Health Consultation

PUBLIC COMMENT VERSION

NORTHEAST CAPE FORMERLY USED DEFENSE SITE (FUDS)

ST. LAWRENCE ISLAND, ALASKA

JULY 24, 2017

COMMENT PERIOD ENDS: OCTOBER 30, 2017

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

PUBLIC COMMENT RELEASE

NORTHEAST CAPE FORMERLY USED DEFENSE SITE (FUDS)

ST. LAWRENCE ISLAND, ALASKA

Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Division of Community Health Investigations

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Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency (EPA) and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been responsible for evaluating public health issues related to National Priorities List sites. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and states with which ATSDR has cooperative agreements. The public health assessment process allows ATSDR scientists and cooperative agreement partners flexibility in the format of the document when they present findings about the public health impact of hazardous waste sites. The flexible format allows health assessors to convey to affected populations important public health messages in a clear and expeditious way.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data are needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and highly exposed people) also receive special attention during the evaluation.

ATSDR uses existing scientific information to evaluate the possible health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available.

Community: ATSDR also needs to learn from the local community about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All public comments related to the document are addressed in the final version of the report.

Conclusions: The report presents conclusions about the public health threat posed by a site. Ways to stop or reduce exposure will then be recommended in the public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA or other regulatory agencies. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the risks. ATSDR can also recommend health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Manager, ATSDR Record Center, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (F-09), Atlanta, GA 30333.

Summary

INTRODUCTION	The Native Village of Savoonga (NVS) requested the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate human exposure to chemicals at the Northeast Cape Formerly Used Defense Site (FUDS), identify potential health impacts, and advise the NVS on actions needed to reduce exposures, if necessary. The site is a former military surveillance and communications station located on St. Lawrence Island, Alaska. While the site is currently used as a seasonal fishing camp, members of the NVS would like to re-establish a Native Village of Northeast Cape in the future. ATSDR used environmental data collected by the NVS, US Army Corps of Engineers, Alaska Community Action on Toxics, Alaska Division of Public Health, and input from Tribal officials and community members to evaluate a number of exposure scenarios and draw the following conclusions.
CONCLUSIONS	ATSDR reached three important conclusions in this health consultation:
Conclusion 1	Eating fish from Northeast Cape in the summer (3 months) is not expected to harm people's health.
Basis for Conclusion	Contaminants are not present in fish at sufficiently elevated levels to be harmful. Contaminants were measured in egg, head and fillet samples of blackfish, Dolly Varden char and pink salmon. ATSDR did not consider blackfish samples in this document because these are not eaten by Tribal members.
Next Steps	ATSDR recommends Tribal members continue to eat fish from the traditional seasonal fishing grounds at Northeast Cape. Subsistence fish have many health, as well as cultural, benefits. If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting additional edible fish samples.
Conclusion 2	Based on available (limited) data, eating greens and berries from Northeast Cape year-round is not expected to harm people's health.
Basis for Conclusion	The concentration of chemicals analyzed did not exceed our non-cancer health effects minimal risk levels for ingestion. Additionally, theoretical cancer doses and lifetime cancer risks were calculated and showed a low additional cancer risk. It must be emphasized that there were very few plant samples analyzed and, except for berries, the analysis included plant parts that are not edible along with the edible portions; therefore, these conclusions may not accurately represent the actual risk from eating greens and berries from Northeast Cape.

	Additionally, native plants have many health benefits that must be considered.
Next Steps	We emphasize that Tribal members should continue to eat greens and berries harvested from many different areas. Additionally, ATSDR recommends that Tribal members discard outer leaves (if possible), wash hands well after harvesting plants from the soil, and thoroughly rinse plants before eating or processing them to reduce their potential risk. If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting additional edible plant samples.
Conclusion 3	Accidentally ingesting soil for half of the year, and drinking Suqitughneq (Suqi) River surface water year-round are not expected to harm people's health.
Basis for Conclusion	Contaminants are not present in soil or Suqi River surface water at sufficiently elevated levels to be harmful.
Next Steps	If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting and analyzing additional Suqi River surface water samples for all water quality parameters before the river is used as a drinking water source.
Conclusion 4	There is not enough contact with site contaminants to suggest that exposures are contributing to cancer and birth defect rates.
Basis for Conclusion	Cancer and birth defect rates are similar to rates in other Native Alaskan communities in the southwest region of Alaska.
Next Steps	Tribal members should continue to eat fish and marine mammals from traditional seasonal fishing grounds at Northeast Cape and other fishing and hunting areas because of the health and cultural benefits.
FOR MORE INFORMATION	If you have questions or comments, you can call ATSDR toll-free at 1-800-CDC-INFO and ask for information on the Northeast Cape site. Detailed information about the toxicology of arsenic is available in ATSDR's Toxicological Profile and Addendum for arsenic at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=22&tid=3; the Toxicological Profile and Addendum for PCBs are available at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=142&tid=26; and the Toxicological Profile for PAHs is available at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=122&tid=25.

Purpose and Health Issues

In October 2011, the President of the Native Village of Savoonga requested that the Agency for Toxic Substances and Disease Registry (ATSDR) conduct a Public Health Assessment or Health Consultation on the Formerly Used Defense Sites (FUDS) of Gambell and Northeast Cape on St. Lawrence Island. The President requested that ATSDR assess health implications from these FUDS, as well as levels of global distillation of persistent organic pollutants and all sources of toxic exposures that Arctic Indigenous Peoples are disproportionately exposed to (NVS 2011). ATSDR determined that there were data available to evaluate exposures to contaminants at the Northeast Cape and Gambell FUDS, regardless of the origin of the source of those contaminants, and make appropriate recommendations to reduce or eliminate the exposures. In the 2012 response letter, ATSDR noted that it would not be possible to definitively determine exposures from the global transport and deposition of pollutants in the environment (ATSDR 2012a).

In February 2012, ATSDR agreed to conduct two Health Consultations. These health consultations focus on assessing the available data to determine whether exposure to contaminants from the Gambell or Northeast Cape sites may be harmful to St Lawrence Island residents. The focus of this health consultation, initiated in April 2014, is the Northeast Cape FUDS. ATSDR previously published a Health Consultation entitled, “Polyaromatic Hydrocarbons and Polychlorinated Biphenyls in Fish from the Suqitughneq River” in March 2006.

Background

Site Description and History

Northeast Cape is located on St. Lawrence Island in the Bering Sea, approximately 135 miles southwest of Nome, Alaska (see Figure 1). It is the site of former military surveillance and White Alice communications stations, which operated from about 1954 to 1972. The Northeast Cape FUDS is approximately 4,800 acres or 7.5 square miles and is bounded by Kitnagak Bay to the northeast, Kangighsak Point to the northwest, and the Kinipaghulghat Mountains to the south (Shannon & Wilson 2005). The Native Village of Northeast Cape (NVNC) is mainly used by the residents of the Native Village of Savoonga (NVS) as a traditional summertime fishing, hunting, and food-gathering camp. It is also used as a rest stop to wait out storms (NVS IRA Council 2012).

Demographics

The nearest community to the Northeast Cape site is the Native Village of Savoonga approximately 60 miles to the northwest. There are currently no year-round residents in the vicinity of the Northeast Cape FUDS; however, people lived in the Native Village of Northeast Cape (NVNC) in the past. Residents of St. Lawrence Island would like to reestablish a community at Northeast Cape in the future. Seasonal dwellings on Kitnagak Bay, at the end of Cargo Beach Road (see Figure 2), are used for subsistence hunting, gathering, and fishing during the summer months (Shannon & Wilson 2005). The NVNC site and surrounding areas are owned in common by Sivuqaq, Inc. and Kukulget, Inc., which consist of Tribal members of the Native Village of Savoonga and the Native Village of Gambell (NVS IRA Council 2009).

