Health Consultation

Human Health Assessment for Use of the Salt Chuck Mine
Area for Recreational and Traditional Purposes –
Salt Chuck Bay, Alaska

SALT CHUCK MINE SITE
PRINCE OF WALES ISLAND, ALASKA

Prepared by
Alaska Department of Health and Social Services

NOVEMBER 2, 2015

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

Health Consultation: A Note of Explanation

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

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

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

HEALTH CONSULTATION

Human Health Assessment for Use of the Salt Chuck Mine Area for Recreational and Traditional Purposes – Salt Chuck Bay, Alaska

SALT CHUCK MINE SITE
PRINCE OF WALES ISLAND, ALASKA

Prepared By:

Alaska Department of Health and Social Services
Division of Public Health, Section of Epidemiology
Environmental Public Health Program
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Forward

The Environmental Public Health Program within the Alaska Division of Public Health has prepared this Health Consultation 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 Health Consultation was prepared in accordance with ATSDR methodology and guidelines.

ATSDR and its cooperative agreement partners review the available information about hazardous substances at a site, evaluate whether exposure to them might cause any harm to people, and provide the findings and recommendations to reduce harmful exposures in documents called Public Health Assessments and Health Consultations. ATSDR conducts public health assessment activities for every site on or proposed for the National Priorities List (NPL; also known as the Superfund list). Health Consultations are similar to Public Health Assessments but they usually are shorter, address one specific question, and address only one contaminant or one exposure pathway. Another difference is that Public Health Assessments are made available for public comment, while Health Consultations usually are not. Public Health Assessments and Health Consultations are not the same thing as a medical exam or a community health study.

Selected Acronyms

≥	Greater than or equal to
≤	Less than or equal to
µg/L	Micrograms per liter
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
mg/kg/day	Milligrams per kilogram body weight per day
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	U.S. Bureau of Land Management
CDC	Centers for Disease Control and Prevention
COC	Contaminant of Concern
CSF	Cancer Slope Factor
CV	Comparison Value
DEC	Alaska Department of Environmental Conservation
DHSS	Alaska Department of Health and Social Services
DNR	Alaska Department of Natural Resources
DRI	Dietary Reference Intake
EPA	U.S. Environmental Protection Agency
EPHP	Environmental Public Health Program
HPAH	High molecular weight polycyclic aromatic hydrocarbons
HQ	Hazard Quotient
LOAEL	Lowest Observed Adverse Effect Level
LPAH	Low molecular weight polycyclic aromatic hydrocarbons
MRL	Minimal Risk Level
NA	Not available
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
PAH	Polycyclic Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PPRTV	Provisional Peer Reviewed Toxicity Values
PSP	Paralytic Shellfish Poisoning
RfD	Reference Dose
SCM	Salt Chuck Mine
TECR	Total excess cancer risk
USFS	U.S. Forest Service

Summary

Introduction

The Native Village of Kasaan, Alaska petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to prepare a health consultation for the use of the Salt Chuck Mine site (SCM), particularly for harvesting shellfish. Residents of Kasaan and of the closest community to SCM, Thorne Bay, in addition to other recreational users, may be exposed to contaminants from this site by eating shellfish and vegetation harvested there and by spending time at the site participating in recreational activities such as hiking and swimming. A priority of the Environmental Public Health Program (EPHP) is to ensure that users of the SCM, either for harvesting customary and traditional foods or for recreational purposes, have sufficient information to safeguard their health. The SCM, located on Prince of Wales Island in southeast Alaska, is an abandoned historic gold, silver, copper, and palladium mine on the U.S. Environmental Protection Agency's (EPA) National Priorities List of Superfund sites. The purpose of this consultation is to evaluate the public health risks of exposure to contaminants at the site, particularly from eating clams and vegetation (alder leaves, crabapple leaves, huckleberry leaves and berries, salmonberry leaves, skunk cabbage leaves, and sea asparagus) that may be contaminated with metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). This report addresses community concerns about potential health effects from use of the site for both customary and traditional food harvesting purposes and recreational use. The actual former mine, the mill on the beach, and tailings at the site are the likely sources of elevated levels of *some* contaminants on-site in comparison to background areas nearby. The conclusions and recommendations of this consultation are summarized below.

Conclusion 1

Harvesting and consuming a variety of sampled clams and vegetation from the SCM site is not expected to harm the health of traditional users (who regularly collect substantial amounts of clams and vegetation from this site only) from exposure to (contact with) metals, PAHs, and PCBs.

Basis for Decision

Risk evaluation for traditional users indicated possible marginally elevated noncancer risks from eating clams containing metals. However, when considering the uncertainties in the risk evaluation process and the plentiful benefits from traditional use that are not accounted for in the risk evaluation, risks will unlikely be elevated among traditional users of the site. In addition, concentrations of PAHs and PCBs were either too low or not detected and hence do not pose a health risk.

Conclusion 2	An adult eating more than 14 pounds or a child eating more than 6 pounds of softshell clams per year harvested from the SCM site may have increased health risks from inorganic arsenic ingestion.
Basis for Decision	Softshell clams had the highest average inorganic arsenic content with 19 percent of the arsenic being in the inorganic form. An adult who eats more than 14 pounds of softshell clams each year for a 40-year period may have a marginally increased skin cancer risk from arsenic exposure. A child who eats more than 6 pounds of softshell clams in a year may be at increased risk of noncancer health effects from arsenic exposure. These effects include skin, nervous system, and cardiovascular problems. The other species of clams from the site had inorganic arsenic concentrations that were less than one percent and the concentration in them was below health comparison values. Eating a variety of clams throughout the year is not expected to pose a health concern from arsenic exposure.
Conclusion 3	Traditional site users with certain liver and iron metabolism diseases may be at elevated (higher) risk of chronic (long-term; >1 year) iron toxicity if they consume large quantities of clams from the SCM site.
Basis for Decision	Clams from the SCM site contain levels of iron that are higher than most foods, including most canned clams. Chronic clam consumption from the SCM site may contribute excess iron that could potentially be associated with adverse health effects in individuals with certain liver and iron metabolism diseases.
Conclusion 4	Use of the SCM site for recreational purposes (including occasional harvesting and consumption of small amounts of clams and vegetation) is not expected to harm the health of recreational users.
Basis for Decision	The EPHP's evaluation of cancer and noncancer risks in recreational users indicated no cancer and noncancer risks for this population.

Next Steps

Recommendations

The State of Alaska EPHP recommends:

- People consume only commercially harvested shellfish that have been screened for the presence of paralytic shellfish poison (PSP). Harvesting shellfish (including clams) from the SCM site or other sites could lead to adverse health effects from PSP. PSP is not related to the Salt Chuck Mine site.
- People eat a variety of clam types. Eating only softshell clams at the full yearly intake estimate (*e.g.,* 26.9 pounds per year for an adult) may be associated with increased health risks from inorganic arsenic exposure.
- Individuals with the following conditions consult with their health care provider before consuming *large* quantities of clams from the SCM site on a *long-term* basis: hereditary hemochromatosis; chronic alcoholism, alcoholic cirrhosis, and other liver diseases; iron-loading abnormalities, particularly thalassemias; congenital atransferrinemia; and aceruloplasminemia. Clams from the SCM site contain levels of iron that are higher than most foods. Consuming large quantities of clams from the site may contribute excess dietary iron that could be associated with adverse health effects in these individuals.
- Samples of fish, shrimp, birds, and eggs may be collected and tested for the same contaminants evaluated in clams, water, and sediment. These data would provide a more complete dietary exposure scenario particularly for the traditional user.

Public Health Actions Planned

- EPHP will disseminate the findings from this health consultation to the communities that would be most likely to use the SCM site in the future.
- EPHP plans to address any community concerns about the health risks and benefits of using the SCM site for both traditional and recreational purposes.

Limitations

The main limitations of this health consultation are summarized below. Please refer to the Uncertainties, Limitations, and Data Gaps section of the document for further information.

- It is very unlikely that people would harvest clams and vegetation from the SCM site only; they would likely also harvest from other locations with fewer or lower levels of contaminants Therefore, their total exposure to SCM contaminants from clam and vegetation consumption is expected to be lower than the outcomes of this evaluation. In addition, EPHP assumed that people would eat a variety of all clams at the site while in fact some may have a preference for one type over the other. Eating only one type of clam, specifically softshell clams, may result in a different risk level than the current calculations indicate.

- Because site-specific consumption data were not available for this risk assessment, EPHP took a conservative (health protective) approach in calculating cancer risks by assuming that a person would eat a generous quantity of clams daily for a 40-year lifetime. This approach is likely to overestimate risk because:
    - Residents in communities near SCM have been staying in their communities for fewer years in recent times than they did in the past. This suggests that people would likely be exposed to site contaminants for less than 40 years in the future.
    - Contaminant concentrations at the site will likely be lower in the future because of proposed cleanup activities by EPA for the site.
    - The clam consumption rate based on community harvest data that EPHP used is likely an overestimation as this assumes no clams go bad or are thrown away.
- Without reliable information on clam and other food consumption rates for communities near SCM, EPHP's evaluation of human health risks posed by contaminants in these foods may not be representative for these communities.
- EPHP assumed that people would be likely to consume clams and other foods collected at the site containing the full range of contaminant concentrations present at the SCM site, while in reality people may be consuming less or more depending on where they harvest the foods.
- EPHP assumed that people would visit the site six times per year, while the actual number of visits may range from no visits to more than six visits.
- EPHP based the vegetation calculations on sparse data. More data may have shifted the risk higher or lower than in this evaluation.
- Inorganic arsenic content in softshell clams is higher in clams from the Salt Chuck Bay area; however, only three softshell clam samples from each area (Salt Chuck Bay and Brown's Bay) were analyzed for arsenic content. Due to the small sample size, comparisons in arsenic content for clams from different areas are uncertain.
- EPHP assumed that traditional and recreational use of the site would be well-represented in harvest data available for 1998, while this may not reflect a standard year's harvest and consumption.
- EPHP assumed recreational use to be comparable to Thorne Bay harvest data as the Thorne Bay community is not traditionally reliant on clams for customary and traditional use. Therefore EPHP assumed that their harvest was "recreational" use.
- EPHP assumed that contaminants absorbed dermally would have cancer and noncancer effects as if they were absorbed through the gastrointestinal tract. This is not necessarily true, as toxicity of a contaminant usually varies by how it enters the body (route of exposure).

For more information Please contact the Environmental Public Health Program at 1-907-269-8000 or the Agency for Toxic Substances and Disease Registry (ATSDR) at1-800-CDC-INFO

Background and Statement of Issues

The Alaska Department of Health and Social Services, Division of Public Health, Environmental Public Health Program (EPHP) evaluated environmental data collected by the U.S. Environmental Protection Agency (EPA) for the Salt Chuck Mine (SCM) site listed on the EPA National Priorities List (NPL) of the nation's most hazardous waste sites. SCM was added to the NPL in March, 2010. Health consultations are required for all sites on the NPL and therefore, EPHP, in cooperation with the Agency for Toxic Substances and Disease Registry, produced this health consultation. The U.S. Bureau of Land Management initiated environmental investigations in the 1990s (BLM, 1998). The URS Corporation (URS; 2002, 2007, 2010) continued the investigations as part of an Engineering Evaluation/Cost Analysis for the U.S. Forest Service (USFS). CH2M HILL then continued the investigations for the EPA and identified the presence of contaminants in mine tailings, clams, surface water, and vegetation. EPHP used the most recent data collected by EPA in 2011 and 2012 (reported in 2012 and 2013) to evaluate human health risks from exposure to contaminants measured at the site. The EPA tested the samples for metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

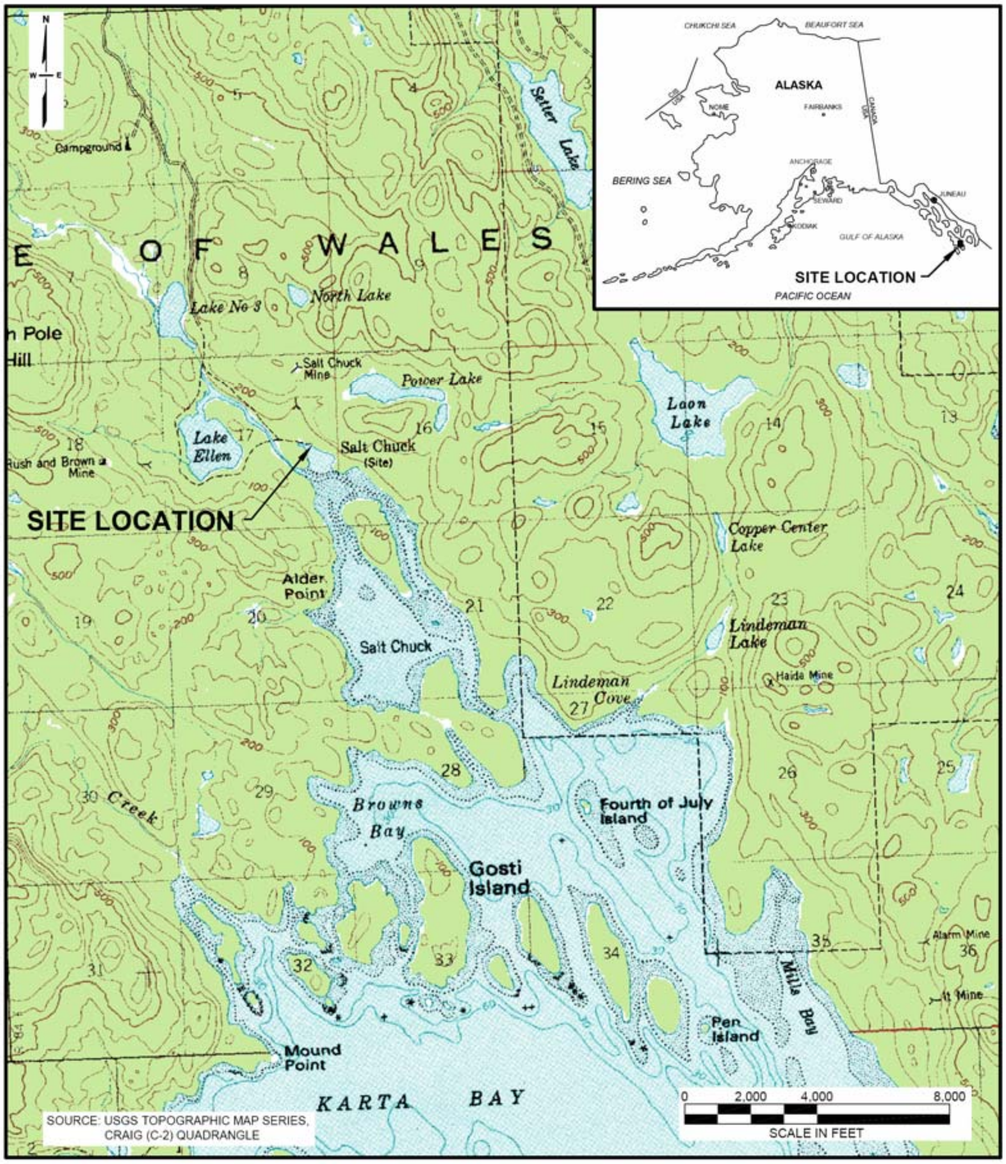
Site Description and Historical Land Use

The SCM is an abandoned historic gold, silver, copper, and palladium underground mine located on the southeast side of Prince of Wales Island in southeast Alaska. The mine and mill site are located on the northern shore of Salt Chuck Bay near the mouth of Lake Ellen Creek in the far northern end of Kasaan Bay (Figures 1 and 2). The mine operated from 1905 to 1941 and was the most important copper producer in the Ketchikan Mining District and of national importance as a palladium producer in the 1920s (CH2M HILL, 2013b). Currently, the SCM site has dual land ownership, with the USFS responsible for the uplands area and the State of Alaska responsible for the intertidal area.

The Alaska Department of Environmental Conservation (DEC) requested that EPA list the site on the NPL because of: 1) the magnitude and location of contamination source areas upland and in the bay; 2) the ecological impacts on Kasaan Bay; and 3) the customary and traditional uses and commercial fisheries that support the local native population (EPA, 2012a).

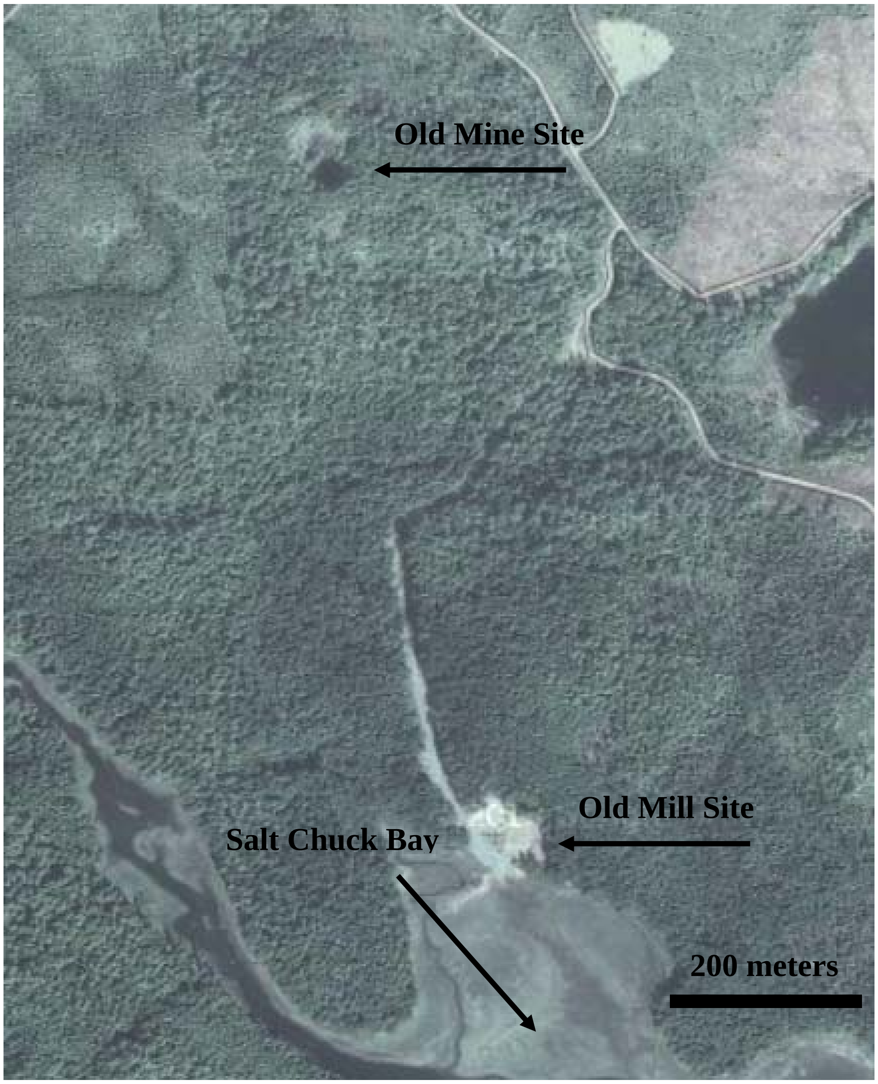
Varying accounts exist on the significance and use of the SCM site for customary and traditional purposes. Written historic accounts of the area, as well as key informant interviews from 2011 and 2012 (Appendix A, Sarcone, 2012), suggest that the local native population, particularly from Kasaan, did not use the SCM site in the past to any major extent. This is because other locations existed that are closer and easier to access for hunting and gathering traditional foods.

Figure 1. Site location at north end of Salt Chuck Bay, Kasaan Peninsula, Prince of Wales Island, southeast Alaska.



Source: URS, 2007. Arrow indicates site of mill and tailings. North of it is the actual Salt Chuck Mine. Salt Chuck (or Salt Chuck Bay) is a lagoon-like arm of Kasaan Bay.

Figure 2. Satellite image of site location at north end of Salt Chuck Bay, Kasaan Peninsula, Prince of Wales Island, southeast Alaska.



Current and Potential Land Use

The Alaska Department of Natural Resources (DNR, 1998) designated Salt Chuck Bay as an area of "intensive public recreation use". Hikers, hunters, boaters, and rock climbers visit the area. A public use cabin is located about one mile southeast of the SCM site along the east side of Salt Chuck Bay. A recreational trail also leads to the site (Seatrails, undated). The SCM site has been a recreational attraction because of the abandoned mine artifacts and structures. In 2011, the USFS led a large-scale effort that removed building debris (*e.g.*, mill structures, diesel tanks, and engines), and excavated petroleum-contaminated soil and metals-contaminated tailings from the uplands area. The USFS grouped the remaining mining equipment at the site in one area, where they remain for historic purposes. The EPA will address the issue of any remaining potentially contaminated soils that remain at the site.

Salt Chuck Bay is also considered to have high fish and wildlife habitat and harvest values (DNR, 1998). Crucial habitat exists in the area for seasonal black bear populations, waterfowl, herring spawning, and salmon rearing and schooling, with future potential use for aquatic farming (DNR, 1998). The bay area is designated for potential intensive community use for harvest of clams, crab, oysters, waterfowl, black bear, and berries by residents of Thorne Bay, Kasaan, Hollis, and Craig. Lake Ellen Creek supports runs of several types of anadromous fish (fish that migrate upstream), and abundant clams inhabit the intertidal area adjacent to the mine site. An oyster farm previously operated in Salt Chuck Bay. The two communities closest to SCM are Kasaan and Thorne Bay, and these residents are likely to be the heaviest users of the SCM site. However, only a small dataset exists to support this assumption. In addition, Kasaan residents have reported little to no use of the site in recent years for recreational or customary and traditional purposes (Appendix A).

