Public Health Assessment

Final Release

ATI WAH CHANG
(FORMERLY KNOWN AS TELEDYNE WAH CHANG)

MILLERSBERG, OREGON

EPA FACILITY ID: ORD050955848

Prepared by the
Oregon Department of Human Services

DECEMBER 2, 2009

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner 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's Cooperative Agreement Partner 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's Cooperative Agreement Partner 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'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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This is the final release of this document. The public comment period for this document extended from October 3, 2008 through November 3, 2008. Appendix A summarizes public comments received and describes how they were addressed in this final version of the report.

Foreword

The Environmental Health Assessment Program (EHAP) within the Oregon Public Health Division (PHD) has prepared this Public Health Assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services, Public Health Service. 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 disease related exposures to toxic substances. This Public Health Assessment was prepared in accordance with ATSDR methodology and guidelines.

An ATSDR Public Health Assessment reviews available information about hazardous substances at a site and evaluates whether exposure to them might cause any harm to people. ATSDR conducts a Public Health Assessment for every site on or proposed for the National Priorities List (the NPL, also known as the Superfund list). A Public Health Assessment is not the same thing as a medical exam or a community health study.

Another type of document produced by ATSDR is known as a Health Consultation. Health Consultations are similar to Public Health Assessments, but they usually are shorter and more limited in scope in that they address one specific question, contaminant or exposure pathway. Another difference between Health Consultations and Public Health Assessments is that Health Consultations usually do not go out for public comment.

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Summary

Introduction	At ATI Wah Chang, EHAP's purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent people from coming into contact with harmful toxic substances.
Overview	EHAP came to *seven* important conclusions about public health effects related to the ATI Wah Chang site.
Conclusion 1	Touching and drinking groundwater from under the Wah Chang plant ***will not*** harm people's health because no one is touching or drinking this groundwater.
Basis for Decision	There are no public or private wells tapping groundwater that is affected by the ATI Wah Chang plant.
Next Steps	None
Conclusion 2	Drinking and touching surface water inside the plant or in Murder and Truax Creek ***will not*** harm people's health because no one is touching or drinking this water.
Basis for Decision	These areas are inaccessible to the general public, either because of fencing and security within the Wah Chang plant itself or because of blackberries and other thick vegetation blocking the way to the water.
Next Steps	To protect public health, EHAP recommends that Wah Chang: • Continue to maintain perimeter fencing and security measures that prevent public access to areas within the Wah Chang plant. • Notify EHAP if Wah Chang operations are altered such that parts of the plant, Truax Creek, or Murder Creek become accessible to the general public.
Conclusion 3	Touching and swallowing soil from inside the Wah Chang plant ***will not*** harm people's health because no one from the general public is touching or swallowing this soil.
Basis for Decision	All areas within the plant are surrounded by fencing, and plant security makes access to the plant impossible for members of the general public.
Next Steps	To protect public health, EHAP recommends that Wah Chang: • Continue to maintain perimeter fencing and security measures that prevent public access to areas within the Wah Chang plant. • Notify EHAP if Wah Chang operations are altered such that parts of the plant, Truax Creek, or Murder Creek become accessible to the general public.
Conclusion 4	Touching or drinking the water from Second Lake is ***not*** expected to harm the health of adults or children who use Second Lake recreationally or as transients.
Basis for Decision	This is because concentrations of chemicals measured in the surface water of Second Lake are too low to harm people's health.

Next Steps	EHAP recommends that people not drink the water from Second Lake, even though measured chemical concentrations are too low to harm health. This is because the water is not treated and may contain non-site-related bacteria or algae that could cause disease.
Conclusion 5	Eating fish from Second Lake or water bodies immediately to the north in the early 1990s was ***not*** expected to harm people's health in the past or present.
Basis for Decision	This is because the concentrations of the contaminants measured in fish in 1991 were too low to harm the health of people who may have been eating them.
Next steps	None
Conclusion 6	Eating fish currently in Second Lake and water bodies immediately to the north is ***not*** expected to harm people's health.
Basis for Decision	This is because concentrations of contaminants in fish measured in 1991 were too low to harm people's health, and since that time, the sources of contaminants have been removed, so concentrations in fish are likely even lower than in 1991.
Next Steps	None
Conclusion 7	Touching or swallowing soil from the Soil Amendment Area north of the Wah Chang plant is ***not*** expected to harm people's health.
Basis for Decision	This is because the levels of radiological contamination measured in the soil are too low to harm people's health.
Next Steps	EHAP recommends that the City of Millersburg (current owner of the Soil Amendment Area) ensure that no buildings are erected in this area without proper radon mitigation systems or remediation of the soil.
For More Information	Contact EHAP at info.ehap@state.or.us, by phone at 1-877-290-6767, or by mail: EHAP 800 NE Oregon St. Suite 640 Portland, OR 97232

Purpose and Health Issues

EHAP prepared this PHA to examine contaminants that are present on and around the ATI Wah Chang plant, and determine whether or not they pose a human health risk. Based on information gathered during a site visit, EHAP confirmed that there is no public access to the Wah Chang plant itself, eliminating the possibility of the public coming into direct contact with contaminants inside of the plant's perimeter. The health and safety of current employees working on the site is under the purview of the Oregon Occupational Safety and Health Division (OR-OSHA), and is not addressed in this report.

EHAP also confirmed that Murder and Truax Creeks are inaccessible to the public, which eliminates the possibility of contact with contaminants located in those waters. Therefore, this report focuses on potential public health hazards associated with the use of two publicly accessible areas that could be affected by Wah Chang's industrial operations: 1- Second Lake, which receives groundwater discharge from Wah Chang, and 2- The Soil

Amendment area to the north of the site. Second Lake is technically part of a city-owned park and is accessible to the public. EHAP was most interested in examining whether people could come into contact with the surface water in Second Lake and whether or not fish, caught from Second Lake or possibly the water bodies just to the north (downstream), such as Third Lake or Conser Slough, contain contaminants from Wah Chang. The health risks for people coming into contact with the Soil Amendment Area would mainly be from breathing or swallowing small amounts of soil while walking on the site.

Background

Site Description and History

The Teledyne Wah Chang Albany site (TWCA) is located in Millersburg, Oregon, an industrial-based community 2 miles north of downtown Albany (Fig. 1). The site is approximately 20 miles south of Salem, 65 miles south of Portland, 60 miles east of the Pacific Ocean, and next to the Willamette River. Portions of the TWCA site are within the river's 100- and 500-year flood plains.

The TWCA plant is bounded on the east by Old Salem Road and Interstate 5 (I-5). The land east of the plant is used mainly for residential and commercial purposes. The land west of the Willamette River, which forms the western boundary of the plant, is used for agriculture. The land surrounding the Farm Ponds Area to the north of the Main Plant is also used for agricultural purposes (Fig. 2).

Albany had a population of 47,470 in July 2007. At that time, Millersburg had a population of about 700 people. The TWCA site is located within an area that is zoned for heavy industry. Industrial facilities closest to the TWCA site include a particle board plant, a resin plant, a wood flour processing plant, and a closed plywood mill.

The TWCA site covers 110-acres, known as the Main Plant, and 115-acres located 3/4 mile north of the Main Plant, called the Farm Ponds Area. The Main Plant is organized into an Extraction Area, a Fabrication Area, and a Solids Storage Area west of the Burlington Northern Railroad. The Farm Ponds Area contains the plant's wastewater treatment ponds, four 2- acre solids storage ponds, and the 50-acre Soil Amendment Area. The Soil Amendment Area has been primarily used in the past for agriculture.

Teledyne Wah Chang operations at the TWCA site began in 1956 under a contract with the U.S. Atomic Energy Commission. This is when Wah Chang Corporation reopened the U.S. Bureau of Mines’ Zirconium Metal Sponge Plant. Additional facilities were built at the location of the existing plant beginning in 1957. These facilities were established primarily for producing zirconium and hafnium metal sponge; however, tantalum and niobium pilot facilities were also included. Melting and fabrication operations were added in 1959. TWCA was established in 1967 after Teledyne Industries, Inc. purchased the Wah Chang Corporation of New York. In 1971, the plant became a separate corporation, Teledyne Wah Chang Albany.

Soil inside the plant's perimeter has historically been heavily contaminated with volatile organic compounds (VOCs), polynucleated aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chromium, thorium, zirconium, radium-226, and radium-228. Groundwater has been contaminated with VOCs, bis(2-ethylhexyl)phthalate, beryllium, copper, manganese, uranium, PCBs, radium-226, radium-228, ammonium, and fluoride. Semisolid sludges dumped in unlined areas of the plant were highly contaminated with arsenic, beryllium, bis(2-ethylhexyl)phthalate, cadmium, chromium VI, nickel, and VOCs[1].

Figure 1. Location of Millersburg within Western Oregon

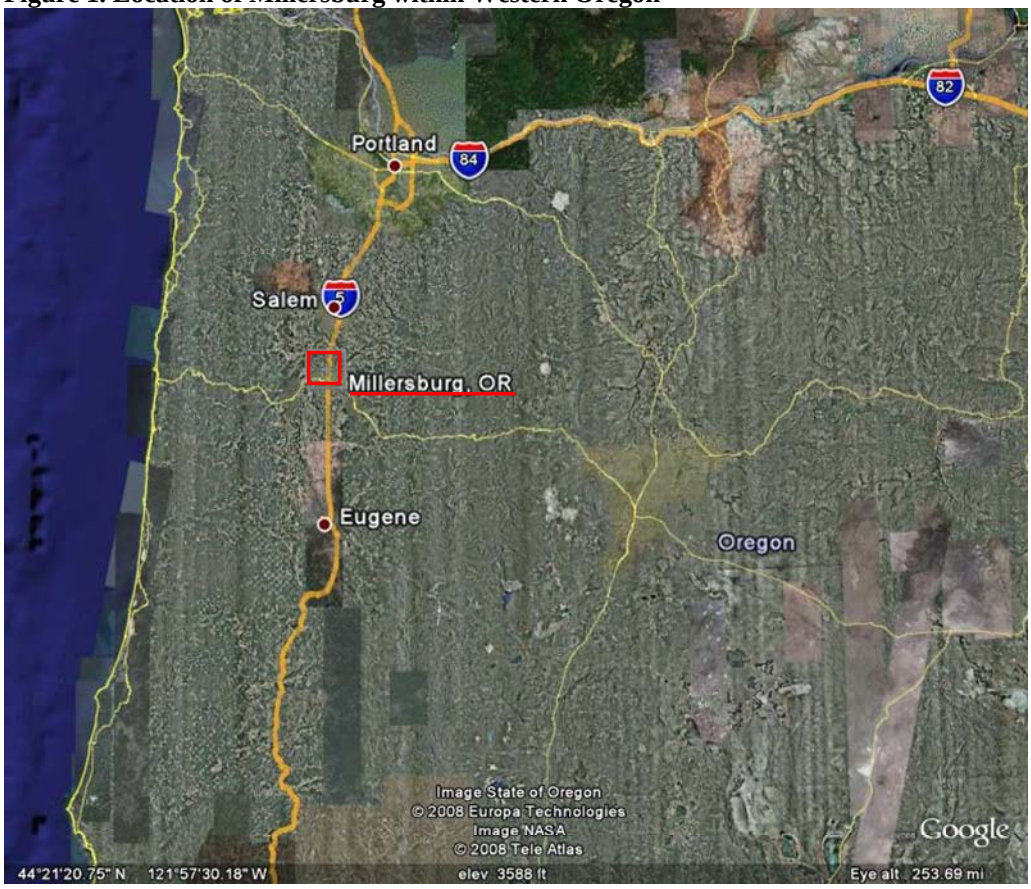
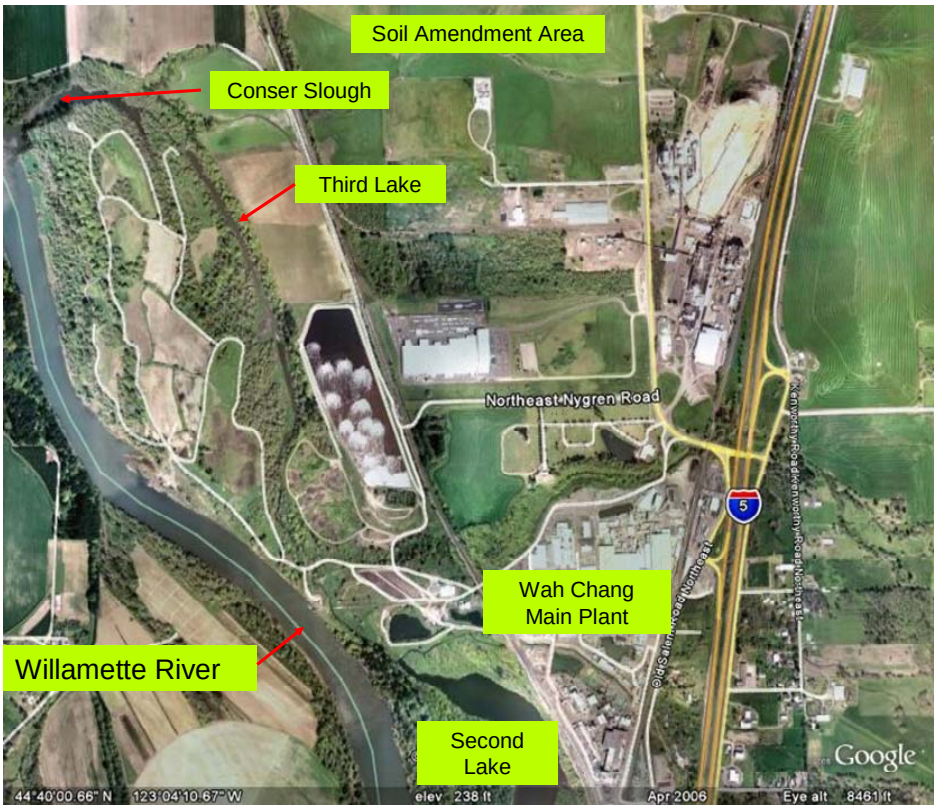