Figure 1. St. Lawrence Island

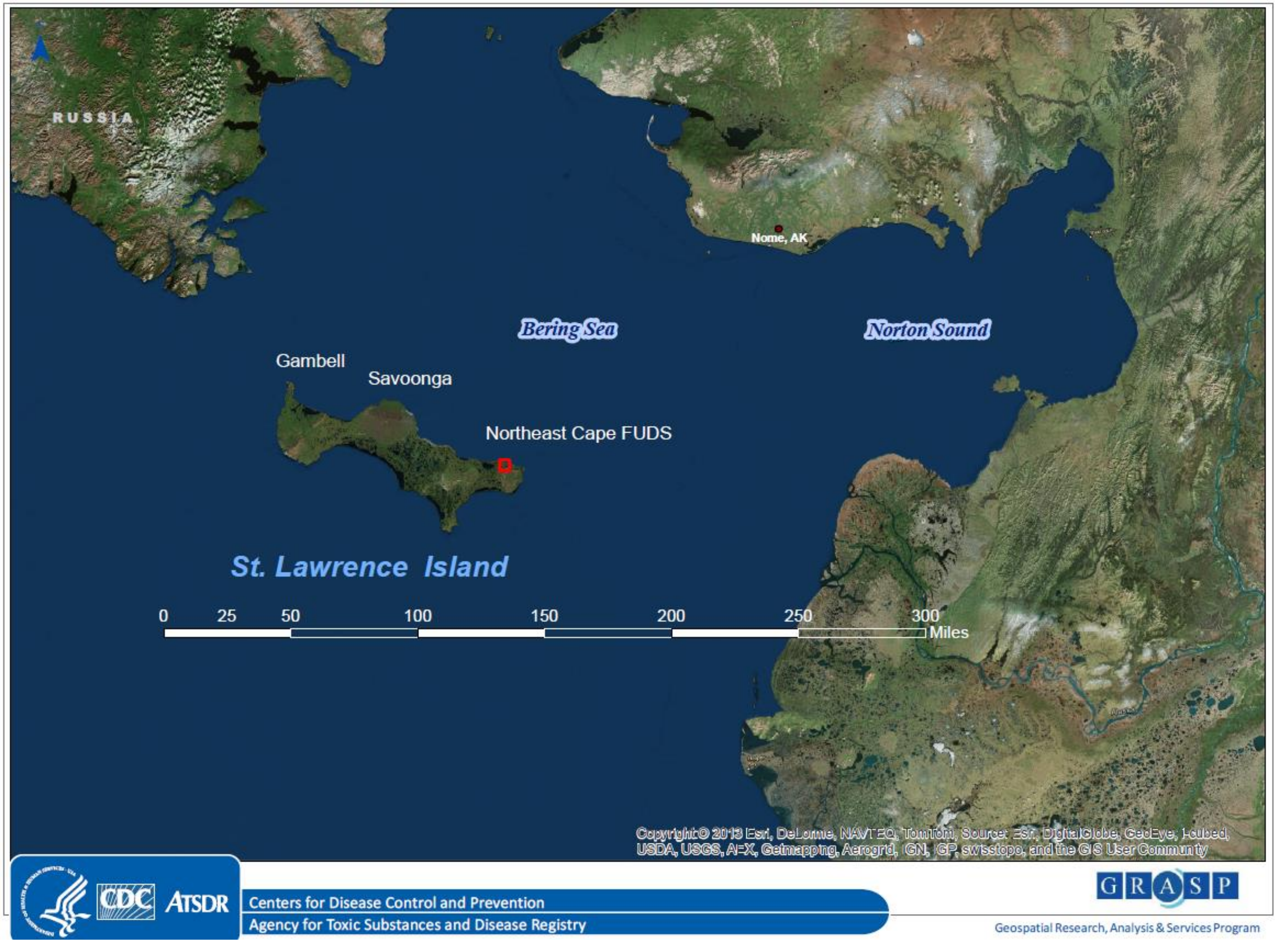


Figure 2. Northeast Cape

Remedial and Cleanup Activity

In recent years there have been many removal actions and remedial activities at Northeast Cape (see Table 1). Between 1994 and 2004, four Remedial Investigations evaluated 34 sites where contaminants were found at some but not all sites (USACE 2009). In September 2006, the Department of Defense (DOD) signed a "Project Closure Report" and "No DOD Action Indicated" for containerized hazardous, toxic, and radioactive waste (CON/HTRW) at the Northeast Cape FUDS (USACE 2006). The US Army Corps of Engineers released a Decision Document in 2009, which presented the selected remedies for the 34 sites at Northeast Cape (USACE 2009). Since then, contractors have been implementing the selected remedial actions at each of the identified sites (see Bristol 2016 for a summary).

In December 2009, the Native Village of Savoonga (NVS) published a Site Investigation Report that focused on sampling and screening of building materials in July 2009 for the presence of asbestos-containing materials and lead-based paint (NVS IRA Council 2009). In April 2012, the NVS published a Removal Action Report detailing several actions including the removal of asbestos containing materials and wood painted with lead-based paint, on-site burning of non-painted wood debris, staging and containment of suspect CON/HTRW, and staging of metallic and non-burnable debris for removal at a later date. These activities took place between August and October 2011 (NVS IRA Council 2012).

In January 2013, the NVS published a Removal Action/Site Investigation Report detailing removal and burning of remaining non-painted wood debris; and removal of wastes previously staged or contained (i.e., scrap metal and non-burnable debris, lead-contaminated burner ash, wood debris containing lead-based paint, and CON/HTRW). The site investigation concluded that contaminants such as diesel-range organics (DRO), residual-range organics (RRO), PAHs, arsenic, cadmium, chromium, lead, and PCBs are present, although not widespread, in soil, sediment, and surface water (NVS IRA Council 2013).

Table 1. Removal Actions and Remedial Activities at Northeast Cape

1990	The Navy and a contractor removed transformers, drums, tanks, fire extinguishers, and other containerized hazardous wastes.
1994	Contractor removed all electrical transformers and their contents from Northeast Cape.
1999	Contractor demolished buildings, removed debris (60 tons) and containerized hazardous and toxic wastes, cleaned above ground storage tanks, and removed a fuel pipeline.
2001	Contractor cleaned above ground storage tanks, decommissioned underground storage tanks, demolished and packaged 3,303 tons of building debris, excavated PCB- and petroleum/oil/lubricant (POL)-contaminated soil, and decommissioned potable water wells. Demolished about half of the buildings in the Air Force Station main operations area.
2003	Contractor demolished and removed the remaining buildings and other structures; removed or decommissioned drums and tanks of hazardous waste; gathered power and communication poles, wires, and cables for disposal; and transported fuel lines off island. Shipped over 5,000 tons of waste and debris off-island for disposal.
2005	Contractor demolished and removed the tramway towers and wire; and removed metal and wooden poles, power and communications wire and cable, 26 tons of debris from Kangukhsam Mountain, and PCB-contaminated concrete and soil. Shipped 1,500 tons of waste and debris off-island for disposal.
2009	Contractor constructed a landfill cap; removed POL-containing drums; and performed a chemical oxidation study.
2010	Contractor excavated POL-, PCB-, and arsenic-contaminated soil; capped a landfill; collected soil, groundwater, and surface water samples; hauled debris off-island for disposal; and monitored a site for natural attenuation.
2011	Contractor excavated diesel range organic- (DRO-), PCB-, and arsenic-contaminated soil; collected additional soil, sediment, and groundwater samples; and removed 34 tons of metal and miscellaneous debris.
2012	Contractor removed POL-, PCB-, arsenic-, ethylene glycol-, and tetrachloroethene (PCE)-contaminated soil; removed over 1,000 gallons of liquid from drums, 15 tons of debris, and 158 poles; decommissioned six monitoring wells; and collected soil samples along the radar dome road.
2013	Contractor removed POL- and arsenic-contaminated soil, contaminated soil and sediment, drums, and pole stumps; abandoned 12 monitoring wells.
2014	Contractor removed PCB-, arsenic-, and POL-contaminated soil, debris, and tar and tar-contaminated soil; abandoned two monitoring wells, reconditioned 8 monitoring wells, and installed seven new monitoring wells; excavated two test pits; and collected surface water and soil samples.