At the request of the Organized Village of Kasaan (OVK), a federally-recognized tribe (see Community Demographics below), DEC posted signs in the intertidal area of the SCM site in 2010 to warn visitors of potential shellfish contamination from Paralytic Shellfish Poisoning (PSP) and other hazardous substances. OVK has stated that the mine site is within their customary and traditional use area.

Community Demographics

Thorne Bay is the nearest community to SCM by road, and is located 47 air miles northwest of Ketchikan on the east coast of Prince of Wales Island and 4.5 miles north-northeast of the mine (DCCED, 2013). Thorne Bay has 471 residents, with 92% White, 2% American Indian/Alaska Native, 78% age 18 and over, and 15% in poverty (Census, 2010). The community has a school (pre-school through 12th grade) and a health clinic. Thorne Bay is governed by a mayor and a city council.

Kasaan, the closest community to SCM by water, is located 10 miles southeast of the mine on the east side of Kasaan Bay and 30 miles northwest of Ketchikan (DCCED, 2013). This small community is accessible by road, air, and water. According to the 2010 census, Kasaan's population is 49, with 53% White, 35% American Indian/Alaska Native, 82% age 18 years and over, and 0% in poverty. The community has a school (kindergarten through 12th grade) and a health center. Kasaan is governed by a mayor and a city council. The OVK is a federally-recognized tribe in the community. Kasaan and Thorne Bay are connected by a gravel road. Traditional foods are a major source of OVK's diet.

Community Health Concerns

Kasaan has been concerned about contamination of customary and traditional foods, harvested from the upland and intertidal areas of the SCM site (Appendix A). Vegetation, fish, and other wildlife can take up environmental contaminants from air, water, sediment, or food sources. People who eat affected vegetation, fish, and wildlife may be exposed to these contaminants.

According to historical documents and recent key informant interviews, Kasaan residents infrequently used the SCM site in the past to harvest shellfish and other traditional foods because of limited access and the availability of more convenient harvesting locations (Appendix A). More recently, concerns about paralytic shellfish poison (PSP) have kept Kasaan residents from harvesting any shellfish from Salt Chuck Bay and other surrounding areas (personal communication with OVK tribal administrator, September 2013). Nevertheless, the likelihood of SCM site use by nearby communities cannot be dismissed altogether, as some Kasaan residents have indicated use of the site for harvesting traditional foods and others have used it for recreational purposes.

According to a survey performed by the Kasaan environmental coordinator at the request of EPHP, residents reported that Kasaan residents do harvest shellfish, although the year and location were not specified. Nonetheless, some residents have recently voiced concerns about the health risks of shellfish consumption from the SCM site in future years.

In the 2012 summary of a community survey and key informant interviews with Kasaan elders and other Kasaan residents, the author states "The perception of the respondents, that there was a high level of subsistence activity at Salt Chuck in the past, is not corroborated [supported] by the elders or by the ethnography [historical accounts]. It appears that there was little use of the Salt Chuck Mine site area for subsistence in the past and that there is little to no use of the area for gathering subsistence species today" (Appendix A). The summary also notes one tribal member as saying that "the perception of loss is greater than the traditional use because it is the potential opportunity for use that can never be relinquished or abandoned."

Because there is little current use of the SCM site for customary and traditional purposes, this health consultation evaluated both current and potential *future* exposures and health risks from the harvest and consumption of sampled foods from the mine area.

It is important to note that EPHP's understanding of past and current use of the SCM site is limited to information collected about Kasaan and from Kasaan residents only, as they have expressed concern about contamination at the site. EPHP does not have information about how other communities on Prince of Wales Island, such as Thorne Bay, Hollis, or Craig may have used or currently use the SCM site.

Discussion

Exposure Pathways

In order for a chemical (contaminant) to harm health, there must be a way for people to be exposed to (come in contact with) the chemical. An "exposure pathway" describes how a contaminant moves from its source and comes into physical contact with people. An exposure pathway has five parts:

1. Contaminant source or release;
2. Way for the contaminant to move through the environment to a place where people could come in contact with it;
3. Place where people could contact the contaminant;
4. Route of exposure to the contaminant, such as breathing it, swallowing it, or absorbing it through skin; and
5. People are exposed to the contaminant.

An exposure pathway is called "completed" if all five parts are present and occurring. If one or more parts are unknown or missing, then it is called a "potential" or "eliminated" exposure pathway.

Even when a completed exposure pathway exists, the potential harm from a contaminant highly depends on several factors:

1. The amount of the contaminant present (called the *level or concentration*),
2. How often a person comes in contact with the contaminant (called the *frequency*),
3. How long a person is in contact with the contaminant (called the *duration*),
4. How much of a contaminant a person is exposed to, taking into consideration body weight and sometimes duration, and frequency (called the *dose*),
5. How harmful the contaminant is (called *toxicity*),
6. The route of exposure (how the chemical contacts the body; see above).

Completed Exposure Pathways

As previously mentioned, most Kasaan residents have not been visiting the SCM site for harvesting traditional foods or for other purposes in recent years. However, some stated that they had. In addition, Thorne Bay residents likely use the site for recreational purposes (personal communication, Michael Wilcox, USFS). Therefore, completed exposure pathways exist for people who come into contact with site contaminants (Table 1a). People who harvest traditional foods from the site in the future could be exposed to site contaminants through the ingestion pathway. Incidental ingestion of sediment could also occur from harvesting activities. This incidental ingestion pathway also includes incidental inhalation of sediment. People could also be exposed to contaminants in the sediment through direct skin contact (dermal pathway) if contaminants are absorbed through skin. Moreover, those harvesting traditional foods or recreating at the site may drink surface water at the site, and would therefore be exposed to contaminants through the ingestion pathway from water. In addition, users of SCM may also be exposed to contaminants from dermal contact with water.

Table 1a. Salt Chuck Mine Completed Exposure Pathways (past, present, and future)

Media/Transport	Point of Exposure	Route of Exposure	Exposed Population
Clams and other traditional foods	SCM site	Ingestion from consumption of foods harvested from mine site	People who eat foods harvested from the mine site.
Sediment	SCM site	Incidental ingestion (accounts for ingestion from incidental inhalation exposure), dermal absorption	People who harvest clams from mine site or come in contact with sediment
Surface water (freshwater streams)	SCM site streams	Ingestion of surface water, dermal absorption	People who drink, play in, or use stream water at mine site.

Eliminated Exposure Pathways

The SCM site has no groundwater wells nearby, so ingestion of groundwater that may be contaminated is an incomplete or eliminated exposure pathway (Table 1b).

Table 1b. Salt Chuck Mine Eliminated Exposure Pathways

Media/Transport	Point of Exposure	Route of Exposure	Exposed Population
Groundwater	None; no groundwater wells on site for drinking	Ingestion, dermal absorption	None

Environmental Sampling

EPA conducted two rounds of environmental sampling in 2011 and 2012 (CH2M HILL, 2012, 2013a). In July and August 2011, EPA collected clam, sediment, and surface water samples

(Table 2). In August 2012, EPA collected vegetation samples along with additional clam, sediment, and surface water samples. The number of samples collected is noted in Table 2.

Concentrations (levels) of the following contaminants were found in clam, sediment, and surface water samples: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. These contaminants were also detected in vegetation samples, except for calcium, manganese, potassium, and sodium. In addition, PAHs and polychlorinated biphenyl compounds (PCBs) were detected in sediment and clams.

Table 2. 2011 and 2012 Environmental Sampling Data for Clams, Sediment, Surface Water, and Vegetation for the Salt Chuck Mine Site.

Media	**Contaminants Measured**	**Total Number of 2011 Samples**		**Total Number of 2012 Samples**	
		Site	**Background**	**Site**	**Background**
Clams (little-neck, butter, softshell, cockles)*	Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc, PAHs, PCBs	20	13	14	13
Sediment	Same as above	51	14	44	5
Surface water	Same as above, minus PAHs and PCBs	NA	NA	15	6
Vegetation (alder leaf, crabapple leaf, huckleberry leaf, huckleberry, salmonberry leaf, skunk cabbage leaf)	Same as above, minus calcium, manganese, potassium, sodium, PAHs, and PCBs	NA	NA	31	13

*Samples are composite and include tissue from 8-12 clams each. Only one clam species was included in any one sample.

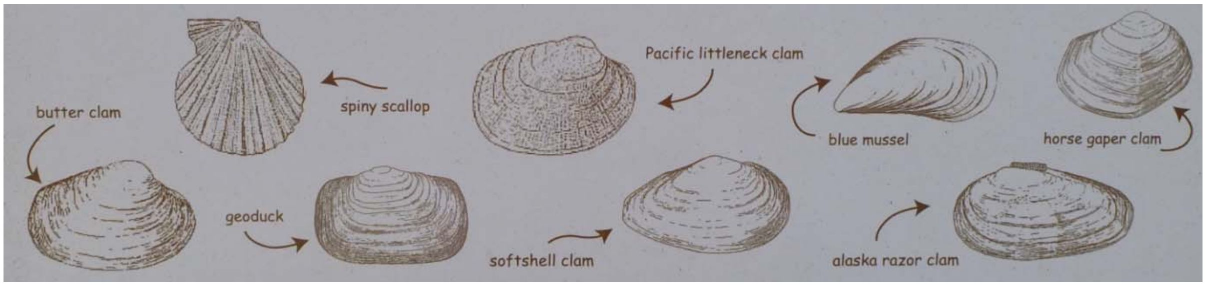
Source: CH2M HILL 2012, 2013a

NA = not available, PAHs = polycyclic aromatic hydrocarbons, PCBs = polychlorinated biphenyls.

Clam Samples

A total of 60 (including field duplicates) composite clam samples (each sample included tissue from 8-12 different clams of the same species) were collected in 2011 and 2012. Clam species sampled included littleneck clams (9 samples), softshell clams (29 samples), butter clams (14 samples) and cockles (8 samples) (Figure 2). In 2011, 20 samples were collected from the intertidal area, which includes the tailings pile in the SCM area, Salt Chuck Bay, and "Unnamed Island" on EPA maps (CH2M HILL, 2013a). In addition, 13 background samples were collected from Gosti Island and Browns Bay. Gosti Island and Browns Bay are located immediately south of Salt Chuck Bay. This background area was identified by the EPA as having environmental conditions similar to those of the intertidal area, but without known contamination sources. In 2012, 14 samples were taken from the intertidal area, and 13 background samples were collected from Gosti Island and Browns Bay (CH2M HILL, 2013a).

Figure 2. Clams and other Shellfish from the Salt Chuck Area as depicted on a sign at the site posted by the Alaska Department of Conservation.



Ten clam samples were analyzed for both the organic form of arsenic and the potentially toxic and carcinogenic (cancer-causing) inorganic form of arsenic. The data revealed differences in arsenic content depending on the species of clam and location (Appendix B, Table B-4). For all sample locations, softshell clams had the highest average inorganic arsenic content at 19% of total arsenic. The other species of clams that were sampled for arsenic type, butter clams and little-neck clams, had inorganic arsenic concentrations that were less than 1%. The average concentration of inorganic arsenic in all sampled clam species taken together was approximately 11%. Table B-4 in Appendix B illustrates the inorganic arsenic content of each species for both the Salt Chuck Bay Intertidal area and the background sample area near Brown's Bay. Softshell clam samples from the Salt Chuck Bay area had an inorganic arsenic content of 28 percent of total arsenic while softshell clam samples from background sample locations had an inorganic arsenic content of 11 percent. These data suggest that the inorganic arsenic content in softshell clams is higher in clams from the Salt Chuck Bay area; however, only three composite softshell clam samples from each area (Salt Chuck Bay and Brown's Bay) were analyzed for arsenic content. Due to the small sample size, comparisons in arsenic content for clams from different areas are uncertain. Both little-neck and butter clams had inorganic arsenic contents of less than one percent in both Salt Chuck Bay and Brown's Bay.

Sediment Samples

A total of 114 sediment samples were collected in 2011 and 2012. In 2011, 51 sediment and tailings samples were collected from the intertidal area and Lindeman Cove. Lindeman Cove lies southeast of the inlet to Salt Chuck Bay. Fourteen background samples were also collected from Gosti Island and Browns Bay.

In 2012, 44 sediment and tailings samples were collected from the intertidal area, Salt Chuck Bay and Unnamed Island. Five background samples were collected from Gosti Island and Browns Bay.

Surface Water Samples

A total of 21 surface water samples were collected in 2012. Ten samples were collected from the upland area of the mine site, which covers approximately 23 acres and includes the mine, the former mill site, and hiking trails. Five samples, including those from Lake Ellen Creek and an unnamed stream that flows into Salt Chuck Bay from the upland area, were collected in the intertidal area. Six background samples were collected from five locations in Lake Ellen Creek and an unnamed stream. All of the background sample locations were upstream from the mine.

Vegetation Samples

In 2012, 31 vegetation samples from the upland (15 samples) and intertidal (16 samples) areas were taken, along with 13 vegetation samples from background locations. Samples from the upland area of SCM included alder leaves, crabapple leaves, huckleberry leaves and berries, salmonberry leaves, and skunk cabbage leaves. The intertidal samples were sea asparagus.

Identifying Contaminants of Concern

To identify contaminants at the SCM site that could pose a health risk, EPHP compared the potential exposures to contaminants (elements and chemicals) from the completed exposure pathways to a health guideline or "comparison value" (CV). These CVs are set by federal or state agencies for each contaminant to protect human health (Appendix B, Tables B-11 through B-15 and Appendix D, Tables D-1 through D-4). When a person's exposure level to a contaminant is higher than the contaminant's CV, that contaminant becomes a "contaminant of concern," or COC. When a person's exposure level is lower than the contaminant's CV, the exposure is not expected to result in health effects and EPHP does not look at the contaminant further. It is important to note that a COC does not mean that harmful effects are expected from exposure to that contaminant. Rather, it simply flags the contaminant for closer evaluation to determine whether health effects may occur.

The Minimal Risk Levels (MRLs) developed by the federal Agency for Toxic Substances and Disease Registry (ATSDR) are the CVs that EPHP primarily used to evaluate noncancer health risks. When MRLs were not available, EPHP used the EPA Reference Doses (RfDs) (EPA, 2013c). In some cases, even when MRLs and RfDs were available, EPHP used other health guidelines if they were applicable to EPHP's evaluation. For example, for essential nutrients, EPHP used dietary reference intake (DRI) values developed by the National Academy of Sciences Institute of Medicine (NAS, 2001). The ATSDR MRLs and EPA RfDs are estimates of daily human exposure to hazardous substances that are likely to be without substantial risk of harmful noncancer health effects over a specified duration of exposure. These estimates, which EPHP uses as screening levels, are substance-specific and are used to identify potential health threats.

To calculate potential cancer risks of COCs, EPHP used EPA cancer slope factors (CSFs) when available (EPA, 2013a). To evaluate the risk of cancer from PAHs, an approach was used from the California Environmental Protection Agency (Cal EPA) that converts the total PAH concentration in a sample to a total carcinogenic PAH concentration (CalEPA, 2005). On the basis of benzo(a)pyrene toxicity, this approach uses potency factors specific for each carcinogenic PAH to change the concentration of that PAH to a benzo(a)pyrene equivalent concentration. Thus, the benzo(a)pyrene equivalent concentration of various individual carcinogenic PAHs in a soil sample are summed to give the total carcinogenic PAHs (cPAH) for that sample.

If a calculated potential cancer risk for a contaminant exceeded one cancer in every million persons exposed, EPHP considered that contaminant a COC that requires further evaluation.

CVs are designed to be conservative in order to provide a large margin of safety from contaminant exposures and possible health risks. ATSDR and EPA sometimes use the no observed adverse effect level (NOAEL), which is the highest tested dose (the amount of a substance per unit of body weight) or level of a contaminant that has been found to have no biologically significant health effects in exposed humans or animals with respect to their appropriate controls. If a NOAEL is not available, the agencies use the lowest observed adverse effect level (LOAEL), which is the lowest concentration or dose that showed biologically significant increases in harmful health effects with respect to the appropriate controls. Out of precaution, ATSDR and EPA divide the NOAEL or LOAEL by uncertainty factors to protect the most sensitive populations and to account for data gaps in the available health studies. These uncertainty factors could be thousands of times lower than the NOAEL or LOAEL. Therefore, MRLs and RfDs for hazardous substances are derived with large margins of uncertainty to protect public health. An alternative method to derive CVs is the benchmark dose modeling method (BMD) that uses the full range of exposure and health findings and relies on more advanced computer modeling than the NOAEL/LOAEL method. Use of BMD usually entails selecting a lower limit (conservative) of the dose associated with a 1% to 10% response in an animal assay or human study, and then dividing by uncertainty factors to account for differences between humans and animals or within humans, and other factors. This approach tends to have less uncertainty that the NOAEL/LOAEL approach.

MRLs are derived for "acute" or short-term (1-14 days), intermediate (15-364 days), and "chronic" or long-term (365 days and longer) periods for oral (ingestion) and inhalation routes of exposure. There are no MRLs for dermal (skin) exposure. MRLs are generally based on the most sensitive health effect that is relevant for humans. RfDs are estimates of daily oral exposures that are likely to be without a significant risk of harmful effects over the course of a lifetime and so RfDs generally apply to long periods of time.

Several of the contaminants had neither an MRL nor an RfD. Some of these contaminants, the metals in particular, are also essential nutrients for the human body at low levels (*e.g.*, copper, iron, selenium, zinc). However, at much higher concentrations they can be poisonous. For these "essential metals," EPHP used the National Academy of Sciences Institute of Medicine Dietary Reference Intake (DRI) tolerable upper intake levels as CVs. DRI upper intake levels are derived after reviewing the medical and scientific literature, and determining an upper intake level of a particular nutrient above which no adverse health effects are anticipated for the majority of the population. These DRIs, like MRLs and RfDs, often have uncertainty considerations in their derivation.

EPHP compared both essential and nonessential metals detected at the site to their respective CVs or CV equivalents. For lead, EPHP used the Centers of Disease Control and Prevention (CDC) reference level of 5 µg/dL (5 micrograms lead per deciliter blood) for children. The CDC states that there is no known safe blood lead level in children; however, the CDC has set the child reference level at the 97.5th percentile blood lead level of a nationwide sample of children. In other words, this level is above the majority (97.5%) of children 1-5 years of age in the U.S. In the past, the level of concern was 10 µg/dL of lead in blood. The new lower value means that more children will likely be identified as having lead exposure that warrant action allowing parents, doctors, public health officials, and communities to act earlier to reduce the child's future exposure to lead. The National Institute of Safety and Health (NIOSH) has set a reference level for adults at 10 µg/dL of lead in blood, though pregnant women and those women who plan to become pregnant should have as low a BLL as possible.

To calculate a daily exposure dose for SCM site users, EPHP used maximum detected concentrations for a contaminant for each exposure pathway (Appendix D, Tables D-1 through D-4) from years 2011 and 2012. The maximum was used as an initial screening tool to identify a maximum possible exposure assuming sustained exposure to the highest concentration in any one medium for both short term and long term periods. This exercise showed several chemicals to exceed their medium-specific CV. Those are arsenic and copper in intertidal sediment

(Appendix D, Table D-1); arsenic, cadmium, cobalt, iron, thallium, and vanadium in clams (Appendix D, Table D-1); cadmium and thallium in vegetation (Appendix D, Table D-2); and benzo(a)pyrene, benzo(b)fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene in clams (Appendix D, Table D-4).

However, for calculation of risk-based exposure calculations, EPHP averaged (arithmetic mean) contaminant concentrations from years 2011 and 2012 together to give one concentration for each contaminant in each medium sampled for the two years for clams, vegetation, sediment, and surface water. EPHP found that an average concentration best represents a value that can be used for calculating potential future exposure, as it incorporates data from both years and given the number of test samples, EPHP felt that the average concentration was an adequately protective value. Tables B-1 through B-3 in Appendix B show these average contaminant concentrations. EPHP then added exposures from each of the completed exposure pathways (Table 1a) for clams, surface water, sediment, and vegetation at the SCM site and compared the cumulative (added) exposure from all the pathways to the respective CV for each contaminant (Appendix B, Tables B-11 through B-15). EPHP did these calculations for children between 1 and 6 years old and for an adult to determine if age is a factor in health risks from contaminants at the SCM site. The calculated exposure doses and their comparison to CVs are shown in tables B-12 through B-15 in Appendix B. The equations EPHP used to calculate the exposure dose for each pathway, as well as the assumptions EPHP used for these calculations, are listed in Tables B-6 through B-10 in Appendix B.

Tables B-12 through B-17 (Appendix B) present the metal and PAH contaminants that EPHP evaluated for two exposure scenarios at the SCM site: 1) a person who consistently collects substantial amounts of clams and vegetation from this site only each year (called a "traditional user") and 2) a person who visits the site for recreational purposes (*e.g.*, hiking, sight-seeing) and collects vegetation and clams to a lesser extent than the traditional user (called a "recreational user").

Of the contaminants listed in the tables, only arsenic, cadmium, iron, and thallium are COCs, because their estimated exposure doses exceeded their respective CV. The other contaminants listed are *not* COCs, because their estimated exposure doses did *not* exceed their respective CV or they were non-detect (ND), meaning they were present in samples below a level that the testing lab could detect.

Site-Specific Exposure Data Sources and Assumptions

To determine whether contaminants at the SCM site pose a potential health risk to people who may use the area for recreational and/or customary and traditional purposes, EPHP used community interviews and surveys, as well as community harvest data, to calculate the health risks. It is important to use exposure information that is specific to a particular site, such as how often people visit the site, or what types of activities people engage in at the site, whenever possible. This type of site-specific information allows for a more tailored risk assessment that reflects the community's exposure scenarios rather than relying only on standard exposure assumptions.

