Health Consultation

Evaluation of Environmental Exposures at the

GAMBELL FORMERLY USED DEFENSE SITE (FUDS)
(aka ST LAWRENCE ISLAND)

NATIVE VILLAGE OF GAMBELL
GAMBELL, ALASKA

EPA FACILITY ID: AKD981765894

SEPTEMBER 29, 2020

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

Health Consultation: A Note of Explanation

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

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or
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Prepared by the
U.S. Department of Health and Human Services
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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 established 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, the Superfund law has required ATSDR to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are/have been 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. Environmental and health scientists from ATSDR and the states that have ATSDR cooperative agreements carry out public health assessments. 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 to evaluate exposure.

Health Effects: If the review of the environmental data shows that people have or could come in 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. Therefore, when evaluating the health threat to a community, ATSDR scientists first consider the health impact to children. 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, ATSDR distributes an early version to the public for their comments. This final report addresses all the public comments related to the document.

Conclusions: The report presents conclusions about the public health threat posed by a site. The public health action plan will then recommend ways to stop or reduce exposure. ATSDR is

primarily an advisory agency, so usually these reports identify what actions are appropriate for EPA or other regulatory agencies to take. 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 additional questions or comments, we encourage you to send them to us.

Address letters as follows:

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

Summary and Statement of Issues

INTRODUCTION	The Native Village of Savoonga asked the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate human exposures and potential public health impacts of contaminants and physical hazards at two Formerly Used Defense Sites (FUDS) on St. Lawrence Island, Alaska. The two FUDS are located on opposite ends of St. Lawrence Island. The Gambell FUDS is a former military surveillance and communications station on the northwestern side of the island, both within and just outside the village of Gambell. The military operated at Gambell from 1948 to the 1960s. The other FUDS, Northeast Cape, included a White Alice Communication System site and operated from 1957 to 1972. Northeast Cape is currently used as a seasonal fishing camp. The military facilities were abandoned until the 1980s when the U.S. Army Corps of Engineers (USACE) began conducting environmental investigations and cleanup of the FUDS. ATSDR has evaluated both FUDS in separate health consultation documents. This health consultation focuses on contaminants in the areas of concern at the Gambell FUDS. To evaluate exposure scenarios. ATSDR used environmental information from the following organizations and agencies: • Native Village of Savoonga • Native Village of Gambell (NVG) • U.S. Army Corps of Engineers (USACE) • Native American Lands Environmental Mitigation Program (NALEMP) • Alaska Drinking Water Program • Alaska Community Action on Toxics (ACAT) • Alaska Division of Public Health (ADPH) • Alaska Department of Health and Social Services (ADHSS); and • Tribal officials and community members ATSDR could not evaluate historical exposure of community members to potential contaminants in drinking water before 1993 when the public water system was established or to chemicals in or near stacked or partially buried metal drums prior to 1995 because no chemical contaminant tests were conducted to identify or characterize the hazard.
CONCLUSIONS	ATSDR reached eight important conclusions in this health consultation:
Conclusion 1	**Metal Debris:** Adults and children might be injured by coming in contact with remaining partially buried or unearthed FUDS-related metal debris while driving all-terrain vehicles or participating in other outside activities, including excavating for artifacts. This physical hazard is a public health hazard.

Basis for Conclusion	Because heavy objects rise to the surface after freeze/thaw events (frost heaving/frost jacking), additional metal objects, once buried, might possibly resurface, creating a physical hazard that can impale, cut, or contribute to any number of other injuries. USACE and NVG contractors have removed more than 130 tons of metal (debris, drums, matting, cable, fuel tanks, etc.) during numerous removal actions. However, neither ATSDR, USACE, nor NVG can ensure that no metal debris remains.
Next Steps	Village leaders can take prudent public health actions to protect residents from debris, by: 1) inspecting the village and beach for resurfaced metal debris at least once each year after the spring thaw and after storms, 2) removing hazardous debris (with possible assistance of NALEMP funds), and 3) continuing hazard awareness education and reporting procedures for suspected items.
Conclusion 2	**Cancer Concerns:** To address the community's concerns about cancer, ATSDR evaluated ways in which people could contact carcinogenic chemical contaminants. Additionally, ATSDR requested ADPH review the cancer registry information specific for Gambell residents. ATSDR found that contact with site contaminants is not occurring or was too infrequent to contribute to cancer rates. ADHSS's review of the cancer registry information for the period 1996 to 2014 found the number of cancers randomly distributed over time with no apparent clustering and the types of cancers were common, with no rare cancers that might be associated with environmental contaminant exposures. For cancer mortality from 1996-2013 for all types of cancer (cancer sites) combined, the number of observed cancer deaths for Gambell was greater than the number of expected cancer deaths due to lung cancer of smokers.
Basis for Conclusion	Chemical contaminants, including those suspected to cause cancer, were not elevated in the community drinking water or ground surface material. Public drinking water is monitored in accordance with U.S. Safe Drinking Water Act. The gravel surface covering the soils prevents direct frequent contact with substances that might have been trapped beneath the ground. Although ATSDR could not assess past exposures, a review of cancers associated with past chemical exposures such as kidney, bladder, and liver cancers or rare types of cancers was conducted, and these were not found to be elevated. The Alaska Cancer Registry performed a study to explore whether the additional cancer deaths on Gambell could be attributed to any particular cancer type. The cancer registry reviewed the number and types of cancer deaths for 1996 – 2013 and found that lung cancer was by far the most common type of cancer death, accounting for 45% of all cancer deaths (the statewide average for Alaska Native people is 28%). The cancer registry

	found that the number of observed lung cancer deaths for Gambell was greater than the number of expected lung cancer deaths. The additional observed lung cancer deaths for Gambell were found to be statistically significant. As tobacco use is the greatest risk factor for lung cancer, the smoking prevalence for St. Lawrence Island was reviewed and found to be more than twice the state average, with an estimated 53.4% of adults being current smokers. All reported lung cancer cases (100%) on St Lawrence Island had a history of smoking. Also, there was a much higher percentage of current smokers among people diagnosed with lung cancer (64.7%), compared to people diagnosed with other types of cancer (34%). This information is consistent with smoking as the leading risk factor for lung cancer.
Next Steps	Low Dose CT scan (LDCT) for lung cancer screening is now available at the Norton Sound Health Corporation (NSHC). NSHC also performs colonography, known as "virtual" colonoscopy. It uses low dose radiation CT scanning to obtain an interior view of the colon that is otherwise only seen with a colonoscopy, which is also available at NSHC. In addition, the Alaska Run for Women awarded a grant to NSHC for the Bering Sea Sisters Circle to increase early detection of breast cancer among Alaska Native women of the Norton Sound region through mammography and other breast imaging services available at NSHC. The first Bering Sea Sisters Circle took place January 30, 2018 in Gambell. The Cancer Registry cancer studies of St. Lawrence Island requested by ATSDR found that lung, colorectal, and breast cancers account for the majority of cancer morbidity and mortality for the Island. Lung, colorectal, and breast cancer screenings are available at the Norton Sound Regional Hospital in Nome. The NSHC continues its outreach for cancer screening and early detection to the residents of St. Lawrence Island.
Conclusion 3	**Birth Defects Concerns:** To address the community's concerns about birth defects, ATSDR evaluated ways in which people could contact chemical contaminants. Additionally, ATSDR requested ADHSS review the birth defects registry information specific for Gambell residents. ADHSS reviewed data from the Alaska Birth Defects Registry covering the period 1996 through 2011 and found the results for St. Lawrence Island to be similar to other Native Alaskan communities.
Basis for Conclusion	Chemical contaminants, including those suspected to cause birth defects, were not elevated in the community drinking water or ground surface material. The cases of birth defects among St. Lawrence Island communities during 1996 through 2011 are not statistically different from other Alaskan

	communities. However, statistically significant differences might not be seen in the small populations of Gambell and Savoonga.
Next Steps	ADHSS will work with the community of Gambell to continue examining the prevalence of birth defects for the years from 2011 to the present. The next ADPH report will include an update from the prevalence study to include the most current data available.
Conclusion 4	**Drinking Water:** Public drinking water in the village of Gambell is not expected to harm people's health.
Basis for Conclusion	Drinking water monitoring has not shown contaminants at levels above EPA's safe drinking water standards or ATSDR health-based comparison values. The village of Gambell Water Plant manages and monitors the drinking water in accordance with the Alaska Department of Environmental Conservation (ADEC) Division of Water Quality/Village Safe Water Program and Division of Environmental Health/Drinking Water Program.
Next Steps	ATSDR recommends that the village of Gambell, in accordance with the Alaska Department of Environmental Conservation (ADEC) Division of Water Quality/Village Safe Water Program and Division of Environmental Health/Drinking Water Program, test all water sources used for drinking on Gambell, including the non-regulated traditional sources, to ensure safety. ATSDR also recommends protecting the back-up water supply by restricting activities in the infiltration gallery.
Conclusion 5	**Ground Surface:** Exposure to soil and gravel contaminants related to the Gambell FUDS is currently not occurring and is therefore not expected to harm people's health.
Basis for Conclusion	Data from removal actions show that contaminants are not present in soil at harmful levels. USACE and NVG contractors have removed more than 85 tons of chemically contaminated subsurface gravel, sediment, and soil and more than 29 tons of waste (e.g., asphalt) in containers.
Next Steps	ATSDR recommends that residents alert the City of Gambell office of spills to ensure that proper measures are taken to protect adults and children from contacting the spill material. When a spill is reported, the community should be on the alert for vapors that might migrate toward their homes, especially during the winter.
Conclusion 6	**Indoor Air:** ATSDR cannot determine whether residents are exposed to volatile vapors in indoor air from subsurface sources without indoor air measurements.