Source: Bristol 2011, 2013a, 2013b, 2016; USACE 2009

Community Health Concerns

Members of the Native Village of Savoonga who use Northeast Cape as a seasonal fishing and hunting village have several health concerns. The village is very remote and there is limited healthcare available on St. Lawrence Island. Tribal members would like to see expanded healthcare services on St. Lawrence Island. The Norton Sound Health Corporation is partnering with the Tribe to improve early detection and treatment of common cancers such as lung, colorectal, breast, and prostate. Residents are concerned because some scientific literature suggests that Tribal members from the Village of Savoonga previously living at, or still visiting, Northeast Cape are more at risk for developing cancer (Hoover et al. 2012). In addition, some biomonitoring studies suggest that some Savoonga residents visiting Northeast Cape have higher levels of PCBs in their blood (Carpenter et al. 2005, Miller et al. 2013). Tribal members would like to know if exposures to contamination from the former military site at Northeast Cape contributed to, or will contribute to, these cancers.

Discussion

ATSDR's public health evaluations are driven by exposure to, or contact with, environmental contaminants. Contaminants released into the environment have the potential to cause harmful health effects. Nevertheless, *a release does not always result in exposure.* People can only be exposed to a contaminant if they come into contact with that contaminant—if they breathe, eat, drink, or have skin contact with a substance containing the contaminant. If no one comes into contact with a contaminant, then no exposure occurs, and thus no health effects could occur.

Often the general public does not have access, or has limited access, to the source area of contamination or areas where contaminants are moving through the environment. This lack of access to these areas becomes important in determining whether people could come into contact with the contaminants. The route of a contaminant's movement to a point of exposure is the pathway. ATSDR identifies and evaluates exposure pathways by considering how people might come into contact with a contaminant. An exposure pathway could involve air, surface water, groundwater, soil, dust, or even plants and animals. Exposure can occur by breathing, eating, drinking, or by skin contact with a substance containing the chemical contaminant.

Chemicals of Concern

When the Department of Defense abandoned the Northeast Cape installation in the 1970s, members of NVNC utilized building materials—including lumber, paint, wiring, and insulation—left by the military. At the time, people were not aware of the potential danger posed by some of the materials, which are now known to contain asbestos and/or lead-based paint (NVS IRA Council 2009). Contamination from polychlorinated biphenyls (PCBs), petroleum-based fuels, volatile organic compounds (VOCs), pesticides, heavy metals, and polycyclic aromatic hydrocarbons (PAHs) has also been identified at Northeast Cape (NVS IRA Council 2012). In addition to contamination by operations at the site, approximately 180,000 gallons of diesel fuel spilled in 1969, impacting the nearby Suqitughneq (Suqi) River drainage.

Contaminants of concern identified through the health consultation process include arsenic, PCBs, and PAHs. These chemicals were identified as contaminants of concern because they exceeded comparison values (CVs) and/or health guidelines. ATSDR examined non-cancer and cancer health effects. The only effects discussed in this health consultation are those of potential health concern at Northeast Cape. Appendix B contains fact sheets with "frequently asked questions" about the contaminants of concern.

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds. Fish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful and has no effect on people at concentrations found in most marine fish (ATSDR 2007).

Total arsenic measurements were available for soil, fish, and plants from Northeast Cape. In this analysis, we assumed that all the arsenic found in soil was inorganic; that all the arsenic in fish was organic; and that 20% of the arsenic found in plants was inorganic. Several studies have shown that ingestion of elevated concentrations of inorganic arsenic in drinking water can increase the risk of skin cancer and cancer of the liver, bladder, and lungs (ATSDR 2007).

PCBs are a mixture of individual chemicals that are no longer produced in the United States, but are still found in the environment because they do not dissolve or degrade easily. PCBs are either oily liquids or solids that are colorless to light yellow when stored. They look like oil spills in the soil, but drop to the bottom when spilled in water. Because they don't burn easily and are good insulating materials, PCBs were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. There are no known natural sources of PCBs in the environment. Some commercial PCB mixtures are known in the United States by their industrial trade name, Aroclor.

A few studies of workers indicate that exposure to PCBs is associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract (ATSDR 2000). Additional human studies found exposure to PCBs associated with an increased risk of non-Hodgkin's lymphoma, prostate cancer, malignant melanoma, and breast cancer (ATSDR 2011, IARC 2015). A recent study also suggests that exposure to PCBs may increase risk of cardiovascular disease (Petriello et al 2016). The International Agency for Research on Cancer (IARC) classifies PCBs as a known human carcinogen.

PAHs are a group of over 100 different chemicals that are formed during the incomplete combustion of coal, oil and gas, garbage, or other organic substances like tobacco, charbroiled meat, or grains. Some PAHs are manufactured. PAHs are found in coal tar, crude oil, creosote, and roofing tar. Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs (e.g., benzo(a)pyrene) have caused cancer in laboratory animals when they ingested them in food (stomach cancer) or had them applied to their skin (skin cancer) (ATSDR 1995).

Environmental Media—where contaminants are found in the environment

ATSDR uses media-specific comparison values (CVs) to screen contaminants of concern in environmental media such as water, air, and soil. ATSDR develops CVs for acute (14 days or less), intermediate (15-364 days), and chronic exposure (365 days or more). ATSDR develops CVs for non-cancer health effects, such as Environmental Media Evaluation Guides (EMEG) and Reference dose Media Evaluation Guides (RMEG), as well as Cancer Risk Evaluation

Guides (CREG). Similarly, EPA develops Regional Screening Levels (RSLs), which are also considered to be protective of human health. ATSDR uses RSLs when other CVs are not available.

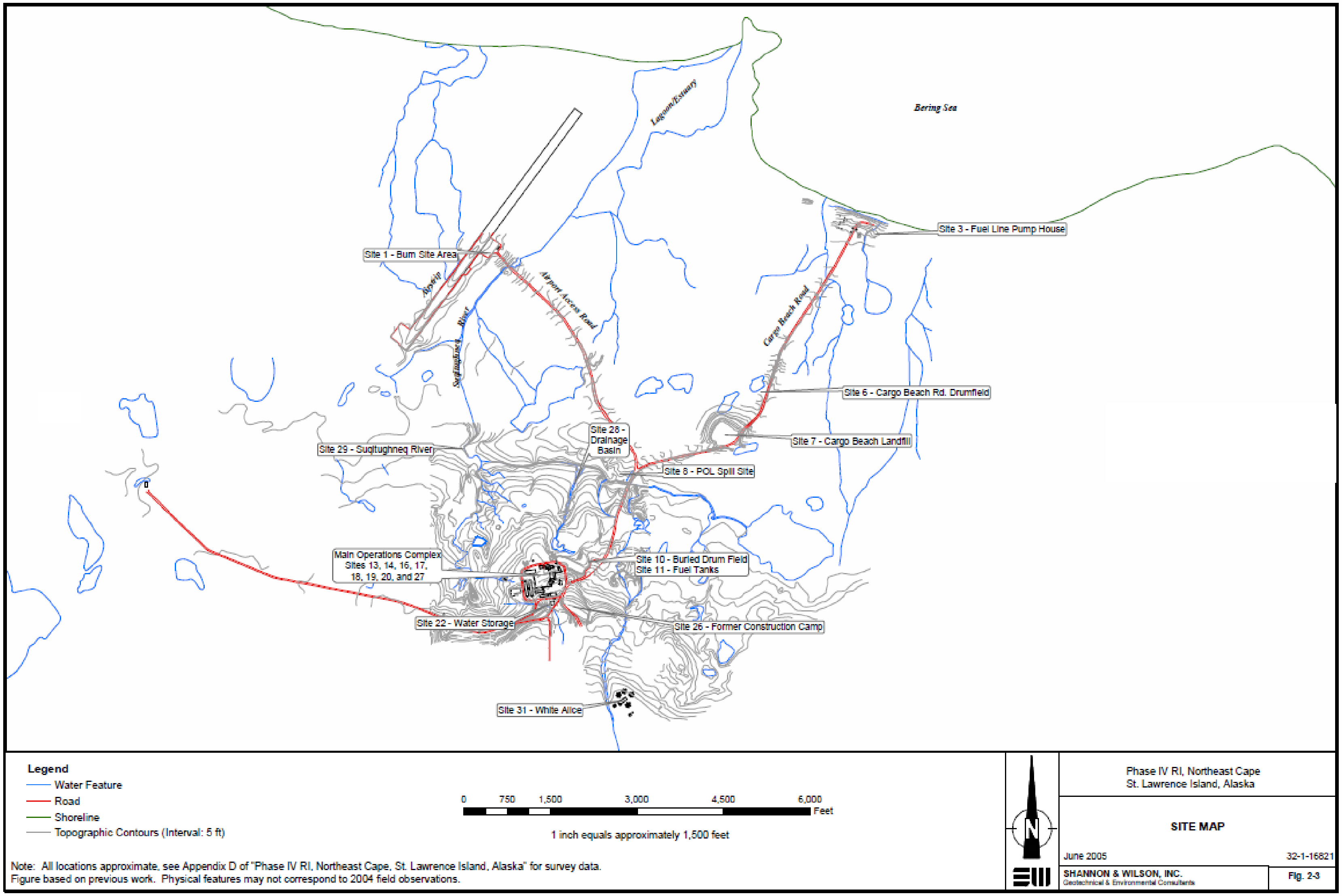
Contaminants with maximum values exceeding CVs were examined more closely by calculating average values. These average values were used to calculate exposure doses using site-specific assumptions. These exposure doses are then compared to Minimal Risk Levels (MRLs). An MRL is an ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), non-carcinogenic effects. If an exposure dose is higher than the MRL, it does not necessarily follow that harmful health effects will occur. It simply indicates to ATSDR that further evaluation is required before a conclusion can be drawn. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions. The MRL is based on the No Observed Adverse Effect Level (NOAEL), which is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects in people or animals; or the Lowest Observed Adverse Effect Level (LOAEL), which is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. *Estimated exposure doses that are less than these health guidelines were not considered to be of health concern.* Cancer doses are calculated similarly to exposure doses, and are used to calculate cancer risk.