Community interview and survey data

Between 2011 and 2013, several rounds of interviews and surveys were conducted with Kasaan residents to collect information about the historical and present day use of the SCM area. No other communities were included. Kasaan residents participated in two rounds of interviews in 2011 and 2012, and a community survey in 2012. In addition, information about how Kasaan residents harvested and consumed clams ("clamming practices") was collected in 2013. Findings from these data sources are summarized below and in Appendix A.

In 2011, ATSDR conducted seven in-person interviews in Kasaan to gather information about the customary and traditional use of the SCM area by Kasaan residents. Interviewees reported that residents historically used the site to harvest shellfish and other traditional foods until about 20 to 40 years ago. Besides shellfish, harvested foods included deer, crab, fish, shrimp, birds, eggs, berries, and plants (beach asparagus, goose tongue, seaweed). Today, Kasaan residents reportedly do not harvest shellfish from the mine site or any other area because of concerns about paralytic shellfish poisoning (PSP) from harmful algal blooms. Interviewees also mentioned that the mine site is harder to reach, compared to areas closer to Kasaan. In addition to harvesting traditional foods, interviewees reported other past activities at the SCM site, like beach-combing, swimming, picnicking, and camping by Kasaan residents.

In general, information from interviews with three elders and a community survey conducted in 2012 by ATSDR and EPA, respectively, echo the findings from the 2011 interviews: that Kasaan residents historically used the SCM site for customary and traditional purposes, but that more recent past and current use has been low to none (*i.e.*, not frequent). According to the survey results, the reasons for this are: 1) contamination concerns, 2) too difficult to reach/better subsistence areas nearby, and 3) PSP concerns. While there are conflicting accounts of how much people used the SCM site for traditional and customary purposes in the more distant past, there is general agreement that the site is used little today, at least among Kasaan residents.

In 2013, at the request of EPHP, the Kasaan environmental coordinator interviewed six residents about their clamming practices and clam consumption (individual results not reported). Questions included how often, how long, and during what time of year they harvested clams, what methods they used to gather clams, and how they consumed clams (*e.g.*, fresh, frozen, or canned). These surveys did not include questions about clam harvesting locations. The number of times people went clamming ranged from one to six times per year, typically during the fall and winter months, for two to several hours at a time. Most people used a shovel or rake, though one person harvested by hand. People ate clams fresh, frozen, smoked, and canned. EPHP used information from this survey to guide assumptions about future use of the SCM site for risk assessment purposes.

In conclusion, it appears that past and present use of the site is minimal, although it exists. EPHP assumes considerable future traditional use. EPHP did not collect information nontraditional (or recreational) use of the site, but assumed that past, present, and future uses would be constant among the different periods.

Community consumption rates for clams and vegetation

Consumption rates (or how much people eat per year, in this case) for clams and vegetation were not consistently available for Kasaan or Thorne Bay, so community harvest data (how much a community harvests) were used to estimate consumption rates of certain foods. Using yearly harvest data to estimate yearly consumption rates may over- or under-estimate how much a person eats because people may receive or give part of the harvest to other communities, discard part of the harvest, or not eat all of it in one year.

Tables 3a and 3b show a summary of 1998 harvest data for Kasaan and Thorne Bay for Kasaan and Thorne Bay (ADFG, 2014). Kasaan had higher harvest amounts of clams and vegetation than Thorne Bay. In 1998, Kasaan harvested 14.2 pounds (50th percentile) of clams (including cockles) and 24.0 pounds of vegetation (50th percentile) per person, while Thorne Bay harvested 0.6 pounds (75th percentile – 50th percentile was zero, so 75th percentile was used instead) of clams (including cockles) and 1.9 pounds of vegetation (50th percentile) per person.

According to ADFG (2014), 1998 harvest data represent current harvest trends better than those from 1987, which are also available for Kasaan and Thorne Bay. Therefore, EPHP used 1998 harvest data for all risk calculations. EPHP used the 50th percentile harvest data from 1998 for cancer risk calculations. These data were available for Kasaan. However, the 50th percentile of clam harvest data was zero for Thorne Bay. Therefore, EPHP used the 75th percentile clam harvest data for Thorne Bay.

For noncancer risk calculations, EPHP used the 1998 95th percentile data from both Kasaan and Thorne Bay (Tables 3a and 3b). Ideally, EPHP would use the 95th percentile harvest data for both cancer and noncancer risk estimates. However, when EPHP considered the likelihood of frequent high use of this site for high clam harvest on a life time basis, EPHP found it unlikely to be representative as Kasaan is relatively far from the SCM and the village residents do not harvest clams at SCM every year due to concerns of harmful algal blooms. Therefore, it is reasonable to use the 50th percentile harvest rate for cancer risk estimate purposes.

Table 3a. Clam harvest data for Kasaan and Thorne Bay – 1998

	95th Percentile Harvest		50th Percentile Harvest*	
Community	**Kasaan**	**Thorne Bay**	**Kasaan**	**Thorne Bay**
Type of Clams	**Clams and cockles**	**Clams and cockles**	**Clams and cockles**	**Clams and cockles**
Quantity of clams per person (Adult) (pounds/year)	26.9	10.5	14.2	0.6*
Quantity of clams per person (Adult) (grams/day)	33.4	13.0	17.7	0.8*

*EPHP used 75th percentile harvest data for Thorne Bay because 50th percentile harvest was zero.
Source: ADFG, 2014

Table 3b. Vegetation harvest data for Kasaan and Thorne Bay. Vegetation includes all types of vegetation. – 1998

	95th Percentile Harvest		50th Percentile Harvest	
Community	**Kasaan**	**Thorne Bay**	**Kasaan**	**Thorne Bay**
Quantity of vegetation per person (Adult) (pounds/year)	33.0	23.2	24.0	1.9
Quantity of vegetation per person (Adult) (grams/day)	41.0	28.9	29.8	2.3

Source: Alaska Department of Fish and Game (ADFG), 2014

Length of Use for the SCM site

EPHP assumed that a person would use the SCM site for 40 years for both recreational and traditional harvesting purposes. This is based on the 90th percentile of residence times obtained for Kasaan in 1998, the most recent year available. For Thorne Bay, it was shorter than 20 years [personal communication with the Alaska Department of Fish and Game (ADFG), 2013]. Kasaan and Thorne Bay residents may currently be living in their communities for shorter durations than in past times. For example, the average length of residence for Kasaan dropped from approximately 27.1 years in 1987 to approximately 17.7 years in 1998 (personal communication, ADFG analysis, 2013).

As mentioned above, EPHP evaluated exposure scenarios for "traditional" and "recreational" users of the SCM site. EPHP describes these scenarios, including the exposure assumptions EPHP made in this exposure assessment, below.

Traditional use exposure

People who engage in customary and traditional clam and vegetation harvesting from the SCM site may be exposed to contaminants from:

1. Eating clams and/or vegetation harvested from the site (Kasaan data used)
2. Coming into skin contact with sediment while harvesting and cleaning the clams and/or recreating at the site
3. Accidentally swallowing sediment while harvesting and cleaning the clams and/or recreating at the site (this also accounts for incidental inhalation of sediment)
4. Drinking surface water from the upland or intertidal areas
5. Coming into skin contact with surface water while harvesting and cleaning clams and/or recreating at the site

EPHP assumed that a traditional user would:

- Visit the site six times per year to harvest clams and vegetation for 40 years
- Consume 26.9 pounds of clams and 24.0 pounds of vegetation per year harvested from the site (ADFG, 2014) for an adult or the EPA age-specific adjusted consumption rates for a child (approximately 6.4 pounds of clams and 4.0 pounds of vegetation per year, respectively; Appendix B, Table B-6).
- Consume two liters of surface water from the site (a little more than two quarts) per visit for an adult or one liter of water (a little more than one quart) per visit for a child. EPHP averaged contaminant concentrations in surface water from both the upland and intertidal areas of the site, as EPHP assumed that a SCM site visitor would drink from both locations.

EPHP also analyzed incidental sediment ingestion and dermal absorption that may occur while harvesting clams. EPHP used ATSDR's default soil adherence factors (Appendix B, Table B-10) and soil intake rates (Appendix B, Table B-8) for adults and children. The ATSDR soil adherence value for adults is equal to EPA's value for adult gardeners, while the ATSDR soil adherence value for children is equal to EPA's value for children playing in wet soil (ATSDR, 2005; EPA, 2004) (see Appendix B, Tables B-6 through B-10 for assumptions used).

Recreational use exposure

For recreational users, EPHP used the same exposure scenarios as the traditional user (described above), such as the type of activities engaged in while at the site, the number of visits to the site each year, and the amount of surface water consumed from the site. The only difference was the recreational user would consume 1.9 pounds of vegetation per year for an adult, based on Thorne Bay harvest data (ADFG, 2014).

Public Health Implications

Evaluation of Noncancer Risks

To evaluate possible noncancer risks from traditional and recreational use of the SCM site, EPHP compared the cumulative daily dose expected from exposure to the individual contaminants to their respective CV (ATSDR's ingestion MRLs, or substitutes if MRLs were not available; *e.g.*, RfDs, DRIs). MRLs and RfDs are expressed in exposure concentrations of milligrams per kilogram of body weight per day (mg/kg/d). Daily exposure doses were calculated for each age group depending on the age group's characteristics, such as differences in body weight, food intake rates, likelihood to ingest dirt, and body part surface area (ATSDR, 2005). All characteristics and assumptions are in Appendix B, Tables B-6 through B-10.

The five exposure pathways that EPHP considered are outlined in the Site-Specific Exposure Data Sources and Assumptions section.

EPHP also used a calculation called the hazard quotient (HQ) to measure whether the various activities and food intake, combined with the contaminant level, could pose a health risk. The HQ is the ratio of the potential exposure to the substance to the level at which no adverse health effects are expected (Equation 1).

Equation 1: Calculated Hazard Quotient (HQ):

$$HQ = (\text{Chronic Daily Dose of contaminant})/CV$$

Where,

Chronic Daily Dose = Amount of contaminant ingested daily on a chronic basis per kilogram body weight
CV = Contaminant's comparison value

If the HQ equals 1 or less ($HQ \leq 1$), then no adverse health effects are expected. If the HQ is greater than 1 ($HQ > 1$), then adverse health effects are possible. It is important to note that an HQ greater than 1 does not necessarily mean that adverse health effects will occur. Equations used to calculate exposures from the different pathways are in Appendix B, Tables B-6 through B-10.

Evaluation of Cancer Risks

To evaluate possible cancer risks from traditional and recreational use of the SCM site, EPHP calculated the excess cancer risk that could be associated with the cumulative daily dose expected from exposure to the individual contaminants over a lifetime. Daily exposure doses were multiplied by each contaminant's cancer slope factor (CSF), an estimate of the risk of cancer associated with exposure to a carcinogenic or potentially carcinogenic substance. As opposed to noncancer risk that may occur within hours to several years after repeated exposure to an agent, cancer risk is calculated based on multi-year exposure (40 years in this consultation). Therefore, for the clam consumption rate, EPHP considered the 50th percentile consumption available for 1998 the year that most likely reflects current consumption (ADFG, 2014). Use of the 50th percentile rather than the 95th percentile, for example, is justified by little current use of the site due to fears from harmful algal blooms and availability of alternative sites for shellfish harvest. The daily exposure dose was calculated for each age group depending on the age group's characteristics, such as differences in body weight, food intake rates, likelihood to ingest dirt, and body surface area (ATSDR, 2005). Specific parameters and assumptions used are in Appendix B, Tables B-6 through B-10. The exposure pathways that EPHP considered are outlined under Site-Specific Exposure Data Sources and Assumptions section.

CSFs are used to estimate the risk of cancer associated with exposure to a cancer-causing or potentially cancer-causing substance. EPHP calculated the possible cancer risks associated with contaminants at the site by using the following equations 2 and 3:
Equation 2: Calculated possible cancer risk (individual contaminant) =

$$EF \times \text{Chronic Daily Dose} \times CSF$$

Where,
EF = Exposure Factor
Chronic Daily Dose = Amount of contaminant ingested daily on a chronic basis per kilogram body weight
CSF = Cancer Slope Factor

Equation 3: Calculated possible cancer risk (combined contaminants) =

$$TECR = \Sigma CR_X$$

Where,
TECR = Total excess cancer risk
ΣCR_X = Sum of possible cancer risks from individual contaminants

The resulting risk of cancer is called an excess cancer risk because it is the risk of cancer above the already existing background risk of cancer. The risk could also be zero. Therefore, one interprets the excess cancer risk as being between 0 and some number for every defined number of people (usually for every 10,000, 100,000, or 1,000,000 people) who are exposed to a contaminant or contaminants over their lifetime (70 years). According to the National Cancer Institute, the background risk of cancer in the U.S. population is about 1 in every 2 men and 1 in every 3 women over a lifetime (NCI, 2014). The estimated cancer risk from the equations above is in addition to this background cancer risk.

If the TECR equals 1 in 10,000 exposed or less (*e.g.*, 1 in 100,000 or 1 in a 1,000,000) then the cancer risk is considered very low or insignificant. If the TECR is greater than 1 in 10,000 exposed (*e.g.*, 1 in 1,000 or 1 in a 100) then that population may be at increased cancer risk. It is important to note that a cancer risk greater than 1 in 10,000 does not necessarily mean that adverse health effects like cancer will occur.

Exposure Factors Used in Exposure Calculations

Absorption factors

The human body does not absorb (take in) all contaminants equally or completely. Some contaminants that enter the body are excreted (removed) with little absorption, while other contaminants are fully absorbed. Thus, a given amount of contaminant ingested in food, for example, may or may not pose a health risk, depending on the contaminant's absorption factor from ingestion. The absorption factor for a contaminant reflects the fraction or portion of the amount of contaminant that the body is expected to absorb, depending on the route of exposure, such as ingestion, inhalation, or dermal contact. An absorption factor of 1 means that the body absorbs 100% of a contaminant, while an absorption factor of less than 1 (*e.g.*, 0.5) means that a portion less than 100% is absorbed. Absorption factors for contaminants are important to consider when determining whether exposure to those contaminants could pose a health risk at the levels detected.

Clam and vegetation ingestion

EPHP used an absorption factor of one for all metals (clam and vegetation) and PAHs (clam), which means EPHP assumed complete absorption through the gut. EPHP assumed complete absorption of these contaminants either based on scientific studies that suggest complete absorption or out of precaution when EPHP could not find absorption information on that contaminant.

Sediment Ingestion

A contaminant may be less bioavailable (absorbed) from sediment or soil than it is in food. This depends on the physical form of the contaminant and on how tightly the contaminant is bound to the matrix, in this case the sediment. For all metals except arsenic, EPHP used an absorption factor of 1, which assumes that the body completely absorbs the metals from sediment. EPHP used an absorption factor of 0.6 for arsenic, as suggested by the EPA (EPA, 2012b). This means that 60 percent of the arsenic consumed during sediment ingestion is absorbed into the body.

Dermal adsorption from sediment

The skin acts as a defense barrier against many chemicals that come in contact with the body. Some chemicals are barely absorbed, while others are readily absorbed. Table B-5 in Appendix B shows the dermal absorption factors that EPHP used for several metals (arsenic, cadmium, and copper) and for PAHs that are not completely absorbed through the skin. For contaminants not mentioned in the dermal exposure pathway section of the table, EPHP assumed complete, 100 percent absorption. When adding contributions from all exposures to any one contaminant at the SCM site, EPHP divided the dermal absorbed dose by the gastrointestinal absorption factor for that contaminant so that this dose would be comparable to an oral CV.

Evaluating the Contaminants of Concern

As discussed earlier, the COCs at the SCM site are arsenic, cadmium, iron, and thallium. For each COC, EPHP describes its health effects and evaluate its noncancer and cancer risks for traditional users and recreational users separately, using the site-specific exposure scenarios described above.

Arsenic

Arsenic is an element that is naturally present in the earth's crust. In soil and water, arsenic is usually attached to other elements like oxygen, chlorine, and sulfur to make inorganic arsenic compounds. In animals and plants, arsenic is usually attached to carbon and hydrogen to form organic arsenic compounds. The main form of arsenic in fish and shellfish (including clams) is the relatively non-toxic organic form. Inorganic arsenic compounds are mostly used as wood preservatives, such as in "pressure-treated" lumber for industrial purposes. Organic arsenic compounds are naturally occurring in marine environments (ATSDR, 2007).

According to EPA personnel, arsenic is not associated with mine-related releases at Salt Chuck Mine. The reasons include: 1) EPA sampling efforts from SCM during 2011 and 2012 revealed that arsenic sediment levels were consistent with naturally-occurring levels; and 2) there is no spatial association between concentrations of arsenic and copper, which is a definitive signature of mine-related releases at the SCM site.

Arsenic Health Effects

Exposures to higher than background levels of arsenic occur mostly in certain industries, near hazardous waste sites, or in areas with high natural levels of arsenic. Very little is known about the health effects of organic arsenic compounds in humans. Simple organic arsenic compounds are less toxic than inorganic arsenic in animals (ATSDR, 2007).

Studies have shown that ingestion of inorganic arsenic can increase the risk of skin, liver, bladder, and lung cancer. Inhalation of inorganic arsenic can cause increased risk of lung cancer. National and international agencies such as the EPA, the Department of Health and Human Services, and the International Agency for Research on Cancer have determined that inorganic arsenic is carcinogenic to humans (ATSDR, 2007).

Arsenic noncancer considerations

Traditional User

The levels of arsenic found at the SCM site are not expected to harm the health of a traditional user of the mine site. This is because the chronic daily exposure dose of arsenic for a traditional user did not exceed the ATSDR chronic MRL for arsenic of 0.0003 mg/kg bw/day (Appendix B, Table B-12). The calculated HQs for noncancer arsenic effects are less than 1 (0.6 for both adults and children; Appendix B, Table B-12).

Recreational User

Similarly, arsenic is not expected to harm the health of a recreational user of the mine site. The chronic daily exposure dose of arsenic for a recreational user did not exceed the ATSDR chronic MRL for arsenic and the calculated HQs for noncancer arsenic effects are less than 1 (0.2 for both adults and children ; Appendix B, Table B-13).

Arsenic cancer considerations

Traditional User

The chronic daily exposure dose of arsenic for a traditional user of the SCM site from multiple routes and sources indicates that arsenic could pose a cancer risk of more than one additional cancer in a million persons exposed during their lifetime. The estimated excess cancer risk for a traditional user is 8 in 100,000 (Appendix B, Table B-16). This cancer risk is an additional or "excess" cancer risk because it is the risk of cancer above the already existing background risk of cancer. Therefore, a possible cancer risk of 8 in 100,000 means that for every 100,000 traditional users of the SCM site over a 40-year period, there may be between 0 and 8 additional cases of cancer due to the exposure. This level of risk is generally regarded as low. This risk characterization is supported by the uncertainty factors and conservative assumptions in both this evaluation of cancer risk and the arsenic cancer slope factor derivation.

Eating the full quantity of clams per year (26.9 pounds per adult) used in this consultation for traditional users in the form of softshell clams may be associated with increased health risks in some *traditional* users. As noted above, softshell clams had the highest average inorganic arsenic content, at 19% of total arsenic. An adult who eats more than 14 pounds of softshell clams each year for a 40-year period may have a marginally increased cancer risk from arsenic exposure. A child who eats more than 6 pounds of softshell clams for a year or longer be at increased risk of noncancer health effects from arsenic exposure (please see Appendix C for calculations).

Recreational User

The chronic daily exposure dose of arsenic for a recreational user of the SCM site from multiple routes and sources indicates that arsenic could pose a cancer risk of more than one additional cancer in a million persons exposed during their lifetime. The estimated excess cancer risk for a recreational user is 4 in 1,000,000 (Appendix B, Table B-17). This cancer risk is an additional or "excess" cancer risk because it is the risk of cancer above the already existing background risk of cancer. Therefore, a possible cancer risk of 4 in 1,000,000 means that for every 1,000,000 recreational users of the SCM site over a 40-year period, there may be between 0 and 4 additional cases of cancer due to the exposure. This level of risk is generally regarded as very low.

Cadmium

Soil, rock, and sediment, as well as coal and mineral fertilizers, contain some cadmium. In the United States, most cadmium is extracted during other metal production, like zinc, lead, and copper. Cadmium does not corrode easily and is used in many products, such as batteries, pigments, metal coatings, and plastics.

Cadmium Health Effects

In the United States, the primary source of cadmium exposure for nonsmokers is from the food supply. In general, leafy vegetables such as lettuce and spinach, potatoes and grains, peanuts, soybeans, and sunflower seeds contain high levels of cadmium, approximately 0.05–0.12 mg cadmium/kg (ATSDR, 2012).

Long-term exposure to levels of cadmium above acceptable health guidelines in air, food, or water can lead to a buildup of cadmium in the kidneys. If the build-up of cadmium is high enough, it will damage the kidneys. Exposure to lower levels of cadmium for a long time can also cause bones to become fragile and break easily (ATSDR, 2012).

The U.S. Department of Health and Human Services and the International Agency for Research on Cancer have determined that cadmium and cadmium compounds can cause cancer. The EPA determined that cadmium is a probable human carcinogen. The risk of cancer from cadmium is known to result only from breathing in air contaminated with cadmium.

Cadmium noncancer considerations

Traditional User

The levels of cadmium found at the SCM site are not expected to harm the health of a traditional user of the mine site. Although the chronic daily exposure dose of cadmium for a traditional user exceeded the ATSDR chronic MRL of 0.0001 mg/kg bw/day (Appendix B, Table B-12) and the calculated HQs for noncancer cadmium effects are 1.1 for both an adult and a child, this does not mean that adverse health effects are expected, for a couple of reasons. First, the ATSDR MRL for cadmium is based on a dietary intake of 0.00033 mg/kg bw/day, divided by an uncertainty factor of 3 (for interhuman variability) to produce the MRL of 0.0001 mg/kg body weight/day. In comparison, EPA (1994) has a RfD, for cadmium of 0.001 mg/kg bw/day that is 10 times higher than ATSDR's MRL. This RfD was derived by a similar method to ATSDR's, and considers several studies of cadmium ingestion. The EPA RfD reflects an uncertainty factor of 10 to account for variability in adverse responses among people. The chronic daily exposure dose of cadmium for a traditional user of the SCM site does not exceed this RfD.