Basis for Conclusion	Community members reported stove oil or diesel odors in 2010. Chemical contaminants were detected in groundwater, soil gas, or subsurface material below ADEC cleanup standards in 2010. However, the potential for vapor intrusion from these media into indoor air was not evaluated. Detection of volatile chemicals in the parts per million range in soil and groundwater samples collected near the former Site 27 presents a concern for volatile vapors to be drawn into heated homes. No indoor air samples were collected. Removal of buried debris and stained soils decrease the potential hazard. Precautions can be taken to prevent future vapor intrusion from new spills. Vapor intrusion occurs when vapor-forming chemicals migrate from a subsurface source into an overlying building. Site 27 was a former military drum storage area. The community fuel pipeline runs through the 1995 housing area. In 1995, new homes were installed in the same area. USACE and NVG have conducted several investigations and waste removals of soil and debris in this area potentially decreasing the hazard, but due to the limitations and lack of sampling information, vapor intrusion presents an uncertain hazard to residents near the former Site 27.
Next Steps	Residents can take basic public health actions to prevent vapors from future spills near buildings from being drawn into heated buildings. ATSDR recommends that containers used to store fuels or volatile chemicals be owner-inspected monthly and seated in a tray to capture spills and prevent vapors from intruding into heated buildings. Community pipelines should be routinely pressure tested to identify leaks before being used. Residents should report leaks or odors to the mayor's office. ADEC needs to consider vapor intrusion into nearby homes when evaluating future fuel leaks or spills. ATSDR also recommends follow-up sampling to show whether residual soil gases have dissipated following the 2003 and 2006 soil, drum, and debris removals. The most recent data from Site 7 are greater than ATSDR's and US EPA's vapor intrusion screening levels, indicating that seasonal paired indoor air and subslab gas sampling would be necessary to assess health from potential indoor air contamination. Including methods to detect aliphatic and aromatic fractions would allow comparison to provisional vapor intrusion screening levels. ATSDR cannot determine the source of the contamination to recommend who should perform this follow-up. Potential sources include the military motor pool, drums, and spills, as well as community fuel supply lines and residential petroleum and chemical uses. The presence of a modern fuel additive indicates that community-sourced fuel is present to some extent. ATSDR recommends that ADEC and the military work together to perform follow-up sampling so that the potential for vapor intrusion into Gambell buildings near Site 7 can be assessed.

Conclusion 7	**Lakes:** There is insufficient information for ATSDR to determine the safety of activities at Troutman and Nayvaghaq Lakes. Because of limited samples, the possible health effects from swallowing water or ice from or recreating in Troutman and Nayvaghaq Lakes are not known. Additionally, because ATSDR, USACE, and NALEMP cannot ensure the complete removal of metallic debris and ordnance from these disposal sites, a small risk of injury from physical hazards remains for those who recreate in the lakes.
Basis for Conclusion	One surface water sample from each lake was tested in 1985. Additional sampling parameters, including biological sampling from multiple surface water locations, are necessary to characterize lake water quality. Additionally, water treatment would be necessary to make the water drinkable.
Next Steps	ATSDR recommends that ADEC conduct additional water quality testing before residents use these lakes for drinking and recreating. To reduce the risk of injury from remaining metal debris to those who recreate in the lakes, ATSDR recommends the community continue hazard awareness training, including reporting procedures for suspected items.
Conclusion 8	**Discarded Drums:** ATSDR cannot evaluate the exposure of adults and children who had direct contact with the contents of leaking 55-gallon metal drums, or adjacent sludge because the contents of the drums and sludge are not known and sampling data are not available for all areas where drums were found.
Basis for Conclusion	Not enough information is available to determine if exposure to the contents of drums had a health impact on residents. USACE and NALEMP contractors have removed more than one thousand 55-gallon drums, more than 85 tons of chemically contaminated soils, and more than 29 tons of containerized waste since cleanup began in 1993. No known leaking drums have been currently identified in Gambell.
Next Steps	If drums are identified in the future, the Village is requested to avoid contact and notify the ADEC to facilitate testing, removal, and potential remediation. Utility workers or other community members who find sludge during soil disturbance activities need to report their findings to Gambell village authorities and ADEC for evaluation.
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 Gambell FUDS site.

Background

Introduction

The Native Village of Savoonga asked the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate human exposures and potential public health impacts of contaminants at two Formerly Used Defense Sites (FUDS) on St. Lawrence Island, Alaska. The two FUDS are located on opposite ends of St. Lawrence Island.

The Gambell FUDS is a former military surveillance and communications station on the northwestern side of the island, within and just outside the village of Gambell where access to the former military installation areas is unrestricted [E & E 1992]. The military operated at Gambell from 1948 to 1965 [USACE 2009]. The other FUDS, Northeast Cape, operated from 1957 to 1972, and included a White Alice Communication System. Northeast Cape is currently used as a seasonal fishing camp. The military facilities were abandoned and left in place with few or no controls until the 1980s when the U.S. Army Corps of Engineers (USACE) began conducting environmental investigations and cleanup of the FUDS.

ATSDR has evaluated each FUDS in separate health consultation documents. This health consultationt focuses on contaminants in the areas at the Gambell FUDS[1]. ATSDR reviewed documents and information from the Native Village of Savoonga, Native Village of Gambell (NVG), U.S. Army Corps of Engineers (USACE), the Native American Lands Environmental Mitigation Program (NALEMP), state of Alaska Drinking Water Program, Alaska Community Action on Toxics (ACAT), Alaska Division of Public Health (ADPH), and Alaska Department of Health and Social Services, and received input from Tribal officials and community members.

Two Native corporations currently own St. Lawrence Island: Sivuqaq, Inc., in Gambell, the state of Alaska, and the Kukulget, Inc., in Savoonga, Alaska [USACE 2009]. On St. Lawrence Island, the state of Alaska owns land used for airstrips (Gambell and Savoonga) and related facilities only [MW 1995; BCS 2007].

Site Description

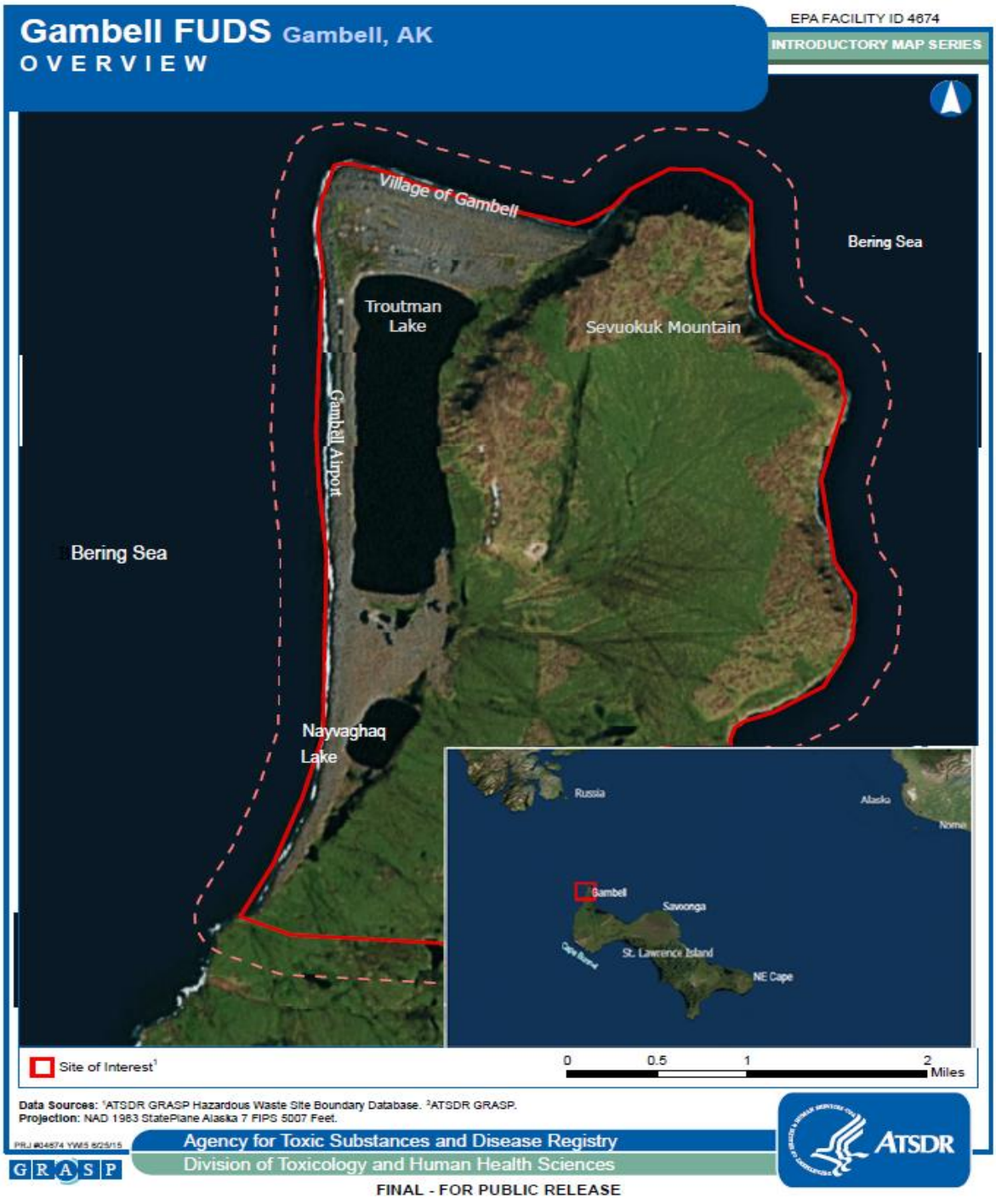
The Gambell FUDS is within the Native Village of Gambell on the northwestern tip (Northwest Cape) of St. Lawrence Island in the western portion of the Bering Sea near the territorial waters of Russia. St. Lawrence Island is approximately 200 air miles southwest of Nome, Alaska, and 36 miles from Siberia, Russia [BCS 2006a]. St. Lawrence Island is about 100 miles long and between 8 and 22 miles wide [University of Washington 1999]. Most of the island is wilderness, consisting of tundra-covered flatland with little to no vegetation, and dotted with small lakes. Rocky mountains rise out of the tundra, naturally dividing the island into western, central, and eastern areas [E&E 1992].

The village of Gambell lies on a gravel spit that projects north and westward from the island. Figure 1 shows St. Lawrence Island and Gambell. The village is relatively flat, with an elevation

[1] The FUDS program cleans up only DOD-generated eligible contamination, which occurred before the transfer of the property to private owners or federal, state or local governments. The FUDS program also does not certify that the property is clean, particularly where contamination may be present as the result of actions of parties other than DOD. Thus, other contamination is possible by parties other than FUDs and might not have been detected by FUDS sampling.

range from sea level to approximately 30 feet above mean sea level [BCS 2006a]. Gambell is bordered on the north and west sides by the Bering Sea; the south side of the Gambell village is adjacent to Troutman Lake, an inland lake, and the east side is bordered by Sevuokuk (Sivuqaq) Mountain. Sevuokuk Mountain rises to a height of 615 feet and is the eastern boundary of the gravel spit. There are no harbors, ports, or docks [MW 1995]. However, the community uses the north shore to land and store boats.

Figure 1. Aerial View of St. Lawrence Island with Expanded view of Gambell, Alaska



The area around the village of Gambell is classified as a FUDS under the Defense Environmental Restoration Program. The Gambell FUDS covers approximately 2.7 square miles. The site includes areas around Troutman Lake and extends from the Bering Sea to the top of Sevuokuk Mountain [BCS 2006a]. The site includes the airstrip and land now used by the Gambell Airport west and south of Troutman Lake to Nayvaghaq Lake [E&E 1992]. Note that the Defense Department does not control the land use of FUDS properties.