Figure 2. Wah Chang aerial including Farm Ponds and Soil Amendment areas



Site Investigations and Actions

Since Wah Chang was listed as a Federal Superfund Site in 1983, the U.S. Environmental Protection Agency (EPA) has implemented three major cleanup actions, which have removed contaminated surface soils and sludges from the site. EPA also installed and maintains permanent groundwater treatment pumps. In addition to these cleanup activities, EPA has implemented land covenants that ensure that all future uses of the plant area will be industrial[1]. Groundwater from the contaminated aquifer beneath Wah Chang is not being used as a drinking water source. All residences and public and private facilities are hooked up to the City of Albany's municipal drinking water supply.

Site visit

EHAP staff conducted a site visit on May 9th, 2008, in order to determine if and how the public could gain access to any potential contamination associated with Wah Chang. The historically contaminated areas of the Wah Chang plant are separated from the public by well maintained razor-wire-topped chain-link fences. The only access to the plant itself is through the visitor center from which point a visitor must be accompanied by a Wah Chang escort at all times. Murder and Truax Creeks run through the plant's property and have steep banks that are covered in thick vegetation, including blackberry bushes, after they leave the Wah Chang property.

The Wah Chang plant discharges groundwater into Second Lake (Fig. 3). Second Lake is a natural water body that is owned and operated by the City of Albany as part of a public recreation area called Simpson Park. As part of the site visit in May of 2008, EHAP staff hiked around Second Lake starting from a public access point in Simpson Park near the south end of First Lake, which is a narrow lake that flows north into Second Lake. Simpson Park includes a public boat-access point into First Lake (Fig. 4). It was apparent that a person in a light canoe or kayak could navigate the canal connecting First Lake to Second Lake. In fact, one Wah Chang employee reported accessing Second Lake from First Lake on a floater tube in order to fish for bass. This employee reported that Second Lake contains large quantities of large bass. EHAP staff followed a trail north from Simpson Park along the west banks of First and Second Lakes on a narrow strip of land separating these lakes from the Willamette River. Several side trails split off from the main trail leading to water access points in First and Second Lakes to the east and the Willamette River to the west. Areas near water access points on the west bank of Second Lake showed signs of frequent human use, including campfires (Fig. 5), garbage, and bank areas denuded of vegetation by foot traffic (Fig. 6). The east banks of Second Lake (the Wah Chang side) are steep and densely vegetated (Fig. 7). EHAP staff did not observe any way that humans could access Wah Chang from this side of the Lake.

Figure 3. Satellite image of Wah Chang plant

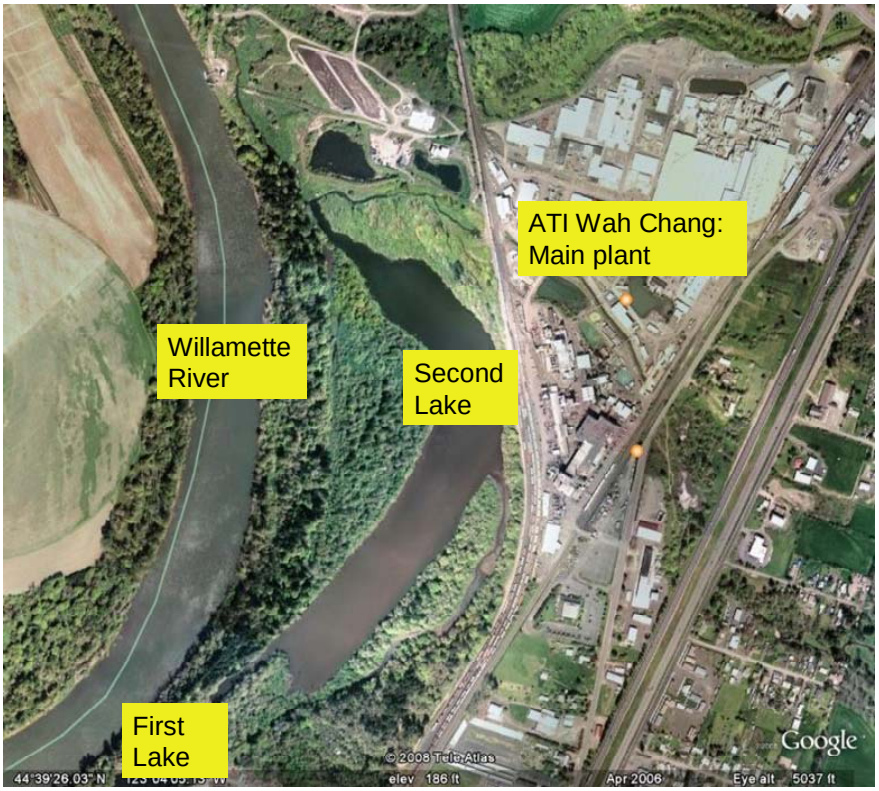


Figure 4. Public boat access to First Lake

Figure 5. Campfire and garbage on banks of Second Lake

Figure 6. Signs of human use on banks of Second Lake

Figure 7. East bank of Second Lake

Representatives of Wah Chang, local city and county officials, and local residents reported to EHAP staff that transient use of the park surrounding First and Second Lakes is a continuing problem. Recently, law enforcement officials had cleared out a large encampment of transients, many of whom had constructed semi-permanent structures in the park. EHAP staff did not observe any signs of current transient use of Second Lake during the site visit.

Community Concerns

Community concerns regarding Wah Chang have primarily come from current and former employees. Their concerns have centered around potential health effects resulting from past and current occupational exposure to contaminants on the work site. Wah Chang differs from many Superfund sites in that it is still in operation as an industrial facility. This places current occupational exposures within the purview of the Oregon Occupational Safety and Health Division (OR-OSHA) and are beyond the scope of this report.

Other community concerns related to the Wah Chang Superfund site include the question of whether or not eating fish caught from Second Lake poses a health risk. The South Extraction area of the Wah Chang plant discharges groundwater into Second Lake, which is also part of a city park and accessible to the general public.

Another community concern regarding Second Lake is use by transients. City, county, and Wah Chang officials all indicated that extensive transient camps have periodically sprung up in the park surrounding Second Lake. Transients may be using the lake in ways that other recreational users are not, and may come into contact with significantly greater amounts of contaminants. For example, transients may eat significantly more fish from the lake than a recreational angler. Transients may also use surface water from Second Lake for bathing, or as a primary drinking water source. EHAP has addressed transient use of Second Lake as a distinct exposure scenario in this report.

Discussion

The discussion includes a brief description of the environmental sampling conducted at the site, the selection of contaminants of concern, a toxicological review of the contaminants of concern, and an analysis of the ways in which humans could come into contact with the contaminants of concern. The discussion also includes estimates of how much contamination people may be coming into contact with, and compares these estimates to established health guidelines. This comparison allows EHAP to assess the health risks to the public. A summary of the health assessment process can be found in Appendix B.

Radiological contamination is a complex issue, and ATSDR addresses this type of contamination in a separate process from the chemical/toxicological health assessment process. Radiological contamination is the primary environmental health concern for the Soil Amendment Area. Therefore, the evaluation of potential health effects from exposure to historical radiological contamination in the Soil Amendment Area is discussed in a section that is separate from that of Second Lake Surface water contamination.

Environmental Sampling

Surface Water

Two surface water sampling stations at either end of Second Lake were used to collect surface water on September 1, 2006. Collected water samples were analyzed for VOCs, metals, and other ionic compounds associated with processes at Wah Chang (Table 1). Samples were collected and analyzed by Wah Chang under the oversight of the U.S. EPA. Wah Chang provided EHAP with the data. To be most protective of human health, the highest measured levels for each chemical from either of the two sampling locations were used for screening and health assessment purposes. When contaminants were not detected, the limit of detection (LD) was substituted for the measured value. It is important to note that LDs may not represent the actual concentration of a contaminant; it means that the contaminant concentration is somewhere between zero and the limit of detection. LDs are the actual limit of the equipment used to detect a contaminant. In Table 1, a “U” in the “Qualifier” column indicates that this value is an LD rather than an actual concentration.

Table 1. Summary of surface water sampling results and identification of contaminants of potential concern (COPC) from Second Lake

Chemical	Concentration (ppb)	Qualifier	CV (ppb)	CV Source	COPC
1,1,1-TRICHLOROETHANE	0.5	U	20,000	RMEG	No
1,1,2,2-TETRACHLOROETHANE	0.5	U	1	CREG	No
1,1,2-TRICHLOROETHANE	0.5	U	0.6	CREG	No
1,1-DICHLOROETHANE	0.5	U	810	Reg. 9 PRG	No
1,1-DICHLOROETHENE	0.5	U	90	EMEG	No
1,2,3-TRICHLOROBENZENE	0.5	U	100	RMEG for 1,2,4-Trichlorobenzene	No
1,2,4-TRICHLOROBENZENE	0.5	U	100	RMEG	No
1,2-DIBROMO-3-CHLOROPROPANE	0.5	U	20	EMEG	No
1,2-DICHLOROBENZENE	0.5	U	3,000	EMEG	No
1,2-DICHLOROETHANE	0.5	U	0.4	CREG	Yes
1,2-DICHLOROPROPANE	0.5	U	900	EMEG	No
1,3-DICHLOROBENZENE	0.5	U	200	EMEG	No
1,4-DICHLOROBENZENE	0.5	U	700	EMEG	No
AMMONIA [NH3]	2000		30,000	LTHA	No
ARSENIC [AS]	20	U	0.02	CREG	Yes
BROMOCHLOROMETHANE	0.5	U	90	LTHA	No
BROMOFORM	0.5	U	4	CREG	No
BROMOMETHANE	0.5	U	10	RMEG	No
CADMIUM [CD]	10	U	1	EMEG	Yes
CARBON TETRACHLORIDE	0.5	U	0.3	CREG	Yes
CHLOROBENZENE	0.5	U	200	RMEG	No
CHLOROETHANE	0.5	U	4.6	Reg. 9 PRG	No
CHLOROFORM	0.5	U	100	EMEG	No
CHLOROMETHANE	0.5	U	30	LTHA	No
CIS-1,2-DICHLOROETHENE	0.5	U	70	LTHA	No
CIS-1,3-DICHLOROPROPENE	0.5	U	0.4	CREG	Yes
DIBROMOCHLOROMETHANE	0.5	U	0.4	CREG	Yes
DICHLORODIFLUOROMETHANE	0.5	U	2000	RMEG	No
FLUORIDE [F]	1000	U	4000	MCL	No
HEXACHLOROBUTADIENE	0.5	U	0.4	CREG	Yes
IRON [FE]	5400		11000	Reg. 9 PRG	No
MANGANESE [MN]	470		300	LTHA	Yes
METHYLENE CHLORIDE	0.5	U	5	CREG	No
NICKEL [NI]	20	U	100	LTHA	No
TETRACHLOROETHENE	0.5	U	0.1	Reg. 6 RBC	Yes
TOTAL DISSOLVED SOLIDS [TDS]	1100000		NS		--
TRANS-1,2-DICHLOROETHENE	0.5	U	100	LTHA	No
TRANS-1,3-DICHLOROPROPENE	0.5	U	0.4	CREG	Yes
TRICHLOROETHENE	0.5	U	0.026	Reg. 6 PRG	Yes
TRICHLOROFLUOROMETHANE	0.5	U	2000	LTHA	No
VINYL CHLORIDE	0.5	U	0.03	CREG	Yes