Second, one apparently could exceed the MRL if they consumed approximately 15 grams of sunflower seeds on a daily basis (ATSDR, 2012; Reeves and Vanderpool, 1997). Third, an average adult living in the U.S. has a cadmium urine concentrations that is higher than what they would be expected to have if they were exposed at the ATSDR MRL for cadmium (CDC, 2013; ATSDR, 2012). Exceeding this or any other chronic MRL does not mean that adverse health effects will occur.

Recreational User

The levels of cadmium found at the SCM site are not expected to harm the health of a recreational user of the mine site. This is because the chronic daily exposure dose of cadmium for a recreational user did not exceed the ATSDR chronic MRL for cadmium of 0.0001 mg/kg bw/day (Appendix B, Table B-13). The calculated HQs for noncancer cadmium effects are 0.5 for both an adult and a child (Appendix B, Table B-13).

Cadmium cancer considerations

Cadmium has been associated with increased cancer risk in some occupational studies involving workers, and in toxicology studies where people and animals were breathing air containing cadmium. However, studies where animals ingested water containing cadmium did not show evidence of cancer in these animals (EPA, 1994; ATSDR, 2012) and human epidemiology studies do not provide adequate support for cadmium-associated carcinogenicity (ATSDR, 2012). As SCM site users are not expected to breathe in water droplets or soil particles that would contribute substantially to their cadmium exposure, cadmium is not of cancer concern at this site and therefore EPHP did not evaluate cancer risks from cadmium.

Iron

Iron is one of the most common elements on earth. Iron is the most widely used of all the metals, accounting for 95 percent of worldwide metal production. It is an essential material in engineering applications such as the construction of machinery and machine tools, automobiles, large ship hulls, and structural components for buildings. Pure iron can be combined with alloying elements to make steel.

Iron Health Effects

Iron is essential to most life forms and to proper body functioning, such as in oxygen transport and cell growth. Low iron in the body can limit oxygen delivery to cells, resulting in fatigue, poor work performance, and decreased immunity. On the other hand, too much iron in the body can be harmful. Most of iron in the body is in hemoglobin, the protein in red blood cells that carries oxygen to the different parts of the body. Some iron is also in myoglobin, a protein that helps supply oxygen to muscle. Iron is also in proteins that store iron for future needs and that transport iron in blood (NIH, 2007). Foods rich in iron include fortified cereal, animal livers, beans, and spinach (USDA, 2002). The National Academy of Sciences Institute of Medicine has established a Daily Tolerable Upper Intake Level for iron of 40-45 mg/day based on reported gastrointestinal effects like stomach cramps, diarrhea, vomiting, and abdominal pain from iron supplements ingested daily for several weeks (NAS, 2001).

Iron noncancer considerations

Traditional User

The levels of iron found at the SCM site are not expected to harm the health of a traditional user of the mine site. As iron is an essential element, EPHP used the Daily Tolerable Upper Intake Level as a CV. The chronic daily exposure dose of iron for a traditional user of the SCM site exceeded the Daily Tolerable Upper Intake Levels for iron of 0.64 mg/kg bw/day for an adult, but not of 2.5 mg/kg bw/day for a child (Appendix B, Table B-12). The calculated HQs for noncancer iron effects are 1.2 and 0.3 for adult and child, respectively. Because the HQ is less than 1 for a child, iron exposure is not expected to harm the health of a child traditional user of the SCM site.

Although the daily chronic intake for an adult exceeded the respective CV, this does not mean that adverse health effects are expected. The Daily Tolerable Upper Intake Level is based on several studies of supplemental iron ingestion without food (NAS, 2001). Taking iron supplements in the absence of food is more likely to cause abdominal problems because food may affect the body's ability to absorb iron, depending on the content of the food; for example, iron is less well absorbed when a high amount of calcium is present.

In addition, the amount of iron that a traditional user could be exposed to from the SCM site, mainly from eating harvested clams, is within the range of some diets. For example, if it is considered that someone eats a serving each of fortified cereal (4.5 - 18 mg iron per serving), beans (3.6 - 8.8 mg iron per serving), canned clams (12 - 24 mg iron per serving), spinach (3.2 mg iron per serving; NIH, 2007; USDA, 2002), and other items rich in iron, he or she would likely exceed this Daily Tolerable Upper Intake Level of iron.

Further, the physical and community-derived benefits of harvesting and sharing clams and vegetation should be considered when weighing a small increase of iron consumption above the recommended Daily Tolerable Upper Intake Level. A relatively high iron intake may help address the iron deficiency that is found among some Alaska Natives (DiGirolamo *et al.*, 2007). The body regulates iron reserves in the body by intestinal iron absorption, so the body will often not absorb excess iron that it does not need (Miret *et al.*, 2003; NAS, 2001).

Recreational User

The levels of iron found at the SCM site are not expected to harm the health of a recreational user of the mine site. This is because the chronic daily exposure dose of iron for a recreational user did not exceed the Daily Tolerable Upper Intake Level for iron of 2.5 mg/kg bw/day or 0.64 mg/kg bw/day for an adult and child, respectively (Appendix B, Table B-13). The calculated HQs for noncancer iron effects are 0.5 and 0.1 for an adult and a child, respectively.

Iron cancer considerations for the Salt Chuck Mine Site

There are no cancer considerations for iron because it is not a carcinogen.

Thallium

Pure thallium is an odorless and tasteless bluish-white metal that is found in trace amounts in the earth's crust. It can also be found combined with other substances, such as bromine, chlorine, fluorine, and iodine. When combined, it appears colorless-to-white or yellow. In the past, thallium was obtained as a by-product from smelting other metals; however, it has not been produced in the United States since 1984. Currently, all the thallium is obtained from imports and from thallium reserves.

Thallium is used mostly in manufacturing electronic devices, switches, and closures, primarily for the semiconductor industry, in addition to some use in special glass manufacturing and for certain medical procedures.

Thallium Health Effects

The health effects of ingesting low levels of thallium over a long time are not well known. Birth defects were not reported in the children of mothers exposed to low levels from eating vegetables and fruits contaminated with thallium (EPA, 2009). However, studies in rats exposed to high levels of thallium showed adverse developmental effects (EPA, 2009).

No adequate studies are available in people or animals on the carcinogenic effects of thallium (EPA, 2009).

Thallium non-cancer considerations

Traditional User

ATSDR does not have an MRL for thallium, so the EPA RfD was used for comparison purposes. The chronic daily exposure dose of thallium for a traditional user of the SCM site exceeded the EPA RfD for thallium of 0.00001 mg/kg bw/day (Appendix B, Table B-12). The calculated HQs for noncancer thallium effects are 1.9 and 2.0 for adult and child, respectively. Although these calculations suggest that thallium from the SCM site could pose a health risk, a closer look at how EPA derived its RfD for thallium suggests otherwise.

The EPA did not officially derive an RfD for thallium because the available toxicity studies for thallium were generally of poor quality (EPA, 2009). The EPA proposed an RfD of 0.00001 mg/kg bw/day based on hair follicle atrophy in rats with alopecia (hair loss). This RfD includes a 3,000-fold uncertainty factor to reflect all the scientific uncertainty surrounding this value. This value is also used as an EPA regional screening value (EPA, 2013a).

Given these limitations, EPHP conclude that the levels of thallium found at the SCM site do not pose a health risk for traditional users.

Recreational User

The chronic daily exposure of a recreational user of the SCM site to thallium from multiple routes and sources did not exceed the EPA RfD for thallium of 0.00001 mg/kg bw/day (Appendix B, Table B-13). The calculated HQs for non-cancer thallium effects are 1.0 for adults and 1.1 for children respectively (Appendix B, Table B-13). Because of the uncertainty in the proposed EPA RfD due to the uncertainty factors that are inherent in the proposed value, thallium exposure is not expected to harm the health of recreational users of the SCM site even though the HQ for children is 1.1.

Thallium cancer considerations

The Department of Health and Human Services, the International Agency for Research on Cancer, and EPA have not classified thallium's human carcinogenicity. It is not known if thallium is a carcinogen. Therefore, there is no adequate information to guide an evaluation of thallium cancer risk for this health consultation.

Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls

Although PAHs are *not* COCs at the SCM site, EPHP compared PAHs detected at the site to CVs, as there were several samples with detectable levels of PAHs. EPHP presents briefly the evaluation of risk from exposure to PAHs at the SCM site. Tables B-14 through B-17 (Appendix B) show both the noncancer and cancer calculated risks for traditional and recreational users, respectively. Some of the chemicals are lacking either a noncancer CV or a cancer CV, so EPHP could not evaluate several of the chemicals detected at the SCM site. For those PAHs that had CVs, none of them had a HQ of 1 or greater (HQ ≥ 1). Also, none of the PAHs or PCBs had a cancer risk ≥ 1 excess cancer in a million exposed except for benzo(a)pyrene and dibenz[a,h]anthracene which rose to risks of 7 in a million and 2 in a million, respectively. Neither chemical was actually detected by the lab test method used in analyzing the clam samples (the main contributor to dose from the SCM site) collected in 2011 and 2012. The number assumed for risk calculations was the limit of detection of the lab chemical analytical method used for these chemicals. Therefore, PAHs are not COCs and PAH exposure from the SCM site is not expected to harm the health of either traditional or recreational users. Test results for PCBs were mainly below the detection limit of the chemical analytical method used and were therefore not considered COCs.

Children's Health Considerations

Children may be at greater risk than adults from exposure to hazardous substances. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their exposure to hazardous substances. Young children can breathe in dust, soil, and vapors found closer to the ground. Their smaller size, higher breathing rate, and higher water and food intake result in a greater dose (amount) of hazardous substance per unit of body weight, compared to adults. An unborn child (fetus) can sustain permanent damage if toxic exposures are high enough during critical growth stages. Exposure during key periods of growth and development could lead to organ damage and early death. A pregnant woman may expose the fetus to hazardous substances through the placenta, and a nursing mother may expose her young child through breast milk.

The main concern for children's health at the SCM site is their lower body weight and higher likelihood of ingesting soil or sediment from the site, or eating more clams than adults relative to their body weight. However, from EPHP's calculations, it does not appear that children are at higher risk than adults from either consuming clams and vegetation or ingesting contaminated sediment from the site. Children's exposures to contaminants from the SCM site are not anticipated to pose a health risk.

Uncertainties, Limitations, and Data Gaps

1. It is unlikely that people would harvest clams and vegetation only from the SCM site. Therefore, their exposure to SCM contaminants from clam and vegetation consumption is expected to be lower than the outcomes of this evaluation. In addition, EPHP assumed that people would eat a variety of all clams at the site while in fact some may have a preference for one type over the other. Eating only one type of clam, specifically softshell clams, may result in a different risk level than the current calculations indicate.
2. Because site-specific consumption data were not available for this risk assessment, EPHP took a conservative approach in calculating cancer risks by assuming that a person would eat a generous quantity of clams daily for a 40-year lifetime. This approach is likely to overestimate risk because:
    a. Residents in communities near SCM have been staying in their communities for fewer years in recent times than they did in the past. This suggests that people would likely be exposed to site contaminants for fewer than 40 years in the future.
    b. Contaminant concentrations at the site will likely be lower in the future because of proposed cleanup activities by EPA for the site.
    c. The clam consumption rate based on community harvest data that EPHP used is likely an overestimation as this assumes no clams go bad or are thrown away.
3. Without reliable information on clam and other food consumption rates for communities near SCM, the evaluation of human health risks posed by contaminants in these foods may not be representative for these communities.
4. EPHP assumed that people would be likely to consume clams and other foods collected at the site containing the full range of contaminant concentrations present at the SCM site, while in reality people may be consuming less or more depending on where they harvest the foods.
5. EPHP assumed that people would visit the site six times per year, while the actual number of visits may range from no visits to more than six visits.
6. EPHP based the vegetation calculations on sparse data. More data may have shifted the risk higher or lower than in this evaluation.
7. Inorganic arsenic content in softshell clams is higher in clams from the Salt Chuck Bay area; however, only three softshell clam samples from each area (Salt Chuck Bay and

Brown's Bay) were analyzed for arsenic content. Due to the small sample size, comparisons in arsenic content for clams from different areas are uncertain.

8. EPHP assumed that traditional and recreational use of the site would be well-represented in harvest data available for 1998, while this may not reflect a standard year's harvest and consumption.
9. EPHP assumed recreational use to be comparable to Thorne Bay harvest data as the Thorne Bay community is not traditionally reliant on clams for customary and traditional use. Therefore, EPHP assumed that their harvest was "recreational" use.
10. EPHP assumed that contaminants absorbed dermally would have cancer and noncancer effects as if they were absorbed through the gastrointestinal tract. This is not necessarily true, as toxicity of a contaminant usually varies by how it enters the body (route of exposure).
11. There are uncertainties inherent to the derivation of CVs, such as the ATSDR MRLs and US EPA RfDs. To derive CVs, ATSDR and US EPA use what is called the no observed adverse effect level (NOAEL), which is the *highest* dose or level of a contaminant that has been found to have *no* harmful health effects in humans or animals. They also use the Lowest Observed Adverse Effect Level, which is the lowest dose or level that had any adverse effect. Out of precaution, ATSDR and US EPA divide the NOAEL or LOAEL by uncertainty factors to protect the most sensitive populations and to account for data gaps in the available health studies. These could include uncertainties in extrapolating from findings of an animal study to humans or to account for variability among humans. Therefore, MRLs and RfDs for hazardous substances are derived with large margins of safety to protect public health.

While this evaluation is useful for assessing risks to metals exposure for people who eat the specific types of clams and vegetation harvested from the area, there are many other potential traditional and customary resources that have not been tested. Fish, shrimp, birds, and eggs are present but were not sampled. Obtaining data for these species is important to get a more accurate assessment of the potential health effects of using the SCM for both traditional and recreational purposes. In May of 2013, EPA collected samples of dungeness crab and while concentrations of arsenic were found in the crab tissue, inorganic arsenic was not detected in any of the samples (EPA, 2014). EPHP therefore did not evaluate crab consumption in this health assessment.

The town of Thorne Bay has access to the site via road and trail, and Kasaan is 10 miles from the site by boat. Subsistence harvest survey data are available from the ADFG for the communities of interest, but is often limited to one or two years and potentially outdated. In addition, harvest rates do not equate directly to consumption rates. Furthermore, an annual per capita harvest rate cannot inform seasonal consumption, which is important when considering duration of exposure.

Without sufficient traditional use and harvest data, EPHP cannot adequately assess human health risk from eating *all* foods in the area. The consumption of clams may be only one of several completed exposure pathways. Even if clams are the only foods harvested, EPHP cannot account for future harvest of other biota from the area. In addition, surveys of benthic community assemblages (*i.e.* organisms living on the bottom of these water bodies) were not performed, so it is not known what other species may be present and harvested.

Conclusions

- Harvesting and consuming a variety of sampled clams and vegetation from the SCM site is not expected to harm the health of traditional users (who regularly collect substantial amounts of clams and vegetation from this site only) from exposure (contact with) to metals, PAHs, and PCBs. Risk evaluation for traditional users of the SCM site indicated possibly marginally elevated noncancer risks from SCM site use, particularly from eating clams. However, EPHP does not find that the health of users is at risk when considering the size of the calculated risk and the uncertainties and assumptions incorporated in this evaluation.
- An adult eating more than 14 pounds or a child eating more than 6 pounds of softshell clams per year harvested from the SCM site may have increased health risks from inorganic arsenic ingestion.
- Traditional site users having certain liver and iron metabolism diseases may be at elevated (higher) risk of chronic (long-term; >1 year) iron toxicity if they plan to consume large quantities of clams from the SCM site.
- Use of the Salt Chuck Mine site for recreational purposes (including occasional harvesting and consumption of small amounts of clams and vegetation) is not expected to harm the health of the users.

Recommendations

The State of Alaska EPHP recommends:

- Consumption of only commercially harvested shellfish that have been screened for the presence of paralytic shellfish poison (PSP). Harvesting shellfish (including clams) from the SCM site or other sites could lead to adverse health effects from PSP. PSP is not related to the Salt Chuck Mine site.
- People eat a variety of clam types. Eating only softshell clams at the full yearly intake estimate (*e.g.,* 26.9 pounds per year for an adult) may be associated with increased health risks from inorganic arsenic exposure.
- Individuals with the following conditions consult with their physician if they plan to consume *large* quantities of these clams on a *long-term* basis: hereditary hemochromatosis; chronic alcoholism, alcoholic cirrhosis, and other liver diseases; iron-

loading abnormalities, particularly thalassemias; congenital atransferrinemia; and aceruloplasminemia. These individuals are susceptible to the adverse effects of excess iron intake. Clams from the SCM site contain levels of iron that are higher than most foods and may contribute excess dietary iron that could be associated with adverse health effects in these individuals.

- Samples of fish, shrimp, birds, and eggs may be collected and tested for the same contaminants evaluated in clams, water and sediment. These data would provide a more complete dietary exposure scenario particularly for the traditional user.

Public Health Action Plan

Actions Undertaken

EPHP staff

1. Attended community meetings to get a better understanding of people's concerns about the site and to address any community questions.
2. Participated in EPA meetings and discussions on cleanup options for the SCM site.

Actions Planned

1. EPHP staff will disseminate the findings from this health consultation to the communities that would be most likely to use the SCM site in the future.
2. EPHP staff will address any community concerns about the health risks and benefits of using the SCM site for both traditional and recreational purposes.

Report Preparation

This Health Consultation for the Salt Chuck Mine site was prepared by the Alaska Department of Health and Social Services, Division of Public Health, Environmental Public Health Program (EPHP) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

Authors

Stacey Cooper, MS
Health Assessor, EPHP
Section of Epidemiology, Division of Public Health
Alaska Department of Health and Social Services

Ali Hamade, PhD, DABT
Manager, EPHP
Section of Epidemiology, Division of Public Health
Alaska Department of Health and Social Services

ATSDR Reviewers

Division of Community Health Investigations (DCHI)

Alan Parham, MPH, Technical Project Officer
Kai Elgethun, PhD, MPH, Western Branch Associate Director for Science
Lynn Wilder, PhD, Division Associate Director for Science
Tina Forrester, PhD, Deputy Division Director

Acknowledgements: EPHP would like to thank Nim Ha, Todd Hudson, Karen Keeley, Lon Kissinger, Lenford O'Garro, Anne Marie Palmieri, Joe Sarcone, Dennis Shelton, Paul Townley, and Ted Wu for their very helpful comments on this health consultation. EPHP would also like to thank Joe Sarcone for his community efforts and helpful information.