Many environmental studies have been conducted at Northeast Cape since it was abandoned in the 1970s. In June 2005, the US Army Corps of Engineers published their Phase IV Remedial Investigation (RI). This RI consisted of soil, sediment, groundwater, and surface water data collected from 15 discrete sites within the installation (see Figure 3). Samples were analyzed for gasoline range organics (GRO), diesel range organics (DRO), residual range organics (RRO), aromatic organic compounds (BTEX), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, semi-volatile organic compounds, and total metals. ATSDR evaluated these data within this health consultation. Background samples were also collected outside the installation boundary (Shannon & Wilson 2005). None of the background concentrations exceeded ATSDR CVs. Additional soil, sediment, and surface water samples have been collected during the recent remedial activities.

In this health consultation, ATSDR evaluated exposures to contaminants in the surface and shallow subsurface soil (less than 12”) for half of the year and Suqi River surface water year-round, as well as from eating plants year-round and fish in the summer. For soil ingestion exposure estimate calculations, 0-2” or 0-3” soil samples are ideal. Therefore, the soil concentrations may over- or under-estimate the surface soil contamination.

There is minimal direct contact with sediment in the Suqi River; therefore ATSDR did not evaluate the sediment pathway further. The shallow, tundra groundwater was never used as drinking water by the Tribal members, nor is it expected to be a potential future drinking water source (USACE 2009). Therefore, groundwater is not evaluated in this health consultation because there is no exposure to this medium.

Figure 3. Site Locations



Source: Shannon & Wilson 2005

Only PCBs in soil, and several polycyclic aromatic hydrocarbons (PAHs) [benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] in surface water contained contaminants with maximum values exceeding ATSDR's lowest CVs or EPA's RSLs (see Table 2). CVs are substance concentrations set well below levels that are known or anticipated to result in adverse health effects. When CVs are not available, ATSDR uses RSLs to screen contaminants. Table 2 shows the contaminants found above CVs or RSLs during the RI. The chemicals with average values exceeding CVs or RSLs are shaded and bolded in Table 2. Exposure doses are generally calculated for contaminants with average values exceeding CVs or RSLs.

Table 2: Chemicals in soil and surface water exceeding ATSDR or EPA comparison values

Chemical	***Matrix***	***#detected/ #samples***	***Max[a] (ppb)***	***Avg[b] (ppb)***	***CV[c] (ppb)***	***Type***
Aroclor 1260 PCB	Soil	9/12	50,800	**6,066**	190	CREG
Benzo(a)anthracene	Surface Water	1/7	0.0433	0.0197	0.034	RSL
Benzo(a)pyrene	Surface Water	1/7	0.0383	**0.0162**	0.0017	CREG
Benzo(b)fluoranthene	Surface Water	1/7	0.036	0.0187	0.034	RSL
Dibenzo(a,h)-anthracene	Surface Water	1/7	0.0324	**0.0268**	0.0034	RSL
Indeno(1,2,3-cd)-pyrene	Surface Water	1/7	0.0396	0.0249	0.034	RSL

Data sources: Soil (Shannon & Wilson 2005); Surface water (MWH 2002 and Shannon & Wilson 2005)
[**ATSDR**, Agency for Toxic Substances and Disease Registry; **CREG**, Cancer Risk Evaluation Guide; **CV**, comparison value; **ppb,** parts per billion; **RSL**, Regional Screening Level]
[a] Maximum concentrations are from the Phase IV RI (Shannon & Wilson 2005).
[b] Average concentrations were calculated using ½ the detection limit for non-detects.
[c] Comparison values used for surface water are based on drinking water or tapwater comparison values.

Some chemicals analyzed in the soil and surface water samples collected for the RI had practical quantitation limits (PQLs), also known as detection limits, which exceeded ATSDR's CVs. These included SVOCs, PCBs, and PAHs. There is no way to know if the actual value exceeded the CV or was something much lower. The CVs that were below quantitation limits were mostly Cancer Risk Evaluation Guides (CREGs). CREGs are very conservative screening tools intended for exposure over a lifetime.

Sometimes it is not technically or practically possible for laboratory equipment to detect and quantify chemicals at levels as low as ATSDR CVs. The difference between ATSDR's comparison values (CV) and the laboratory's detection limits (PQL) is a limitation of this analysis. When soil, sediment, and surface water samples are analyzed in the future, it would be helpful to set quantitation limits below ATSDR CVs whenever possible.

Soil

Exposure to soil at the site is possible; therefore, an exposure dose was calculated for PCBs in soil. Aroclor 1260 was the only contaminant in soil with an average concentration exceeding CVs. The Department of Health and Human Services (HHS) has classified PCBs as "reasonably anticipated to be a carcinogen" and the IARC classifies PCBs as a known human carcinogen.

We calculated the lifetime increased risk of cancer from exposure to Aroclor 1260 in soil (Appendix A). We first calculated a cancer dose that assumed daily exposure to soil for half of the year for 60 years (from the opening of the site in 1954 to the clean-up of the site by 2014) to a maximally exposed individual. The cancer dose was then multiplied by the EPA cancer slope factor to generate the theoretical increased cancer risk estimate (see Appendix A). The calculated increased lifetime cancer risk for PCBs in soil at the site in the past was about 1 additional cancer cases in 100,000 people. ATSDR considers this a low increased lifetime risk of getting cancer above a person's background risk of 40,000 of every 100,000 people.

Since the remedial investigation (RI), contractors have removed thousands of tons of PCB-contaminated soil and sediment from Northeast Cape (Bristol 2016). Soil and sediment with concentrations greater than the cleanup level (1 ppm for soil; 0.7 ppm for sediment) have been removed from Sites 13, 16, 21, 28, and 31 (Bristol 2011, 2013b; USACE 2009, 2015). The calculated lifetime increased cancer risk for PCBs in soil at the 1 ppm cleanup level presents no apparent increased risk (about 3 additional cancer cases in one million people).

Surface Water

Surface water samples were also taken from the Suqitughneq (Suqi) River in 2001 and 2004 as part of the Phase III and IV RIs, respectively (MWH 2002; Shannon & Wilson 2005). These samples were analyzed for GROs, DROs, RROs, BTEX, PAHs, and PCBs. During remedial activities, additional surface water samples were collected from sites with surface water that flows into the Suqi River (Bristol 2012, 2013b; USACE 2016). Many of these samples did not exceed Practical Quantitation Limits (PQLs), also known as detection limits. Of the contaminants detected in the Suqi River with CVs available, only benzo(a)pyrene (a PAH) exceeded ATSDR's lowest CV. Several other PAHs—benzo(a)anthracene, benzo(b)flouranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene—do not have ATSDR CVs, but their detected concentration exceeded EPA RSLs. Of these, only benzo(a)pyrene and dibenzo(a,h)anthracene had average concentrations exceeding their CV or RSL.