Gambell Airport is a public airport on approximately 200 acres owned by the state of Alaska. The airport contains one asphalt and concrete paved runway measuring 4,500 by 96 feet on the small strip of land west of Troutman Lake [FAA 2015].

Demographics

St. Lawrence Island currently contains two populated communities approximately 50 miles apart: Gambell and Savoonga. Gambell is at the northwestern end of St. Lawrence Island and Savoonga is on the north central coast. Northeast Cape is approximately 50 miles farther east from Savoonga and currently has no full-time residents [E&E 1992; ATSDR 2013]. However, residents of St. Lawrence Island have expressed an interest in reestablishing a community at Northeast Cape in the future [NVS IRA Council 2009].

The people who live on St. Lawrence Island are primarily St. Lawrence Island Yupik, who are descendants of the Siberian Yupik Eskimos and belong to either the Native Village of Gambell or the Native Village of Savoonga. Organized pursuant to the Indian Reorganization Act, both villages are federally recognized Tribes that operate under a federally approved constitution [E&E 1992, 1993]. The 2015 US Census Factfinder estimates 701 people living in Gambell and 671 people in Savoonga, of which 95% are Alaskan Natives [US Census 2015]. Appendix A contains demographic information for the village of Gambell [HTL 2014].

Land Use and Natural Resource Use

The Yupik people lead a Tribal subsistence lifestyle that relies on natural resources for nutritional, cultural, economic, and religious purposes. Land use at the Gambell site is residential and recreational with community service facilities and open space. The primary uses for the recreational and open space lands are subsistence hunting, gathering, and eco-tourism [USACE 2009]. There are no gardens in Gambell. The ocean surrounding the Gambell area is used extensively for subsistence hunting of walrus, seals, sea birds, polar bears, and whales [MW 1999]. A subsistence use study indicates Gambell residents eat mainly marine mammals (94%), salmon (3%), other fish (1%), birds and eggs (1%), and plants and berries (1%) [Kawerak 2007]. The Gambell area supports habitats for a variety of seabirds, waterfowl, and mammals that either breed in or visit the area. Birds and bird eggs from a large rookery atop Sevuokuk Mountain also serve as a food source to residents [E&E 1992].

Archeological artifact digging is conducted within Gambell by permission. Both archeologists and local residents have excavated sites in Gambell. Finds from several archeological sites (Hillside, Levoghiyoq, Mayowagh, Ayveghyaget, Old Gambell, and Seklowaghyaget) show that humans have lived in the area for more than 2,000 years [Kawerak 2012; NPS 2014]. Excavation sites are highly visible as large mounds with scattered soil piles that are remnants of ongoing digging for

artifacts by local residents. Sea mammal bones, structural wooden and bone remnants, pottery fragments, ground stone tools, and metal and glass fragments are scattered within and between soil piles. Military debris, consisting of rusted barrels, cable, and miscellaneous pieces of metal, were found and removed within the boundaries of the Mayowagh, Old Gambell, and Seklowaghyaget mounds. Digging up buried ivory and artifacts for crafts and sale provides some cash inflow [URS 1985]. Other sources of cash income come from selling ivory, carvings, crafts, and, in the past, fox skins [Jolles 2002; ADEC 2012; Kawerak 2012].

Climate and Weather

St. Lawrence Island has a cool, moist, subarctic maritime climate with some continental influences during winter, when pack ice caps much of the Bering Sea. Winds and fog are common; precipitation occurs approximately 300 days per year as light rain, mist, or snow. Annual snowfall averages 98 inches per year. Annual precipitation is about 18.6 inches per year, and more than half falls as light rain between June and September. Summer temperatures average between 34°F and 49°F, with a record high of 65°F. Winter temperatures range from -2°F to 10°F, with an extreme low of -26°F. Freeze-up normally occurs in October or November, and ice breakup normally occurs in June [E&E 1992, MW 1999].

The temperature in Gambell for much of the year (January–May and October–December) is below freezing. Snow can remain on the ground from mid-November through the end of May. The snow on the surface of the ground acts as a barrier between people and the ground. The wind is constant, ranging from 12 miles per hour (mph) to 24 mph. Winds exceed 12 mph 70% of the time [MW 1999]. Consistent with community observations, regional climate data show two warming periods in the past 50 years, one in the late 1970s and another around 2000. During these periods, average minimum temperatures increased, and sea ice decreased [NOAA 2018]. Other studies of sea surface temperatures show a regional warm period from around 1925-1943 only, followed by a cold period from 1945-1957 [Mantua 1997].

Geology

The geology of St. Lawrence Island and the village of Gambell has an important influence on the likelihood for chemical contaminants to remain on the surface where people can come in contact with them. The island is composed of older sedimentary rocks (limestone, greywacke, and shale), granitic rocks (monzonite), Quaternary basalt, and highly permeable unconsolidated surficial deposits (gravel and other materials) likely deposited as successive beach ridges [Patton 1980, BCS 2006a]. Underlying the village of Gambell is highly permeable, unconsolidated Quaternary gravels, with minor coarse sands, over continuous permafrost occurring at 3–15 feet below ground surface (bgs) [USGS 1971].

The Gambell spit is mostly rocky, without plants, except for a few patches of beach grass. The village stands primarily on basalt gravel, typically, 2–6 cm (0.5–3 inches) in diameter, with slightly smaller gravel on the beach [USGS 1971]. The unconsolidated, free-moving gravel has smooth edges resembling river rocks. The gravelly, sandy beach soils are well drained [Munter 1992]. Villagers often refer to the large gravel as “cobble.” Patches of sand and soil occur in only a few locations, intermingled among rock at the base, slope, and top of Sevuokuk Mountain, and provide a substrate for the grasses, shrubs, heaths, sedges, mosses, and lichen [MW 1995]. Residents have used all-terrain vehicles (ATVs) for transport across the gravel spit [E&E 1993]. Walking on the gravel is difficult and takes much effort [Jolles 2002].

Sevuokuk Mountain is composed of Cretaceous quartz monzonite, a gray, coarsely crystalline granite rock, rich in quartz and feldspars. Exposed Cretaceous quartz monzonite of the Sevuokuk Mountain pluton appears along the cliffs and higher elevations on the island. Exposed outcrops of quartz monzonite are coarsely crystalline and massive [MW 1995]. A flat, wave-cut plateau tops the mountain. No trees grow on St. Lawrence Island [BCS 2006a; Jolles 2002]. Tundra is present near moist areas at higher elevations, such as on Sevuokuk Mountain [MW 1995].

Surface Water

Freshwater resources at Gambell consist of Troutman Lake (approximately 574 acres and approximately 10 feet deep) and Nayvaghaq Lake (approximately 93 acres) [URS 1985]. The level of Troutman Lake is about 4 feet above sea level, and is fed by Troutman Creek, a freshwater stream at its south end. Storm surges reportedly break over the spit periodically and cause the lake water to be brackish. The lake has no surface water outlet [Munter 1992]. The terrain east of Gambell is wet tundra, with standing water. Snowmelt runoff forms rivulets on steeper slopes [URS 1985, E&E 1992].

Groundwater

Groundwater occurs within the surficial deposits of western St. Lawrence Island and provides the primary public drinking water source although some people still use the unregulated traditional sources. Depth to water within these deposits has been measured at 4 to 11 feet bgs throughout the vicinity of Gambell and south of Troutman Lake and is influenced by surface water [URS 1986].

Site History

In 1943, the U.S. Army built Gambell Army Airfield, now known as Gambell Airport. They used it as a transport base during World War II and as an emergency landing field for aircraft patrolling the west coast of Alaska in the years that followed. From 1948 until the 1960s when operations ceased, various units of the U.S. Army and U.S. Air Force used approximately 2,543 acres of land in Gambell under Special Use Permits and Public Land Order. The Air Force built a base camp in 1950 at the foot of Sevuokuk Mountain and a radar site on the mountaintop. The Air Force laid communications cables from the village of Gambell, up Sevuokuk Mountain, and south to Bunnell Cape.

The Army used several areas during the late 1950s, with a main base camp located just northeast of Troutman Lake [E&E 1992]. The military abandoned their locations at Gambell by 1956. The Air Force land was transferred to the Bureau of Land Management (BLM) in 1962, and the Army's land was transferred to BLM in 1963 [MW 1998]. Reportedly, several hundred men were stationed at Gambell, with many local men hired on occasion. [USACE 2008, USACE 2009].

When the military ceased operations at Gambell, Department of Defense (DOD) structures were either abandoned and scavenged or demolished and burned, with the debris buried on-site [MW 1998]. From the 1960s until the mid-1980s, the military left waste buried in landfills and piled throughout the village. Military littering of the village of Gambell created stress and potentially affected the health and welfare of the residents of Gambell [ATSDR 2013].

In the mid-1980s, the military began environmental investigations and established Gambell as a Formerly Used Defense Site, a program managed by the USACE under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as CERCLA or Superfund. This law provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites, as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment.

In 1986, the Superfund Amendments and Reauthorization Act (SARA) reauthorized the law. SARA requires a phased approach that characterizes site conditions, determines the nature of the waste, assesses risk to human health and the environment, evaluates the performance and cost of treatment technologies, and conducts cleanup activities. USACE contractors conducted environmental investigations at Gambell from the mid-1980s to 2008. During the environmental investigation, USACE contractors identified 38 areas of concern for contamination (Appendices B and C). The primary contaminants detected in the soil and sediments included petroleum fuels, oils, and metals.

USACE contractors conducted clean-up activities at areas where contamination and debris were determined to pose a hazard. Contractors removed more than 29 tons of hazardous and non-hazardous containerized wastes, including asphalt drums, paint, generators, batteries, and transformer debris once containing polychlorinated biphenyls (PCBs). Additionally, more than 1,000 empty 55-gallon drums that once contained chemicals such as petroleum fuels and other unknown compounds were removed. Contractors also removed more than 130 tons (71 tons in 1999 and 59 tons in 2006) of exposed metal debris including runway Marston matting[2], other metal debris (towers), cables, vehicles, equipment, fuel tanks, tractors, and batteries; and excavated 85 tons of contaminated soil (72 tons in 1999 and 13 tons in 2006).

Figure 2: Marston matting removed from Site 6

[NVG 2006]

The U.S. DOD decided that no further action was needed for 35 of the 38 sites that had no evidence of any remaining environmental hazards. The decision documents dated June 2005 and September 2007 include detailed summaries of the remedial investigation results, removal of debris and hazardous materials, and other previous activities [USACE 2005, 2008].