References

1. ADFG, 2013. Personal communication with David Koster, Division of Subsistence, October 2nd, 2013.
2. ADFG, 2014. Personal communication with David Koster Division of Subsistence, April, 2014.
3. Alaska Department of Natural Resources (ADNR). 1998. Prince of Wales Island Area Plan. ADNR Div. Of Mining, Land, and Water, Resource Assessment and Development Section. Originally approved June 1985, revised October 1998.
4. Agency for Toxic Substances and Disease Registry. 2003. Barton Springs Pool Health Consultation. Austin, Travis County, Texas. http://www.atsdr.cdc.gov/HAC/pha/pha.asp?docid=59&pg=1#refs
5. Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for Copper. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
6. Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Public Health Guidance Manual (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
7. Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological profile for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
8. Agency for Toxic Substances and Disease Registry, 2012. ATSDR Dose Calculator. http:// http://www.atsdr.cdc.gov/sites/brownfields/dose_calculator.html
9. Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
10. Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Vanadium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
11. Agency for Toxic Substances and Disease Registry (ATSDR). 2013. Toxic Substances Portal. http://www.atsdr.cdc.gov/mrls/index.asp (Accessed on 10/5/2013).
12. Bureau of Land Management (BLM). 1998. Final Report, Removal Preliminary Assessment, Salt Chuck Mine. Ketchikan Ranger District, Tongass National Forest, Region 10 – Alaska. Prepared by BLM, Juneau Field Office, Interagency Agreement No. 961A-10-012.
13. Battelle and Exponent, 2000. Guide for Incorporating Bioavailability Adjustments into Human Health and Ecological Risk Assessments at U.S. Navy and Marine Corps Facilities, Part 1: Overview of Metals Bioavailability p. 2-9.
14. Centers for Disease Control and Prevention (CDC). 2013. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables, (September, 2013). Atlanta, GA: U.S. Department of
15. Health and Human Services, Centers for Disease Control and Prevention. http://www.cdc.gov/exposurereport/
16. CH2M HILL, 2012. Salt Chuck Mine – Preliminary Findings for Pre-Remedial Investigation 2011 Field Sampling Activities.
17. CH2M HILL, 2013a. Salt Chuck Mine – Preliminary Findings for 2012 Remedial Investigation Field Sampling Activities - Draft

18. CH2M HILL, 2013b. Risk Assessment Work Plan, Salt Chuck Mine Remedial Investigation.
19. DCCED. 2013. Department of Commerce, Community, and Economic Development Online Community Database. http://www.commerce.state.ak.us/cra/DCRAExternal/Community
20. Debetto P, Arslan P, Antolini M, Luciani S. 1988. Uptake of chromate by rat thymocytes and role of glutathione in its cytoplasmic reduction. Xenobiotica. Jun;18(6):657-64.
21. DiGirolamo AM, Perry GS, Gold BD, Parkinson A, Provost EM, Parvanta I, Grummer-Strawn LM. 2007. Helicobacter pylori, anemia, and iron deficiency: relationships explored among Alaska native children. Pediatr Infect Dis J. 26(10):927-34.
22. Eary, L. E. and Rai, D. 1988. "Chromate Removal from Aqueous Wastes by
23. Reduction with Ferrous Ion," Environ. Sci. Technol., 22(8):972-977.
24. Eary, L. E. and Rai, D. 1989. "Kinetics of Chromate Reduction by Ferrous Ions
25. Derived from Hematite and Biotite at 25°C," Amer. J. Sci., 289:180-213.
26. EPA, 1994. IRIS Cadmium. http://www.epa.gov/iris/subst/0141.htm
27. EPA, 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, Risk Assessment and Fish Consumption Limits, Third Edition.
28. EPA, 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)
29. EPA, 2009. Toxicological Review for Thallium. EPA/635/R-08/001F.
30. EPA. 2010. Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). Windows® version (IEUBKwin v1.1 build 11).
31. EPA, 2011. Highlights of the Exposure Factors Handbook.
32. EPA, 2012a. National Priorities List Site Narrative for Salt Chuck Mine. (http://epa.gov/superfund/sites/npl/nar1812.htm). Accessed on 8/29/2013
33. EPA, 2012b. Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil.
34. EPA, 2013a. Regional Screening Levels Tables. (http://www.epa.gov/reg3hwmd/risk/human//rb-concentration_table/Generic_Tables/docs/master_sl_table_run_MAY2013.pdf)
35. EPA, 2013b. Salt Chuck Mine Superfund Site – Arsenic Speciation in Clam Tissue. Unpublished data, personal communication, July 1st, 2013.
36. EPA, 2013c. Integrated Risk Information System (IRIS). http://www.epa.gov/iris/
37. EPA, 2014. 2013 Salt Chuck Mine Superfund Site Field Data Report Prince of Wales Island, Alaska.
38. Expert Group on Vitamins and Minerals, 2003. Risk Assessment, Iron.
39. Expert Group on Vitamins and Minerals, 2003. Risk Assessment, Vanadium.
40. Miret S, Simpson RJ, McKie AT. 2003. Physiology and molecular biology of dietary iron absorption. Ann Rev Nutr 23:283-301.
41. Fendorf, S. E. and Li, G., "Kinetics of Chromate Reduction by Ferrous Iron,"
42. Environ. Sci. Technol., 30(5):1614-1617, 1996.
43. MRI (Midwest Research Institute). (1988) Toxicity of thallium (I) sulfate (CAS No. 7446-18-6) in Sprague-Dawley rats. Vol. 2. Subchronic (90-day) study [revised final report]. Prepared by Dynamac Corporation, Rockville, MD, for the Office of Solid Waste, Washington, DC; Project No. 8702-L(18); Work Assignment No. 111148-008.
44. Myers, 1998. http://www.dtic.mil/dtic/tr/fulltext/u2/a346291.pdf

45. National Cancer Institute. Surveillance, Epidemiology, and End Results Program. Accessed on February 12, 2014 (http://seer.cancer.gov/).
46. Nielsen, FH, in Present Knowledge in Nutrition, 8th ed., Bowman, BA, Russell, RM, Eds., ILSI Press, Washington, DC, 2001.
47. National Academy of Sciences. Institute of Medicine. Food and Nutrition Board. 2001. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc.
48. NIH, 2007. http://ods.od.nih.gov/factsheets/Iron-HealthProfessional/
49. Petrilli FL, de Flora S. 1988. Metabolic reduction of chromium as a threshold mechanism limiting its in vivo activity. *Sci Total Environ*. 71(3):357-64.
50. Reeves PG, Vanderpool RA. 1997. Cadmium burden of men and women who report regular consumption of confectionery sunflower kernels containing a natural abundance of cadmium. *Environ Health Perspect*. 105(10):1098-104.
51. Sarcone, J. 2012. Summary of Key Informant Interviews. Alaska Agency for Toxics and Substances Disease Registry.
52. Schoeny, R.; Poirier, K. 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, Washington, DC, EPA/600/R-93/089 (NTIS PB94116571).
53. Seatrails, Undated. http://www.seatrails.org/com_thornebay/trl-saltchuck.htm (Accessed on September 15, 2013)
54. Turnlund, 1998. Copper absorption, excretion, and retention by young men consuming low dietary copper determined by using the stable isotope^{65} Cu. The American Journal of Clinical Nutrition. 67:1219–25.
55. United States Census, 2010. https://www.census.gov/
56. URS, 2002. Final Work Plan, Engineering Evaluation/Cost Analysis (EE/CA) for Salt Chuck Minen Tongass National Forest, Alaska.
57. URS, 2007. Draft Report, Engineering Evaluation/Cost Analysis (EE/CA), Salt Chuck Mine, Tongass National Forest, Alaska.
58. URS. 2010. Draft Report Focused Upland Engineering Evaluation/Cost Analysis (EE/CA) Salt Chuck Mine, Tongass National Forest, Alaska.
59. USDA, 2002. Nutritive Value of Foods, Home and Garden Bulletin No. 72 (HG-72) http://www.ars.usda.gov/Services/docs.htm?docid=6282

Appendix A

Summary of Key Informant Interviews

To: Ali Hamade, PhD, Director, Environmental Public Health Program, Alaska Division of Public Health

From: Joe Sarcone, Regional Representative – Alaska, Agency for Toxic Substances and Disease Registry (ATSDR)

Date: September 26, 2012

Subject: Salt Chuck Mine Site - Summary of Key Informant Interviews on the Customary and Traditional Use of the Site

In 1946 the federal government initiated a project to document the traditional land use of American Indian people.``Haa Aani - Our Land: Tlingit and Haida Land Rights and Use," is the 1946 Southeast Alaska project report by Theodore Haas, the chief counsel for the U.S. Bureau of Indian Affairs; anthropologist Walter Goldschmidt, and Tlingit schoolteacher Joseph Kahklen. Included in "Haa Aani" is an historic account of the rich resources found in the Prince of Wales Island, Kasaan Territory. The ethnography includes specific information on subsistence site location and access, the subsistence species collected at the sites, and the intensity of the use of the sites. There is one sentence on Salt Chuck in the ethnography: "At Salt Chuck north of Paul's Creek area, Natives obtained cohos, picked high bush cranberries, and hunted beaver ([redacted])."

[redacted] is a respected Haida elder and historian [redacted]. An interview was conducted with [redacted] in Hydaburg on July 25, 2012 and followed up on with a telephone interview on August 1, 2012. [redacted] shared that the Haida people of the Kasaan Territory, like many other American Indian and Alaska Native populations, were devastated by small pox followed by the 1918 influenza pandemic. At the close of World War II the population of what is now the village of Kasaan was perhaps 120 people. Over the years the continuous outmigration for work in Ketchikan and other cities has brought the current population of Kasaan to approximately 50 people.

In the period 1974-1975 [redacted] catalogued 1100 cultural and historic sites in the area including Prince of Wales Island for the Sealaska Corporation. In conducting this work [redacted] had assistance from a number of the original key informants for the "Haa Aani" report including [redacted] all of Kasaan village and all of whom have since passed away. [redacted] said that the person in Kasaan today that is the most knowledgeable of the customary and traditional use of the area is [redacted]. [redacted] noted that the most important historic and cultural site between Kasaan village and Salt Chuck is Chief Skowl's grave and that, otherwise, there are "not many historic sites up that way."

[redacted] is a Kasaan elder who was born in Kasaan and has lived there for all of his [redacted] years. A telephone interview was conducted with [redacted] on August 1, 2012. [redacted] said that in the past people dug clams at the entrance to Salt Chuck, crabbed in Salt Chuck and hunted in the area. [redacted] said that in the early 1900's cohos were caught by net at Lake Ellen Creek, but that there is no longer a salmon run in Salt Chuck. He did not know of anyone using the area for subsistence at this time.

In interviews with [redacted] (Kasaan elder, [redacted] years of age, interviewed in Kasaan on September 21, 2011 and Hydaburg on July 25, 2012) all made these key points: historically shellfish including butter clams, horse clams, and cockles were, and continue to be, available throughout Kasaan Bay, people took their subsistence from places where subsistence species were abundant, proximate and easy to access, and that historically Salt Chuck, because it is far away and difficult access and because there are good places closer, has historically not seen intensive use for subsistence. The same can be said for Salt Chuck today (See the attached [at the end of this appendix]: Agency for Toxic Substances and Disease Registry (ATSDR), Draft Summary of the Organized Village of Kasaan Key Informant Interviews on the Customary and Traditional Use of the Salt Chuck Mine Site October, 2011 based on interviews conducted in Kasaan in September, 2011. At the time it was incorrectly concluded that, "Historically the Salt Chuck was a significant subsistence resource area.")

In July, 2012 the Environmental Protection Agency with assistance from [redacted], Brownfields Coordinator for the Organized Village of Kasaan collected responses to a questionnaire on the use of the Salt Chuck Mine Site. In all eleven (11) individuals from Kasaan provided input to ten (10) completed questionnaires:

- In answer to the question "During the early days of mining, between 1910-1930, what is your understanding of how much subsistence activity was happening at the Salt Chuck Mine area?," seven (7) respondents said that there was a high amount of subsistence activity at Salt Chuck in the past and three (3) said they didn't know.
- In answer to the question, "What is your understanding of the amount of subsistence activity at the Salt Chuck Mine Area that is going on now?," nine (9) respondents said there is a low amount of subsistence activity at Salt Chuck mine going on now and one (1) person said they didn't know.
- In response to the question, "How much are <u>you</u> now using (or have used within the past year or so) the Salt Chuck Mine area for subsistence use,?" eight (8) persons said that they are not using the Salt Chuck Mine area for subsistence now and two (2) persons said they are using the Salt Chuck Mine area very little for subsistence now.
- To the question, "If you do not use Salt Chuck for subsistence now, or use it very little, please tell us why,?" almost all of the respondents cited multiple reasons (listed with the question); too contaminated from past mine activities, too far away/too difficult to reach, other subsistence areas closer, concerns about Paralytic Shellfish Poisoning (PSP). Two respondents (2) cited that their only reason for not using Salt Chuck for subsistence now is that the site is too contaminated from past mining activity (four others cited this reason in combination with other reasons).

- None of the respondents harvest fish from the Lake Ellen Creek which drains into Salt Chuck. In response to the question, “What other foods do you harvest near the Salt Chuck Mine area?” seven (7) respondents said none, two (2) respondents said deer, and one (1) respondent said, “the nearest things are crab, seal, berries.”

When [redacted] were asked why the current perception is that the Salt Chuck Mine area had a high amount of subsistence use in the past their response was that the people that would have known about past use are gone and that those that are here today couldn’t know. In speaking with a younger member of the Organized Village of Kasaan his sense was that the perception of loss is greater than the traditional use because it is the potential opportunity for use that can never be relinquished or abandoned.

The perception of the respondents, that there was a high amount of subsistence activity at Salt Chuck in the past, is not corroborated by the elders or by the ethnography. It appears that there was little use of the Salt Chuck Mine site area for subsistence in the past and that there is little to no use of the area for gathering subsistence species today. Because of this there are no traditional or current subsistence consumption data for the site, no completed exposure pathway for the contaminants identified in the environment and biota at the site, and no exposed population. There is not information available on which to base a health assessment or health consultation.

Agency for Toxic Substances and Disease Registry (ATSDR)

Summary of the Organized Village of Kasaan Key Informant Interviews on the Customary and Traditional Use of the Salt Chuck Mine Site

October, 2011

The Agency for Toxic Substances and Disease Registry (ATSDR) in cooperation with our partner the Alaska Division of Public Health has the responsibility to assess the presence and nature of health hazards at Superfund sites and to help reduce further exposure. The Salt Chuck Mine site is on the National Priority List (NPL) of Superfund sites under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). ATSDR and the Division of Public Health have undertaken a health consultation on the Salt Chuck Mine Site to investigate community exposures to hazardous chemicals and releases; assess associated health effects; and, recommend actions to stop, prevent, or minimize harmful effects.

ATSDR and the Division of Public Health met with the council of the Organized Village of Kasaan, July 8, 2010 and ATSDR conducted seven key informant interviews in Kasaan, September 21, 2011. The purpose of the qualitative in-depth interviews was to collect information on the customary and traditional use of the Salt Chuck Mine Site area for subsistence. A copy of the interview questions is attached.

The village of Kasaan and the Salt Chuck Mine have a rich history. This summary focuses on information provided by the interviewees. Historically Salt Chuck Bay provided "shellfish, deer, (and) berries," to those living in the area. The father of one interviewee lived and worked at the Salt Chuck Mine for a number of years until 1937 when he moved back to Kasaan. Each year he would dig clams (in Salt Chuck) and, "give (them) to every body in Ketchikan." Two interviewees said that clams were harvested (in Salt Chuck) "40 years ago", "(to) when I don't know." An interviewee stated that, "from 1937 to 1980 (people were) still living off of the beach, (they are) not living off of the land now."

Two interviewees said that they harvested clams from Salt Chuck until twenty (20) years ago. One interviewee said that butter clams were harvested at the neck of Salt Chuck Bay until about twenty-five (25) years ago. Another interviewee said that in the past horse clams were collected at Poor Man Creek just east of Salt Chuck. One interviewee said that people have taken sea cucumbers from Salt Chuck for personal use.

The interviewees stated two concerns regarding the collection of clams in Salt Chuck Bay: the potential health risks of consuming the clams and the access to Salt Chuck Bay. Comments on the health risks of consuming the clams included: "Quit going up because the clams were black and smelled", "Made aware of possible contamination (from Salt Chuck Mine)", "(the Paralytic Shellfish Poisoning) PSP problem in (the) area effects the way clams (are) collected, even (the way) crab viscera (are consumed)", "Before PSP, people used to eat a lot more clams." Three interviewees said less shellfish are being eaten due to (PSP) concerns.

Comments on access to Salt Chuck included: "Hard to get there, tides very strong", "(Have to) hit Chuck at high tide", "There are other places to go", "Kind of a long ways", "(With) price of gas (go for) clams that are closer", "For subsistence, people never really went far." Five interviewees stated that there are clams in areas closer to the village. An interviewee reported that at this time they collect clams from Fourth of July Island and another interviewee stated that some clams are collected from Mills Bay.

"In the late 1940's there was a retired person that would (come to Kasaan) every mail day and sell cooked crabs for twenty-five cents per crab." At this time there is a prohibition on commercial crabbing in all of Kasaan Bay including Salt Chuck. According to those interviewed there are people who do crab (Dungeness crabs) in Salt Chuck but that most people crab in other locations, specifically Mills Bay and Browns Bay.

One interviewee stated that many years ago, (perhaps) into the 1940's, people hunted deer and trapped in Salt Chuck. Another interviewee said that they "imagined people did hunt deer around Salt Chuck. " One interviewee observed that there has always been hunting all over the Kasaan Peninsula. One interviewee said he hunts in Browns Bay a little. Another interviewee said that he has, "never hunted up inside Salt Chuck."

The interviewees spoke about plants in the context of both traditional plants and vegetable gardens. Two interviewees talked about harvesting traditional plants including beach asparagus, goose tongue, and red ribbon seaweed from Grindall pass/island (at entrance to Kasaan Bay-North). Another interviewee talked about picking berries at Lindeman Cove and Poor Man Creek. One interviewee stated that there are berries closer (than Salt Chuck). Another interviewee said that "maybe tea" was collected in Salt Chuck. Two other interviewees said that no plants are collected from Salt Chuck.

Historically people planted vegetable gardens in the Salt Chuck Area. Several interviewees spoke about the Charlie Wong homestead inside of Salt Chuck. Mr. Wong had a large vegetable garden and would give or sell vegetables to the people of Kasaan. Note: not certain of the time period when Mr. Wong resided in Salt Chuck. There are no vegetable gardens in Salt Chuck at this time.

Interviewees spoke about other activities in Salt Chuck including: beach combing, swimming, picnicking, and camping. There was no specific reference to the fact that these activities are happening now. In the words of one interviewee, "nobody from here goes up there that much." Historically the Salt Chuck was utilized as a subsistence resource area. In the recent past and today it does not seem to be highly utilized.

Appendix B
Tables

Table B-1: Average (maximum) metals concentrations, mg/kg, in clams, vegetation, and sediment (CH2M HILL 2012, 2013a).*

Element	Clams [n=34]	Background Clams [n=26]	Intertidal Vegetation [n=16]	Background Intertidal Vegetation [n=6]	Upland Vegetation [n=15]	Background Upland Vegetation [n=7]	Intertidal Sediment [n=95]	Background Sediment [n=19]
Aluminum	295 (1,193)	93.80 (360)	21.53 (73.72)	2.56 (5.60)	14.66 (63.6)	10.67 (53.40)	9,101.16 (24,700)	7,792.11 (16,400)
Antimony	0.072 (0.1)	0.07 (0.11)	0.014 (0.017)	0.014 (0.016)	0.08 (0.20)	0.06 (0.10)	1.16 (1.70)	1.16 (1.9)
Arsenic	3.30 (6.52)	2.81 (5.67)	0.033 (0.098)	0.009 (0.013)	0.01 (0.03)	0.006 (0.01)	3.22 (28.7)	3.64 (9.3)
Barium	1.09 (3.07)	0.77 (1.51)	0.09 (0.20)	0.071 (0.076)	4.37 (42.7)	5.02 (20.00)	11.34 (34.5)	8.39 (16)
Beryllium	0.068 (0.17)	0.08 (0.17)	0.002 (0.002)	0.002 (0.002)	0.17 (0.25)	0.13 (0.24)	0.58 (0.84)	0.58 (0.93)
Cadmium	0.23 (0.54)	0.31 (0.59)	0.002 (0.004)	0.002 (0.002)	0.05 (0.62)	0.007 (0.014)	0.61 (3.8)	0.58 (0.93)
Calcium	1,210.25 (5,100)	NA	NA	NA	NA	NA	17,407.58 (163,000)	24,067.89 (149,000)
Chromium	1.52 (11)	0.75 (2)	0.06 (0.33)	0.025 (0.058)	0.10 (0.37)	0.067 (0.110)	7.99 (57.4)	7.77 (11.8)
Cobalt	0.43 (1.69)	0.13 (0.32)	0.02 (0.07)	0.011 (0.030)	0.07 (0.27)	0.04 (0.10)	15.08 (41.9)	5.60 (14.5)
Copper	15.77 (93)	2.28 (5.65)	1.79 (3.44)	0.310 (0.42)	3.80 (10.80)	1.88 (5.40)	644.93 (3870)	95.75 (1,100)
Iron	1,544.79 (8,210)	206.19 (700)	77.69 (273.88)	7.945 (16.56)	45.49 (205.00)	10.78 (22.90)	36,372.32 (112,000)	16,528.95 (33,400)
Lead	0.22 (0.7)	0.17 (0.26)	0.036 (0.051)	0.036 (0.038)	0.22 (0.50)	0.15 (0.26)	4.95 (132)	1.57 (4.00)
Magnesium	705 (1,209)	570.19 (829)	581.19 (660.38)	564.55 (588.12)	1086.34 (2860.00)	441.14 (1250.00)	8,932.32 (25,600)	7,116.32 (14,200)

Element	**Clams [n=34]**	**Background Clams [n=26]**	**Intertidal Vegetation [n=16]**	**Background Intertidal Vegetation [n=6]**	**Upland Vegetation [n=15]**	**Background Upland Vegetation [n=7]**	**Intertidal Sediment [n=95]**	**Background Sediment [n=19]**
Manganese	8.62 (32.55)	3.03 (9.94)	NA	NA	NA	NA	348.18 (1,340)	266.21 (509)
Mercury	0.016 (0.034)	0.01 (0.02)	0.011 (0.015)	0.014 (0.014)	0.014 (0.026)	0.013 (0.016)	0.12 (2.7)	0.09 (0.14)
Molybdenum	0.190 (0.44)	NA	NA	NA	NA	NA	NA	NA
Nickel	1.04 (5.78)	0.59 (1.47)	0.07 (0.21)	0.12 (0.23)	0.39 (1.80)	0.52 (2.63)	11.05 (33.1)	7.06 (11.4)
Potassium	2,279.50 (3,000)	NA	NA	NA	NA	NA	630.64 (1,370)	577.37 (893)
Selenium	0.48 (0.76)	0.44 (0.65)	0.004 (0.006)	0.004 (0.004)	0.04 (0.22)	0.015 (0.024)	3.18 (144)	2.63 (4.6)
Silver	0.14 (2.4)	0.32 (3.25)	0.002 (0.004)	0.002 (0.003)	0.014 (0.048)	0.007 (0.012)	0.63 (1.5)	0.58 (0.93)
Sodium	2,893.00 (3,700)	NA	NA	NA	NA	NA	2,418.66 (10,500)	2,670.53 (6,580)
Thallium	0.024 (0.051)	0.02 (0.05)	0.004 (0.004)	0.004 (0.004)	0.02 (0.05)	0.015 (0.024)	0.58 (0.84)	0.58 (0.93)
Vanadium	5.47 (27.9)	0.58 (1.80)	0.32 (1.19)	0.016 (0.032)	0.11 (0.54)	0.010 (0.019)	164.55 (410)	67.51 (285)
Zinc	12.60 (16.2)	12.24 (17.00)	1.30 (2.54)	0.98 (1.11)	8.35 (42.40)	4.12 (9.74)	40.61 (163)	28.96 (41.8)

mg/kg = milligrams per kilogram, NA = Not available; shading added for ease of viewing of the different media data

*Numbers in brackets in the top row are the number of samples collected and analyzed per contaminant. Contaminant concentrations are presented as mean (maximum). Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

Table B-2. Average (maximum) metals concentrations, μg /L, in water (CH2M HILL, 2013a).