"CV" = Comparison Value
"U" = Under detection limit - Detection limit presented instead of measured value
"NS" = No Standard available
"EMEG" = Environmental Media Evaluation Guide (ATSDR)
"CREG" = Cancer Risk Evaluation Guide (ATSDR)
"RMEG" = Reference Dose Media Evaluation Guide (ATSDR)
"MCL" = Maximum Contamination Level for drinking water (EPA)
"PRG" = Preliminary Remediation Goal (EPA) - vary by EPA region
"LTHA" = Lifetime Health Advisory for drinking water (EPA)
"RBC" = Risk Based Concentration (by EPA region)
Bold text indicates a contaminant of potential concern
"---" = Unknown

Fish Tissue

During a May 9th, 2008 site visit, EHAP staff learned that some people have eaten bass from Second Lake. Although unconfirmed in this location, transients near other water bodies in Oregon frequently eat large quantities of fish from local waters. While there are no current fish tissue data for Second Lake, in 1991 Wah Chang collected fish tissue samples and analyzed them for polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB).

PCBs and HCB are chemical compounds that are associated with historical operations at the Wah Chang plant. They were found in high concentrations in the sediment of Truax Creek in 1991 at the same time the fish tissue sampling took place. EHAP analyzed these data to find out whether people who ate fish from the area in the past could have been affected.

EHAP's analysis focused on fish tissue samples taken from species typically eaten by locals: catfish, bluegill, and bass. Wah Chang analyzed filets only when fish were big enough (the parts that people are most likely to eat). When fish were too small, the whole-body was analyzed (head, fins, guts, and all). All of the bluegill and bass caught from Second Lake were small, so these fish were analyzed as whole-body samples. Further, bluegill and bass were combined into single composite samples to get enough tissue for analysis. Only a few catfish were big enough to analyze filets only, and the smaller fish were analyzed as whole-body samples. While it is most likely that people eat the filets of the fish, it is possible that some fishers eat the whole bodies of smaller fish.

EHAP divided analysis of fish tissue data into the following groups: 1- Whole-body catfish (combined samples of catfish too small to filet), 2- Filet only catfish (combined samples of catfish large enough to filet), and 3- Bluegill/Bass (combined samples of whole-body bluegill and bass). EHAP then grouped these fish samples into two geographical collection areas: 1- All locations north of the dam separating Second Lake from Truax Creek (Truax Creek, Murder Creek, Third Lake, Conser Slough) (See Fig. 2), and 2- Burkhart Creek which empties into the south end of Second Lake and is upstream of the plant. The Burkhart Creek sampling location may be the most representative of the fish in Second Lake. Table 2 summarizes the fish tissue data collected by Wah Chang in 1991, which was analyzed by EHAP to evaluate past public health implications.

Table 2. Fish tissue data for PCBs (from 1991) for surface waters around Wah Chang plant

Location	Sample Type	Sample Number	Non-Detects	Minimum (mg/kg)	Maximum (mg/kg)	Location of Maximum	Mean (mg/kg)
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole body)	2	0	0.47	2.8	Truax Creek inside plant	---
	Catfish (filet only)	3	0	0.56	2.9	Truax Creek inside plant	2.09
	Bass/Bluegill (whole body)	4	0	0.31	1.6	Conser Slough	0.84
Burkhart Creek	Catfish (filet only)	1	0	0.47	0.47		---
	Bass/Bluegill (whole body)	1	0	0.38	0.38		---

"---" = Too few samples for mean. Only maximums were used to calculate dose in these cases
Note: Each sample was composite of 1-12 fish grouped by sampling location
mg/kg = Milligrams of contaminant per kilogram of fish tissue

Table 3. Fish tissue data for HCB (from 1991) for surface water around Wah Chang Plant

Location	Sample Type	Sample Number	Non-Detects	Minimum (mg/kg)	Maximum (mg/kg)	Location of Maximum	Mean (mg/kg)
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole body)	1	1	ND	<1.9	---	---
	Catfish (filet only)	3	1	ND	21	Truax Creek outside plant downstream	---
	Bass/Bluegill (whole body)	4	2	ND	10	Truax Creek outside plant downstream	---
Burkhart Creek	Catfish (filet only)	1	1	ND	<2.1	---	---
	Bass/Bluegill (whole body)	1	1	ND	<1.9	---	---

ND = Non-Detect. When only non-detects available for a sample group, no doses were calculated
"<" = Limit of detection for non-detect samples
"---" = Either all non-detects or not enough samples to calculate a mean
mg/kg = Milligrams of contaminant per kilogram of fish tissue

Identification of contaminants of potential concern (COPC)

EHAP has a standard way to determine whether or not a chemical poses a health concern, and involves a process approved by ATSDR. This screening process first identifies contaminants of "potential" concern (COPCs). The contaminant concentrations in water from Second Lake were compared against health-based environmental standards, also called comparison values (CVs). This process is outlined in Appendix B. Contaminants that measured higher than the CVs were COPCs (Table 1), and warranted a closer look. Since ATSDR does not have CVs for fish tissue data, EHAP automatically labeled the two contaminants tested in the fish (PCBs and HCB) as COPCs and examined them further in the next stages of analysis.

Most of the contaminants that were sampled for in the surface water of Second Lake were not detected at all. This is because they were either not there, or they were there in amounts so low that they couldn't be detected because the machines used to detect them do not measure that low (below the limit of detection). These are identified in Table 1 with a "U" in the qualifier column. In these cases, the number in the second column of Table 1 is the detection limit of the equipment instead of the actual concentration. The actual concentration for these contaminants is somewhere between zero and the detection limit. The detection limits for eleven contaminants that were not detected were higher than their CVs, so these contaminants were included as COPCs. Three metals (arsenic, cadmium, and manganese) fell into this category. In these cases, however, it is important to understand that the actual concentration of the contaminant may be much lower than the detection limit listed in the second column of Table 1, or these contaminants may not be present at all.

When the concentration or detection limit for a contaminant is higher than a CV, it does not mean that health problems will occur. It simply means the contaminant needs further evaluation. COPCs identified for surface water in Second Lake included several chlorinated organic compounds like 1,2-dichloroethane, carbon tetrachloride, cis- and trans-1,3-dichloropropene, hexachlorobutadiene, and tetra- and tri-chloroethene; heavy metals and metalloids like arsenic, cadmium, and manganese; and the poly-halogenated organic compound dibromochloromethane. All COPCs were advanced to the next phase of analysis as described in appendices B and C. This second phase was used to identify contaminants of concern (COCs). The results of this analysis are presented and explained in the next section.

Exposure Pathway Analysis

There are always five elements of what is called an "exposure pathway" that are evaluated to determine whether people are actually coming into contact with hazardous chemicals. If the criteria are met for all of the five elements, then the exposure pathway is considered "completed", which means that people are actually being exposed to a contaminant. If it is unknown whether any of the five elements are missing, the exposure pathway is considered "potential", which means that people might be exposed to a contaminant, but we don't know for sure. If we know for sure that any of the five elements are missing, then the exposure pathway is considered "eliminated", which means that people are not being exposed to the contaminant. The five elements for a completed exposure pathway are:

- A contaminant source or release
- A way for the chemical to move through the environment to a point of exposure
- Exposure point or area
- Route of exposure or a way for the contaminant to reach a population (eating, breathing, crossing through skin, etc.)
- A population that comes in contact with the contaminant

Completed Exposure Pathways

Surface water
Exposure to contaminants in the surface water of Second Lake is a completed exposure pathway. Industrial processes from Wah Chang are the source of contamination. Movement of contaminants through groundwater from Wah Chang into the surface water in Second Lake is how contaminants reach the lake, also called the "point of exposure". Contaminants in surface water at Second Lake could enter a person's body by either swallowing water and/or by absorbing it through the skin while swimming or otherwise having water-to-skin contact. Periodically, Second Lake has been heavily used by transients. It has not been confirmed that the surface water from Second Lake has been used as a drinking water source. However, to be most protective of human health it is best to assume that transients use, or have used, Second Lake as a drinking water source and bathing area. This assumption was used to justify a "worst case scenario" so that if the contamination posed no health risks for transient use, then it would not pose health risks for more typical recreational use.

Once chemicals were identified as COPCs, EHAP used measured concentrations or limits of detection for those chemicals to calculate estimated doses to individuals who may be exposed to surface water from Second Lake (Appendix C). Where estimates are based on detection limits, it may be that doses are much lower than estimated or that no exposure is occurring. These calculations were based on assumptions about the ways people might use the water (See Appendix C for complete list of assumptions), and calculated doses were compared against CVs that are known to be protective of human health.

Surface soil in the Soil Amendment Area
Coming into contact with radiological contaminants in the soil from the Soil Amendment Area is considered a completed exposure pathway because this area is accessible to the public. As mentioned previously, the health effects of radiological contaminants in this area will be discussed separately in its own section.

Potential Exposure Pathways

Fish consumption
During the site visit, EHAP learned that some residents do catch fish, especially bass, from Second Lake. EHAP also assumed that transients, who periodically inhabit the west bank of Second Lake, would most likely eat fish caught from the lake. Truax and Murder Creeks are not accessible to fishers because the banks of these water bodies are too overgrown and unreachable. However, Third Lake and Conser Slough are accessible from their west banks and via boat from the Willamette River. These water bodies are all connected, so fish in Truax or Murder Creeks could migrate into Third Lake or Conser Slough. No one has reported catching or eating fish from Third Lake or Conser Slough, but EHAP treated this as a potential exposure pathway for fish consumption because of the fish's potential migration.

EHAP used the fish tissue data collected in 1991 (Tables 2 and 3) to draw health conclusions for people who may have eaten fish from waters around Wah Chang in the past. There are no current fish tissue data, and currently, there is no way for contaminants from Wah Chang to migrate from the plant into Second Lake or water bodies to the north. There are no surface water bodies that connect the Wah Chang Plant with Second Lake. Since 1958, a stormwater runoff diversion system has channeled stormwater from all areas of the site into a stormwater treatment system that discharges (after treatment) into either Truax or Murder Creeks. Truax and Murder Creeks drain through Third Lake and Conser Slough into the Willamette River, not into Second Lake. Most of the groundwater from the Wah Chang plant discharges into Truax or Murder Creeks. Groundwater from the southern portion of the plant does discharge into Second Lake, however groundwater data from that portion of the plant did not indicate elevated levels of contaminants that concentrate in fish tissue (i.e., no detectable PCBs or HCB) [2]. Sediment data from Second Lake did not indicate any historical deposits of Wah Chang-related contaminants [2].