The Native American Lands Environmental Mitigation Program (NALEMP), funded through the DOD, addressed buried debris that was not eligible for cleanup under the FUDS program. NALEMP cleaned up

[2] Marston matting was used during World War II and later to quickly build temporary runways. The pierced steel planks used to make the runways measure 10 feet long and 15 inches wide and have holes stamped through them. The matting was used extensively at Gambell as a runway surface. Figure 2 is an example of Marston matting. [http://guadalcanal.homestead.com/files/s_Airfield_marston_matting__Pagoda_HIll_area.JPG]

construction debris and small remaining quantities of hazardous substances. The USACE cleanup of the Gambell FUDS was completed in 2007 and 2008, when all of the associated contaminated sites were determined to be "Cleanup Complete" [ADEC 2013]. However, NALEMP continues to be funded on an annual, as-needed basis to address metal debris and other non-FUDS issues.

ATSDR Site Visits and Community Outreach

In the petition letter, the Native Village of Savoonga Tribal Council President Ronnie Toolie states, "ATSDR needs to learn what people on our island know about FUDS and what concerns they may have about the sites' impact on the health of our Yupik people." In 2001, to address health concerns by the communities of St. Lawrence Island, ATSDR evaluated persistent organic pollutant (POP) levels in St. Lawrence Island reindeer. In the 2001 Exposure Investigation report, ATSDR found that detectable health effects were not expected in individuals on St. Lawrence Island who consumed reindeer muscle and fat.

For this request, ATSDR visited St. Lawrence Island seven times, twice before receiving the petition and five times since receiving the petition. The first site visit was in March 2013. The health education specialist from ATSDR's field office in Seattle, Washington, and the regional representative from Anchorage, Alaska, travelled to both villages to meet with community members and gather community concerns regarding the FUDS at Northeast Cape and Gambell. Appendix D gives a summary of the meeting and the Gambell community's concerns. A separate document contains the meeting summary for Savoonga and the village concerns about Northeast Cape.

A health assessor from ATSDR headquarters in Atlanta, Georgia, and the regional representative from Anchorage, Alaska conducted a second site visit in August 2013. During this visit, ATSDR representatives were able to tour Northeast Cape and Gambell to see the remaining portions of the two FUDS and gather firsthand knowledge from Tribal members who were present when the sites were in operation. ATSDR also held community meetings to explain its plans and to continue gathering additional knowledge from residents regarding the potential human health effects associated with exposure to contaminants from the FUDS.

A third site visit occurred in mid-September 2014. The ATSDR regional representative, Alaska Office, and a preventive medicine physician from the Centers for Disease Control and Prevention (CDC) visited the villages of Savoonga and Gambell. The main purpose was to discuss the State Cancer Registry studies for Gambell and Savoonga and to gather knowledge from the people on the occurrence of cancer in the communities. In addition, they met with Angie Gorn, CEO/Executive Director of the Norton Sound Health Corporation (NSHC), and the health corporation board to discuss cancer incidence on St. Lawrence Island and cancer prevention outreach to the villages.

A fourth visit to the villages of Savoonga and Gambell took place in September 2015. The lead health assessor from ATSDR headquarters in Atlanta, Georgia, and the regional representative from Anchorage, Alaska, met with the Tribal councils of Gambell and Savoonga and Tribal members to present the preliminary findings of ATSDR's data validation drafts of the Gambell and Northeast Cape health consultations.

A fifth visit to Gambell and Savoonga took place in July 2017. Joe Sarcone, ATSDR regional representative, Alaska Office, and Rhonda Kaetzel, PhD, ATSDR Region 10 director, presented a summary of findings from the public comment drafts of the Gambell and Northeast Cape Health consultations to the Tribal councils and people of Gambell and Savoonga.

In addition to the village visits, ATSDR was an active participant in the St. Lawrence Island Dialogue Group (2012-2013). The group, convened by the EPA and facilitated by a public policy mediator, brought together the villages, non-governmental organizations, and government agencies in an effort to find common ground to address the former military sites' contaminant impacts.

In response to health concerns expressed by community members of Gambell and Savoonga, ATSDR convened the St. Lawrence Island Healthcare and Public Health Providers Working Group (2013-2014). The Working Group's primary goal was to coordinate the public health and healthcare response to community concerns regarding the impact of contaminants on health. The co-facilitators for the group were Joe Sarcone, ATSDR regional representative, Alaska Office, and Vi Waghiyi, Tribal member, Native Village of Savoonga and Environmental Health & Justice Program Director, Alaska Community Action on Toxics (ACAT).

Community Health Concerns

In October 2011, the president of the Native Village of Savoonga asked ATSDR to conduct a public health assessment or health consultation on the FUDS of Gambell and Northeast Cape on St. Lawrence Island. Specifically, the president requested ATSDR investigate "…what **concerns** they (the people of St. Lawrence Island) may have about the sites' impact on the health of our Yupik people." The president also asked ATSDR to assess levels of persistent organic pollutants and all sources of excessive toxic exposures affecting Arctic Indigenous Peoples [NVS 2011].

ATSDR found that data were available to evaluate some community exposures and make appropriate recommendations to reduce or eliminate the exposures. ATSDR did note, however, the impossibility of determining the sources and levels of contaminants from other parts of the world that pollute the local environment and the sea mammals on which St. Lawrence Island residents rely [ATSDR 2012].

In February 2012, ATSDR agreed to conduct two separate health consultations. These health consultations focus on assessing the available data to determine whether exposure to contaminants from the Gambell or Northeast Cape sites might be harmful to St Lawrence Island residents.

In March 2013, ATSDR interviewed people from the Native Village of Gambell (Appendix D). Members of the village had several health concerns about what they observed as elevated rates of cancer and other serious illnesses in their community. The village is very remote and available health care on St. Lawrence Island is limited. Tribal members would like to see expanded health-care services on St. Lawrence Island. The Norton Sound Health Corporation has partnered with the Tribe to set up mobile clinics for early detection and treatment of common types of cancers such as lung, colorectal, breast, and prostate.

Residents from both communities have observed what they consider a high number of cancer cases and birth defects within their communities. In response to the St. Lawrence Island communities' knowledge of cancer cases, cancer deaths, and birth defects, ATSDR worked with the Alaska Department of Health and Social Services (DHSS) to review the cancer and birth

defects registries' data for Gambell and Savoonga. A review of the two registries' data cannot show cause and effect from exposure to contaminants, but can provide an idea of the burden of disease in Gambell and Savoonga relative to other Native Alaskan communities.

The DHSS Cancer Registry conducted several cancer studies of Gambell and Savoonga. In the initial Gambell cancer studies, they found that rates of cancer in Gambell were similar to those in other Alaska Native villages. In a more recent study, cancer incidence in Gamble was significantly more than expected incidence in comparison to other Alaska Native villages. Further study found that the significantly higher cancer incidence was directly associated with a high rate of lung cancer. The Cancer Registry notes that the scientific methodology of epidemiology has significant limitations that do not make it possible to determine whether any increases in cancer or birth defects are a result from chance variation, lifestyle risk factor, family history, or potential contaminants at the Gambell FUDS. The Health Outcome Data Evaluation section of this report presents these evaluations.

Community members have also expressed concern through the Alaska Community Action on Toxics (ACAT) about contact with Troutman and Nayvaghaq Lakes and potential vapors intruding into indoor air from contaminants in soil or groundwater. ATSDR reviewed the environmental information and the limited sampling data. The following sections discuss our evaluation. The community continues to be concerned about the potential for hazards in areas the military declared to require "no further action."

Environmental Contaminant Data, Pathways Analyses, and Contaminant Screening

ATSDR reviewed environmental sampling reports from the USACE and the NALEMP programs to determine what contaminants were present and what levels were found in the sampled environmental media around the village of Gambell [NVG 2007, 2008, 2009, 2010, 2011; USACE 2005, 2008].

ATSDR identified the following potential public health hazards at the Gambell FUDS:

1) **Health Hazard** - Contact with remaining exposed metal debris can occur.
2) **No Health Hazard** - Drinking from the Gambell public drinking water system is not expected to harm people's health.
3) **No Health Hazard** – Contact with surface soil and gravel contaminants related to the Gambell FUDS is not occurring and therefore, not expected to harm people's health.
4) **Uncertain Health Hazard –** ATSDR cannot determine whether vapors from volatile chemicals or fuels spilled or buried in the ground are moving into buildings. Samples collected near the former Site 27 are close to homes and indicate a concern for vapor intrusion, but no indoor air samples were collected. Removal of buried debris and stained soils decrease the potential hazard. Precautions can be taken to prevent future vapor intrusion from new spills.
5) **Uncertain Health Hazard** - Drinking and direct contact with surface water at Troutman and Nayvaghaq Lakes is an uncertain hazard because there are too few samples.

6) **Uncertain Health Hazard** - Direct contact with chemicals in drums left by the military is an uncertain hazard because the contents of the drums are unknown.

Discussion

The community is concerned about past spills trapped in the ice. The military operated during a regional warming period and left during a cooling period [Mantua 1997], and the recent warming period has the potential to release contaminants as documented in other Arctic ice. While ATSDR was concerned about this potential, the current data show little contamination near the permafrost, and the conditions at Gambell limit the potential for current human exposures. The climate, weather, and geology of Gambell decrease the chances for people to contact chemical contaminants that have spilled, leaked, or been deposited in the environment. The high winds, cool temperatures, snow cover, and moist air reduce the frequency at which people contact environmental media.

The large gravel substrate on which Gambell is located is highly permeable, allowing contaminants and water to flow through it quickly from 40 to 26,000 feet per day [Munter 1994]. Typically, soil acts as a natural filter and slows the movement of substances down to groundwater. It captures contaminant particles by retaining chemicals or dissolved substances on the soil particle surface. Microbes in the soil breakdown the chemicals. Gambell's surface, however, is mostly gravel, with only a few spots of soil. Contaminants that spill or leak onto the ground would not readily adhere to the course gravel, but would likely move quickly down through the gravel to the groundwater table and out to sea [Munter 1992].

ATSDR evaluates exposure situations by comparing the chemical sampling data with media-specific (water, soil, sediments, and air) comparison values (CVs) to screen contaminants and to identify those that might harm health. We then examine more closely those contaminants exceeding CVs by calculating exposure doses using site-specific exposure assumptions. For the exposure situations identified at the Gambell FUDS (see previous section), we could evaluate only the drinking water pathway by this methodology. Table 1 provides a summary of ATSDR's evaluations. Discussion of ATSDR's evaluations for the exposure situations follows (Table 1).

Table 2. Summary of Exposure Evaluations. This table summarizes ATSDR's evaluation of possible ways people could contact chemicals or physical hazards left from military use and disposal at the Gambell FUDS.

