	-	-	7.00E-03

n/a = not applicable, no mean was calculated for total chromium measured by the XRF
ND = non - detect

Table 7. Exposure Dose Estimates

(only used assumptions for young children and adults in exposure calculations)

DOSE ESTIMATES - [mg/kg/day]	Mean		Maximum	
Residential, Non-Cancer				
Incidental Ingestion	**Young Child**	**Adult**	**Young Child**	**Adult**
Antimony	1.85E-05	1.98E-06	1.43E-04	1.53E-05
Chromium (Total), XRF	-	-	1.17E-06	1.25E-07
Iron	3.78E-01	4.05E-02	6.74E-01	7.22E-02
Lead	5.98E-03	6.41E-04	1.87E-01	2.00E-02
Mercury	3.57E-05	3.83E-06	4.53E-04	4.85E-05

"-" = not able to calculate because no mean value was available for the estimate

Table 8. Exposure Risk Calculations

RISK CALCULATIONS - HAZARD QUOTIENTS [unitless]	Mean		Maximum	
Residential, Non-Cancer				
Incidental Ingestion	**Young Child**	**Adult**	**Young Child**	**Adult**
Antimony	0.05	0.00	0.36	0.04
Chromium (Total)	-	-	0.00	0.00
Iron	**1.26**	0.13	**2.25**	0.24
Lead	no health guideline, action level = 400 ppm in soil			
Mercury	0.01	0.00	0.06	0.01

"-" = not calculated

$$\textbf{Incidental Ingestion Dose}_{\text{non-cancer}}\ \textbf{(mg/kg/day)} = \frac{C \times CF \times SIR \times EF \times ED \times BV}{BW \times AT_{nonc}}$$

Appendix B. ATSDR glossary of environmental health terms.

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and provides trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Additive Effect:	A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.
Bioavailability:	See **Relative Bioavailability**.
Cancer:	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
CERCLA:	See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See **Exposure Pathway**.
Comparison Value: **(CVs)**	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	**CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.
Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See **Environmental Contaminant**.
Delayed Health Effect:	A disease or injury that happens as a result of exposures that may have occurred far in the past.
Dermal Contact:	A chemical getting onto your skin. (see **Route of Exposure**).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Dose / Response:	The relationship between the amount of exposure (dose) and the change in body function or health that result.
Duration:	The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology:	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure:	Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Assessment:	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway:	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Receptor Population. When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.
Frequency:	How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.
Hazardous Waste:	Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) 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 can be exposed to chemicals from the site.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: **P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:
– Urgent Public Health Hazard
– Public Health Hazard
– Indeterminate Public Health Hazard
– No Apparent Public Health Hazard
– No Public Health Hazard

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.

Relative Bioavailability: The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
– breathing (also called inhalation),
– eating or drinking (also called ingestion), and
– getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

SARA: The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.

Sample Size: The number of people that are needed for a health study.

Sample: A small number of people chosen from a larger population (See **Population**).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard:	This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.