Eliminated Exposure Pathways

Soils and surface water inside the plant
Soil and surface water inside the operating Wah Chang plant are inaccessible to the general public. Fencing and other security barriers effectively prevent access by anyone not employed by Wah Chang. Therefore, there is no point of exposure for contaminants for the general public and this pathway has been eliminated for current and future exposures.

Surface Water in Murder and Truax Creeks
Murder and Truax Creeks run through the Wah Chang plant before joining with each other and flowing into the Willamette River. After passing through the plant, both of these creeks have steep banks with thick vegetation including the dense overgrowth of blackberries. EHAP staff determined these creeks are inaccessible to the general public until the point where they join the Willamette River. Therefore, exposure to surface water within these creeks is considered an eliminated exposure pathway.

Groundwater
All public and private buildings above the groundwater aquifer affected by Wah Chang are connected to municipal water for domestic purposes. The direction of groundwater flow in the area is toward the Willamette, and there are no residences between Wah Chang and the Willamette. Groundwater also moves north from Wah Chang into Murder Creek and south into Truax Creek which then flow west into the Willamette. Municipal water is available to any new developments that may be built above the affected aquifer. Therefore, direct exposure to contaminated groundwater from Wah Chang has been eliminated as an exposure pathway.

Public Health Implications by Exposure Scenarios

The discussion about public health implication of exposure to contaminants in the surface water of Second Lake and in fish tissue for past exposures is divided into sections based on exposure scenarios. Before the discussion about various exposure scenarios, however, it might be helpful to understand the process of determining non-cancer and cancer risk and the process for upgrading COPCs to actual contaminants of concern (COC) based on those calculated risks.

Identification of Contaminants of Concern (COC)

Non-cancer
Based on exposure pathway information compiled in the previous section, EHAP calculated estimated doses of COPCs for adult recreational users, children, and transient users (See Appendix C). Tables 4, 6, 8, 10, 12, 14, and 16 compared estimated doses of COPCs from contacting surface water in Second Lake or from eating fish caught from waters surrounding Wah Chang against health-guideline comparison doses for the same COPCs. The comparison dose is a dose below which no health effects would be expected to occur (cancer effects are examined separately). If the total estimated dose for a COPC was higher than the comparison dose, that COPC was upgraded to a COC. The total estimated dose was also divided by the comparison dose to produce a Hazard Quotient (HQ). A COPC with an HQ greater than 1 was upgraded to a COC. The sum of all the HQs is called the Hazard Index. A Hazard Index less than 1 indicated that the risk for any health effect other than cancer was very low.

It’s important to note that identifying a COC does not mean that we expect to see health effects. It simply means that the contaminant has been moved up to the final step of

evaluation. For more information about the dose estimate calculations or the COC identification process see Appendix C or D, respectively.

Cancer
Cancer risk is a theoretical term that attempts to forecast how many additional cancer cases out of a theoretical population would occur if everyone in that population received the same dose of the same chemical every day over their entire lifetimes. For example, a cancer risk of 1E-4 means that we would expect to see 1 additional case of cancer out of 10,000 people that were exposed every day for their entire lifetimes to the same chemical, at the same estimated dose. This is considered a low risk.

EHAP considers a cancer risk of 1E-5 or 1 additional case out of 100,000 to be a very low risk, and a cancer risk of 1E-6 or 1 additional case out of 1,000,000 to be an insignificant risk. In this report, when the total estimated dose of a COPC resulted in a cancer risk greater than 1E-4, then EHAP upgraded that COPC to a COC. Identification as a COC does not mean that increased cancer risk is expected, but that the COC was moved up to the final step of evaluation for a closer examination. For more information about the dose estimate calculations or the COC identification process see Appendix C or D, respectively.

When a COPC is considered carcinogenic, the total estimated dose for that contaminant is averaged over a 70 year lifetime. This adjusted dose is then multiplied by the Cancer Slope Factor (CSF) for that COPC. CSFs are designed to estimate the increased cancer risk for individuals based on their estimated dose of a specific contaminant. Tables 5, 7, 9, 11, 13, 15, and 17 show the adjusted total estimated doses for each of the different scenarios considered for Second Lake, along with their associated CSF and cancer risk for each of the carcinogenic COPCs found in the surface water of Second Lake or in the fish from the waters around Wah Chang. Some COPCs are not considered carcinogenic, and were not included in the cancer risk analysis.

Adult Recreational User

Surface Water
To calculate total estimated doses, EHAP conservatively assumed that an adult recreational user would swim in Second Lake for 1 hour/day on 128 days/year. EHAP did not see evidence that people routinely swim in Second Lake, but this assumption is very protective of public health because it includes a total body skin exposure. Therefore, any exposure to water less than full body immersion would indicate a health risk even less than that calculated here. It should also be noted that, for total estimated doses calculated from detection limits rather than from measured concentrations, it is possible that even a lower dose or no dose at all would be expected. No COCs were identified for adult recreational users for either non-cancer (Table 4) or cancer (Table 5) health effects. EHAP concluded that drinking and touching surface water in Second Lake is ***not*** expected to harm the health of adult recreational users.

Table 4. Non-cancer risk for adult recreational users from surface water in Second Lake

			Adults		
Contaminant of Potential Concern	Comparison Dose (mg/kg/day)	Source of Comparison Dose	Total Estimated Dose (mg/kg/day)	Hazard Quotient	Contaminant of Concern?
1,2-DICHLOROETHANE	2.0E-01	Intermediate MRL	3.3E-07	1.6E-06	No
ARSENIC [AS]	3.0E-04	Chronic MRL	7.0E-06	2.3E-02	No
CADMIUM [CD]	1.0E-04	Chronic MRL	3.5E-06	3.5E-02	No
CARBON TETRACHLORIDE	7.0E-04	Chronic RfD	9.0E-07	1.3E-03	No
CIS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	3.3E-07	1.1E-05	No
DIBROMOCHLOROMETHANE	9.0E-02	Chronic MRL	1.3E-07	1.4E-06	No
HEXACHLOROBUTADIENE	2.0E-04	Intermediate MRL	4.1E-06	2.0E-02	No
MANGANESE [MN]	5.0E-02	Chronic RfD	1.6E-04	3.3E-03	No
TETRACHLOROETHENE	1.0E-02	Chronic RfD	1.7E-06	1.7E-04	No
TRANS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	3.3E-07	1.1E-05	No
TRICHLOROETHENE	3.0E-04	Proposed Chronic RfD	7.1E-07	2.4E-03	No
VINYL CHLORIDE	3.0E-03	Chronic MRL	4.0E-07	1.3E-04	No
Hazard Index- Sum of hazard quotients for all contaminants				8.6E-02	No
Intermediate- Comparison dose developed based on exposures less than 1 year in duration					
Chronic- Comparison dose developed based on exposures 1 year or longer					
MRL- Minimal Risk Level- Dose at which no non-cancer health effects are expected (Developed by ATSDR)					
RfD- Reference Dose- Dose at which no non-cancer health effects are expected (Developed by EPA)					

Table 5. Cancer risk for adult recreational users from surface water in Second Lake

Contaminant of Potential Concern*	Cancer Slope Factor (1/(mg/kg/day))	Total Estimated Dose (mg/kg/day)	Cancer Risk	Contaminant of Concern?
1,2-DICHLOROETHANE	9.1E-02	1.4E-07	1.3E-08	No
ARSENIC [AS]	5.7E+00	3.0E-06	1.7E-05	No
CARBON TETRACHLORIDE	1.3E-01	3.9E-07	5.0E-08	No
CIS-1,3-DICHLOROPROPENE	1.0E-01	1.4E-07	1.4E-08	No
DIBROMOCHLOROMETHANE	8.4E-02	5.4E-08	4.5E-09	No
HEXACHLOROBUTADIENE	7.8E-02	1.7E-06	1.4E-07	No
TRANS-1,3-DICHLOROPROPENE	1.0E-01	1.4E-07	1.4E-08	No
TRICHLOROETHENE	4.0E-01	3.0E-07	1.2E-07	No
VINYL CHLORIDE	1.4E+00	1.7E-07	2.4E-07	No
*COPC list excludes cadmium, manganese, and tetrachloroethene which do not have cancer slope factors				

Fish Consumption – past exposure

EHAP used fish tissue data from 1991 to calculate total estimated doses and assess health risks for people who may have eaten fish from these waters in the early 1990's. EHAP conservatively assumed that an adult recreational angler would eat 17.5 g of fish per day (g/day). This translates into about two and a half 8-ounce meals of fish per month. Eight ounces of fish is about the size of a thin paperback book. EHAP calculated doses for recreational anglers who were fishing exclusively from Second Lake and Burkhart Creek, and doses for recreational anglers who were fishing exclusively from the water bodies north of Second Lake. Water bodies north of Second Lake include Truax Creek, Murder

Creek, Third Lake, and Conser Slough. The rationale is that fish could easily move between these water bodies[1], so an angler focused on Third Lake or Conser Slough could catch a fish that had been in any of the other 3 water bodies. However, fish from these northern water bodies were physically separated from those in Second Lake and Burkhart Creek because of a dam at the north end of Second Lake that was installed in the 1960's. The dam was later removed in the mid-1990s, so currently a fish could swim between all of the water bodies surrounding Wah Chang.[2] Detailed assumptions that EHAP used to calculate doses to recreational anglers from eating fish near Wah Chang in the past are in Appendix C.

Table 6 details the dose and risk calculations for non-cancer health effects for adult recreational anglers. PCBs and HCB were not considered contaminants of concern for adult recreational anglers when considering non-cancer health effects because none of the doses were higher than their MRL (comparison "safe" dose). EHAP does ***not*** expect that eating 2 and a half or less 8-ounce meals of fish from these waters would have harmed anyone's health in the past.

Table 6. Non-Cancer dose and risk to adult recreational anglers from eating fish (1991) from around Wah Chang

			Estimated Daily Dose (ng/kg/day)		MRL (ng/kg/day)	Hazard Quotient (Chronic)	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Chronic**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	1.9	20	---	0.096
		HCB	---	---	50	---	---
	Catfish (filet only)	Total PCBs	1.4	2.0	20	0.072	0.1
		HCB	---	14	50	---	0.29
	Bass/Bluegill (whole-body)	Total PCBs	0.58	1.1	20	0.029	0.055
		HCB	---	6.8	50	---	0.14
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	0.32	20	---	0.016
		HCB	---	---	50	---	---
	Bass/Bluegill (whole-body)	Total PCBs	---	0.26	20	---	0.013
		HCB	---	---	50	---	---

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data
ng/kg/day = nanograms (1 billionth of a gram) per kilogram body-weight per day

Table 7 details the calculated past cancer risk to adult recreational anglers who may have caught and eaten fish from waters surrounding Wah Chang in the early 1990's. None of the cancer risks for individual contaminants or total cancer risks were higher than 1E-04.

[1] Personal communication from Steven Mamoyac with the Oregon Department of Fish and Wildlife
[2] Personal communication from Lee Weber at Wah Chang

Therefore, neither PCBs nor HCB were upgraded to COCs for cancer risk and EHAP does not expect that adult recreational anglers eating 2 and a half or less 8-ounce meals of fish from these waters per month in the early 1990's will have an increased risk of cancer.

Table 7. Cancer dose and risk to adult recreational anglers from eating fish (1991) from around Wah Chang

			Estimated Cancer Daily Dose (mg/kg/day)			Cancer Risk	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Oral Cancer Slope Factor**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	8.2E-07	2	**---**	1.6E-06
		HCB	---	---	---	**---**	---
		Total Cancer Risk				**---**	**1.6E-06**
	Catfish (filet only)	Total PCBs	6.1E-07	8.5E-07	2	1.2E-06	1.7E-06
		HCB	---	6.2E-06	1.6	---	9.9E-06
		Total Cancer Risk				**1.2E-06**	**1.2E-05**
	Bass/Bluegill (whole-body)	Total PCBs	2.5E-07	4.7E-07	2	4.9E-07	9.4E-07
		HCB	---	2.9E-06	1.6	---	4.7E-06
		Total Cancer Risk				**4.9E-07**	**5.6E-06**
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	1.4E-07	2	---	2.8E-07
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**2.8E-07**
	Bass/Bluegill (whole-body)	Total PCBs	---	1.1E-07	2	---	2.2E-07
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**2.2E-07**

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data

Adult recreational anglers may bring their catches home to feed their families. Young children represent a particularly vulnerable population. Therefore, EHAP calculated dose and risk for non-cancer (Table 8) and cancer (Table 9) risks for children ages 1-6 who could have eaten fish that was brought home from the waters around Wah Chang during the early 1990's. Appendix C explains the assumptions used to calculate dose in more detail. EHAP assumed that young children of a recreational user could have eaten up to 7 g-fish/day which works out to two 3.7-ounce fish meals per month.