Exposure Conclusions	Remedial Activities	ATSDR Hazard	Basis of Conclusion	Recommendations and Planned Actions
1. Metal Debris: Contact with metal debris can cause injury. Adults and children might be injured by contact with remaining metal debris while driving all-terrain vehicles or digging. This physical hazard is a public health hazard.	Removals. USACE and NVG contractors have removed more than 130 tons of metal debris during numerous removal actions**.** However, neither the contractors nor ATSDR can assure with certainty that no metal debris remains.	**Public health hazard (past, current, and future).**	Because heavy objects will rise to the surface after freeze/thaw events (frost heaving/frost jacking), additional metal objects once buried might possibly resurface, creating a physical hazard.	Prudent public health actions by the community include 1) inspecting the village and beach for resurfaced metal debris at least once each year after the spring thaw, 2) removing hazardous debris, and 3) continuing hazard awareness and education on reporting procedures for suspected items.
2. Drinking Water: Solvents, fuels, metals, and PCBs[1] **have not been found in the public drinking water well.** ATSDR does not expect that drinking water from the Gambell public drinking water system to harm people's health. Gambell's public water system is regularly monitored.	Removal of buried drums near Site 5 which is close to the source of the public drinking water well in 1999 and 2001. Monitoring of groundwater continued through 2009 when all remediation under FUDs was completed.	**No harm expected (current and future).**	The village of Gambell Water Plant manages and monitors public drinking water in accordance with ADEC Division of Water Quality/Village Safe Water Program, Division of Environmental Health/Drinking Water Program, and EPA Safe Drinking Water Act. Testing has not shown contaminants above EPA safe drinking water standards.	Regularly scheduled monitoring of the water system helps ensure safety of the water system.
3. Ground Surface: Contact with surface soil and gravel contaminants from the Gambell FUDS is not occurring and therefore is not expected to harm people's health.	Removals. USACE and NALEMP contractors have removed more than 29 tons of chemical contaminated soils, and more than a thousand 55-gallon drums.	**No exposure (current and future).**	Chemical spills that occurred in the past (during and after the military disposal) have been difficult to find from subsurface sample testing because liquids travel quickly through the large gravel substrate in the Gambell area.	Residents and workers need to report suspected or known fuel spills to the City of Gambell offices. Mark the area, but do not touch suspected hazardous substances.

Exposure Conclusions	Remedial Activities	ATSDR Hazard	Basis of Conclusion	Recommendations and Planned Actions
4. Indoor Air: ATSDR cannot determine whether vapors from volatile chemicals or fuels spilled or buried in the ground are moving into buildings.	Removals. USACE and NVG contractors have removed contaminated soil and buried metallic debris and drums from the Sites 7, 16, 27, the high school area, the New Housing Area, and throughout Gambell. No known drums remain.	**Uncertain Health Hazard (past, current, and future).**	Results of soil, soil gas and groundwater tested before and after homes were installed in 1995, show low levels of fuel related compounds that indicate vapor intrusion of contaminants from the Gambell FUDS is not likely to be a concern. However, no soil gas samples were collected beneath homes after homes were installed in 1995. Of greatest concern today, are fuel spills and leaks from the community pipelines or from residential use recently spilled on the ground near the footprint of a home. Vapors from recently spilled or leaked fuels could occur and be sucked into heated buildings. Even though most buildings are built on footings above the ground, and average ambient temperatures and vapor pressure are low, the vapors from new fuel spills near heated buildings could be drawn into the buildings.	Precautions can be taken to prevent future vapor intrusion from new spills. Residents can take prudent public health precautions to prevent vapor intrusion issues from new spills. ATSDR recommends that containers used to store fuels or volatile chemicals be owner-inspected monthly and seated in a tray to capture spills and prevent vapors from intruding into heated buildings. ATSDR recommends ADEC evaluate the potential for vapor intrusion into nearby homes when investigating leaks or spills. Soil gas or indoor air samples need to be tested to ensure residents are not impacted.

Exposure Conclusions	Remedial Activities	ATSDR Hazard	Basis of Conclusion	Recommendations and Planned Actions
5. Lakes: Safety of activities at surface water lakes is uncertain. There is insufficient information for ATSDR to determine whether drinking water or eating ice from or recreating in Troutman and Nayvaghaq Lakes could harm people's health. Additionally, because USACE/NVG and ATSDR cannot assure the complete removal of metallic debris and ordnance from these disposal sites, a small risk of injury from physical hazards remains for those who recreate in the lakes.	Removals. USACE and NVG contractors have removed buried and submerged metal debris including small arms ammunition and grenades from Troutman Lake waste site (Site 15) and drums and contaminated soil near Nayvaghaq Lake waste site (Site 12)	**Uncertain Health Hazard (past, current, and future).**	USASCE/NALMP tested one surface water sample from each lake in 1985. Characterizing lake water quality would require additional sampling parameters, including biological sampling from multiple surface water locations. Additionally, water treatment would be necessary to make the water drinkable.	Before residents can safely use these water bodies for drinking and recreating, ATSDR recommends that ADEC conduct additional water quality testing. To reduce the risk of injury from remaining metal debris to those who recreate in the lakes, ATSDR also recommends the community continue hazard awareness training including reporting procedures for suspected items.
6. Discarded Drums: Health impact of past contact with chemicals in drums is uncertain. ATSDR cannot evaluate past direct contact of adults and children with the contents of leaking 55-gallon metal drums, because no sampling data exist and the contents of the drums are unknown.	Removals. USACE and NALEMP contractors have removed more than 29 tons of chemically contaminated soils and more than a thousand 55-gallon drums from the Gambell area.	**Uncertain Health Hazard (past).**	In the past, because of the exposed piles of disposed waste, people could have directly touched chemicals leaking from abandoned containers. However, no data are available to evaluate those types of exposures. Not enough information is available to determine if exposure to the contents of drums had a health impact on residents. No known drums remain.	If drums are identified in the future, ADEC requested the Village to notify the agency for testing, removal, and potential remediation.

[1] PCBs – were analyzed in the public drinking water well as part of the Site 5 remedial investigations and is not routinely monitored.

1. **Metal Debris: Contact with remaining exposed metal debris can cause injury.**

Contact with any remaining metal debris while driving ATVs or engaging in other activities such as digging might injure adults and children. This physical hazard is a ***public health hazard****.*

Freezing and thawing can cause heavy objects to rise to the surface, and additional metal objects once buried might resurface, creating a physical hazard. Residents are concerned about the potential for ATV and snowmobile accidents caused by collision with the debris. Metal cables and other debris in the past have surfaced and presented a physical hazard.

Soil within Gambell is spotty, occurring near the base of Sevuokuk Mountain at the ancestral archeological dig sites and near the end of the Gambell airstrip. Digging for artifacts in areas with soil and contact with metal debris could cause injury. Any remaining debris could be heaved to the surface from the permafrost layer below the ground surface.

During the environmental investigations, USACE and NALEMP identified 38 areas of concern (AOCs) for further investigation. Appendix B details those AOCs. Appendix C includes a map of the AOCs. The following AOCs contained surface debris, which posed a physical hazard in the past: 1A, 1C, 2, 3, 4E, 8A, 15, 17, 20, 23, 24, and 27. USACE and NALEMP contractors removed extensive metal debris at these sites and listed them as warranting no further action. However, in AOC 18B, USACE and NALEMP could not remove debris that remains close to the above ground water tanks because of the risk of compromising the water tanks [USACE 2005].

Prudent public health actions for Gambell residents include inspecting the village for resurfaced metal debris once each year after the spring thaw. Areas along the exposed beach may be more likely to present with exposed metal debris. ATSDR recommends that ATV and snowmobile riders pay close attention and use caution while riding on the ATV trails or along the beach and report any surface debris to the NALEMP program for removal [ATSDR 2016c]. Residents who dig or walk around Gambell need to be aware of the potential for surface debris. Although the probability of encountering remaining hazardous metal debris is low, continued awareness of the hazard and education regarding reporting procedures for suspected items will reduce exposure to these physical hazards.

2. **Drinking Water: Solvents, fuels, metals, and PCBs have not been found in the public drinking water well.**

Public drinking water in the village of Gambell is ***not expected to harm people's health****. Drinking water in the Gambell public drinking water system is regularly monitored. Testing has not shown contamination above levels of health concern.*

Drinking water in Gambell comes from groundwater, but the state considers groundwater to be under the influence of surface water. There are no private wells. There are two drinking water supply points for the village, the village water well and the infiltration gallery[3].

[3] An infiltration gallery is a man-made conduit built in permeable earth for collecting groundwater. Collected water is then pumped to a storage tank, treated as needed, and distributed [World Health Organization 1996].

The infiltration gallery was used as the primary source until 1996 when the Public Health Service constructed the Gambell village well. The infiltration gallery is still used as a backup water supply. Both are near the base of Sevuokuk Mountain [MW 1999; BCS 2006a, 2006b].

The Gambell public water supply serves approximately 140 homes through direct plumbing. Approximately 40 additional homes are not plumbed. Those homes obtain their water by carrying it from the washeteria, which is supplied by the public water system [ATSDR 2016d]. The village of Gambell Water Plant manages and monitors the Gambell public water supply on a regular basis, in accordance with ADEC, Division of Water Quality/Village Safe Water Program, and Division of Environmental Health/Drinking Water Program.

Village elders described a dynamic fresh water-salt water hydrogeology amidst changing permafrost conditions. The water source is at the base of the hill "where water gathers from the hill," "land (is) all gravel on permafrost," "fresh water flows on top permafrost out towards the sea," "anything sits on top of permafrost…always shifting down there," "all the spills, fuel migrating all over the top of permafrost," and "(if) storm surge is too great then contamination pushes back to water source." The community has some concern that this back up supply is susceptible to contamination. There are several reports of oil spills near the beach and near the community since 1980's (searchable at https://dec.alaska.gov/spar/ppr/spill-information/response/).

According to a State of Alaska hydrogeological investigation report, the Gambell aquifer appears to originate along the front of the steep bluff of Sevuokuk Mountain and continue north towards the Bering Sea [Ireland 1994]. The aquifer appears to be a pool that has thawed from the permafrost. As the permafrost expands or recedes, the aquifer dimensions vary accordingly. Warm recharge water from Sevuokuk Mountain effectively melts the permafrost where the mountain face joins the gravel spit. Most of the water entering the aquifer comes from two springs that flow from the steep bluffs of the mountain into the gravel. Shallow groundwater across the gravel spit does not appear to be continuous because of the presence of shallow permafrost [Munter 1992; MW 1995, 1999; USACE 2005; BCS 2006a, 2006b, 2007].