Although Suqi River water is not thought to be used for drinking water currently, it was reported to have been used occasionally in the past (prior to contamination). No use of the Suqi River for current drinking water was reported to ATSDR by community members; however, one source (Alaska Community Action on Toxics) identifies the Suqi River as a drinking water source. Additionally, Tribal members would like to use it for drinking water in the future. For these reasons, the Suqi River water samples were compared to drinking water CVs. The surface water spring in the foothills of the Kangusham Mountain (upgradient of the Main Operations Complex) has also been used as a drinking water source in the past.

Only one of the seven Suqi River water samples had detections of PAHs that were above the detection limits (PQLs). The sample location was downstream of the Lower Suqi Bridge. The bridge is constructed of creosote-treated wood, which could explain the detected PAHs. Benzo(a)pyrene was detected in this sample at an estimated concentration of 0.0383 ppb, which exceeds ATSDR's Cancer Risk Evaluation Guide (CREG) of 0.0017 ppb for drinking water. Dibenzo(a,h)anthracene was also detected in this water sample at 0.0324 ppb, which exceeds the EPA RSL of 0.0034 ppb for drinking water. The other PAHs were below detection limits (PQLs) for all seven samples. Other surface water samples collected from areas that flow into the Suqi River had similar mostly non-detect results for PAHs.

Since some PAHs are known or possible carcinogens, we calculated the increased lifetime cancer risk associated with drinking Suqi River water containing the maximum level of each of the five PAHs shown in Table 2. Although we know there were periods of time when the Suqi River was not used as a water source and that conditions would have been different prior to the fuel spill in 1969, we assumed people would be drinking the water over a 79-year lifetime. We assumed an average or typical use of drinking water. Specific assumptions for different age ranges can be found in Appendix A. Because the PAHs occur together and have similar health effects, we summed the increased cancer risk of the individual PAHs. The total lifetime increased cancer risk from drinking water containing the maximum amount of PAHs in the Suqi River was 2 additional cancer cancers in 100,000 people (2.0×10^{-5}). This a low increased lifetime risk of getting cancer above a person's background risk of 40,000 of every 100,000 people. Given that the majority of samples were non-detect, the maximum concentration was used for calculations instead of averaging this value with the non-detect levels, and the cancer risk calculations assumed that people will be drinking the river water daily over their entire lifetime, harmful health effects are not expected from the PAHs in Suqi River water.

Biota—plants and animals in the environment

Non-cancer health effects

Plants

In 2002, 2006, and 2007 sediment core and plant sampling was conducted at Northeast Cape and control sites to attempt to determine if PCBs and pesticides were derived from military sites or long-range transport (Scrudato et al. 2012). Plants collected in the vicinity of the main operation complex at Northeast Cape had the highest concentrations of PCBs. The authors concluded that the excess contamination came from cleanup activities redistributing PCB-contaminated dust onto the plants (Miller et al. 2013; Scrudato et al. 2012).

Plant sampling was conducted as part of the Phase III RI, which was published in March 2003. Seventeen plant tissue samples representing 15 different species were collected from five areas within the Drainage Basin. The species sampled included berries and greens, which are used as subsistence foods, and willows and lichens that reindeer graze on. Samples of three plant species were also collected from a location upgradient (uphill) of the Drainage Basin on the east side of Cargo Beach Road. The plants were analyzed for PAHs, PCBs, and metals (including arsenic). With the exception of berries, all plant parts (roots, stems, leaves, flowers, and non-berry fruits) were analyzed together (MWH 2002). Samples were accompanied by specific handling instructions which stated that, "Plant roots are to be free from soil before sample preparation has begun" (MWH 2003). ATSDR focused the health evaluation on the plants eaten by people—berries and greens. These data are somewhat limited because they include only 7 of the 20 samples, but provide enough information to inform health conclusions.

ATSDR CVs are not available for biota, so ATSDR calculated exposure doses for PAHs, PCBs, and metals (including arsenic). The exposure doses were calculated similarly to those for environmental media; however different site-specific exposure assumptions were made regarding ingestion of food, versus soil or surface water. Exposure dose calculations can be found in Appendix A.

ATSDR used a total plant ingestion rate of 42 grams/day for adults and 21 grams/day for children. This ingestion rate was the result of a January 2003 community survey of subsistence fishers, hunters, and gathers. In the summertime (three months), survey respondents estimated that adults eat approximately four 8-ounce meals per week and children eat approximately four 4-ounce meals per week. During the non-summer (nine) months, survey respondents estimated that they eat about one meal every other week (MWH 2004). The ingestion rates ATSDR used may result in overly conservative exposure doses. According to the Alaska Department of Fish and Game Community Subsistence Information System "green and vegetable" harvest rate data, the 95th percentile harvests for Kasaan are about one third of the results from the 2003 community survey (personal communication with Ali Hamade, Alaska Section of Epidemiology, 2016).

The only chemical detected in plants with calculated exposure doses exceeding ATSDR's minimal risk levels (MRLs) was Aroclor 1254. The calculated exposure doses for Aroclor 1254 exceeded ATSDR chronic MRLs (Table 3). An MRL is an ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), non-carcinogenic effects. The PCB chronic MRL is based on the lowest observed adverse effect level (LOAEL), which is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in animals. The calculated exposure doses did not exceed the LOAEL for PCBs. The samples included whole plants, and one would expect that the non-edible roots would absorb more chemicals than what would be transported to the edible leaf portion. Additionally, since the ingestion rate assumed for these calculations is very high, the exposure dose could be even lower. Therefore, non-cancer health effects are not expected from exposure to PCBs in edible plants.

Table 3: Plant contaminant exposure doses exceeding MRLs

Chemical	***#detected/ #samples***	***Average Concentration (mg/kg)***	***Ingestion Rate (kg/day)***	***Body Weight (kg)***	***Dose (mg/kg/day)***	***Minimal Risk Level (chronic)***	***Basis for Minimal Risk Level***
Aroclor 1254	7/7	0.0545	0.042	80	2.86×10^{-5}	2×10^{-5}	5×10^{-3} (LOAEL)
			0.021	16	7.16×10^{-5}		

Source: MWH 2002
LOAEL – Lowest observed adverse effect level from animal studies.

Fish

In 1969, diesel fuel from a punctured tank at the military site spilled into a tributary of the Suqi River. This spill contaminated the river's drainage basin with PAHs. The widespread contamination caused by the spill dramatically reduced the river's fish population. Members of the Savoonga Tribe recall very bleak times when there were no fish to eat in the Suqi River. Routine military activities at Northeast Cape also resulted in accidental spills of other chemicals such as PCBs. PAHs and PCBs are of concern because they can be taken up by fish and potentially harm people who eat them (ATSDR 2006).

> The University of Alaska Anchorage has collected additional Dolly Varden samples from the Suqi River; however, they have not been analyzed due to a lack of funding. Because these are a species that are eaten by Tribal members, ATSDR would be interested in evaluating these data should they become available.

As a result of the scarcity of fish in the Suqi River following the 1969 fuel spill, subsistence fishing was not possible for many years. Recently, fish have begun to come back to the river and Tribal members are once again using the area as a seasonal fishing camp (ATSDR 2006). Blackfish, Dolly Varden char, and pink salmon were collected as part of the Phase III RI in 2001. The fish were analyzed for PAHs, PCBs, and metals (including arsenic) (MWH 2002). There are no subsistence resource fish species living full time in the drainage basin. Dolly Varden were collected from the lagoon/estuary downstream of the Airport Bridge Road in the Suqi River. Dolly Varden and pink salmon were also collected from the Tapisagahak River, which is considered a background, uncontaminated location (MWH 2003). Both of these species are migratory and spend much of their life eating in open waters of the Bering Sea.