Table 8. Non-Cancer dose and risk to young children of recreational anglers from eating fish (1991) from around Wah Chang

			Estimated Daily Dose (ng/kg/day)		MRL (ng/kg/day)	Hazard Quotient (Chronic)	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Chronic**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	3.4	20	---	0.17
		HCB	---	---	50	---	---
	Catfish (filet only)	Total PCBs	2.5	3.5	20	0.13	0.17
		HCB	---	25	50	---	0.50
	Bass/Bluegill (whole-body)	Total PCBs	1.0	1.9	20	0.050	0.096
		HCB	---	12	50	---	0.24
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	0.56	20	---	0.028
		HCB	---	---	50	---	---
	Bass/Bluegill (whole-body)	Total PCBs	---	0.46	20	---	0.023
		HCB	---	---	50	---	---

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data
ng/kg/day = nanograms (1 billionth of a gram) per kilogram body-weight per day

Table 9. Cancer dose and risk to young children of recreational anglers from eating fish (1991) from around Wah Chang

			Estimated Cancer Daily Dose (mg/kg/day)			Cancer Risk	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Oral Cancer Slope Factor**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	2.9E-07	2	**---**	5.8E-07
		HCB	---	---	1.6	**---**	**---**
		Total Cancer Risk				**---**	**5.8E-07**
	Catfish (filet only)	Total PCBs	2.1E-07	3.0E-07	2	4.3E-07	6.0E-07
		HCB	---	2.2E-06	1.6	---	3.5E-06
		Total Cancer Risk				**4.3E-07**	**4.0E-06**
	Bass/Bluegill (whole-body)	Total PCBs	8.6E-08	1.6E-07	2	1.7E-07	3.3E-07
		HCB	---	1.0E-06	1.6	---	1.6E-06
		Total Cancer Risk				**1.7E-07**	**2.0E-06**
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	4.8E-08	2	---	9.7E-08
		HCB	---	---	1.6	**---**	**---**
		Total Cancer Risk				**---**	**9.7E-08**
	Bass/Bluegill (whole-body)	Total PCBs	---	3.9E-08	2	---	7.8E-08
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**7.8E-08**

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data

PCBs and HCB were not considered contaminants of concern for young children of recreational anglers (ages 1-6 years) because calculated doses of these contaminants were below their MRLs and because none of the cancer risks were higher than 1E-4. EHAP does not expect young children who ate two or less 3.7-ounce meals of fish from these waters per month in the early 1990's will have an increased risk of cancer.

Fish Consumption – current exposure

Since the time of fish sampling in 1991, the sources of PCBs and HCB in the sediment of Truax Creek have been remediated, and there is no longer a completed pathway for PCBs or HCB to move from the Wah Chang plant into the fish around the plant. Concentrations of PCBs and HCB in fish would have decreased over time because of clean-up activities that have occurred at the site. Based on this, and on present day surface water sampling,

EHAP concludes that eating fish currently in waters surrounding Wah Chang would not harm the health of children or adults.

Child Recreational User

Surface water
EHAP assumed that Second Lake is largely inaccessible to children younger than 12, unless supervised by an adult because it is a fairly long walk from the more accessible areas around First Lake. However, Second Lake is entirely within reach of youth between the ages of 12-18. For recreational use dose calculations, EHAP assumed that children would swim for an hour a day, 128 days a year, and were divided by age group into children aged 12-15 years, and those aged 15-18. The complete list of assumptions can be found in appendix C.

No COCs were identified for either cancer or non-cancer health effects for children in either age group (see tables 10 and 11). EHAP concludes that touching and drinking the water in Second Lake is ***not*** expected to harm the health of children.

Table 10. Non-cancer risk for children from surface water in Second Lake

			Child 12-15			Child 15-18		
Contaminant of Potential Concern	Comparison Dose (mg/kg/day)	Source of Comparison Dose	Total Estimated Dose (mg/kg/day)	Hazard Quotient	Contaminant of Concern?	Total Estimated Dose (mg/kg/day)	Hazard Quotient	Contaminant of Concern?
1,2-DICHLOROETHANE	2.0E-01	Intermediate MRL	3.5E-07	1.8E-06	No	3.5E-07	1.8E-06	No
ARSENIC [AS]	3.0E-04	Chronic MRL	7.7E-06	2.6E-02	No	7.7E-06	2.6E-02	No
CADMIUM [CD]	1.0E-04	Chronic MRL	3.8E-06	3.8E-02	No	3.8E-06	3.8E-02	No
CARBON TETRACHLORIDE	7.0E-04	Chronic RfD	9.4E-07	1.3E-03	No	9.4E-07	1.3E-03	No
CIS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	3.6E-07	1.2E-05	No	3.6E-07	1.2E-05	No
DIBROMOCHLOROMETHANE	9.0E-02	Chronic MRL	1.4E-07	1.6E-06	No	1.4E-07	1.6E-06	No
HEXACHLOROBUTADIENE	2.0E-04	Intermediate MRL	4.2E-06	2.1E-02	No	4.2E-06	2.1E-02	No
MANGANESE [MN]	5.0E-02	Chronic RfD	1.8E-04	3.6E-03	No	1.8E-04	3.6E-03	No
TETRACHLOROETHENE	1.0E-02	Chronic RfD	1.8E-06	1.8E-04	No	1.8E-06	1.8E-04	No
TRANS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	3.6E-07	1.2E-05	No	3.6E-07	1.2E-05	No
TRICHLOROETHENE	3.0E-04	Proposed Chronic RfD	7.4E-07	2.5E-03	No	7.4E-07	2.5E-03	No
VINYL CHLORIDE	3.0E-03	Chronic MRL	4.2E-07	1.4E-04	No	4.2E-07	1.4E-04	No
Hazard Index- Sum of hazard quotients for all contaminants				9.3E-02	No		9.3E-02	No
Intermediate- Comparison dose developed based on exposures less than 1 year in duration								
Chronic- Comparison dose developed based on exposures 1 year or longer								
MRL- Minimal Risk Level- Dose at which no non-cancer health effects are expected (Developed by ATSDR)								
RfD- Reference Dose- Dose at which no non-cancer health effects are expected (Developed by EPA)								

Table 11. Cancer risk for children from surface water in Second Lake

		Children 12-15			Children 15-18		
Contaminant of Potential Concern*	Cancer Slope Factor (1/(mg/kg/day))	Total Estimated Dose (mg/kg/day)	Cancer Risk	Contaminant of Concern?	Total Estimated Dose (mg/kg/day)	Cancer Risk	Contaminant of Concern?
1,2-DICHLOROETHANE	9.1E-02	1.5E-08	1.4E-09	No	1.5E-08	1.4E-09	No
ARSENIC [AS]	5.7E+00	3.3E-07	1.9E-06	No	3.3E-07	1.9E-06	No
CARBON TETRACHLORIDE	1.3E-01	4.0E-08	5.2E-09	No	4.0E-08	5.2E-09	No
CIS-1,3-DICHLOROPROPENE	1.0E-01	1.5E-08	1.5E-09	No	1.5E-08	1.5E-09	No
DIBROMOCHLOROMETHANE	8.4E-02	6.1E-09	5.1E-10	No	6.1E-09	5.1E-10	No
HEXACHLOROBUTADIENE	7.8E-02	1.8E-07	1.4E-08	No	1.8E-07	1.4E-08	No
TRANS-1,3-DICHLOROPROPENE	1.0E-01	1.5E-08	1.5E-09	No	1.5E-08	1.5E-09	No
TRICHLOROETHENE	4.0E-01	3.2E-08	1.3E-08	No	3.2E-08	1.3E-08	No
VINYL CHLORIDE	1.4E+00	1.8E-08	2.5E-08	No	1.8E-08	2.5E-08	No
*COPC list excludes cadmium, manganese, and tetrachloroethene which do not have cancer slope factors							

Fish Consumption

EHAP assumed children aged 12-18 who might eat the fish from Second Lake would follow the same pattern as adult recreational fishers, and EHAP believes their risks are adequately addressed in the adult recreational angler and transient user scenarios above and below.

Transient Users

Surface Water

EHAP assumed that transient users might use the water from Second Lake as a source of drinking water and might also bathe and/or swim in the water. For purposes of calculating doses of contaminants for these individuals, EHAP assumed that transients would drink and bathe/swim in the water every day for one year. The most likely scenario is that transients, by nature, move from place to place and would not stay in this area for longer than a year. The complete list of assumptions used to calculate doses can be found in Appendix C.

Arsenic was identified as a COC for non-cancer health effects for transient users (Table 12). For non-cancer health effects, the estimated dose of arsenic was only slightly higher than its comparison dose. However, arsenic was not actually detected in Second Lake, so doses were estimated based on limits of detection. This means that the actual concentration and dose is probably less than that shown here. EHAP does not expect any non-cancer health effects from arsenic for transient users.

Table 12. Non-cancer risk for transient users from surface water in Second Lake

			Transient User		
Contaminant of Potential Concern	Comparison Dose (mg/kg/day)	Source of Comparison Dose	Total Estimated Dose (mg/kg/day)	Hazard Quotient	Contaminant of Concern?
1,2-DICHLOROETHANE	2.0E-01	Intermediate MRL	1.5E-05	7.4E-05	No
ARSENIC [AS]	3.0E-04	Chronic MRL	5.8E-04	1.9E+00	Yes
CADMIUM [CD]	5.0E-04	Intermediate MRL	2.9E-04	5.8E-01	No
CARBON TETRACHLORIDE	7.0E-04	Chronic RfD	1.7E-05	2.4E-02	No
CIS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	1.5E-05	5.0E-04	No
DIBROMOCHLOROMETHANE	9.0E-02	Chronic MRL	1.4E-05	1.6E-04	No
HEXACHLOROBUTADIENE	2.0E-04	Intermediate MRL	2.6E-05	1.3E-01	No
MANGANESE [MN]	5.0E-02	Chronic RfD	1.4E-02	2.7E-01	No
TETRACHLOROETHENE	1.0E-02	Chronic RfD	1.9E-05	1.9E-03	No
TRANS-1,3-DICHLOROPROPENE	3.0E-02	Chronic MRL	1.5E-05	5.0E-04	No
TRICHLOROETHENE	3.0E-04	Proposed Chronic RfD	1.6E-05	5.3E-02	No
VINYL CHLORIDE	3.0E-03	Chronic MRL	1.5E-05	5.0E-03	No
Hazard Index- Sum of hazard quotients for all contaminants				3.0E+00	Yes
Intermediate- Comparison dose developed based on exposures less than 1 year in duration					
Chronic- Comparison dose developed based on exposures 1 year or longer					
MRL- Minimal Risk Level- Dose at which no non-cancer health effects are expected (Developed by ATSDR)					
RfD- Reference Dose- Dose at which no non-cancer health effects are expected (Developed by EPA)					

There were no COCs identified as a cancer risk for transient users at Second Lake (Table 13). Cadmium is listed as a carcinogen, but no cancer slope factor has been established to calculate cancer risk for cadmium. Further, the only cancers associated with cadmium in the literature are associated with inhalation of cadmium in the air. Swallowing cadmium in water is not expected to increase the risk of cancer [3]. Therefore, EHAP concludes that touching and drinking the water in Second Lake is not expected to harm the health of transient users.