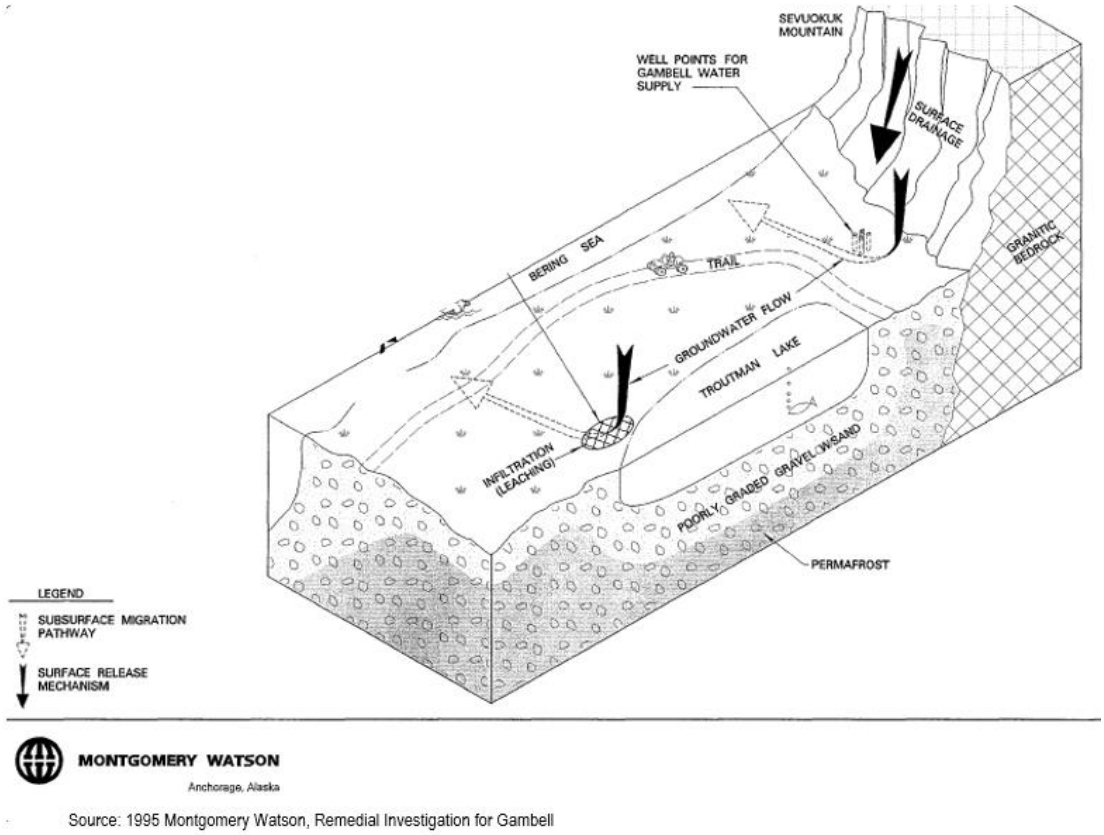
The documented groundwater flow direction in this area during the summer months is to the north, parallel to the base of Sevuokuk Mountain, towards the Bering Sea, as depicted in Figure 3 (approximately 1,200 feet). The groundwater flow rate, as determined by the hydraulic gradient, ranges from 30 to 1,100 feet per day [MW 1995]. This range of groundwater flow rate indicates rapidly moving groundwater, decreasing the likelihood that contaminants from the 1950s would still be in the groundwater. Golder 1994 noted during the winter 1992-1993 study period, groundwater flow direction reversed slightly when surface water froze [Golder 1994]. Saltwater intrusion has not been detected in the groundwater [Golder 1994].

The results of the State of Alaska hydrogeological investigation bear similarities to the elders' knowledge of the Gambell hydrogeology. The difference is that the elder knowledge describes a dynamic system where the "spill, fuel" remains "migrating all over the top of the permafrost." The State investigation maintains that the rapid groundwater flow rate toward the sea decreases the likelihood that contaminants would remain in the groundwater over time.

Both the state investigation and elder knowledge agree that the ground water flow direction can reverse. However, a state investigation found this reversal to be slight, corroborated by the

absence of saltwater intrusion in the drinking water well. The elder knowledge suggests that not only could storm surges reverse the flow, resulting in saltwater intrusion, but would also push the remaining contaminants back and into the drinking water well. This reinforces the importance of routine monitoring of the drinking water well for contaminants the elders know have been spilled in the area of the well.

Figure 3. Schematic of Surface and Groundwater Flow



Source: 1995 Montgomery Watson, Remedial Investigation for Gambell

Village Well

The village water well is inside a building within a fenced area. The well, constructed in 1996, consists of a well point completed to a depth of 20 feet. The depth-to-water fluctuates seasonally, but averages around 10 feet bgs [BCS 2006a, 2006b, 2007; MW 1999]. The well pump has a maximum capacity of 30 gallons per minute (gpm) and an optimum pump rate of 20 gallons per minute. The water is treated to reduce particulates, iron, manganese, and infectious agents and to control corrosion. In 1994, fluoride was added, but samples collected in 2010 showed that was no longer occurring.

Three storage tanks (500,000; 212,000; and 100,000-gallon capacities) in a separate treatment plant building in Gambell store the treated water before delivery to the village water system. The tanks provide a continuous water supply, buffer the demand on the pump, and provide adequate contact time for chlorination. The tanks refill as needed at a rate of 20 gallons per minute.

Typical daily water use is 30,000 gallons [MW 1999]. A separate pipe provides a return flow to the well house from the storage tank. Water from this pipe discharges back into the well to prevent freezing. The well, pump, and storage tanks are used year-round.

Infiltration Gallery

Before well water was available for the village, an infiltration gallery was built near the foot of Sevuokuk Mountain in 1992 as a seasonal potable water source for village residents of Gambell (Figure 4) [MW 1995; BCS 2006a, 2006b, 2007]. Surface water likely seeps into the belowground water collection system, making it susceptible to contamination. A small spring in the area is thought to be recharged by surface and subsurface flow from the base of the mountain. During the winter, the gallery freezes and is not usable. The pipes that connected the gallery to the village water supply have been capped and the gallery is currently available as a back-up supply, but is potentially susceptible to contamination [MW 1999].

Figure 4. Infiltration Gallery Building

Building surrounding the infiltration gallery. Photo by ADEC.

Drinking Water Sampling Results

Gambell Water Plant and USACE contractors have collected water samples for different purposes. The Gambell Water Plant tests drinking water samples after the treatment process to determine the safety of the finished drinking water. USACE contractors conducting environmental investigations tested raw, untreated water to determine if environmental contaminants were present in the groundwater before treatment.

Gambell Water Plant drinking water reports sampling results to the State of Alaska Drinking Water Program/Village Safe Water Program. The programs use the results to represent the drinking water to which people are exposed and measure compliance of the public utility. Table 2 presents a summary of the drinking water results.

ATSDR reviewed the drinking water sampling results from the village of Gambell public water supply for the period August 1992 through January 2019. Data on water are available online at: https://dec.alaska.gov/dww/JSP/WaterSystemDetail.jsp?tinwsys_is_number=3436&tinwsys_st_code=AK&wsnumber=AK2340751

State of Alaska Drinking Water Program/Village Safe Water Program tests drinking water samples for coliforms, inorganic compounds (such as arsenic, lead, copper, iron, and manganese), nitrates, nitrites, VOCs (such as benzene, trichloroethylene, toluene, ethylbenzene, and total xylenes), chlorination byproducts (trihalomethanes), radionuclides, and semi volatile organic compounds (SVOCs) (such as pesticides: Endrin, BHC-g, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP). Testing occurs according to an established schedule. The Program may collect additional samples when equipment is changed, if an analyte is detected, or for other reasons.

The village well was tested for polycyclic aromatic hydrocarbons (PAHs) and PCBs during remedial investigations and cleanup [MW 1998, 1999, BCS 2006b]. PAHs and PCBs were not detected in groundwater or the Village Well with a 0.05 micrograms per liter detection limit.

Results over the last 25 years of sampling (Table 2) show no contaminants in the Gambell water supply above EPA safe drinking water standards or ATSDR health comparison values. During one quarterly sampling, chlorination byproducts (trihalomethanes) appeared slightly elevated, due to a broken pump (that was replaced), but they were below levels of health concern.

Several members of the Gambell community expressed concerns about the fuel contaminants in the drinking water system. Fuel-related compounds include benzene, toluene, ethylbenzene, and xylenes (BTEX). To address concerns, ATSDR evaluated levels of chemical analytes detected since 1996, including occasional detections of trace levels of ethylbenzene, toluene, and total xylenes (summarized in Table 2). Sampling has not detected benzene in drinking water.

Detection of one of the fuel-related chemicals has not corresponded with simultaneous detections of any other fuel-related chemical from the same sample. More than one chemical does not occur in the same sample and repeated samples do not show the same chemical; therefore, these detections are classified as *transient*, *intermittent*, or *trace*, and indicate that the larger reservoir of water as a whole is not contaminated. Levels of these chemical are so low they are considered *trace levels* occurring right at the limits of detection. ATSDR identified no contaminants in the Gambell water supply above EPA's safe drinking water standard or ATSDR's health comparison values. Therefore, ATSDR does not expect the Gambell public water to harm people's health.

Table 3. Public Drinking Water Monitoring Results (1996 to 2018)

Chemical Analyte	Number of Detections per Number of Sampling Events	Public Water Supply 1996 – 2018 (mcg/L)	EPA's Maximum Contaminant Level Safe Drinking Water Standards (mcg/L)	ATSDR Health Comparison Values (mcg/L)
Benzene	0 / 28	BRL	5	EMEGc Child: 5 EMEGc Adult: 18 CREG: 0.64
Ethylbenzene	4 / 28	BRL - 15.7[1]	700	EMEGi Child: 4,000
Toluene	6 / 28	BRL - 1.0[2]	1000	EMEGi Child: 2,000 EMEGi Adult: 700 RMEG Child: 800 RMEG Adult: 2,800
Total Xylenes	5 / 28	BRL – 79.4[3]	10,000	EMEGc Child: 2,000 **EMEGc Adult: 7,000**
PCBs	0 / 4	ND	0.5	CREG: 0.018
PAH: Benzo(a)pyrene	0 / 4	ND	0.2	CREG: 0.0048
Other PAHs	0 / 4	ND	0.2 – 3400	None

mcg/L – micrograms per Liter
EPA – U.S. Environmental Protection Agency
BRL – Below Reporting Limit (0.5 mcg/L for BTEX)
PCBs – Polychlorinated Biphenyls
PAHs – Polycyclic Aromatic Hydrocarbons
Not Detected – Detection Limit (0.05 mcg/L for PAHs and PCBs,) (BCS 2006b PAHs) (MW 1998, 1999 PCBs)
EMEG – Environmental Media Evaluation Guide (ATSDR)
CREG – Cancer Risk Evaluation Guide (ATSDR)
RMEG – Reference Dose Media Evaluation Guide (EPA)
LTHA – Lifetime Health Advisory (EPA)

a. acute (occurring less than 14 days)
i. intermediate (occurring between 14 and 365 days)
c. chronic (occurring for more than 365 days)
MCL – Maximum Contaminant Level (EPA)
MCLG - Maximum Contaminant Level Goal (EPA)
[1] – Sample ID V0F0912054-03A (12-1-2009)
[2] – Sample ID VB*F1002023-02A (2-1-2010)
[3] – Sample ID V0F0912054-03A (12-1-2009)