ATSDR calculated exposure doses for the Dolly Varden and pink salmon, which are species eaten by Tribal members. However, because blackfish are not a species that is eaten by Tribal members (Byrne et al. 2015), these data can be evaluated for ecological purposes, but not for human health risks. Detection of PCBs in resident blackfish have been reported (MWH 2002). The source of the PCBs has not been determined and could be site-specific, fish returning to the river from the open sea, or from global transport. Depending on the waterbody, blackfish may be prey or predator to several different species of fish, birds and/or marine mammals. PCBs could be retained (bioaccumulated) in species eating blackfish; however, no information about these species or their consumption is available at this time. The edible fish species data are somewhat limited, but provide enough information to form health conclusions.

ATSDR used the same fish ingestion rates in this health consultation that were used in ATSDR's 2006 health consultation for Northeast Cape. Because Northeast Cape is used as a seasonal fishing camp, ATSDR assumed people would eat these fish for three months of the year. ATSDR assumed adults would eat 108 grams per day, which is equal to about one 8-ounce meal every other day (ATSDR 2006). A child's ingestion rate was assumed to be half that of an adult. Egg, head, and fillet samples were analyzed because Tribal members eat all those parts. None of the calculated exposure doses exceeded ATSDR MRLs. Therefore, eating Dolly Varden fish from the Suqi River at the calculated ingestion rate is not expected to cause harmful non-cancer health effects.

Cancer risk

Cancer risk was calculated for exposure to arsenic, Aroclor 1254 and 1260 (PCBs), and benzo(a)pyrene (a PAH) in edible plants; and Aroclor 1254 and 1260 (PCBs) and benzo(a)pyrene in Dolly Varden fish using EPA cancer slope factors. Benzo(a)pyrene concentrations averaged 0.00216 mg/kg in fish from Northeast Cape. PAHs can be found naturally in smoked and grilled meat. For comparison, in a study of uncontaminated, commercially available grilled and smoked meat products, total average concentrations of the carcinogenic PAHs (benzo[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene) ranged from non-detectable in several meat products to 0.0074 mg/kg in grilled pork chops; and from 0.0002 mg/kg in trout to 0.016 mg/kg in salmon (Gomaa et al. 1993).

Cancer dose is calculated like exposure dose; however, for an adult, the calculation uses a lifetime risk of 79 years (USEPA 2011) rather than the standard 30 years, and 21 years for children. For plant cancer risk calculations, the exposure period was assumed to be 60 years because of soil remediation. Based on the literature, the bioavailability of arsenic from ingested plants was assumed to be 20% (ATSDR 2007) and the bioavailability of benzo(a)pyrene from ingested plants was assumed to be 58% (ATSDR 1995). Multiplying the cancer dose by the EPA slope factor generates the possible cancer risk estimate. The calculated cancer risk and calculations from Northeast Cape plants and fish can be found in Appendix A.

All cancer risks for plants and fish presented a low increased risk (1×10^{-5} range; or one additional cancer case for every 100,000 people) or no apparent increased risk (1×10^{-6} range; or one additional cancer case for every 1,000,000 people). For context, one in two American males will develop cancer in their lifetime, and one in three American females will develop cancer in their lifetime (ACS 2013).

ATSDR emphasizes that a subsistence lifestyle has been shown to be healthier than the alternative western diet (ADHSS 2001). It must also be emphasized that the analysis of the seven plant samples included all plant parts, and one would expect that the non-edible roots would absorb more chemicals than what would be transported to the edible leaf portion (MWH 2003). Therefore, these conclusions may not accurately represent the actual risk from eating greens and berries from Northeast Cape.

The leading cause of death in Alaska Natives is cancer (ANTHC 2006). Many of these cancer cases are preventable by maintaining a healthy traditional diet and lifestyle, and reducing or eliminating tobacco use and the consumption of alcohol. For example, smoking accounts for at least 30% of all cancer deaths, and 87% of lung cancer deaths in the US (ACS 2013). More specifically, during the most recent time period of 2011-2013, 21.8% of all Alaska adults were smokers, compared to 43.7% in the Nome census area, which is the area that includes St. Lawrence Island.

Additionally, the increasing age of the population may contribute to more cancer cases on St. Lawrence Island, with no apparent increase in cancer rates. Between 2000 and 2010 there was a 43.6% increase in the 50 year old and older population in Savoonga, and a 22.5% increase in the 50 year old and older population in Gambell. The incidence of cancer increases with age [ACS 2013]. While the statistical analyses of the cancer data adjust for the difference in rates by age, it is understandable how members of the community would look at the number of cancer *cases* and not the cancer rate.

Other Traditional Foods

A large portion of Tribal members' diet consists of mammals such as seal, walrus, whale, caribou and reindeer including the meat, blubber, and rendered oil. In 2000, the U.S. Army Center for Health Promotion and Preventative Medicine (CHPPM) collected 41 samples from caribou at St. Lawrence Island. These samples were analyzed for PCBs, pesticides, and PAHs in muscle tissue, fat and serum. A total of 1,540 discrete analyses were performed. PCBs were not detected in any of the field samples of caribou. The majority of the pesticide analytes were undetected; however several were flagged for estimated values. These samples were flagged as estimated quantities, indicating there is cause to question the accuracy or precision of the reported value. Two samples had detected values. The majority of the PAH analytes were undetected; however some were flagged for estimated values, and several serum samples had detected values (USACHPPM 2001a). Additional serum samples were collected from 13 caribou and analyzed for PAHs. All 220 PAH analytes were undetected, save one sample for benzo(a)anthracene, which was estimated to be 10 µg/L (USACHPPM 2001b). These results suggest that the caribou were mostly unaffected by PCB, pesticide, and PAH contamination on St. Lawrence Island.

From 2005-2009, Yupik community field researchers collected samples from a variety of fresh and prepared traditional foods on St. Lawrence Island (Miller et al. 2013; Welfinger-Smith et al. 2011). Samples were analyzed for PCBs, seven metals, and three chlorinated pesticides. The study authors compared the levels detected to EPA fish consumption advisories. This comparison showed that PCBs in rendered oil and blubber from all marine mammals were at levels that trigger consumption advisories; while reindeer meat and organs were safe to eat in any amount. The lowest concentrations of contaminants were found in plants, reindeer meat, and meat from marine mammals. The authors stressed the importance of preserving the culture associated with a traditional subsistence lifestyle, as well as providing Tribal members with information they need to make informed decisions. They concluded that it is necessary to "reduce exposures where possible and eliminate sources of PCB, chlorinated pesticides, and metals through state, national, and international policy actions" (Welfinger-Smith et al. 2011).

Benefits May Outweigh Risks

Before changing subsistence patterns, it is important to consider the risks of the contaminants against the nutritional and cultural benefits of the subsistence lifestyle. The Alaska Department of Health and Social Services studied contaminants in subsistence foods in the Western Alaska Coastal Region (ADHSS 2011). The study notes that subsistence foods provide 24–98% of the energy, protein, omega-3 fatty acids, iron, and vitamins A and B12 requirements for the village residents studied. Further, store-bought foods also contain trace levels of contaminants and are generally not likely to be as healthful, available, or diverse as subsistence foods.

Biomonitoring—testing humans for contaminants

A biomonitoring project conducted from 2001-2003 found that the Yupik people of St. Lawrence Island had higher body burdens of PCBs than populations in the lower 48 states and Canada (Carpenter et al. 2005). The authors suggest that the long-range transport to this northern region is the cause of the elevated PCB blood serum levels of the people of Savoonga and Gambell. In the study there were higher levels among those Savoonga residents who spent significant time at Northeast Cape, compared with other residents of Savoonga and Gambell. The authors believe this suggests added exposures to contamination from the Northeast Cape military site (Carpenter et al. 2005, Miller et al. 2013). However, the Alaska Division of Public Health (ADPH) reviewed these same data and concluded that PCB concentrations detected in St. Lawrence Island village residents were similar to other Alaska Native populations (ADPH 2003). The discrepancy between these two analyses is the result of treating the data differently with respect to age. When similar age groups are compared to one another, St. Lawrence Island residents do **not** have significantly higher serum PCBs than other Alaska Native populations. Because PCBs bioaccumulate over time, older people are expected to have higher levels; therefore, similar age groups must be compared for a valid assessment. Additionally, ADPH concluded that the PCB concentrations in the blood of St. Lawrence Island residents would not be expected to cause adverse health effects (ADPH 2003). They concluded that these concentrations are in the expected range for a population with a healthy northern subsistence lifestyle centered on fish and marine mammal consumption (AMAP 1998).