Table 13. Cancer risk for transient users from surface water in Second Lake

Contaminant of Potential Concern*	Cancer Slope Factor (1/(mg/kg/day))	Total Estimate Dose (mg/kg/day)	Cancer Risk	Contaminant of Concern?
1,2-DICHLOROETHANE	9.1E-02	2.1E-07	1.9E-08	No
ARSENIC [AS]	5.7E+00	8.2E-06	4.7E-05	No
CARBON TETRACHLORIDE	1.3E-01	2.4E-07	3.1E-08	No
CIS-1,3-DICHLOROPROPENE	1.0E-01	2.1E-07	2.1E-08	No
DIBROMOCHLOROMETHANE	8.4E-02	2.0E-07	1.7E-08	No
HEXACHLOROBUTADIENE	7.8E-02	3.6E-07	2.8E-08	No
TRANS-1,3-DICHLOROPROPENE	1.0E-01	2.1E-07	2.1E-08	No
TRICHLOROETHENE	4.0E-01	2.3E-07	9.1E-08	No
VINYL CHLORIDE	1.4E+00	2.2E-07	3.0E-07	No
*COPC list excludes cadmium, manganese, and tetrachloroethene which do not have cancer slope factors				

Fish Consumption – past exposure

Eating fish from Second Lake is considered the most significant way that transient users could come into contact with contamination from Wah Chang's industrial pollutants. This is both because transients are more likely to eat larger amounts of fish and because they are more likely to eat non-standard parts of fish such as internal organs and skin. Young children (ages 1-6 years) living among transients would be particularly vulnerable.

Fish tissue data from 1991 allowed EHAP to calculate doses of PCBs and HCB to transients and their families who may have been eating fish from affected waters at that time. For transient users, EHAP used Oregon DEQ's subsistence fish intake rate which is 175 g/day for adults and 73.5 g/day for children (1-6 years of age). This works out to be twenty-three 8-ounce meals of fish per month for adults and twenty-three 3-ounce meals of fish per month for children (1-6 years of age).

Doses and health risks for transient adults (Tables 14-15) and children (Tables 16-17) from eating fish caught out of waters surrounding Wah Chang are shown below. Tables 14 and 16 show non-cancer doses and risks, while tables 15 and 17 show cancer doses and risks. Appendix C describes the assumptions and formulas used to calculate dose and Appendix D describes the methods and formulas used to calculate risk.

Table 14. Non-Cancer dose and risk to adult transients from eating fish (1991) from around Wah Chang

			Estimated Daily Dose (ng/kg/day)		MRL (ng/kg/day)	Hazard Quotient (Intermediate)	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Intermediate**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	19	30	---	0.64
		HCB	---	---	100	---	---
	Catfish (filet only)	Total PCBs	14	20	30	0.48	0.66
		HCB	**---**	**140**	**100**	**---**	**1.4**
	Bass/Bluegill (whole-body)	Total PCBs	5.8	11	30	0.191	0.37
		HCB	---	68	100	---	0.68
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	3.2	30	---	0.11
		HCB	---	---	100	---	---
	Bass/Bluegill (whole-body)	Total PCBs	---	2.6	30	---	0.087
		HCB	---	---	100	**---**	**---**

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data
ng/kg/day = nanograms (1 billionth of a gram) per kilogram body-weight per day

As shown in Table 14, the HQ for the adult transient HCB dose from eating catfish filets from Truax Creek, Murder Creek, Third Lake, or Conser Slough in the early 1990's is greater than 1. This made HCB a COC for adult transients who ate fish from those water bodies around Wah Chang north of Second Lake. However, the estimated daily dose (140 ng/kg/day) is still 71 times lower than any dose that has been shown to cause health effects (10000 ng/kg/day) in monkeys dosed with HCB over a 90 day period [4-6]. Based on this evidence, EHAP concludes that eating fish from around Wah Chang in the early 1990's would not have significantly increased the risk for any non-cancer health problems.

Table 15 describes the cancer risk to adult transient users, who may have eaten fish from around Wah Chang in the early 1990's. None of the cancer risks were greater than 1 in 10,000 (1E-4), so EHAP does not expect that eating fish from around Wah Chang would have significantly increased the cancer risk for adult transient users in the early 1990's. Overall, EHAP concludes that eating fish from around Wah Chang was ***not*** expected to harm the health of adult transient users in the early 1990's.

Table 15. Cancer dose and risk to adult transients from eating fish (1991) from around Wah Chang

			Estimated Cancer Daily Dose (mg/kg/day)			Cancer Risk	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Oral Cancer Slope Factor**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	2.7E-07	2	---	5.5E-07
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**5.5E-07**
	Catfish (filet only)	Total PCBs	2.0E-07	2.8E-07	2	4.1E-07	5.7E-07
		HCB	---	2.1E-06	1.6	---	3.3E-06
		Total Cancer Risk				**4.1E-07**	**3.9E-06**
	Bass/Bluegill (whole-body)	Total PCBs	8.2E-08	1.6E-07	2	1.6E-07	3.1E-07
		HCB	---	9.8E-07	1.6	---	1.6E-06
		Total Cancer Risk				**1.6E-07**	**1.9E-06**
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	4.6E-08	2	---	9.2E-08
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**9.2E-08**
	Bass/Bluegill (whole-body)	Total PCBs	---	3.7E-08	2	---	7.4E-08
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**7.4E-08**

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data

Because all young children (ages 1-6) eat more food per body size than adults, and because young bodies are still developing, children are especially vulnerable to chemical contaminants in their environment. Young children of transients that may have eaten fish from the Wah Chang area in the early 1990s are of particular concern to EHAP. Table 16 indicates that the HQs for these children were greater than 1 for PCBs and HCB from fish caught out of the northern water bodies around Wah Chang. However, the HQ's for PCBs (1.2 and 1.3) are still well within the margin of safety, so no non-cancer health problems would be expected from PCBs, for children of transients in the early 1990's. The HQ for HCB found in catfish filets (2.6) raises HCB to being a contaminant of concern (COC) for young children of transients. However, the estimated dose of HBC (260 ng/kg/day) is still 38 times lower than any dose (10000 ng/kg/day) that has been shown to cause health effects in monkeys who had been dosed with HCB over a 90 day period [4-6]. Therefore,

EHAP does not expect that children of transient users eating fish from around Wah Chang in the early 1990's would be at increased risk for non-cancer health problems.

Table 16. Non-Cancer dose and risk to young children of transients who may have eaten fish from around Wah Chang (1991)

			Estimated Daily Dose (ng/kg/day)		MRL (ng/kg/day)	Hazard Quotient (Intermediate)	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Intermediate**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	35	30	---	**1.2**
		HCB	---	---	100	---	**---**
	Catfish (filet only)	Total PCBs	26	37	30	0.88	**1.2**
		HCB	---	260	100	---	**2.6**
	Bass/Bluegill (whole-body)	Total PCBs	11	20	30	0.35	0.67
		HCB	---	130	100	---	**1.3**
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	5.9	30	---	0.2
		HCB	---	---	100	---	---
	Bass/Bluegill (whole-body)	Total PCBs	---	4.8	30	---	0.16
		HCB	---	---	100	---	---

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data
ng/kg/day = nanograms (1 billionth of a gram) per kilogram body-weight per day

Table 17 indicates that estimated cancer risk for young children of transient users never exceeded 1 in 10,000 (1E-4), so EHAP does not expect that children of transient users who ate fish from around Wah Chang in the early 1990's are at any increased risk for developing cancer. Overall, EHAP concludes that eating fish from around Wah Chang in the early 1990's was not expected to harm the health of young children of transient users.

Table 17. Cancer dose and risk to young children of transients who may have eaten fish from around Wah Chang (1991)

			Estimated Cancer Daily Dose (mg/kg/day)			Cancer Risk	
Location	**Species**	**Contaminant**	**Average**	**Maximum**	**Oral Cancer Slope Factor**	**Average**	**Maximum**
Truax Creek, Murder Creek, Third Lake, Conser Slough	Catfish (whole-body)	Total PCBs	---	5.0E-07	2	---	1.0E-06
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**1.0E-06**
	Catfish (filet only)	Total PCBs	3.8E-07	5.2E-07	2	7.5E-07	1.0E-06
		HCB	---	3.8E-06	1.6	---	6.0E-06
		Total Cancer Risk				**7.5E-07**	**7.1E-06**
	Bass/Bluegill (whole-body)	Total PCBs	1.5E-07	2.9E-07	2	3.0E-07	5.8E-07
		HCB	---	1.8E-06	1.6	---	2.9E-06
		Total Cancer Risk				**3.0E-07**	**3.5E-06**
Burkhart Creek (Second Lake)	Catfish (filet only)	Total PCBs	---	8.5E-08	2	---	1.7E-07
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**1.7E-07**
	Bass/Bluegill (whole-body)	Total PCBs	---	6.8E-08	2	---	1.4E-07
		HCB	---	---	1.6	---	---
		Total Cancer Risk				**---**	**1.4E-07**

Note: Numbers rounded to 2 significant digits. Complete numbers were used in calculations.
"---" = Insufficient data

Fish Consumption – current exposure
Since the time of fish sampling in 1991, the sources of PCBs and HCB in the sediment of Truax Creek have been remediated, and there is no longer a completed pathway for PCBs or HCB to get from the Wah Chang plant into the fish around the plant. Concentrations of PCBs and HCB in fish would therefore have decreased over time. EHAP does not expect that eating fish that are currently in the waters surrounding Wah Chang would harm people's health.

Soil Amendment Area

The Soil Amendments Area (SAA) received soils from Wah Chang as an agricultural enhancement. Upon later investigation, these soils were found to be contaminated with

radium-226. Radium-226 is a naturally occurring radioactive decay product arising from uranium-238. During the radium decay, alpha particles, gamma radiation, and radon-222 gas are emitted. The alpha particle is almost immediately absorbed by the surrounding soil particles, but the gamma radiation is highly penetrating. The radon gas is radioactive and inert dissipating in the atmosphere while undergoing decay.