3. Ground Surface: Contact with surface soil and gravel is not likely harmful.

*Exposure to soil and gravel contaminants related to the Gambell FUDS is currently not occurring and **is not expected to harm people's health***. More than 85 tons of chemically contaminated soils and more than a thousand 55-gallon drums have been removed. Sampling and removal actions occurred during 1993–2010. Exposure to soil, sediment, and gravel through skin contact or swallowing is also unlikely to have been a hazard for the following reasons:

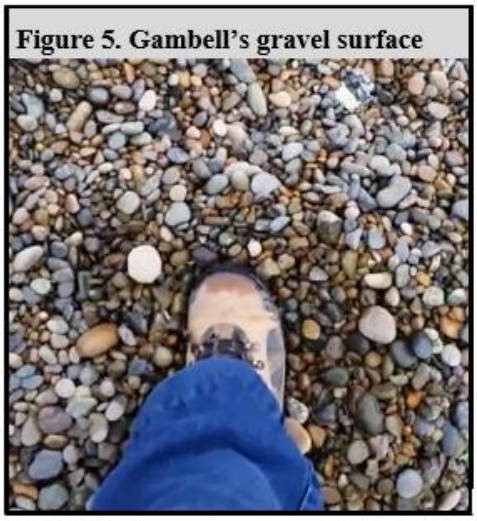


Figure 5. Gambell's gravel surface

By T. Holt 2014


Figure 6. Gravel beneath the surface

By L. MacDonald. [BERS 2008]

- Large gravel (Figure 5) on the surface (to which people are exposed) does not trap contaminants. Contaminants from chemical spills that occurred in the past during and after the military disposal would not likely stick on the smooth surface of the large gravel rock because there are no fine soil particles or organic material to trap them. Instead, chemicals would travel down through the gravel and sediment below, where they would spread out, be diluted by the groundwater, and move toward the Bering Sea. A fuel spill associated with the Bering Strait School District tank farm occurred as recently as June 2018 [ADEC 2018].
- Gravel soils allow liquids to move 10,000 faster than silt and 100,000 times faster than clay [Geotech 2013]. Soil permeability values (the average distance that a liquid spilled on the surface would travel in a day) were determined to be 30 to 1,500 feet/day with an average of 800 feet/day [MW 1995]. Munter (1992) reported that two samples of gravel at Gambell yielded permeability values of 16,000 and 26,000 feet per day. These data indicate that although the permeability of the gravels underlying the Gambell spit may be quite variable, in general, permeability is very high, allowing liquids on the surface to move quickly through the gravel matrix.
- ATSDR considers that people might be exposed to surface soil between 0 to 3 inches deep during their normal living and recreational activities (non-occupational). However, surface soil samples collected at Gambell were defined by USACE contractors as lying from 6 to 18 inches bgs. Field logs report gravel grain size 0.5 inches down to about 5 feet bgs. [E&E 1993; MW 1995, 1999]. Figure 6 shows that the gravel decreases in size only slightly with depth. Few people would access this depth of soil with sufficient frequency to be a concern. The likelihood of dermal exposure is lessened somewhat if contaminants are deeper than 3 inches below the surface of the soil.
- Moisture and even standing water are present in the gravel just below the first few inches of the surface. This increases the solubility and opportunity for natural attenuation or degradation of organic contaminants. It also reduces the likelihood that inorganic contaminants would stick to hands.

4. Indoor Air: ATSDR cannot determine whether vapors from volatile chemicals or fuels spilled or buried in the ground are moving into buildings.

Results of soil, soil gas, and groundwater tests conducted at the Gambell FUDS contaminated sites before and after nearby homes were installed in 1995, showed levels of fuel related compounds greater than ADEC cleanup levels and ATSDR vapor intrusion comparison values. Contaminated soil was removed in 2003 and 2006. Follow-up soil gas screening found concentrations greater than provisional screening levels for petroleum. No indoor air samples or soil gas samples beneath homes were collected after they were installed in 1995, so indoor air levels are unknown.

Of greatest concern today, are fuel spills and leaks from the community pipelines or from residential use recently spilled on the ground near the footprint of a home. Even though most buildings are built on footings above the ground, and average ambient temperatures and vapor pressure are low, the vapors from recently spilled or leaked fuels could occur and be sucked into heated buildings. ADEC needs to evaluate the potential for vapor intrusion when called out to investigate leaks or spills of fuel or hazardous substances to ensure residents are not impacted.

Community members have expressed concern through ACAT about potential vapors in indoor air. The movement of volatile chemicals and gases from soil and groundwater into indoor air, known as "vapor intrusion," can be a concern for people who may inhale the vapors that accumulate indoors [ATSDR 2008].

To address concern about vapor intrusion, ATSDR reviewed the ways in which people could be exposed to vapors in indoor air from the Gambell FUDS. ATSDR identified Sites 7, 16, and 27 as most likely to have potential for vapor intrusion for the following reasons:

- Visual reports of soils staining [E&E 1993, MW 1995, USACE 2005]
- Historical use, storage, and disposal or burial of 55-gallon chemical drums or motor pool
- Reuse of property as residential or close to residential areas

Figure 7. Area Showing Sites 7, 16 and 27 near Homes and Buildings

Travis/Peterson Environmental Consulting, Inc. [NVG 2010]

Site 7 Investigations

Site 7 is identified as the Former Military Power Facility and Motor Pool. The power facility was reportedly demolished and buried in this location. It is north of the Gambell Municipal Building, which may also have contained a military motor pool. Site 7 contained a 10' x 25' concrete pad, and surface debris and buried debris (removed in 2003). Buried community fuel supply lines from the North Beach off-loading area run through this historical site. The nearest home is approximately 90 feet away. The following activities summarize the investigations.

- 1994, 2000, and 2010: geophysical surveys for buried metal debris
- 1994: five soil borings to permafrost (6.5 to 15.0 feet below ground surface). One subsurface, four for monitoring wells.
- 1994 samples:
    - Soil: two surface soil (less than 2 feet bgs), 17 subsurface soil at 2.5 feet, 5 feet, 10 feet and 15 feet bgs when possible. Analysis for VOCs, GRO[4], DRO[5], TRPH[6], PCBs, and metals.
    - Groundwater: four monitoring wells: one dry, three with high salt and particle content. Analysis for VOCs, GRO, DRO, TRPH, and metals.
- 2001: three soil borings to permafrost (6.2, 7.2 and 10.0 feet bgs).
- 2003: removal of stained soil, debris, and concrete pad. Samples collected from beneath the debris were analyzed for DRO, residual-range organics (RRO), PCB, and target analyte list (TAL)
- 2006: removal of 4 tons of contaminated soil [Bristol Environmental 2006].
- 2010: PID[7] screened 7 soil samples (headspace) for VOCs. Three also sent for laboratory analysis. Rusted drums, scrap metal, and soil removed [NVG 2011].

Site 7 Test Results

In 1994, 2001, and 2003 contamination was detected in soil and groundwater near the concrete pad. In 1994, several VOCs were detected in groundwater samples (Table 3). The detection of 74 mcg/L 4-methyl-2-pentanone (MIBK), a chemical not in use at the time of the Gambell FUDS operations, indicates that more recent fuel spills or leaks have occurred [MW 1995]. Benzene was detected greater than ATSDR's cancer VICV of 0.57 mcg/L in one groundwater sample at 19 micrograms per liter (mcg/L) with Method Detection Limit (MDL) 3 to 5 mcg/L. EPA's Safe Drinking Water standard for benzene is 5 mcg/L. Benzene was not detected in any other groundwater or soil sample at this site. Groundwater naphthalene and trichloroethylene were greater than ATSDRs cancer VICVs. The only analyte detected above the ADEC Table B migration to groundwater cleanup levels was DRO in soil.[8] DRO concentrations ranged from

[4] GRO – Gasoline Range Organic Compounds

[5] DRO – Diesel Range Organic Compounds

[6] TRPH – Total Recoverable Petroleum Hydrocarbons

[7] PID – Photoionization detector – handheld instrument used to detect vapors and gases from VOCs and fuels

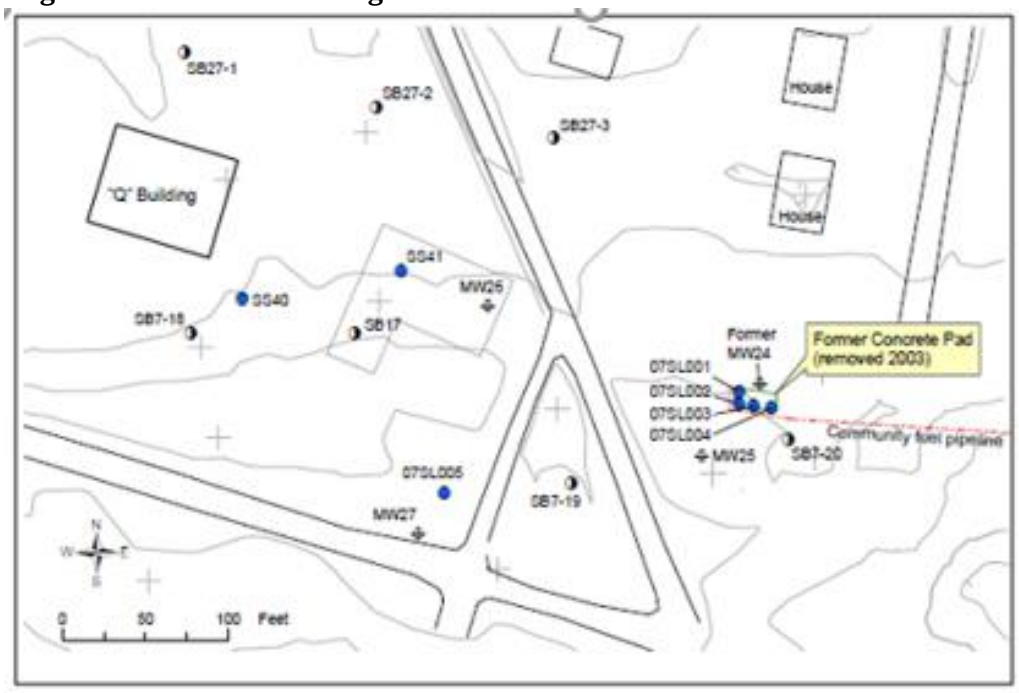
[8] ADEC Table B migration to groundwater cleanup levels are 250 mg/kg for DRO, 300 mg/kg for GRO, and 11,000 mg/kg for RRO.