	Upland Surface Water, Dissolved Metals[n=10]	Upland Surface Water, Total Metals[n=10]	Intertidal Surface Water, Dissolved Metals[n=5]	Intertidal Surface Water, Total Metals[n=5]	Background Surface Water, Dissolved Metals[n=6]	Background Surface Water, Total Metals [n=7]
Aluminum	148.8 (213)	171.3 (282)	240.6 (308)	470.8 (966)	265.7 (397)	261.1 (362)
Antimony	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)
Arsenic	1.1 (1.5)	1.1 (1.5)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)
Barium	10.0 (10)	10.0 (10)	10.0 (10)	10.0 (10)	10.0 (10)	10.0 (10)
Beryllium	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)
Cadmium	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)
Calcium	7,710.0 (32,100)	7,660.0 (31,600)	8,006.0 (12,200)	7,614.0 (11,500)	6,058.3 (7,510)	5,817.1 (7,460)
Chromium	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)	2.0 (2)
Cobalt	1.0 (1)	1.0 (1)	1.0 (1)	1.1 (1.6)	1.0 (1)	1.0 (1)
Copper	11.8 (95)	11.4 (87.1)	9.0 (12.9)	20.1 (30.3)	2.7 (4.5)	3.4 (9.6)
Iron	372.9 (706)	361.2 (608)	541.0 (730)	893.6 (1,620)	617.2 (1,060)	616.9 (1,110)
Lead	1.0 (1)	1.0 (1)	1.0 (1)	1.1 (1.4)	1.0 (1)	1.0 (1)
Magnesium	1,833.1 (5,000)	1,834.4 (5,000)	15,400.0 (27,800)	14,580.0 (26,100)	7,873.5 (15,600)	6,696.7 (15,800)
Manganese	13.5 (22.5)	23.9 (108)	26.5 (37.7)	58.9 (148)	21.9 (35)	22.8 (37.8)
Mercury	0.2 (0.2)	0.2 (0.2)	0.1 (0.2)	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)
Nickel	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)
Potassium	2,177.7 (5,000)	2,111.2 (5,000)	4,950.0 (9,080)	4,782.0 (8,740)	3,201.8 (5,280)	2,724.1 (5,460)
Selenium	2.7 (6.1)	2.6 (6)	0.9 (1.7)	0.9 (1.9)	1.3 (5)	2.6 (5)
Silver	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)
Sodium	5,115.0 (6,150)	5,105.0 (6,050)	126,680 (235,000)	119,820.0 (222,000)	60,683.3 (134,000)	51,900.0 (137,000)
Thallium	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)	1.0 (1)

	Upland Surface Water, Dissolved Metals[n=10]	Upland Surface Water, Total Metals[n=10]	Intertidal Surface Water, Dissolved Metals[n=5]	Intertidal Surface Water, Total Metals[n=5]	Background Surface Water, Dissolved Metals[n=6]	Background Surface Water, Total Metals [n=7]
Vanadium	4.2 (5)	4.6 (5)	5.0 (5)	5.1 (5.3)	5.0 (1)	5.0 (5)
Zinc	3.2 (8.8)				3.9)	3.4 (10.5)

µg/L = micrograms per liter; shading added for ease of viewing of the different media data

*Numbers in brackets in the top row are the number of samples collected and analyzed per contaminant. Contaminant concentrations are presented as mean (maximum). Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

Table B-3. Average (maximum) PAH concentrations, (µg/kg), in clams and sediment (CH2M HILL 2012, 2013a).

	SCM Site Clams [n=17]	**Background Clams** [n=10]	**SCM Site Sediment [n=95]**	**Background Sediment[n=19]**
1-methyl-Naphthalene	1.29 (2.4)	1.02 (1.2)	NA	NA
2-methyl-Naphthalene	8.35 (21)	7.08 (16)	7.66 (61)	4.15 (7.60)
Acenaphthene	0.95 (0.96)	0.95 (0.97)	7.88 (48)	4.19 (8.20)
Acenaphthylene	1.03 (2.1)	0.95 (0.97)	10.30 (430)	3.34 (4.40)
Anthracene	1.05 (2.1)	0.95 (0.97)	17.36 (460)	3.20 (4.40)
Benzo(a)-anthracene	1.40 (4.7)	0.95 (0.97)	41.32 (1,300)	3.28 (19.00)
Benzo(a)pyrene	3.51 (12)	1.78 (1.9)	55.86 (1,300)	9.82 (61.00)
Benzo(b)-Fluoranthene	2.16 (8.1)	0.95 (0.97)	57.26 (1,600)	5.24 (36.00)
Benzo(ghi)-perylene	4.29 (11)	2.53 (3.5)	23.09 (280)	5.86 (53.00)
Benzo(k)-fluoranthene	1.11 (2.4)	0.95 (0.97)	26.17 (400)	6.36 (50.00)
Chrysene	1.32 (4.3)	0.95 (0.97)	43.59 (1,300)	3.22 (22.00)
Dibenzo(ah)-anthracene	0.98 (1.3)	0.95 (0.97)	9.38 (100)	4.09 (10.00)
Dibenzofuran	0.95 (0.96)	0.95 (0.97)	NA	NA
Fluoranthene	1.55 (5.4)	0.95 (0.97)	69.83 (2,900)	2.87 (28.00)
Fluorene	NA	NA	9.55 (170)	4.01 (8.20)
Indeno[1,2,3-cd]-pyrene	1.87 (5.5)	1.20 (2.4)	44.96 (394,000)	4.22 (4.30)
Naphthalene	0.96 (1.2)	0.97 (1.1)	10.38 (405,000)	4.22 (4.30)
Phenanthrene	1.16 (3.3)	0.95 (0.97)	35.77 (630)	3.76 (4.20)
Pyrene	2.19 (9.5)	0.95 (0.97)	164.18 (3,200)	4.22 (4.30)

Total HPAH	NA	NA	605.25 (9598)	4.22 (4.30)
Total LPAH	NA	NA	228.56 (4,504)	3.26 (4.20)
Total PAH	NA	NA	833.81 (14,102)	3.26 (4.20)

SCM = Salt Chuck Mine
µg/kg = micrograms per kilogram
NA = Not available

*Numbers in brackets in the top row are the number of samples collected and analyzed per contaminant. Contaminant concentrations are presented as mean (maximum). Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

Table B-4. Average Inorganic Arsenic in Clams (EPA, 2013b).

All Sample Locations

Clam Species	Sample number (n)	Inorganic % of Total Arsenic	Standard deviation (%)
Softshell	6	19.39	0.101
Little Neck	2	0.57	0.001
Butter	3	0.56	0.001
Average of all species	NA	10.83	8.87

Salt Chuck Bay Intertidal Area

Clam Species	Sample number (n)	Inorganic % of Total Arsenic	Standard deviation (%)
Softshell	3	28.14	0.02
Little Neck	1	0.64	NA
Butter	2	0.5	0
Average of all species	NA	9.76	0.2

Background Locations

Clam Species	Sample number (n)	Inorganic % of Total Arsenic	Standard deviation (%)
Softshell	3	10.65%	0.05
Little Neck	1	0.50%	NA
Butter	1	0.67%	NA
Average of all species	NA	3.94%	0.06

Table B-5. Absorption Factors and Permeability Coefficients Used in Calculations

Absorption Factors*			
	Analyte	Absorption Factor	Source
Dermal	Arsenic	0.03	EPA, 2004
	Cadmium	0.001	EPA, 2004
	Copper	0.06	ATSDR, 2004
	Vanadium	NA	ATSDR, 2012
	All PAHs	0.13	EPA, 2004
Gastrointestinal (Gut) (GI_{abs})	Antimony	0.15	EPA, 2004
	Arsenic	0.95	EPA, 2004
	Barium	0.07	EPA, 2004
	Beryllium	0.007	EPA, 2004
	Cadmium	0.025	EPA, 2004
	Chromium	0.025	EPA, 2004
	Copper	0.71	Turnlund, 1998
	Iron	0.15	Expert Group on Vitamins and Minerals, 2003
	Lead**	See note	EPA, 2010
	Magnesium	1	EPA, 2004
	Manganese	0.04	EPA, 2004
	Mercury	0.95	EPA, 2004
	Nickel	0.04	EPA, 2004
	Potassium	1	EPA, 2004
	Selenium	0.8	EPA, 2004
	Silver	0.04	EPA, 2004
	Sodium	1	EPA, 2004
	Thallium	1	EPA, 2004
	Vanadium	0.026	EPA, 2004
	Zinc	1	EPA, 2004
	All PAHs	1	EPA, 2004
Permeability Coefficients*			
	Analyte	Permeability Coefficient (cm/hr)	Source
Dermal	Cobalt	0.0004	EPA, 2010
	Lead	0.0001	EPA, 2004
	Nickel	0.0002	EPA, 2004
	Potassium	0.002	EPA, 2004
	Silver	0.0006	EPA, 2004
	Zinc	0.0006	EPA, 2004

*For all analytes with no absorption factors listed in the table, EPHP used an absorption factor of 1. For analytes with no permeability coefficients listed in the table, EPHP used a permeability

coefficient of 0.001. **For lead, EPHP used the default absorption factors for each media in the EPA Integrated Exposure Uptake Biokinetic (IEUBK) model (EPA, 2010).
GI_{abs} = Gastrointestinal absorption factor
cm/hr = centimeters per hour

Table B-6. Equation for the ingestion of clams and vegetation exposure pathway.

Exposure Pathway: Ingestion of Clams or Vegetation

Equation*: Dose (mg/kg/day) = (C x IR x AF) / BW Source: ATSDR, 2005

Parameter	Parameter Definition	Units	Value	Reference/ Reason
C	Contaminant Concentration	mg contaminant/kg clam or vegetation (mg/kg)	Tables B-1 and B-3	CH2M HILL 2012, 2013
IR	Intake Rate of clams or vegetation	kg clams or vegetation/day (kg/day)	"Traditional" user: Clams: Adult = 0.033 Child = 0.008* Vegetation: Adult = 0.041 Child = 0.009* "Recreational" User: Clams: Adult = 0.013 Child = 0.003* Vegetation: Adult = 0.029 Child = 0.007* (Tables 3a and 3b)	ADFG, 2014
AF	Bioavailability Factor**	Unitless	1	Dose is compared to CV. No additional bioavailability considerations
BW	Body Weight	kg	Adult = 70 Child (1-6 yrs) = 16	Adult and Child, ATSDR, 2005

mg/kg/day = milligrams per kilogram body weight per day, kg = kilogram

*For children, the dose, D, was multiplied by a body weight multiplier, Multiplier_{BW}: Multiplier_{BW} (unitless) = Child Body Weight (kg)/ Adult Body Weight (kg) (EPA, 2000);

**The bioavailability factor represents, as a percent, the total amount of a substance ingested, inhaled, or contacted that actually enters the bloodstream and is available to possibly harm a person. Typically, the bioavailability factor is assumed to be 1 (100%) for screening purposes. That is, all of a substance to which a person is exposed is assumed to be absorbed.

Table B-7. Equations for the ingestion of surface water exposure pathway.

Exposure Pathway: Ingestion of Surface Water

Equations: Dose (mg/kg/day) = (C x IR x EF) / BW

EF = (F x ED) / AT Source: ATSDR, 2005

Parameter	Parameter Definition	Units	Value	Reference/Reason
C	Contaminant Concentration	mg contaminant/ L of water (mg/L)	Table B-2	CH2M HILL 2012, 2013
IR	Intake Rate of water	L/day	Adult = 2 L/day Child = 1 L/day	ATSDR, 2005
EF	Exposure Factor	Unitless	Child = 0.016, Adult = 0.016	ATSDR, 2005
F	Frequency of Exposure	Days/year	6	Information gathered from community interviews
ED	Exposure duration	Years	Child = 6, Adult = 40	ADFG, 2013
AT	Averaging time (ED x 365 days/year)	Days	Child = 2,190; Adults = 14,600	ATSDR, 2005
BW	Body Weight	kg	Adult = 70 Child (1-6 yrs) = 16	Adult and Child, ATSDR, 2005

mg/kg/day = milligrams per kilogram body weight per day, kg = kilogram

Table B-8. Equations for the ingestion of sediment exposure pathway.

Exposure Pathway: Ingestion of Sediment **Equations: Dose (mg/kg/day) = (C x IR x EF x CF) / BW** **EF = (F x ED) / AT** Source: ATSDR, 2005				
Parameter	**Parameter Definition**	**Units**	**Value**	**Reference/Reason**
C	Contaminant Concentration	mg contaminant/kg of sediment (mg/kg)	Tables B-1 and B-3	CH2M HILL 2011, 2012
IR	Intake Rate of sediment	mg/day	Adult = 100 Child = 200	ATSDR, 2005
EF	Exposure Factor	Unitless	Child = 0.016, Adult = 0.016	ATSDR, 2005
F	Frequency of Exposure	Days/year	6	Information gathered from community interviews
ED	Exposure duration	Years	Child = 6, Adult = 40	ADFG, 2013
AT	Averaging time (ED x 365 days/year)	Days	Child = 2,190; Adults = 14,600	ATSDR, 2005
CF	Conversion factor	kg/mg	1 kg/1000 mg	ATSDR, 2005
BW	Body Weight	kg	Adult = 70 Child (1-6 yrs) = 16	Adult and Child, ATSDR, 2005

mg/kg/day = milligrams per kilogram body weight per day, kg/mg = kilograms per millogram, kg = kilogram

Table B-9. Equation for the dermal absorption of surface water pathway.

Exposure Pathway: Dermal absorption of Surface Water

Equations: Dose (mg/kg/day) = (C x P x SA x ET x EF x CF) / BW

EF = (F x ED) / AT Source: ATSDR, 2005

Parameter	Parameter Definition	Units	Value	Reference/Reason
C	Contaminant Concentration	mg contaminant/ L of water (mg/L)	Tables B-2	CH2M HILL 2011, 2012
P	Permeability coefficient	cm/hr	Table B-5	EPA, 2004
SA	Exposed body surface area	cm^2	Hands: Adult = 1008, Child = 317 Feet: Adult = 1370, Child = 400	ATSDR, 2012 and EPA, 2011
ET	Exposure time	Hours/day	2	Estimate
EF	Exposure Factor	Unitless	Child = 0.016, Adult = 0.016	ATSDR, 2005
F	Frequency of Exposure	Days/year	6	Information gathered from community interviews
ED	Exposure duration	Years	Child = 6, Adult = 40	ADFG, 2013
AT	Averaging time (ED x 365 days/year)	Days	Child = 2,190; Adults = 14,600	ATSDR, 2005
CF	Conversion factor	L/cm^3	1 L/1,000 cm^3	ATSDR, 2005
BW	Body Weight	kg	Adult = 70 Child (1-6 yrs) = 16	Adult and Child, ATSDR, 2005

mg/kg/day = milligrams per kilogram body weight per day, cm/hr = centimeters per hour, cm^2 = centimeters squared, L/cm^3 = liters per centimeters cubed, kg = kilogram

Table B-10. Equations for the dermal absorption from sediment exposure pathway.

Exposure Pathway: Dermal absorption from sediment

Equations: $\mathbf{Dose\ (mg/kg/day) = (C \times A \times SA \times AF \times EF \times CF) / (BW \times GI_{abs})}$

$\mathbf{EF = (F \times ED) / AT}$ Source: ATSDR, 2005

Parameter	Parameter Definition	Units	Value	Reference/Reason
C	Contaminant Concentration	mg contaminant/kg sediment (mg/kg)	Tables B-1 and B-3	CH2M HILL 2011, 2012
A	Total soil adhered	mg/cm^2	Adult = 0.07, Child = 0.2	ATSDR, 2005
SA	Exposed body surface area	cm^2	Hands: Adult = 1008, Child = 317	ATSDR, 2012 and EPA, 2011
AF	Dermal Absorption Factor	Unitless	See Table B-5	See Table B-5
EF	Exposure Factor	Unitless	Child = 0.016, Adult = 0.016	ATSDR, 2005
F	Frequency of Exposure	Days/year	6	Information gathered from community interviews
ED	Exposure duration	Years	Child = 6, Adult = 40	ADFG, 2013
AT	Averaging time	Days	Child = 2,190; Adults = 14,600	ATSDR, 2005
CF	Conversion factor	kg/mg	1 kg/1000 mg	ATSDR, 2005
BW	Body Weight	kg	Adult = 70 Child (1-6 yrs) = 16	Adult and Child, ATSDR, 2005
GI_{abs}	Gastrointestinal absorption factor*	Unitless	Table B-5	EPA, 2004

mg/kg/day = milligrams per kilogram body weight per day, mg/cm^2 = milligrams per centimeter squared, cm^2 = centimeters squared, kg/mg = kilograms per milligram, kg = kilogram

[*] GI_{ABS} is the gastrointestinal absorption factor (dimensionless) that expresses the fraction of the orally administered contaminant in the toxicity study that was absorbed via the gastrointestinal tract. The U.S. EPA recommends making adjustments to the toxicity factors only when there is evidence to indicate that the oral absorption in the critical study is far less than complete (*i.e.*, <50 percent) (EPA, 2004; Battelle and Exponent, 2000).

Table B-11. Calculated Cancer and Noncancer Risks for Contaminants of Concern – Traditional User

	Life Stage	**Ingestion Dose (Clams) (mg/kg/d)**	**Ingestion Dose (Incidental sediment ingestion) (mg/kg/d)**	**Dermal Absorption (sediment) (mg/kg/d)**	**Ingestion Dose (Vegetation) (mg/kg/d)**	**Ingestion Dose (Surface Water) (mg/kg/d)**	**Dermal Absorption (water) (mg/kg/d)**	**Site Mean Dose (mg/kg/d)**	**Comparison Value (Noncancer) (mg/kg/d)**	**CV Source**	**Hazard Quotient (Noncancer)**	**Estimated Excess Cancer Risk**
Arsenic	Child	0.0002	6.62E-07	6.29E-09	1.25E-05	1.05E-06	1.47E-09	0.0002	0.0003	ATSDR chronic MRL	0.6	NA
		0.0002	4.54E-08	1.60E-09	1.24E-05	4.81E-07	1.12E-09	0.0002	0.0003	NA	0.6	0.00008
Cadmium Adult	Child	0.0001	1.26E-07	3.99E-11	1.55E-05	1.03E-06	1.47E-09	0.0001	0.0001	ATSDR chronic MRL	1.1	NA
		0.0001	1.44E-08	1.02E-11	1.54E-05	4.70E-07	1.12E-09	0.0001	0.0001	NA	1.1	NA
Adult Iron	Child	0.74	7.47E-03	2.37E-03	3.63E-02	6.45E-04	1.32E-06	0.8	2.5	NAS IOM Tolerable Upper Intake Level	0.3	NA
	Adult	0.74	8.54E-04	6.03E-04	3.610E-02	2.95E-04	9.98E-07	0.8	0.64	NA	1.2	NA
Thallium	Child	0.00001	1.19E-07	3.77E-08	7.31E-06	1.03E-06	1.47E-09	0.00002	0.00001	EPA Screening Level Tables RfD	2.0	NA
	Adult	0.00001	1.36E-08	9.62E-09	7.26E-06	4.70E-07	1.12E-09	0.00002	0.00001	NA	1.9	NA

Site Mean Dose = sum of doses from individual exposure pathways (*i.e.*, clam ingestion, vegetation ingestion, sediment ingestion (accounts for sediment inhalation), water ingestion, sediment dermal absorption, water dermal absorption). Equations for individual pathway dose calculations are in Tables B-6 through B-10. Intake rates, absorption factors, and other parameters and assumptions are in Tables B-5 through B-10. Metal contaminant concentrations are in Tables B-1 and B-2. Body weight, BW for adult = 70 kg, child (1 to 6 yrs) = 16 kg; MRL = Minimal Risk Levels for chronic oral intake; EPA RfD = Environmental Protection Agency Reference Dose; Hazard quotient = site mean dose/comparison value. NAS IOM=National Academy of Sciences Institute of Medicine.

[#]MRL for cadmium = 0.00011 mg/kg/d. Table shows a rounded MRL=0.0001 mg/kg/d.