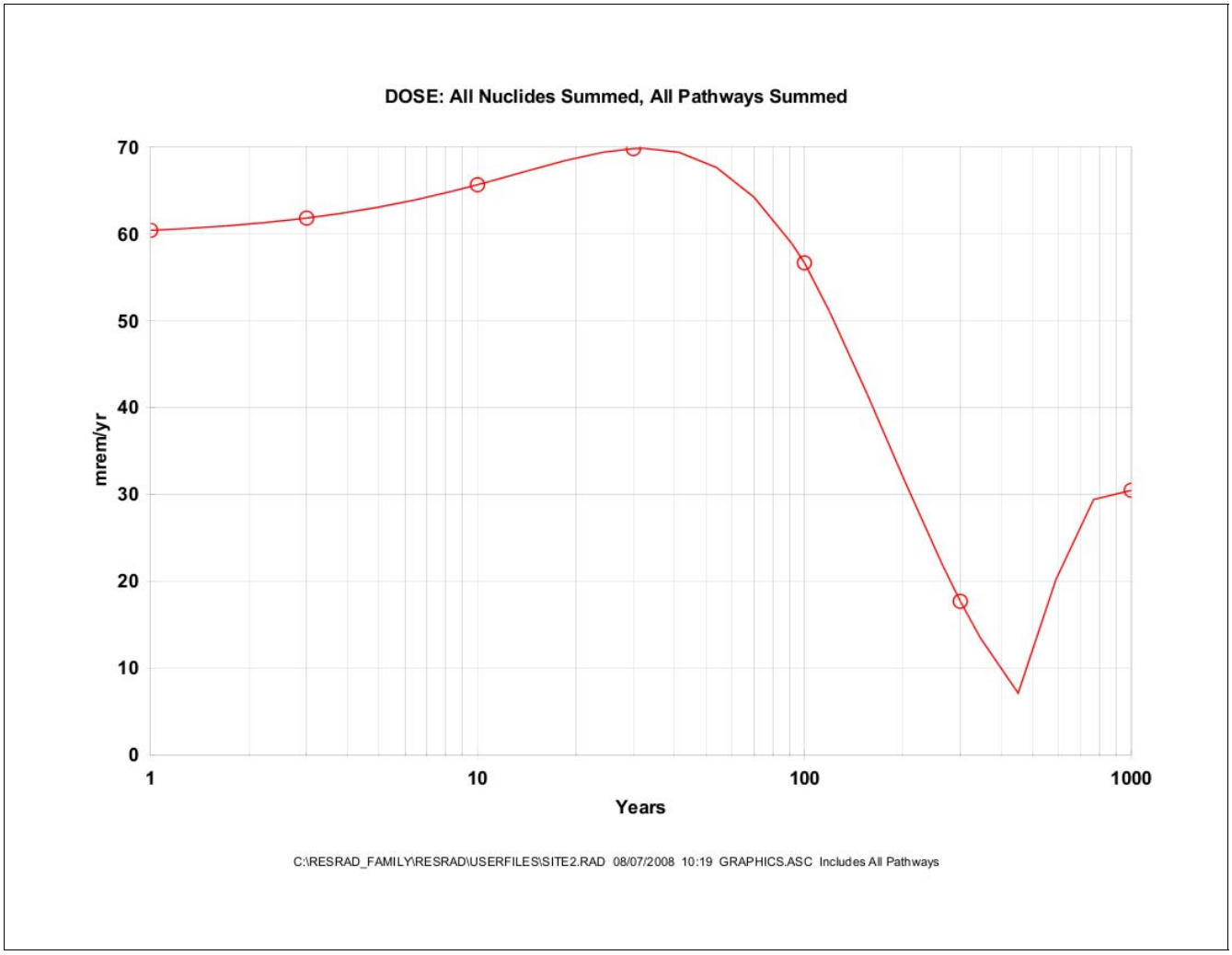
EPA analyzed radium concentrations and conducted gamma radiation surveys at Wah Chang in 1995. ATSDR uses an average value of 5 picocuries per gram (pCi/g) above background levels as its health-based standard for radium contamination in soils. In the SAA, the maximum radium concentration reported was 8 pCi/g and the average was about 5 pCi/g. Because measured concentrations of radium in the SAA did not exceed the health-based standard, radium in soil in the SAA is ***not*** expected to harm people's health.

ATSDR's standard for gamma radiation is set at 20 microroentgens per hour (μR/h) above background levels. The background gamma radiation exposure level near the SAA is about 12.5 μR/h. Of the approximately 190 gamma measurements taken in this area, the maximum exposure rate measured in the SAA was about 27 μR/h, including background. This means that the average rate at which people are exposed to gamma radiation in the SAA is less than 16 μR/h, inclusive of background levels. This does not exceed ATSDR's health-based standards, and EHAP concludes that gamma radiation in the SAA is ***not*** expected to harm people's health.

The ATSDR standard for radium in soil, derived from existing federal regulations (40 CFR 192) is 5 pCi/g, and is thought to limit the release of gaseous radon-222 into the atmosphere as to not exceed a release limit of 20 pCi per square meter of ground per second. This is important because radon gas above this level could cause health problems for people who breathe it (lung cancer). Therefore, under current land use conditions, radon gas in the SAA is ***not*** expected to harm people's health.

In addition to standards for radium concentrations in soil and gamma radiation levels, ATSDR also has a health-based standard (Minimal Risk Level [MRL]) for total ionizing radiation dose. This MRL is 100 millirem per year[7]. ATSDR used the ResRad computer model to estimate the potential total ionizing radiation dose from radium at the concentrations measured in the SAA. According to the model, the annual ionizing radiation dose arising from all pathways combined in the SAA would be less than the ATSDR MRL of 100 millirem/year (Figure 8). Therefore, ionizing radiation in the SAA is ***not*** expected to harm people's health.

Figure 8. ResRad results for 5 pCi/g in soils, all pathways combined.



Evaluation of Health Outcome Data

Health outcome data are existing data that measure disease mortality or morbidity or other health effects that could have resulted from exposure to site contaminants. Health outcome data analyses or reviews are descriptive epidemiologic analyses. In the case of ATI Wah Chang, EHAP is unaware of any community members that are experiencing any health effects from exposure to contaminants from the plant. Therefore, there is no available health outcome data to evaluate relative to this site.

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 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 Second Lake where their behaviors or sensitivity to contaminants could put them at greater risk. Because access to the Wah Chang plant is restricted to the public and access to Second Lake requires a walk of a mile or more, EHAP assumed that children under the age of 12 would not come into contact with contaminants from Wah Chang's industrial pollution in the water. Children 12-18 were evaluated separately as to their exposures and susceptibilities as described in the Discussion section. If a child younger than 12 accesses Second Lake, EHAP assumed that they would be accompanied by an adult and their activities monitored. The only exception to this assumption centers around eating fish caught from around Wah Chang and brought home to the child by a parent. EHAP thoroughly addressed this exposure pathway for young children in the Discussion section under the recreational user and transient user exposure scenarios. EHAP believes that the measures and assumptions outlined in this report protect children.

Conclusions

EHAP came to seven important conclusions about public health effects related to the ATI Wah Chang site.

Touching and drinking groundwater from under the Wah Chang plant ***will not*** *harm people's health because no one is touching or drinking this groundwater.* This is because there are no public or private wells tapping groundwater that is affected by the ATI Wah Chang plant.

Drinking and touching surface water inside the plant or in Murder and Truax Creek ***will not*** *harm people's health because no one is touching or drinking this water.* These areas are inaccessible to the general public, either because of fencing and security within the Wah Chang plant itself or because of blackberries and other thick vegetation blocking the way to the water. The health of Wah Chang employees is under the purview of Oregon Occupational Safety and Health Division.

Touching and swallowing soil from inside the Wah Chang plant ***will not*** *harm people's health because no one from the general public is touching or swallowing this soil.* All areas within the plant are surrounded by fencing, and plant security makes access to the plant impossible for members of the general public. The health of Wah Chang employees is under the purview of Oregon Occupational Safety and Health Division.

*Touching or drinking the water from Second Lake is **not** expected to harm the health of adults or children who use Second Lake recreationally or as transients.* This is because concentrations of chemicals measured in the surface water of Second Lake are too low to harm people's health. However, the water in Second Lake is not treated, and there may be non-site-related bacteria or algae in the water that could cause disease. Second Lake is not intended as a drinking water source.

*Eating fish from Second Lake or water bodies immediately to the north in the early 1990s was **not** expected to harm people's health in the past or present.* This is because the concentrations of the contaminants measured in fish in 1991 were too low to harm the health of people who may have been eating them.

*Eating fish currently in Second Lake and water bodies immediately to the north is **not** expected to harm people's health.* This is because concentrations of contaminants in fish measured in 1991 were too low to harm people's health, and since that time, the sources of contaminants have been removed, so concentrations in fish are likely even lower than in 1991.

*Touching or swallowing soil from the Soil Amendment Area north of the Wah Chang plant is **not** expected to harm people's health.* This is because the levels of radiological contamination measured in the soil are too low to harm people's health. Specifically:

- The annual radiation dose as shown by the ResRad model and using all model default parameters except for area of contamination (150503 square meters used) indicate the potential radiation dose is less than the ATSDR MRL of 100 millirem/year.
- The radium concentrations in surface soils are less than ATSDR's health-based standard (5 pCi/g above background). Therefore, we do not expect the levels in the SAA to be a public health concern.
- The gamma radiation exposures as measured at the SAA are within regulatory limits and would not result in radiation doses that would be a public health concern.

Recommendations

To protect public health, EHAP recommends that Wah Chang:

- Continue to maintain perimeter fencing and security measures that prevent public access to areas within the Wah Chang plant.
- Notify EHAP if Wah Chang operations are altered such that parts of the plant, Truax Creek, or Murder Creek become accessible to the general public.

To protect public health, EHAP recommends that the City of Millersburg (current owner of the Soil Amendment Area):

- Ensure that no buildings are erected in this area without proper radon mitigation systems or remediation of the soil.

To protect public health, EHAP recommends that recreational and transient users of Second Lake:

- Refrain from drinking water from and swimming in Second Lake.

Public Health Action Plan

A Public Health Action Plan ensures that the Public Health Assessment identifies public health risks and provides a plan of action that is designed to reduce and prevent illness that would result from contacting hazardous substances in the environment. This plan includes a description of actions that will be taken by EHAP in collaboration with other agencies to pursue the implementation of the recommendations outlined in this document.

Public health actions that have been taken so far:

- In May 2008, EHAP staff conducted a site visit and met with community members to collect community concerns.
- EHAP released the public comment version of this report on October 3, 2008.
- EHAP has incorporated public comments received into this final version as explained in Appendix A.

Public health actions that will be implemented in the future:

- EHAP will be available to consult with members of the public to answer their questions about the findings in this report.
- EHAP will be available to host a public availability session to answer questions from the community if requested.

Site Team

Oregon Department of Human Services
Environmental Health Assessment Program (EHAP) team

Author of Report
David Farrer, PhD
Toxicologist

EHAP Team
Karen Bishop, MPH
Public Health Educator

Sujata Joshi, MSPH
Epidemiologist

Laura Boswell
Program Manager

Jae P. Douglas, MSW, Ph.D.
Principle Investigator

Agency for Toxic Substances and Disease Registry
Ric Robinson
Regional Representative
Office of Regional Operations
ATSDR

Paul Charp
Senior Health Physicist
Division of Health Assessment and Assessment
ATSDR

Audra Henry
Technical Project Officer
Division of Health Assessment and Assessment
ATSDR

Certification

The Oregon Department of Human Services prepared the Ati Wah Chang Public Health Assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time that this public health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

Audra Henry
Technical Project Officer, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry

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

Alan W. Yarbrough
Team Lead, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry

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7. ATSDR, *Toxicological Profile for Ionizing Radiation*. 1999: Atlanta, GA.

Appendix A. Response to public comment

This appendix describes how EHAP incorporated public comment into this final version of the Wah Chang Public Health Assessment. Where multiple comments fell under a similar theme, these comments were summarized and answered together in one response.

Comment 1: Wah Chang agrees with the major conclusions in the report and believes the ATSDR report accurately evaluates the exposure pathways and potential risks to the public posed by chemicals associated with plant activities.

Response: Noted.

Comment 2: "The only potential health concern raised by the ATSDR report is classified as "indeterminate" for the consumption of fish by transient users of Second Lake. This indeterminate classification was reached by ATSDR because no fish tissue has been sampled or analyzed for contaminants related to Wah Chang,…"

Response: Since the public comment version of this document was released, EHAP found fish tissue data for water bodies just north of Second Lake and Burkhart Creek which empties into the south end of Second Lake. These data are from 1991 and could not be used to assess the current condition of fish tissue in Second Lake or surrounding water bodies. However, EHAP did use the 1991 data to make some public health determinations about people who may have consumed fish from these water bodies in the early 1990s (See Discussion and Conclusions sections of document). EHAP found that eating fish from water bodies surrounding Wah Chang in the early 1990s was not expected to harm people's health. Since the major sources of PCBs and HCB were removed since 1991, concentrations in fish could only have decreased, so EHAP also concluded that eating fish currently in water bodies surrounding Wah Chang is not expected to harm people's health.

Comment 3: "As mentioned above, there is no direct surface water connection between the Willamette River and Second Lake. There also is no surface water connection between Wah Chang's facility and Second Lake. The two creeks that pass through the Wah Chang facility, Truax Creek and Murder Creek, converge and flow to the Willamette, not to Second Lake."

Response: This information has been incorporated into the final version of this document.

Comment 4: "Stormwater from the Wah Chang facility either is collected in the wastewater treatment system, which discharges to Truax Creek, or it sheet flows to one of the two creeks mentioned above (with the one exception discussed below). The only possible pathways for contaminants from the Wah Chang facility to migrate to Second Lake would be through groundwater migration and stormwater migration from a single catch basin in the receiving dock which is a non-industrial area of the plant."

Response: This information has been incorporated into the final version of this document.