Enough serum remained from 71 participants in the above biomonitoring study to also analyze organochlorine pesticides (Byrne et al. 2015). The authors controlled for sex and age in their multivariate models and found a non-significant rise in serum concentrations of ∑-DDT[1] compounds and a significant rise in serum hexachlorobenzene concentrations in participants with ties to Northeast Cape compared to those from Gambell. They also found elevated ∑-chlordane levels for those visiting camps at Northeast Cape compared to Gambell (Byrne et al. 2015). The authors also compared their results to the general U.S. population (using the 2001-2002 National Health and Nutrition Examination Survey (NHANES) data on human exposures to environmental chemicals) and other Alaska Native groups and First Nations of Canada. Residents of St. Lawrence Island appear to be more exposed to organochlorine pesticides than the general U.S. population, but similarly exposed to other Alaska Native groups and First Nations of Canada. Exposure is predominantly through eating traditional foods that have accumulated pesticides through long-range transport (Byrne et al. 2015).

Health Outcome Data Analysis

ATSDR representatives attended public meetings with residents from both villages (Gambell and Savoonga) to gather their concerns about the two FUDS on St. Lawrence Island. Many of the concerns were about the health of the communities and the number of cancer cases and birth defects within the communities. ATSDR, working with the Alaska Department of Health and Social Services, was able to obtain the number of birth defects and cancer cases for Gambell and Savoonga [ABDR 2012; ACR 2014].

Cancer Registry Data

Cancer registry data review cannot provide a cause and effect evaluation related to the chemicals identified at the site; however, it provides an idea of the burden of disease in Savoonga relative to other native Alaskan communities. ATSDR asked the ADPH to review the cancer registry information. The Alaska Cancer Registry is a database that contains information on the number of cancer cases diagnosed in Alaska since 1996.

They found that the number of observed cancer cases for Savoonga (41) is very similar to the number of expected cases (40); and the number of observed cases for Gambell and Savoonga communities combined (85) exceeded the number of expected cases (77) for the period 1996 to 2013. More than 70% of these cancers are from six types: lung, colorectal, stomach, female breast, uterus, and pancreatic. These are fairly common cancers, and the numbers for each is typically what is expected in the Alaska population [ACR 2014].

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[1] DDE and PCB-85 were co-eluted, which could bias the result toward a positive association between Northeast Cape and ∑-DDT (Byrne et al. 2015).

Based on available data, the number of cases in a cluster of years does not appear to be unusually high, and the distribution by year appears to be random. Also, there does not appear to be a large number of uncommon cancer cases. Although the percentage of cancer deaths in Savoonga and Gambell is slightly higher than the rest of Alaska, the number of cancer deaths per year and the types of cancer deaths do not appear unusual [ACR 2014]. Even though the number of observed cases exceeds the number of expected cases for both communities, the statistical test does not show these increases to be statistically significant. In other words, these increases are just as likely to result from chance as they are to be associated with lifestyle risk factors, family history, or the potential contaminants at the Northeast Cape FUDS.

Birth Defects

The National Birth Defects Prevention Network (NBDPN) has defined 45 major birth defects (congenital anomalies) [NBDPN 2016]. For birth defects, ADPH analyzed only the prevalence of non-alcohol-related birth defects. The summary of the analysis is presented here.

Birth defects are rare events. When they occur in a small population, rate calculations can be statistically unreliable. For the analysis completed by the Alaska Birth Defects Registry (2012), all major anomalies were examined by summing the cases in 5-year intervals. Even after summing the cases in 5-year increments, the confidence intervals were extremely wide. The wide confidence intervals indicate a high level of uncertainty.

The data can include diagnostic bias, whereby some health-care providers might have more sophisticated equipment or clinical specialists, and better report some of the birth defects. Birth defects are reportable up to age six years. The prevalences presented include all reports for children born during 1996-2011 that were received before January 1, 2012.

St. Lawrence Island is within the Southwest Region category of the Alaska census database. During 1996–2011, the prevalence of major, non-alcohol–related defects among infants born to St. Lawrence Island residents (666.7, CI: 457.4-875.9) was higher than the prevalence rate for the remainder of the Southwest Region (602.3, CI: 560.5–644.1). However, the confidence intervals for St. Lawrence Island fit within the confidence intervals of those other census areas, indicating no statistically significant difference. The St. Lawrence Island prevalence is more similar to census areas with predominately Alaska Native populations, as well as the Anchorage Native population group [ABDR 2012].

According to staff at the Alaska Department of Fish and Game, in general, communities in the census areas of Dillingham, Nome, North Slope Borough, and Wade Hampton (renamed "Kusilvak" Census Area in 2015) have diets that include marine mammals (whales and walrus) more similar to communities on St. Lawrence Island. The birth defects data indicate that there is no statistically significant difference in overall prevalence among those communities [ABDR 2012].

Some of the anomalies include, but are not limited to, cardiovascular, alimentary tract, genitourinary, central nervous system, eye and ear, musculoskeletal, and chromosomal defects. During 1996–2011, major congenital anomalies, including alcohol-related defects, affected approximately 6% of Alaskan live births annually. This rate is twice the national average. Further analysis indicated the prevalence of major congenital anomalies was higher among Alaska Native children than among non-native children.

Data limitations do exist. Some birth defects undergo medical records abstraction and case verification. During this analysis, ADPH based the prevalence of cases on the number of cases reported under the qualifying International Classification of Diseases (ICD)-9 codes, regardless of case verification.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and physiological differences between children and adults demand special emphasis. Children are at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If some chemical exposures are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Lead exposure is a special concern in children as there is no known safe level of blood lead. The average level of lead in Dolly Varden in the Suqi River fish was 0.004731 mg/kg, and the average level of lead in edible greens and berries from Northeast Cape was 1.366 mg/kg. Lead-based paint was present in some of the former military building materials, but has since been abated. ATSDR supports the Centers for Disease Control and Prevention (CDC) and American Academy of Pediatrics recommendations for childhood blood lead screening at ages 1 and 2 (CDC 2012). The cost of the test is covered under Medicaid and many private insurance policies nationwide.

ATSDR specifically evaluated exposures to children in this health consultation, such as:

1. Eating fish from Northeast Cape in the summer (3 months).

2. Eating greens and berries from Northeast Cape year-round.

3. Exposure to the soil at Northeast Cape and Suqitughneq River surface water.

Conclusions

1. ATSDR concludes that eating Dolly Varden fish from Northeast Cape in the summer (3 months) is not expected to harm people's health because contaminants are not present at sufficiently elevated levels.

2. ATSDR concludes that eating greens and berries from Northeast Cape year-round is not expected to cause harmful non-cancer health effects. The theoretical increased lifetime cancer risk from ingesting plants was considered low. It must be emphasized; however, that very few plant samples were analyzed; therefore, these conclusions may not accurately represent the actual risk from eating greens and berries from Northeast Cape. Conversely, native plants have many health benefits that must also be considered.

3. ATSDR concludes that soil and Suqitughneq River surface water are not expected to harm people's health because contaminants are not present at sufficiently elevated levels.

4. There is not enough contact with site contaminants to suggest that exposures are contributing to cancer and birth defect rates.

Recommendations

1. ATSDR recommends Tribal members continue to eat fish from the traditional seasonal fishing and hunting grounds at Northeast Cape. Subsistence fish have many health, as well as cultural, benefits. If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting additional edible fish samples.

2. We emphasize that Tribal members should continue to eat local greens and berries, especially if they are collected from several different locations. Additionally, ATSDR recommends that Tribal members discard outer leaves (if possible), wash hands well after harvesting plants from the soil, and thoroughly rinse plants before eating or processing them to reduce their potential risk. If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting additional edible plant samples.

3. If Northeast Cape becomes a year-round community in the future, ATSDR recommends collecting Suqitughneq River surface water samples before the river is used as a drinking water source.