Table B-12. Calculated Noncancer Risks for Metal Contaminants – Traditional User

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
Aluminum	Child	0.2	1.0	ATSDR chronic MRL	0.2	No
	Adult	0.2	1.0	ATSDR chronic MRL	0.2	No
Antimony	Child	0.00007	0.0004	EPA RfD	0.2	No
	Adult	0.00006	0.0004	EPA RfD	0.2	No
Arsenic	Child	0.0002	0.0003	ATSDR chronic MRL	0.6	No
	Adult	0.0002	0.0003	ATSDR chronic MRL	0.6	No
Barium	Child	0.002	0.2	ATSDR chronic MRL	0.009	No
	Adult	0.002	0.2	ATSDR chronic MRL	0.009	No
Beryllium	Child	0.00009	0.002	ATSDR chronic MRL	0.04	No
	Adult	0.00009	0.002	ATSDR chronic MRL	0.04	No
Cadmium	Child	0.0001	0.0001	ATSDR chronic MRL	1.1#	Yes
	Adult	0.0001	0.0001	ATSDR chronic MRL	1.1#	Yes
Calcium	Child	0.6	156.3	NAS IOM Tolerable Upper Intake Level	0.004	No
	Adult	0.6	35.7	NAS IOM Tolerable	0.02	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
				Upper Intake Level		
Chromium†	Child	0.0008	1.5	EPA RfD	0.0005	No
	Adult	0.0008	1.5	EPA RfD	0.0005	
Cobalt	Child	0.0002	0.0003	EPA PPRTV	0.8	No
	Adult	0.0002	0.0003	EPA PPRTV	0.8	No
Copper	Child	0.009	0.12	NAS IOM Tolerable Upper Intake Level	0.07	No
	Adult	0.009	0.14	NAS IOM Tolerable Upper Intake Level	0.06	No
Iron	Child	0.8	2.5	NAS IOM Tolerable Upper Intake Level	0.3	No
	Adult	0.8	0.64	NAS IOM Tolerable Upper Intake Level	1.2	Yes
Lead	Child	0.2**	**	N/A	0.04	No
	Adult	<0.2**	**	NA	<0.04	No
Magnesium	Child	0.8	5.47	NAS IOM Tolerable Upper Intake Level	0.2	No
	Adult	0.8	5.00	NAS IOM Tolerable Upper Intake Level	0.2	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
Manganese	Child	0.005	0.15	NAS IOM Tolerable Upper Intake Level	0.03	No
	Adult	0.004	0.16	NAS IOM Tolerable Upper Intake Level	0.03	No
Mercury	Child	0.00002	0.0004	ATSDR chronic MRL	0.04	No
	Adult	0.00002	0.0004	ATSDR chronic MRL	0.04	No
Molybdenum	Child	0.00009	0.028	NAS IOM Tolerable Upper Intake Level	0.003	No
	Adult	0.00009	0.029	NAS IOM Tolerable Upper Intake Level	0.003	No
Nickel	Child	0.0006	0.016	NAS IOM Tolerable Upper Intake Level	0.04	No
	Adult	0.0006	0.014	NAS IOM Tolerable Upper Intake Level	0.04	No
Potassium	Child	1.1	26.375*	Calculated CV*	0.04	No
	Adult	1.1	6.03*	Calculated CV*	0.2	No
Selenium	Child	0.0002	0.0075	NAS IOM Tolerable	0.03	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
				Upper Intake Level		
	Adult	0.0002	0.0057	NAS IOM Tolerable Upper Intake Level	0.04	No
Silver	Child	0.00007	0.005	EPA RfD	0.01	No
	Adult	0.00007	0.005	EPA RfD	0.01	No
Sodium	Child	1.4	106.25	NAS IOM Tolerable Upper Intake Level	0.01	No
	Adult	1.4	32.86	NAS IOM Tolerable Upper Intake Level	0.04	No
Thallium	Child	0.00002	0.00001	EPA RfD	2.0	Yes
	Adult	0.00002	0.00001	EPA RfD	1.9	Yes
Vanadium	Child	0.003	0.005	EPA RfD	0.6	No
	Adult	0.003	0.005	EPA RfD	0.5	No
Zinc	Child	0.009	0.59	NAS IOM Tolerable Upper Intake Level	0.02	No
	Adult	0.009	0.57	NAS IOM Tolerable Upper Intake Level	0.02	No

Site Mean Dose = sum of doses from individual exposure pathways (*i.e.*, clam ingestion, vegetation ingestion, sediment ingestion (accounts for sediment inhalation), water ingestion, sediment dermal absorption, water dermal absorption). Equations for individual pathway dose calculations are in Tables B-6 through B-10. Intake rates, absorption factors, and other parameters and assumptions are in Tables B-5 through B-10. Metal contaminant concentrations are in Tables B-1 and B-2. Body weight, BW for adult = 70 kg, child (1 to 6 yrs) = 16 kg; MRL = Minimal Risk Levels for chronic oral intake; EPA RfD = Environmental Protection Agency Reference Dose; Hazard quotient = site mean dose/comparison value. NAS IOM=National Academy of Sciences Institute of Medicine.

* For a CV EPHP used the potassium content of an average Chiquita banana = 422 mg of potassium (www.chiquitabananas.com)

** EPHP calculated potential lead exposure by using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model (EPA, 2010). There is no CV for lead. The CDC uses a reference value of 5 µg/dL for children under 6 years of age and EPHP uses this same level for all children under 18. In the past, the level of concern was 10 µg/dL of lead in blood. The new lower value means that more children will likely be identified as having lead exposure that warrant action allowing parents, doctors, public health officials, and communities to act earlier to reduce the child's future exposure to lead.

#MRL for cadmium = 0.00011 mg/kg/d. Table shows a rounded MRL=0.0001 mg/kg/d.

† EPHP assumed all chromium at SCM to be trivalent chromium, because clams and sediment at the SCM site are rich in iron (CH2M HILL, 2011, 2012) and iron has been shown to efficiently reduce or foster the reduction of chromium in environmental media (Eary and Rai, 1988; Fendorf and Li, 1996) and animal tissue (Myers, 1998), respectively. In addition, should sediment and water at SCM contain hexavalent chromium, this chromium will be rapidly reduced to trivalent chromium once in contact with clam tissue or plant tissue, as hexavalent chromium is highly reactive and will generally be reduced in the presence of organic matter and cellular molecules (Debetto et al., 1988; Petrilli and De Flora, 1988). The National Academy of Sciences Institute of Medicine also states that hexavalent chromium is generally not found in food (NAS, 2001).

Table B-13. Calculated Noncancer Risks for Metal Contaminants – Recreational User

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
Aluminum	Child	0.07	1	ATSDR chronic MRL	0.06	No
	Adult	0.06	1	ATSDR chronic MRL	0.06	No
Antimony	Child	0.00004	0.0004	EPA RfD	0.09	No
	Adult	0.00004	0.0004	EPA RfD	0.09	No
Arsenic	Child	0.00007	0.0003	ATSDR chronic MRL	0.2	No
	Adult	0.00007	0.0003	ATSDR chronic MRL	0.2	No
Barium	Child	0.001	0.2	ATSDR chronic MRL	0.006	No
	Adult	0.001	0.2	ATSDR chronic MRL	0.006	No
Beryllium	Child	0.00006	0.002	ATSDR chronic MRL	0.03	No
	Adult	0.00005	0.002	ATSDR chronic MRL	0.02	No
Cadmium	Child	0.00005	0.0001	ATSDR chronic MRL	0.5	No
	Adult	0.00005	0.0001	ATSDR chronic MRL	0.5	No
Calcium	Child	0.2	156.3	NAS IOM Tolerable Upper Intake Level	0.001	No
	Adult	0.2	35.7	NAS IOM Tolerable Upper Intake Level	0.006	No
Chromium †	Child	0.0003	1.50	EPA RfD	0.0002	No
	Adult	0.0003	1.50	EPA RfD	0.0002	No
Cobalt	Child	0.0001	0.0003	EPA PPRTV	0.4	No
	Adult	0.0001	0.0003	EPA PPRTV	0.3	No
Copper	Child	0.003	0.12	NAS IOM Tolerable Upper Intake Level	0.03	No
	Adult	0.003	0.14	NAS IOM Tolerable	0.02	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
				Upper Intake Level		
Iron	Child	0.3	2.5	NAS IOM Tolerable Upper Intake Level	0.1	Yes
	Adult	0.3	0.64	NAS IOM Tolerable Upper Intake Level	0.5	Yes
Lead	Child	0.2**	**	NA	0.04	No
	Adult	<0.2**	**	NA	<0.04	No
Magnesium	Child	0.5	5.47	NAS IOM Tolerable Upper Intake Level	0.09	No
	Adult	0.5	5.00	NAS IOM Tolerable Upper Intake Level	0.1	No
Manganese	Child	0.002	0.16	NAS IOM Tolerable Upper Intake Level	0.01	No
	Adult	0.002	0.16	NAS IOM Tolerable Upper Intake Level	0.01	No
Mercury	Child	0.000008	0.0004	ATSDR chronic MRL	0.02	No
	Adult	0.000008	0.0004	ATSDR chronic MRL	0.02	
Molybdenum	Child	0.00004	0.028	NAS IOM Tolerable Upper Intake Level	0.001	No
	Adult	0.00004	0.028	NAS IOM Tolerable Upper Intake Level	0.001	No
Nickel	Child	0.0003	0.016	NAS IOM Tolerable Upper Intake Level	0.02	No
	Adult	0.0003	0.014	NAS IOM Tolerable	0.02	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
				Upper Intake Level		
Potassium	Child	0.4	26.38*	Calculated CV*	0.02	No
	Adult	0.4	6.03*	Calculated CV*	0.07	No
Selenium	Child	0.0001	0.0075	NAS IOM Tolerable Upper Intake Level	0.01	No
	Adult	0.0001	0.0057	NAS IOM Tolerable Upper Intake Level	0.02	No
Silver	Child	0.00003	0.005	EPA RfD	0.006	No
	Adult	0.00003	0.005	EPA RfD	0.006	No
Sodium	Child	0.6	106.25	NAS IOM Tolerable Upper Intake Level	0.005	No
	Adult	0.6	32.86	NAS IOM Tolerable Upper Intake Level	0.02	No
Thallium	Child	0.00001	0.00001	EPA RfD	1.0	No
	Adult	0.00001	0.00001	EPA RfD	1.0	No
Vanadium	Child	0.0001	0.005	EPA RfD	0.03	No
	Adult	0.0001	0.005	EPA RfD	0.02	No
Zinc	Child	0.004	0.59	NAS IOM Tolerable Upper Intake Level	0.007	No
	Adult	0.004	0.57	NAS IOM Tolerable Upper Intake Level	0.008	No

Site Mean Dose = sum of doses from individual exposure pathways (*i.e.*, clam ingestion, vegetation ingestion, sediment ingestion (accounts for sediment inhalation), water ingestion, sediment dermal absorption, water dermal absorption). Equations for individual pathway dose calculations are in Tables B-6 through B-10. Intake rates, absorption factors, and other parameters and assumptions are in Tables B-5 through B-10. Metal contaminant concentrations are in Tables B-1 and B-2. Body weight, BW for adult = 70 kg, child (1 to 6 yrs) = 16 kg; MRL = Minimal Risk Levels for chronic oral intake; EPA RfD = Environmental Protection Agency

Reference Dose; Hazard quotient = site mean dose/comparison value. NAS IOM=National Academy of Sciences Institute of Medicine.

* For a CV EPHP used the potassium content of an average Chiquita banana = 422 mg of potassium (www.chiquitabananas.com)

** EPHP calculated potential lead exposure by using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model (EPA, 2010). There is no CV for lead. The CDC uses a reference value of 5 and 25 µg/dL.

[#] MRL for cadmium = 0.00011 mg/kg/d. Table shows a rounded MRL=0.0001 mg/kg/d.

† EPHP assumed all chromium at SCM to be trivalent chromium, because clams and sediment at the SCM site are rich in iron (CH2M HILL, 2011, 2012) and iron has been shown to efficiently reduce or foster the reduction of chromium in environmental media (Eary and Rai, 1988; Fendorf and Li, 1996) and animal tissue (Myers, 1998), respectively. In addition, should sediment and water at SCM contain hexavalent chromium, this chromium will be rapidly reduced to trivalent chromium once in contact with clam tissue or plant tissue, as hexavalent chromium is highly reactive and will generally be reduced in the presence of organic matter and cellular molecules (Debetto et al., 1988; Petrilli and De Flora, 1988). The National Academy of Sciences Institute of Medicine also states that hexavalent chromium is generally not found in food (NAS, 2001).

Table B-14. Calculated Noncancer Risks for PAH Contaminants – Traditional User

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
2-Methylnaphthalene*	Child	0.000002	0.04	ATSDR chronic MRL	0.00006	No
	Adult	0.000001	0.04	ATSDR chronic MRL	0.00002	
Acenaphthene*	Child	0.000006	0.06	EPA RfD	0.0001	No
	Adult	0.000004	0.06	EPA RfD	0.00007	
Acenaphthylene	Child	0.000003	NA	NA	-	No
	Adult	0.000001	NA	NA	-	
Anthracene	Child	0.000004	0.3	EPA RfD	0.00001	No
	Adult	0.000001	0.3	EPA RfD	0.000003	
Benz(a)anthracene	Child	0.000009	NA	NA	-	No
	Adult	0.000001	NA	NA	-	
Benzo(a)pyrene*	Child	0.000012	NA	NA	-	No
	Adult	0.000002	NA	NA	-	
Benzo(b)fluoranthene	Child	0.000013	NA	NA	-	
	Adult	0.000003	NA	NA	-	
Benzo(ghi)perylene*	Child	0.000006	NA	NA	-	No
	Adult	0.000002	NA	NA	-	
Benzo(k)fluoranthene	Child	0.000007	NA	NA	-	No
	Adult	0.000003	NA	NA	-	
Chrysene	Child	0.00001	NA	NA	-	No
	Adult	0.000002	NA	NA	-	No
Dibenz[a,h]anthracene*	Child	0.000003	NA	NA	-	No
	Adult	0.000001	NA	NA	-	No
Fluoranthene	Child	0.00002	0.04	EPA RfD	0.0004	No
	Adult	0.000002	0.04	EPA RfD	0.00005	No

	Life Stage	**Site Mean Dose (mg/kg/d)**	**Comparison Value (Noncancer) (mg/kg/d)***	**CV Source**	**Hazard Quotient**	**Contaminant of Concern (COC)**
Fluorene	Child	0.000002	0.04	EPA RfD	0.00006	No
	Adult	0.000001	0.04	EPA RfD	0.00002	No
Indeno[1,2,3-cd]pyrene	Child	0.00001	NA	NA	-	No
	Adult	0.000002	NA	NA	-	No
Naphthalene*	Child	0.000003	0.02	EPA RfD	0.0002	No
	Adult	0.000001	0.02	EPA RfD	0.00006	
Phenanthrene	Child	0.000008	0.3^{**}	EPA RfD	0.00003	No
	Adult	0.000001	0.3^{**}	EPA RfD	0.000004	No
Pyrene	Child	0.00003	0.03	EPA RfD	0.001	No
	Adult	0.000004	0.03	EPA RfD	0.0001	No

* Level of chemical in media was under the limit of detection of the chemical analysis method.

** EPA RfD for anthracene used because phenanthrene RfD not available. As mentioned here (http://www.dep.state.fl.us/deepwaterhorizon/files2/FLScreeningLevels.pdf) these two molecules have a similar chemical makeup and are structurally similar; toxicities may be comparable.

Dose is calculated by using the limit of detection of test method used. Site Mean Dose = sum of doses from individual exposure pathways (*i.e.*, clam ingestion, sediment ingestion (accounts for sediment inhalation), sediment dermal absorption). Equations for individual pathway dose calculations are in Tables B-6 through B-10. Intake rates, absorption factors, and other parameters and assumptions are in Tables B-5 through B-10. Metal contaminant concentrations are in Table B-3. Body weight, BW for adult = 70 kg, child (1 to 6 yrs) = 16 kg; MRL = Minimal Risk Levels for chronic oral intake; EPA RfD = Environmental Protection Agency Reference Dose; Hazard quotient = site mean dose/comparison value.

Table B-15. Calculated Noncancer Risks for PAH Contaminants – Recreational User

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
2-Methylnaphthalene*	Child	0.000002	0.04	ATSDR chronic MRL	0.00005	No
	Adult	0.0000004	0.04	ATSDR chronic MRL	0.00001	No
Acenaphthene*	Child	0.000003	0.06	EPA RfD	0.00005	No
	Adult	0.000002	0.06	EPA RfD	0.00003	No
Acenaphthylene*	Child	0.000002	NA	NA	-	No
	Adult	0.0000004	NA	NA	-	No
Anthracene	Child	0.000004	0.3	EPA RfD	0.00001	No
	Adult	0.0000006	0.3	EPA RfD	0.000002	No
Benz(a)anthracene	Child	0.000009	NA	NA	-	No
	Adult	0.000001	NA	NA	-	No
Benzo(a)pyrene*	Child	0.00001	NA	NA	-	No
	Adult	0.000002	NA	NA	-	No
Benzo(b)fluoranthene	Child	0.00001	NA	NA	-	No
	Adult	0.000002	NA	NA	-	No
Benzo(ghi)perylene*	Child	0.000005	NA	NA	-	No
	Adult	0.0000009	NA	NA	-	No
Benzo(k)fluoranthene	Child	0.000006	NA	NA	-	No
	Adult	0.000001	NA	NA	-	No
Chrysene	Child	0.000009	NA	NA	-	No
	Adult	0.000001	NA	NA	-	No
Dibenz[a,h]anthracene*	Child	0.000002	NA	NA	-	No
	Adult	0.0000005	NA	NA	-	No

	Life Stage	Site Mean Dose (mg/kg/d)	Comparison Value (Noncancer) (mg/kg/d)*	CV Source	Hazard Quotient	Contaminant of Concern (COC)
Fluoranthene*	Child	0.00001	0.04	EPA RfD	0.0004	No
	Adult	0.000002	0.04	EPA RfD	0.00005	No
Fluorene	Child	0.000002	0.04	EPA RfD	0.00005	No
	Adult	0.0000004	0.04	EPA RfD	0.00001	No
Indeno[1,2,3-cd]pyrene	Child	0.000009	NA	NA	-	No
	Adult	0.000001	NA	NA	-	No
Naphthalene*	Child	0.000002	0.02	EPA RfD	0.0001	No
	Adult	0.0000006	0.02	EPA RfD	0.00003	No
Phenanthrene	Child	0.000008	0.3**	EPA RfD	0.00002	No
	Adult	0.000001	0.3**	EPA RfD	0.000003	No
Pyrene	Child	0.00003	0.03	EPA RfD	0.001	No
	Adult	0.000004	0.03	EPA RfD	0.0001	No

* Level of chemical in media was under the limit of detection of the chemical analysis method. Dose is calculated by using the limit of detection of test method used. Site Mean Dose = sum of doses from individual exposure pathways (*i.e.*, clam ingestion, sediment ingestion (accounts for sediment inhalation), sediment dermal absorption). Equations for individual pathway dose calculations are in Tables B-6 through B-10. Intake rates, absorption factors, and other parameters and assumptions are in Tables B-5 through B-10. Metal contaminant concentrations are in Table B-3. Body weight, BW for adult = 70 kg, child (1 to 6 yrs) = 16 kg; MRL = Minimal Risk Levels for chronic oral intake; EPA RfD = Environmental Protection Agency Reference Dose; Hazard quotient = site mean dose/comparison value.

**EPA RfD for anthracene used because phenanthrene RfD not available. As mentioned here (http://www.dep.state.fl.us/deepwaterhorizon/files2/FLScreeningLevels.pdf) these two molecules have a similar chemical makeup and are structurally similar; toxicities may be comparable.

Table B-16. Calculated Cancer Risks for Metals and PAH Contaminants – Traditional User

Traditional	**Life Stage**	**Site Mean Dose (mg/kg/d)**	**Slope Factor**	**Contaminant of Concern (COC)**	**Estimated Excess Cancer Risk**
Arsenic	Adult	0.0002	1.5	Yes	7.96E-05
Acenaphthene	Adult	0.000002	0.0073	No	7.6E-09
Acenaphthylene	Adult	0.0000004	0.0073	No	1.8E-09
Anthracene	Adult	0.000001	0.073	No	2.5E-08
Benz(a)anthracene	Adult	0.000001	0.73	No	4.9E-07
Benzo(a)pyrene*	Adult	0.000002	7.3	No	6.6E-06
Benzo(b)fluoranthene	Adult	0.000002	0.73	No	8.5E-07
Benzo(ghi)perylene*	Adult	0.000001	0.073	No	4.0E-08
Benzo(k)fluoranthene	Adult	0.000001	0.073	No	6.1E-08
Chrysene	Adult	0.000001	0.0073	No	5.2E-09
Dibenz[a,h]anthracene*	Adult	0.0000005	7.3	No	2.0E-06
Fluoranthene	Adult	0.000002	0.0073	No	7.6E-09
Fluorene	Adult	0.0000004	0.0073	No	1.7E-09
Indeno[1,2,3-cd]pyrene	Adult	0.000001	0.73	No	5.7E-07
Phenanthrene	Adult	0.000001	0.0073	No	4.3E-09
Pyrene	Adult	0.000004	0.0073	No	1.7E-08
Total Excess Cancer Risk					9.0E-05

*No detections in any sample. For this reason, none of these contaminants are COCs even if their cancer risk is greater than 1 in 1,000,000.

Cancer risks were calculated using the following equations:

Calculated possible cancer risk (individual contaminant) = EF × Chronic Daily Dose × CSF

Where,
EF = Exposure Factor (absorption factors)
Chronic Daily Dose = Amount of contaminant ingested daily on a chronic basis per kilogram body weight
CSF = Cancer Slope Factor

Calculated possible cancer risk (combined contaminants) =

$$TECR = \Sigma CR_X$$

Where,
TECR = Total excess cancer risk
ΣCR_X = Sum of possible cancer risks from individual contaminants

Table B-17. Calculated Cancer Risks for Metals and PAH Contaminants – Recreational User

Recreational	Life Stage	Site Mean Dose (mg/kg/d)	Slope Factor	Contaminant of Concern (COC)	Estimated Excess Cancer Risk
Arsenic	Adult	0.00003	1.5	Yes	4.3E-06
Acenaphthene	Adult	0.0000003	0.0073	No	1.2E-09
Acenaphthylene	Adult	0.0000002	0.0073	No	1.1E-09
Anthracene	Adult	0.0000004	0.0073	No	1.8E-08
Benz(a)anthracene	Adult	0.000001	0.73	No	4.1E-07
Benzo(a)pyrene*	Adult	0.000001	7.3	No	5.5E-06
Benzo(b)fluoranthene	Adult	0.000001	0.73	No	5.8E-07
Benzo(ghi)perylene*	Adult	0.0000006	0.073	No	2.4E-08
Benzo(k)fluoranthene	Adult	0.0000007	0.073	No	2.8E-08
Chrysene	Adult	0.000001	0.0073	No	4.3E-09
Dibenz[a,h]anthracene*	Adult	0.0000002	7.3	No	9.8E-07
Fluoranthene*	Adult	0.000002	0.0073	No	6.9E-09
Fluorene	Adult	0.0000002	0.0073	No	9.8E-10
Indeno[1,2,3-cd]pyrene	Adult	0.000001	0.73	No	4.5E-07
Phenanthrene	Adult	0.0000009	0.0073	No	3.6E-09
Pyrene	Adult	0.000004	0.0073	No	1.6E-08
Total Excess Cancer Risk	Adult				1.2E-05

*No detections in any sample. For this reason, none of these contaminants are COCs even if their cancer risk is greater than 1 in 1,000,000.