Comment 5: “In order to confirm that migration of soil particles from the plant to Second Lake has not occurred, the RI/FS included sampling sediment at six locations in Second Lake… for a broad spectrum of chemicals including metals, semi volatile organic compounds (SVOCs), volatile organic compounds (VOCs) and PCBs. This sampling was directed at the area along the eastern shoreline nearest to Wah Chang to assess whether chemicals from the plant have reached the lake sediments.

“The results indicate no apparent migration of soil particles from Wah Chang to Second Lake. For example, sediment samples were analyzed for PCBs which were found in soils within the plant and in sediment in Truax Creek. PCBs were not found above method detection limits in sediment samples collected adjacent to Wah Chang.”

Response: This information has been noted and incorporated into this final version of the Public Health Assessment.

APPENDIX B. Summary of the health effects evaluation process

Screening Process

In evaluating these data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific media (soil or water) 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 may inhale or ingest each day.

As health-based thresholds, 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, and 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. For chemicals for which both cancer and non-cancer numbers exist, the lower level is used to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed. Chemicals whose concentrations exceeded CVs were labeled Contaminants of Potential Concern (COPC) and singled out for further evaluation.

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 one 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 3 or Region 9 toxicologists.

Lifetime Health Advisory (LTHA) is derived by EPA assuming that a person was to drink contaminated water for their entire lifetime from childhood on.

Maximum Contaminant Levels (MCL) Are derived by EPA as enforceable standards for municipal water systems. These standards assume that a person would use the water as a primary drinking water source for a lifetime.

Evaluation of Public Health Implications

Estimation of Exposure Dose
The next step is to take COPCs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person's body. See Appendix B for dose calculations and assumptions for Second Lake.

EHAP evaluated three exposure scenarios for surface water in Second Lake: 1- adult recreational users, 2- children- divided into a 12-15 and 15-18-year-old age groups, and 3- transient users. The total doses for each scenario were calculated by adding the oral dose (water accidentally swallowed while swimming or intentionally swallowed as a drinking water source) to the dermal dose (contaminants absorbed through the skin while swimming/bathing). These calculated doses were compared with health-based guidelines to determine the risk for exposed individuals to develop non-cancer and cancer health effects. Doses are reported as milligrams-contaminant per kilogram-body weight per day (mg/kg/day).

Non-cancer Health Effects
The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this 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, and/or the use of the lowest observed adverse effect level. 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. MRLs are designed for exposures of different lengths. For example, a chronic MRL is designed for exposures that last longer than 1 year. Intermediate MRLs are designed for exposures that last between 15 and 364 days, and acute MRLs are designed for exposures that last 14 days or less. EHAP used chronic MRLs in this assessment. When a chronic MRL was not available, EHAP used intermediate MRLs or EPA reference doses (see next). An MRL should not be used as a predictor of adverse health effects. EHAP preferentially used intermediate MRLs for transients who are expected to

be in the spot for only 1 year or less. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.

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/.

If the estimated exposure dose for a chemical is less than the health guideline value, 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, then the exposure dose is compared to known toxicological values for that chemical and is discussed in more detail in the public health assessment (see Discussion Section). These toxicological values are doses derived from human and animal studies which are summarized in the ATSDR Toxicological Profiles. 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.

Risk of Carcinogenic Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by EPA's corresponding Cancer Slope Factor (CSF) (which can be found at http://www.epa.gov/iris/). Note that when calculating doses for cancer risk, average daily doses were averaged over 70 years (a lifetime by convention). The results estimate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant.

The actual risk of cancer is probably lower than the calculated number. The method used to calculate EPA's CSF assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that there is no safe level for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, suggesting that the cancer risk is actually lower, perhaps by several orders of magnitude.

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data. Therefore, the carcinogenic risk is described in words (qualitatively) rather than giving a numerical risk estimate only. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

APPENDIX C. Dose Calculations and Exposure Factors

Does Calculations

First, an oral dose was calculated based on estimates of water accidentally swallowed while swimming for adult recreational users and children. For transients, the oral dose was calculated based on an adult male using the water from Second Lake as a primary drinking water source and incidental ingestion while swimming/bathing. Explanation of terms in the following calculation formulas are shown in table C1.

Oral dose calculation:

$$\text{Oral ADD} = \frac{C \times IR \times CF_1 \times EF \times ED}{BW \times AT}$$

Next, a dermal dose was calculated based on the exposure assumptions listed in table C1. Permeability coefficients (P in the formula below) are chemical specific and pertain to the rate at which that chemical in water can penetrate the skin. Permeability coefficients for the chemicals analyzed for dermal exposure are in table C2.

Dermal dose calculation:

$$\text{Dermal ADD} = \frac{C \times SA \times P \times CF_1 \times CF_2 \times ET \times EF \times ED}{BW \times AT}$$

A total dose for each chemical was estimated by calculating the doses from oral and dermal exposures and adding them together. Where chemicals were missing permeability coefficients, dermal doses could not be calculated. For these chemicals, EHAP considered the oral dose to be the total dose.

Total dose calculation:

Total ADD = Oral ADD + Dermal ADD

Doses used for cancer risk calculation are the same as those shown above but the averaging time (AT) used is 25550 (365 days x 70 year lifetime) instead of the exposure duration times 365 days. This is done because cancer risk is accumulated over an entire lifetime of exposure to various carcinogens from various sources. Averaging daily exposure doses over an entire lifetime is a mathematical way to model this principle.

Table C1. Exposure assumptions for surface water dose calculations

Oral Exposure		Units		
ADD	Average daily dose	mg/kg/day		
C	Concentration	µg/L	chemical specific	
IR_{dwa}	Ingestion rate for use as drinking water for adults	L/day	2	ATSDR
IR_{ii}	Ingestion rate for incidental ingestion from swimming	L/day	0.05	ATSDR
EF_{dw}	Exposure frequency for drinking water use (Transient)	Days/year	365	Professional judgement - Daily use and only source of water
EF	Exposure frequency for recreational use	Days/year	128	Professional judgement - 5 days/week May-September and 4 days/month rest of the year
$ED_{t\text{-}1\ year}$	Standard exposure duration for transient use	Years	1	Professional judgement - 1 years residence in one place for a transient
ED_c	Exposure duration for children	Years	3	ATSDR
ED_a	Exposure duration for adults	Years	30	ATSDR
$AT_{nc\text{-}child}$	Averaging time for non-cancer health effects in children	Days	1095	3 years x 365 days/year
$AT_{nc\text{-}transient\text{-}1\ year}$	Averaging time for non-cancer health effects in transients at Second Lake for 1 year	Days	365	Days in a year
$AT_{nc\text{-}adult}$	Averaging time for non-cancer health effects in adults	Days	10950	30 years x 365 days/year
AT_c	Averaging time for cancer	Days	25550	70 years x 365 days/year
$BW_{c\text{-}12\text{-}15}$	Body weight for a child 12-15 years old	Kg	50.6	EPA average 12-15 year-olds (boys and girls)
$BW_{c\text{-}15\text{-}18}$	Body weight for a child 15-18 years old	Kg	61.6	EPA average 15-18 year-olds (boys and girls)
BW_a	Body weight for an adult	Kg	70	ATSDR approximate average
CF_1	Conversion factor micrograms to milligrams	or mg/µg	0.001	
Dermal Exposure				
P	Permeability coefficient	cm/hr	chemical specific	See table of chemicals and their permeability coefficients
$SA_{c\text{-}12\text{-}15}$	Exposed body surface area for children 12-15 years old	cm^2	14900	ATSDR 12-15 year-old males
$SA_{c\text{-}15\text{-}18}$	Exposed body surface area for children 15-18 years old	cm^2	17500	ATSDR 15-18 year-old males
SA_a	Exposed body surface area for adults	cm^2	19400	ATSDR
ET	Exposure time	hours/day	1	Professional judgment - 1 hour swimming/day
CF_1	Conversion factor micrograms to milligrams	or mg/µg	0.001	
CF_2	Conversion factor cubic centimeters to L	L/cm3	0.001	

Table C2. Permeability Coefficients

Permeability coefficients	cm/hr
1,2-DICHLOROETHANE	0.004197
ARSENIC [AS]	0.001
CADMIUM [CD]	0.001
CARBON TETRACHLORIDE	0.016
CIS-1,3-DICHLOROPROPENE	0.0043
HEXACHLOROBUTADIENE	0.081
MANGANESE [MN]	0.001
TETRACHLOROETHENE	0.033
TRANS-1,3-DICHLOROPROPENE	0.0043
TRICHLOROETHENE	0.012
VINYL CHLORIDE	0.0056

Oral doses of PCBs and HCB from eating fish in the early 1990s were calculated as follows:

$$\text{Dose} = \frac{C \times IR \times ED \times C_1}{AT \times BW}$$

Where: (see next page)
Cancer dose is calculated the same way but the AT is 365 days x a 70 year lifetime as explained above for surface water dose calculation.

Table C3. Terms and assumptions for dose calculation for fish consumption

Exposure Factor	Description	Value		Units	Rationale
		Adult	Child		
C	Concentration of contaminant in fish tissue	---	---	mg/kg	Specific for each species (site-wide values used)
IR_R	Ingestion rate for recreational anglers and their children	17.5	7	g/day	From ATSDR guidance (2005)
IR_T	Ingestion rate for transient subsistence fishers and their children	175	73.5	g/day	Oregon's new subsistence rate to be used at Portland Harbor Superfund site and soon to be generalized throughout Oregon (2009)
ED_R	Exposure duration for recreational anglers	30	6	years	From ATSDR guidance (2005)
ED_T	Exposure duration for transient subsistence fishers and their children	1	1	years	Professional judgment
BW	Body weight	70	16	kg	From ATSDR guidance (2005)
AT_C	Averaging time for cancer risk calculation	25550	25550	Days	From ATSDR guidance (2005) 70 year lifetime times 365 days/year
$AT_{nc\text{-}Rec}$	Averaging time for non-cancer risk for recreational anglers and their children	10950	2190	days	ED_R x 365 days/year
$AT_{nc\text{-}Tran}$	Averaging time for non-cancer risk for transient anglers and their children	365	365	days	ED_T x 365 days/year
C_1	Conversion factor from grams to kilograms	0.001	0.001	kg/g	Converts g → kg

Appendix D explains how total doses were compared with health guidelines, called comparison doses in this report.

Appendix D. Criteria for Identifying Contaminants of Concern (COC)

Non-Cancer Contaminants of Concern (COC)

For non-cancer health effects, total estimated doses (calculated as described in appendix B) for COPCs identified in the screening step (table 1 in Discussion) were divided by their comparison dose or health guidelines. The outcome is called a hazard quotient (HQ):

$$HQ = \frac{\text{Total ADD}}{\text{Comparison dose}}$$

Hazard quotients less than 1 indicate that no health outcomes are expected based on the estimated doses of that chemical at Second Lake. A contaminant whose HQ is greater than 1 is considered a Contaminant of Concern (COC) and is singled out for further evaluation. Identification of COCs does not mean that adverse health effects will occur, but these chemicals are evaluated further. HQs for all of the COPCs were added together to generate a Hazard Index (HI). If HI is less than 1, then no health effects are expected from that exposure pathway in that exposure scenario. A hazard index greater than 1 indicates that, even though no individual contaminant may have a HQ greater than one, exposure to the mixture of the critical contaminants at the site should be evaluated further.

Note that for transients, doses derived from fish consumption were divided by the intermediate MRL as opposed to the chronic. Intermediate MRLs are most pertinent to exposures lasting between 14 and 364 days as would be the case for most transients.

Cancer COC

For cancer risk evaluation, estimated contaminant doses were multiplied by their CSF. A cancer risk greater than 1 E-4 (or one additional case of cancer in ten thousand people exposed) flagged a chemical as a COC. This does not mean that EHAP expects cancer cases to occur from exposure to that contaminant at Second Lake, only that the chemical should be singled out for further evaluation.

$$\text{Cancer Risk} = \text{Total ADD}_{cancer} \times \text{CSF}$$

APPENDIX E. 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. 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, or 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).

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.

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. PRPs are expected to help pay for the clean up of a site.

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

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 not 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**.