Public Health Action Plan

1. ATSDR will meet with members of the Native Village of Savoonga to present the results of this Health Consultation and to receive their comments. Comments may also be sent in writing to ATSDRRecordsCenter@cdc.gov *or* Attention: Manager, ATSDR Record Center, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (F-09), Atlanta, GA 30333.
2. Tribal members would like to see expanded healthcare services on St. Lawrence Island. ATSDR recommends that the Norton Sound Health Corporation continue to partner with the Tribe to set up screening for early detection and treatment of common cancers such as lung, colorectal, breast, and prostate.
3. If Tribe-approved marine mammal ingestion rates and marine mammal chemical data are made available to ATSDR, ATSDR will calculate exposure doses for these subsistence foods, upon request.

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Appendix A: Dose and Cancer Risk Calculations

The equations and assumptions used to calculate exposure doses and increased lifetime cancer risk estimates follow for the ingestion pathways. Media specific increased lifetime cancer risk calculations for this site can be found in Table A-1.

Exposure Dose Calculations

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

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

Where:

Dose = exposure dose (mg/kg-day)
C = contaminant concentration (ppb=µg/L; or mg/kg), chemical specific
CF = conversion factor for units
IR = ingestion rate of contaminant (L/day or kg/day)
EF = frequency of exposure (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (years x days/year)

Assumptions for ingestion cancer risk calculations:

Age Group	Ingestion Rates (IR)				Body Weight (BW) (kg)	Exposure duration (ED) (years)	Age-dependent adjustment factor (ADAF)*
	Soil (mg/day)	Water (L/day)	Plants (kg/day)	Fish (kg/day)			
Child Birth to < 1 yr		0.504			7.8	1	10
Child 6 wks to < 1 yr	100				9.2	0.88	10
Child 1 to < 2yr	200	0.308	0.021		11.4	1	10
Child 2 to < 6 yr	200	0.376	0.021	0.054	17.4	4	3
Child 6 to < 11 yr	200	0.511	0.021	0.054	31.8	5	3
Child 11 to < 16 yr	200	0.637	0.021	0.054	56.8	5	3
Child 16 to < 21 yr	200	0.770	0.021	0.054	71.6	5	1
Adult > 21 yr	100		0.042		80	39	
Adult > 21 yr	100		0.042		80	60	
Adult > 21 yr	100	1.227	0.042	0.108	80	58	1

*For the chemicals of concern, only PAHs are considered mutagenic.

Exposure frequency (soil)	183 days/year
Exposure frequency (water)	365 days/year
Exposure frequency (plant meals)	365 days/year
(summer 4 days/week, winter 1 day/every other week)	
Exposure frequency (fish meals)	90 days/year
Total Lifetime	79 years
Averaging Time (non-cancer)	(F/365) days
Averaging Time (cancer)	28,835 days

Increased Lifetime Cancer Risk Calculations

The estimated increased lifetime cancer risk calculation is:

Cancer Risk = Dose x CSF x ADAF

Where:

Cancer Risk = Expression of the cancer risk (unitless)
Dose = Site-specific dose of carcinogen (mg/kg/day)
CSF = Cancer Slope Factor in $(mg/kg/day)^{-1}$, a measure of cancer potency
ADAF = Age dependent adjustment factor (for carcinogens that are mutagens)

Table A-1: Increased cancer risk calculations for soil, surface water, plants and fish

Chemical by media	#detected/ #samples	Concentration	Cancer slope factor $(mg/kg/day)^{-1}$	Number of years exposed	Increased cancer risk
Soil		Average (mg/kg)			
Aroclor 1260	9/12	6.066	2	21 (child)	1.0×10^{-5}
				39 (adult)	3.7×10^{-6}
				60 (total past)†	1.4×10^{-5}
				60 (adult only)‡	5.8×10^{-6}
Aroclor 1260		1	2	21 (child)	1.7×10^{-6}
(remedial maximum)				58 (adult)	9.2×10^{-7}
				79 (lifetime)	2.6×10^{-6}
Surface Water		Maximum§ (ppb)			
Benzo(a)anthracene	1/7	0.0433	0.73	21 (child)	6.6×10^{-7}
				58 (adult)	3.6×10^{-7}
				79 (lifetime)	1.0×10^{-6}
Benzo(a)pyrene	1/7	0.0383	7.3	21 (child)	5.9×10^{-6}
				58 (adult)	3.2×10^{-6}
				79 (lifetime)	9.1×10^{-6}
Benzo(b)fluoranthene	1/7	0.0360	0.73	21 (child)	5.5×10^{-7}
				58 (adult)	3.0×10^{-7}
				79 (lifetime)	8.5×10^{-7}
Dibenzo(a,h)anthracene	1/7	0.0324	7.3	21 (child)	5.0×10^{-6}
				58 (adult)	2.7×10^{-6}
				79 (lifetime)	7.7×10^{-6}
Indeno(1,2,3-cd)pyrene	1/7	0.0396	0.73	21 (child)	6.1×10^{-7}
				58 (adult)	3.3×10^{-7}
				79 (lifetime)	9.4×10^{-7}
Total PAH surface water	1/7			21 (child)	1.3×10^{-5}
				58 (adult)	6.9×10^{-6}
				79 (lifetime)	2.0×10^{-5}

Chemical by media	#detected/ #samples	Concentration	Cancer slope factor (mg/kg/day)$^{-1}$	Number of years exposed	Increased cancer risk
Plants		Average (mg/kg)			
Arsenic¶	2/7	0.0301	1.5	20 (child)	7.6×10^{-6}
				39 (adult)	1.2×10^{-5}
				60 (total past)†	1.9×10^{-5}
				60 (adult only)‡	1.8×10^{-5}
Aroclor 1254	7/7	0.0545	2	20 (child)	1.8×10^{-5}
				39 (adult)	2.8×10^{-5}
				60 (total past)†	4.7×10^{-5}
				60 (adult only)‡	4.3×10^{-5}
Aroclor 1260	7/7	0.0264	2	20 (child)	8.9×10^{-6}
				39 (adult)	1.4×10^{-5}
				60 (total past)†	2.3×10^{-5}
				60 (adult only)‡	2.1×10^{-5}
Benzo(a)pyrene**	4/7	0.0108	7.3	20 (child)	5.0×10^{-5}
				39 (adult)	2.0×10^{-5}
				60 (total past)†	7.0×10^{-5}
				60 (adult only)‡	3.1×10^{-5}
Fish		Average (mg/kg)			
Aroclor 1254	13/13	0.0135	2	19 (child)	2.5×10^{-6}
				58 (adult)	6.6×10^{-6}
				77 (lifetime)	9.1×10^{-6}
Aroclor 1260	2/13	0.000958	2	19 (child)	1.8×10^{-7}
				58 (adult)	4.7×10^{-7}
				77 (lifetime)	6.4×10^{-7}
Benzo(a)pyrene	4/7	0.00216	7.3	19 (child)	4.0×10^{-6}
				58 (adult)	3.9×10^{-6}
				77 (lifetime)	7.9×10^{-6}

Data Sources: Shannon & Wilson 2005 and MWH 2002

†Total past exposure includes 21 years as a child and 39 years as an adult (note, child does not ingest plants in the first year).

‡Adult only exposure assumes that the entire 60 years at the site was as an adult.

§Since only one surface water sample had detectable concentrations of these PAHs, the decision was made to use the maximum concentration because of the uncertainty of calculating an average based on non-detection levels. The cancer risk calculations represent the worst case.

¶Bioavailability of arsenic from ingesting plants was assumed to be 20%.

**Bioavailability of benzo(a)pyrene from ingesting plants was assumed to be 58%.

Appendix B: ToxFAQs for contaminants of concern

Arsenic - ToxFAQs™

CAS # 7440-38-2

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic

Agency for Toxic Substances and Disease Registry
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CS249955-F

Arsenic

CAS # 7440-38-2

compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Polychlorinated Biphenyls - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

- PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.
- PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.
- PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.
- PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

- Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.
- Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.
- Breathing air near hazardous waste sites and drinking contaminated well water.
- In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over

Polychlorinated Biphenyls

several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. PCBs have been classified as probably carcinogenic, and carcinogenic to humans (group 1) by the Environmental Protection Agency (EPA) and International Agency for Research on Cancer (IARC), respectively.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risks of exposure to PCBs?

- You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U.S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.
- Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.
- Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.
- If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Polycyclic Aromatic Hydrocarbons (PAHs) - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.
- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

Polycyclic Aromatic Hydrocarbons

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.