Cancer risks were calculated using the following equations:

Calculated possible cancer risk (individual contaminant) = EF × Chronic Daily Dose × CSF

Where,
EF = Exposure Factor (absorption factors)
Chronic Daily Dose = Amount of contaminant ingested daily on a chronic basis per kilogram body weight
CSF = Cancer Slope Factor

Calculated possible cancer risk (combined contaminants) =

$$\text{TECR} = \Sigma \text{CR}_X$$

Where,
TECR = Total excess cancer risk
ΣCR_X = Sum of possible cancer risks from individual contaminants

Appendix C

Method used to calculate an acceptable amount of annual softshell clams consumption:

For an adult: There was a calculated excess cancer risk of 8 in 100,000 to adults from arsenic associated with consuming 26.9 pounds of a mix of all clam species sampled from the SCM site per year. The calculated risk was based on actual arsenic speciation of clams from the SCM site. Softshell clams were distinguished from all other clam species sampled at the site by having the highest percentage of the harmful inorganic arsenic of 19% (The average of all clam species, including softshells had approximately 10% inorganic arsenic of all arsenic content). To calculate an acceptable amount of softshell clams that an adult can consume without exceeding the excess cancer risk of 1 in 10,000 exposed, EPHP used the following equation:

Acceptable annual amount of softshell clams consumed by an adult =

A / B = 26.9 lbs/1.9 = 14.2 lbs = 14 lbs.

Where

A = amount acceptable to consume if one consumed a mix of clams having 10% of arsenic content as inorganic arsenic (iAs)

B = the ratio of iAs fraction of total As in softshells to the iAs fraction of total As in all clams including softshells = 1.9

lbs = pounds

For a child: For a child, there was a calculated noncancer HQ=0.6 if the child consumed 6.4 pounds of a mix of all clam species sampled from the SCM site per year. This HQ was based on actual arsenic speciation of clams from the SCM site. Softshell clams were distinguished from all other clam species sampled at the site by having the highest percentage of the harmful inorganic arsenic of 19% (The average of all clam species, including softshells had approximately 10% inorganic arsenic of all arsenic content). To calculate an acceptable amount of softshell clams that a child can consume without exceeding the acceptable HQ=1, EPHP used the following equation:

Acceptable annual amount of softshell clams consumed by a child =

A / B = 10.7 lbs/1.9 = 5.6 lbs = 6 pounds.

Where

A= amount acceptable to consume if one consumed a mix of clams having 10% of arsenic content as iAs = 6.4lbs annually HQ=1/HQ=0.6

B= the ratio of iAs fraction of total As in softshells to the iAs fraction of total As in all clams including softshells = 0.19/0.10 = 1.9

lbs = pounds

Appendix D

Table D-1: Maximum metals concentrations in clams and sediment (CH2M HILL 2012, 2013a).*#

Element	Clams (mg/kg) [n=34]	Background Clams (mg/kg) [n=26]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Shellfish for child CV (mg/kg/d)†	Type of CV	Intertidal Sediment (mg/kg) [n=95]	Background Sediment (mg/kg) [n=19]	Health-Based Soil CV (mg/kg)†	Type of CV
Aluminum	1,193	360	0.57	1.0	ATSDR chronic MRL	24,700	16,400	700,000	cEMEG
Antimony	0.1	0.11	0.00005	0.0004	EPA RfD	1.70	1.9	50,000	cEMEG
Arsenic	6.52	5.67	0.0003	**0.00026 mg As/kg clam** 0.0003	CREG ATSDR chronic MRL	**28.7**	**9.3**	0.47 15	CREG cEMEG child
Barium	3.07	1.51	0.0015	0.2	ATSDR chronic MRL	34.5	16	10,000	cEMEG child
Beryllium	0.17	0.17	0.00008	0.002	ATSDR chronic MRL	0.84	0.93	100	cEMEG
Cadmium	0.54	0.59	**0.00026**	0.0001	ATSDR chronic MRL	3.8	0.93	5	cEMEG
Calcium	5,100	NA	2.45	156.3	NAS IOM Tolerable Upper Intake Level	163,000	149,000	NA	NA
Chromium	11	2	0.0053	1.5	EPA RfD	57.4	11.8	120,000	cEMEG
Cobalt	1.69	0.32	**0.00081**	0.0003	EPA PPRTV	41.9	14.5	3,100	EPA RSL
Copper	93	5.65	0.045	0.12	NAS IOM Tolerable Upper Intake Level	**3870**	**1,100**	500	iEMEG
Iron	8,210	700	**3.94(child) ; 3.92 (adult)**	2.5 (child); 0.64 (adult)	NAS IOM Tolerable Upper Intake Level	112,000	33,400	NA	NA
Lead	0.7	0.26	0.00032	**	N/A	132	4.00	400	RSL
Magnesium	1,209	829	0.58	5.47	NAS IOM Tolerable	25,600	14,200	NA	NA

Element	Clams (mg/kg) [n=34]	Background Clams (mg/kg) [n=26]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Shellfish for child CV (mg/kg/d)†	Type of CV	Intertidal Sediment (mg/kg) [n=95]	Background Sediment (mg/kg) [n=19]	Health-Based Soil CV (mg/kg)†	Type of CV
					Upper Intake Level				
Manganese	32.55	9.94	0.016	0.16	NAS IOM Tolerable Upper Intake Level	1,340	509	2,500	RMEG
Mercury	0.034	0.02	0.000016	0.0004	ATSDR chronic MRL	2.7	0.14	5	RMEG for MeHg
Molybdenum	0.44	NA	0.00021	0.028	NAS IOM Tolerable Upper Intake Level	NA	NA	NA	NA
Nickel	5.78	1.47	0.0028	0.016	NAS IOM Tolerable Upper Intake Level	33.1	11.4	1,000	RMEG
Potassium	3,000	NA	1.44	26.38 (child); 6.03 (adult)	Calculated CV**	1,370	893	NA	NA
Selenium	0.76	0.65	0.00036	0.0075	NAS IOM Tolerable Upper Intake Level	144	4.6	250	cEMEG
Silver	2.4	3.25	0.0011	0.005	EPA RfD	1.5	0.93	250	RMEG
Sodium	3,700	NA	1.78	32.86 (child); 106.25 (adult)	NAS IOM Tolerable Upper Intake Level	10,500	6,580	NA	NA
Thallium	0.051	0.05	**0.00002**	0.00001	EPA RfD	0.84	0.93	8.1	ADEC residential soil cleanup level

Element	Clams (mg/kg) [n=34]	Background Clams (mg/kg) [n=26]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Shellfish for child CV (mg/kg/d)†	Type of CV	Intertidal Sediment (mg/kg) [n=95]	Background Sediment (mg/kg) [n=19]	Health-Based Soil CV (mg/kg)†	Type of CV
Vanadium	27.9	1.80	**0.013**	0.005	EPA RfD	410	285	500	cEMEG
Zinc	16.2	17.00	0.0078		NAS IOM Tolerable		41.8	15,000	cEMEG

mg/kg = milligrams per kilogram, mg/kg/d = milligrams per kilogram per day; NA = Not available; shading added for ease of viewing of the different media data

- CREG, Cancer Risk Evaluation Guide (ATSDR)
- MRL, Minimal Risk Levels for Hazardous Substances for non-carcinogenic effects (ATSDR)
- EMEG, Environmental Media Evaluation Guide for chronic (cEMEG) or intermediate (iEMEG) exposures to children (ATSDR)
- NAS IOM, National Academy of Sciences Institute of Medicine
- RMEG, Reference Dose Media Evaluation Guide for exposures to children (ATSDR)
- RSL, Regional Screening Levels for chemicals with non carcinogenic effects (EPA)

*Number in brackets in top row is the number of samples collected and analyzed. Contaminant concentrations are presented as maximum. Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

** For a CV EPHP used the potassium content of an average Chiquita banana = 422 mg of potassium (www.chiquitabananas.com)

Numbers in bold type that are underlined indicate potential exceedance of the CV for the respective exposure pathway when considering maximum measured contaminant value to be representative of all exposure concentrations in that pathway

(a) max exposure dose calculated on averaging max for each element for all sample location results. Calculation equations in Tables B6 through B8.

Table D-2: Maximum metals concentrations in vegetation (CH2M HILL 2012, 2013a).*#

Element	Intertidal Vegetation (mg/kg)[n=16]	Background Intertidal Vegetation (mg/kg) [n=6]	Upland Vegetation (mg/kg) [n=15]	Background Upland Vegetation (mg/kg) [n=7]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Vegetation CV for child (mg/kg/d)†	Type of CV
Aluminum	73.72	5.60	63.6	53.40	0.04	1.0	ATSDR chronic MRL
Antimony	0.017	0.016	0.20	0.10	0.000064	0.0004	EPA RfD
Arsenic	0.098	0.013	0.03	0.01	0.000037	0.0016 mg As/Kg vegetation 0.0003	CREG ATSDR chronic MRL
Barium	0.20	0.076	42.7	20.00	0.013	0.2	ATSDR chronic MRL
Beryllium	0.002	0.002	0.25	0.24	0.000074	0.002	ATSDR chronic MRL
Cadmium	0.004	0.002	0.62	0.014	**0.00018**	0.0001	ATSDR chronic MRL
Calcium	NA	NA	NA	NA		156.3	NAS IOM Tolerable Upper Intake Level
Chromium	0.33	0.058	0.37	0.110	0.00021	1.5	EPA RfD
Cobalt	0.07	0.030	0.27	0.10	0.0001	0.0003	EPA PPRTV

Element	Intertidal Vegetation (mg/kg)[n=16]	Background Intertidal Vegetation (mg/kg) [n=6]	Upland Vegetation (mg/kg) [n=15]	Background Upland Vegetation (mg/kg) [n=7]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Vegetation CV for child (mg/kg/d)†	Type of CV
Copper	3.44	0.42	10.80	5.40	0.004	0.12	NAS IOM Tolerable Upper Intake Level
Iron	273.88	16.56	205.00	22.90	0.14	2.5 (child); 0.64 (adult)	NAS IOM Tolerable Upper Intake Level
Lead	0.051	0.038	0.50	0.26	0.00016	**	N/A
Magnesium	660.38	588.12	2860.00	1250.00	1.4	5.47	NAS IOM Tolerable Upper Intake Level
Manganese	NA	NA	NA	NA	NA	0.16	NAS IOM Tolerable Upper Intake Level
Mercury	0.015	0.014	0.026	0.016	0.000012	0.0004	ATSDR chronic MRL
Molybdenum	NA	NA	NA	NA	NA	0.028	NAS IOM Tolerable Upper Intake Level
Nickel	0.21	0.23	1.80	2.63	0.00059	0.016	NAS IOM Tolerable

Element	Intertidal Vegetation (mg/kg)[n=16]	Background Intertidal Vegetation (mg/kg) [n=6]	Upland Vegetation (mg/kg) [n=15]	Background Upland Vegetation (mg/kg) [n=7]	Max Exposure Dose for child (mg/kg/d) (a)	Health-Based Vegetation CV for child (mg/kg/d)†	Type of CV
							Upper Intake Level
Potassium	NA	NA	NA	NA	NA	26.38*; 6.03 (adult)	Calculated CV*
Selenium	0.006	0.004	0.22	0.024	0.000067	0.0075	NAS IOM Tolerable Upper Intake Level
Silver	0.004	0.003	0.048	0.012	0.000015	0.005	EPA RfD
Sodium	NA	NA	NA	NA	NA	106.25; 32.86 (child)	NAS IOM Tolerable Upper Intake Level
Thallium	0.004	0.004	0.05	0.024	**0.000016**	0.00001	EPA RfD
Vanadium	1.19	0.032	0.54	0.019	0.00051	0.005	EPA RfD
Zinc	2.54	1.11	42.40	9.74	0.013	0.59	NAS IOM Tolerable Upper Intake Level

mg/kg = milligrams per kilogram, mg/kg/d = milligrams per kilogram per day; NA = Not available; shading added for ease of viewing of the different media data

- CREG, Cancer Risk Evaluation Guide (ATSDR)
- MRL, Minimal Risk Levels for Hazardous Substances for non-carcinogenic effects (ATSDR)
- EMEG, Environmental Media Evaluation Guide for chronic (cEMEG) or intermediate (iEMEG) exposures to children (ATSDR)
- RfD, Reference Dose
- RMEG, Reference Dose Media Evaluation Guide for exposures to children (ATSDR)

- RSL, Regional Screening Levels for chemicals with non carcinogenic effects (EPA)

*Number in brackets in top row is the number of samples collected and analyzed. Contaminant concentrations are presented as maximum. Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

** For a CV EPHP used the potassium content of an average Chiquita banana = 422 mg of potassium (www.chiquitabananas.com)

Numbers in bold type that are underlined indicate potential exceedance of the CV for the respective exposure pathway when considering maximum measured con tions in that pathway

(a) max exposure dose calculated on ts. Calculation equations in Tables B6 through B8.

Table D-3. Maximum metals concentrations in water (CH2M HILL, 2013a).

	Upland Surface Water, Dissolved Metals (µg/L) [n=10]	Upland Surface Water, Total Metals (µg/L) [n=10]	Intertidal Surface Water, Dissolved Metals (µg/L) [n=5]	Intertidal Surface Water, Total Metals (µg/L) [n=5]	Background Surface Water, Dissolved Metals (µg/L) [n=6]	Background Surface Water, Total Metals (µg/L) [n=7]	Health-Based Water CV (µg/L)†	Type of CV
Aluminum	213	282	308	966	397	362	10,000	cEMEG (child)
Antimony	2	2	2	2	2	2	6	MCL
Arsenic	1.5	1.5	1	1	1	1	8.5 3	CREG cEMEG (child)
Barium	10	10	10	10	10	10	2,000	cEMEG (child)
Beryllium	1	1	1	1	1	1	20	cEMEG (child)
Cadmium	1	1	1	1	1	1	1	cEMEG (child)
Calcium	32,100	31,600	12,200	11,500	7,510	7,460	NA	NA
Chromium	2	2	2	2	2	2	100	MCL
Cobalt	1	1	1	1.6	1	1	6,000	EPA tap water screening concentration
Copper	95	87.1	12.9	30.3	4.5	9.6	800	EPA tap water screening concentration
Iron	706	608	730	1,620	1,060	1110	NA	NA
Lead	1	1	1	1.4	1	1	5 µg/dL blood level	CDC reference level
Magnesium	5,000	5,000	27,800	26,100	15,600	15,800	NA	NA
Manganese	22.5	108	37.7	148	35	37.8	430	EPA tap water screening concentration
Mercury	0.2	0.2	0.2	0.2	0.2	0.2	2	MCL
Nickel	1	1	1	1	1	1	220	EPA tap water screening concentration

	Upland Surface Water, Dissolved Metals (µg/L) [n=10]	Upland Surface Water, Total Metals (µg/L) [n=10]	Intertidal Surface Water, Dissolved Metals (µg/L) [n=5]	Intertidal Surface Water, Total Metals (µg/L) [n=5]	Background Surface Water, Dissolved Metals (µg/L) [n=6]	Background Surface Water, Total Metals (µg/L) [n=7]	Health-Based Water CV (µg/L)†	Type of CV
Potassium	5,000	5,000	9,080	8,740	5,280	5,460	NA	NA
Selenium	6.1	6	1.7	1.9	5	5	50	MCL
Silver	1	1	1	1	1	1	94	EPA tap water screening concentration
Sodium	6,150	6,050	235,000	222,000	134,000	137,000	NA	NA
Thallium	1	1	1	1	1	1	2	MCL
Vanadium	5	5	5	5.3	5	5	150	EPA tap water screening concentration
Zinc	8.8	4.2	2.8 (3.6)	5.1	3.9	10.5	3,000	cEMEG (child)

µg/L = micrograms per liter; shading added for ease of viewing of the different media data, NA = Not available; shading added for ease of viewing of the different media data

- MCL, Maximum Contaminant Level (EPA)
- EMEG, Environmental Media Evaluation Guide for chronic (cEMEG) or intermediate (iEMEG) exposures to children (ATSDR)

*Number in brackets in top row is the number of samples collected and analyzed. Contaminant concentrations are presented as maximum. Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

Numbers in bold type that are underlined indicate potential exceedance of the CV for the respective exposure pathway when considering maximum measured contaminant value to be representative of all exposure concentrations in that pathway

Table D-4. Maximum PAH concentrations, µg/kg, in clams and sediment (CH2M HILL 2012, 2013a).*#

	SCM Site Clams [n=17]	**Background Clams** [n=10]	**Health-Based Shellfish CV for child (a)**	**Type of CV**	**SCM Site Sediment [n=95]**	**Background Sediment [n=19]**	**Health-Based Soil CV†**	**Type of CV**
1-methyl-Naphthalene	2.4	1.2	86.24	cEMEG	NA	NA	3,500,000	cEMEG
2-methyl-Naphthalene	21	16	49.28	cEMEG	61	7.60	200,000	RMEG
Acenaphthene	0.96	0.97	739.24	iEMEG	48	8.20	3,000,000	RMEG
Acenaphthylene	2.1	0.97			430	4.40	3,000,000	RMEG
Anthracene	2.1	0.97	12,320.68	iEMEG	460	4.40	15,000,000	RMEG
Benzo(a)-anthracene	4.7	0.97	5.4	CREG (BaP eq)	1,300	19.00	960	CREG (BaP eq)
Benzo(a)pyrene	**12**	**1.9**	0.54	CREG	1,300	61.00	96	CREG
Benzo(b)-Fluoranthene	**8.1**	0.97	5.4	CREG (BaP eq)	1,600	36.00	960	CREG (BaP eq)
Benzo(ghi)-perylene	11	3.5	36.96	RMEG (pyrene)	280	53.00	1,500,000	RMEG (pyrene)
Benzo(k)-fluoranthene	2.4	0.97	54	CREG (BaP eq)	400	50.00	9,600	CREG (BaP eq)
Chrysene	4.3	0.97	540	CREG (BaP eq)	1,300	22.00	96,000	CREG (BaP eq)
Dibenzo(ah)-anthracene	**1.3**	**0.97**	0.54	CREG (BaP eq)	100	10.00	96	CREG (BaP eq)
Dibenzofuran	0.96	0.97	NA	NA	NA	NA	78,000	RSL
Fluoranthene	5.4	0.97	492.83	iEMEG	2,900	28.00	2,000,000	RMEG
Fluorene	NA	NA	492.83	iEMEG	170	8.20	2,000,000	RMEG
Indeno[1,2,3-cd]-pyrene	**5.5**	2.4	5.4	CREG (BaP eq)	394,000	4.30	960	CREG (BaP eq)
Naphthalene	1.2	1.1	739.24	iEMEG	405,000	4.30	1,000,000	RMEG
Phenanthrene	3.3	0.97	36.96	##	630	4.20	1,500,000	RMEG (pyrene)

Pyrene	9.5	0.97	36.96	RMEG	3,200	4.30	1,500,000	RMEG
Total HPAH	NA	NA	NA	NA	9598	4.30	NA	NA
Total LPAH	NA	NA	NA	NA	4,504	4.20	NA	NA
Total PAH	NA	NA	0.54	CREG (BaP eq)	14,102	4.20	96	CREG (BaP eq)

SCM = Salt Chuck Mine
µg/kg = micrograms per kilogram
NA = Not available

- BaP-EQ Benzo(a)pyrene Equivalents: sum of individual cPAHs multiplied by the relative potency factor (RPF) describing the carcinogenic potential relative to BaP
- CREG, Cancer Risk Evaluation Guide (ATSDR)
- EMEG, Environmental Media Evaluation Guide for chronic (cEMEG) or intermediate (iEMEG) exposures to children (ATSDR)
- RMEG, Reference Dose Media Evaluation Guide for exposures to children (ATSDR)
- RSL, Regional Screening Levels for chemicals with non-carcinogenic effects (EPA)

*Number in brackets in top row is the number of samples collected and analyzed. Contaminant concentrations are presented as maximum. Some samples resulted in no detections of a contaminant, but the maximum estimated method detection limit was used.

Numbers in bold type that are underlined indicate potential exceedance of the CV for the respective exposure pathway when considering maximum measured contaminant value to be representative of all exposure concentrations in that pathway

(a) max exposure dose calculated on averaging max for each element for all sample location results. Calculation equations in Tables B6 through B8.

†Using CVs based on residential soil exposures for exposures to sediments is a conservative approach to screening and sediment screening values are scarce.

See footnote in Appendix B, Table B-14

Greetings,

You are receiving a document from the Agency for Toxic Substances and Disease Registry (ATSDR). We are very interested in your opinions about the document you received. We ask that you please take a moment now to complete the following ten question survey. You can access the survey by clicking on the link below.

Completing the survey should take less than 5 minutes of your time. If possible, please provide your responses within the next two weeks. All information that you provide will remain confidential.

The responses to the survey will help ATSDR determine if we are providing useful and meaningful information to you. ATSDR greatly appreciates your assistance as it is vital to our ability to provide optimal public health information.

https://www.surveymonkey.com/r/ATSDRDocumentSatisfaction

LCDR Donna K. Chaney, MBAHCM
U.S. Public Health Service
4770 Buford Highway N.E. MS-F59
Atlanta, GA 30341-3717
(W) 770.488.0713
(F) 770.488.1542

USPHS COMMISSIONED CORPS
1889