ND (MDL 0.005 mg/kg) to 710 mg/kg. The DRO concentrations did not exceed the ingestion pathway ADEC cleanup level of 10,250 mg/kg. Weathered DRO concentrations greater than 250 mg/kg indicate the potential to form a free phase layer of petroleum on top of the groundwater table, which may pose an increased risk for vapor intrusion [EPA 2015].

After the 2003 removal action, contractors collected five confirmation soil samples from the edges of the concrete pad excavation and one sample from beneath the excavated drum. The soil samples were analyzed for DRO, RRO, PCBs, and TAL metals. One sample contained DRO at 570 mg/kg, which did not exceed the ADEC Table B ingestion cleanup level of 10,250 mg/kg. This detection may correspond to leakage from a community fuel pipeline present at the edge of the pad [USACE 2005].

Results from 2010 soil gas testing: PID testing found levels between 1.6 and 13.3 parts per million (ppm). USEPA's vapor intrusion screening level for total petroleum hydrocarbons is 0.7 ppm. No VOCs were detected in the laboratory analysis with estimated detection limits 2 ppm for benzene to 24 ppm for ethylbenzene, toluene, and total xylenes [NVG 2011].

Figure 8 – Site 7 Monitoring Well Locations



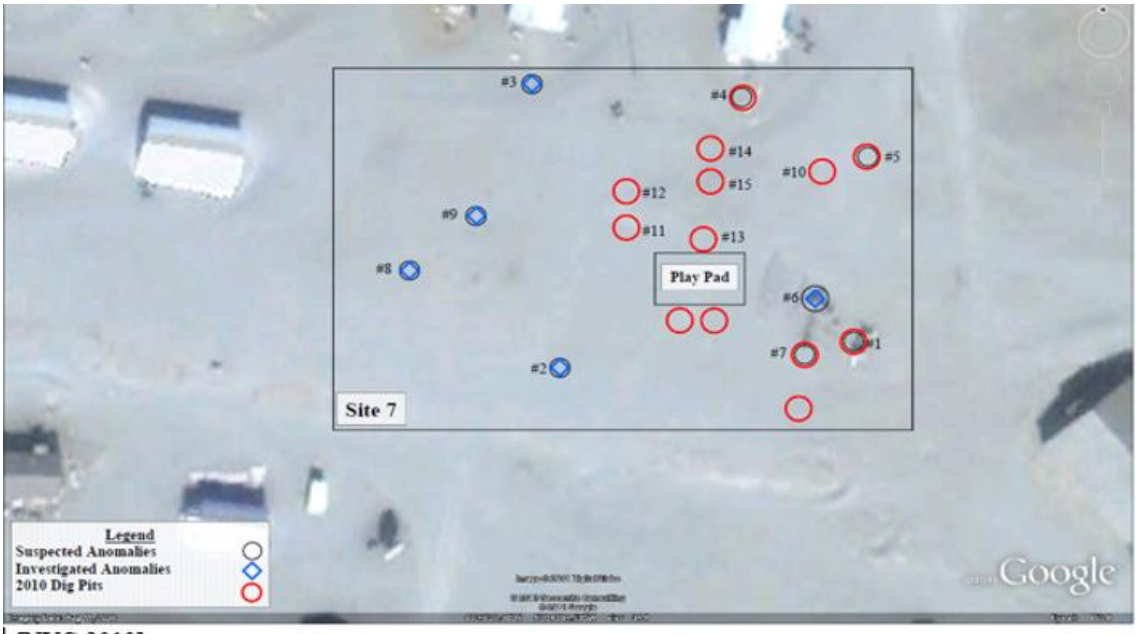
[2005 USACE Decision Document]

Table 3: Site 7 – 1994 Monitoring Well Groundwater Testing Results

Chemical →	Units	TRPH	DRO	GRO	Benzene	Ethyl-benzene	Toluene	Total Xylenes	Napthalene	MIBK	TCE	PCE
Groundwater	mcg/L											
EPA's Drinking Water Standard		NS	NS	NS	5	700	100	10,000	NS	NS	5	5
Method Reporting Limit		200	50	50	0	0.5	0.5	0.5	2	20	0.5	0.5
ATSDR VICV basis					0.57 CREG	810 EMEG	14,000 EMEG	370 RMEG	4.6 CA C	530,000 RMEG	0.52 CREG	5.3 CREG
MW24		4200	18	844	19	17	95	97	110	44	3	1.7
MW25		NA	19	NA	ND	ND	5.4	ND	ND	74	ND	ND
MW27		1100	1.2	103	ND	0.9	1.9	8.8	4	ND	ND	ND

GRO – Gasoline Range Organic Compounds
MIBK - 4-methyl-2-pentanone
TCE – Trichloroethylene
PCE – Tetrachloroethylene
NS – No standard establish
ATSDR VICV – Agency for Toxic Substances and Disease Registry vapor intrusion comparison value
CREG – Cancer Risk Evaluation Guide
EMEG – Environmental Media Evaluation Guide
RMEG – Reference Dose Media Evaluation Guide
CA C – California Carcinogen

Figure 9. Site 7 - 2010 Soil Gas Sampling Locations



[NVG 2010]

Site 16 Investigations

Site 16 is identified as the Gambell Municipal Building Site. It consisted of a 35 by 55-foot area of stained gravel, located immediately west of the Municipal Building. The origin of the stain is unknown, and staining was most visible after a rainfall event. The following activities summarize the investigations.

- 1994, 2000, and 2009: geophysical surveys for buried metal debris
- 1994: one soil boring to a depth of 11.5 feet bgs (permafrost) [MW 1995]
- 1994 samples:
    - Surface Soil: two surface soil (less than 2 feet bgs). Analysis for DRO, GRO, TRPH and metals.
    - Subsurface Soil: three subsurface soil at 2.5 feet, 5 feet, 10 feet bgs. Analysis for VOCs, GRO, DRO, TRPH, PCBs, and metals.
    - Groundwater: No groundwater was found in the soil boring.
- 2001: four soil borings to permafrost (6.2, 7.2 and 10.0 feet bgs). Analysis for petroleum hydrocarbons (DRO, GRO, RRO[9]), VOCs and BTEX, and metals [USACE 2005].
- 2003: removal of stained soil and debris
- 2009: a number of investigatory holes dug at the northeast corner and along the entire west side of the Municipal building.

Site 16 Test Results

Results from 1994 show low levels of DRO and TRPH in the two surface soil samples. DRO ranged from 9 to 16 mg/kg and TRPH ranged from 24 to 45 mg/kg. Toluene was the only VOC detected at

[9] RRO – Recoverable Range Organics from petroleum hydrocarbon fuels.

0.021 mg/kg. Benzene was not detected at this site. No other contaminants were identified at Site 16 above the ADEC Table B migration to groundwater pathway soil cleanup levels.

Additional soil borings were drilled in 2001 to further investigate the potential for soil contamination, and to address continuing community concerns regarding Site 7. Three soil borings (SB7-18, SB7-19, SB7-20) were drilled to permafrost (6.2, 7.2 and 10.0 feet bgs). The 2001 investigation results showed DRO in one soil sample at a maximum concentration of 710 mg/kg, which does not exceed the ADEC Table B ingestion cleanup level of 10,200 mg/kg.

In 2009, several pieces of metallic debris were discovered including the old drinking water pipe, but there was no indication of contaminated soil [NVG 2010]. Several partially exposed drums were located near the northeast corner of the municipal building at Site 16. These drums were dug up and readied for off-island disposal [NVG 2010].

Figure 10. Site 16 - 2010 Sampling Locations

Travis/Peterson Environmental Consulting, Inc. [NVG 2010]

Site 27 Investigations

Site 27 is identified as the Drum Storage Area. It contains an area that appeared as a stained soil patch approximately 10-feet in diameter and smelled of stove oil or diesel. The community was also concerned about an area of rust-stained soil at this site. The site is located north of the former military power facility (Site 7), within the new housing area. The drums stored at this site were removed in 2003. The following activities summarize the investigations.

- 1994, 2000, and 2010: geophysical surveys for buried metal debris
- 2001: Analysis of a 1955 aerial photograph indicated this location was a historical drum storage area.

- 2001: four soil borings to permafrost (6.2, 7.2 and 10.0 feet bgs).
    - eight subsurface soil samples analyzed for petroleum hydrocarbons (DRO, GRO, RRO), VOCs, PCBs, and metals [USACE 2005].
    - a 4-foot hole was dug and five soil samples were collected. Samples #4 and #5 contained gravel that was too large to sample for DRO and RRO.
- 2003: removal of stained soil, and debris
- 2010: community reports of stove oil smell investigated. Ten pits dug between 2 to 4 feet bgs, five PID readings and five soil samples collected [NVG 2010].

Site 27 Test Results

During the 2001 supplemental remedial investigation, four soil borings were drilled to frozen soil to determine if contamination was present. Eight subsurface soil samples were collected and analyzed for petroleum hydrocarbons (DRO, GRO, RRO), VOCs, PCBs, and metals. The soil sampling results were less than the ADEC Table B cleanup levels, based on the migration to groundwater pathway.

Results from 2010 soil testing showed low estimated levels of GRO from 0.63 to 0.96 mg/kg, DRO estimated from 25 to detected at 34 mg/kg, and RRO estimated at 12 mg/kg. BTEX compounds were not detected with estimated detection limits between 5 and 8 mg/kg for benzene, 19 to 36 mg/kg for ethylbenzene, toluene, and total xylenes (Data Qualifier "U").

Results from 2010 soil gas testing: PID testing found levels between 14.2 and 24.4 ppm [NVG 2011]. USEPA's vapor intrusion screening level for total petroleum hydrocarbons is 0.7 ppm.

Figure 11. Site 27 - 2010 Sampling Locations Among Homes installed in 1995.

Travis/Peterson Environmental Consulting, Inc. [NVG 2010]

Basis of the Conclusion

Low levels of fuel-related contaminants have been detected in the soil matrix and groundwater at Sites 7, 16, and 27. Although these low levels indicate that vapor intrusion of contaminants from the Gambell FUDS is unlikely to be a concern, fuels from the community pipeline or from individual home use containers that spill or lean on the ground near the footprint of a building could occur and be sucked into heated buildings. ATSDR has no data to evaluate this potential exposure, but individuals can take simple precautionary measures to help reduce the risk of vapor intrusion from new chemical or fuel spills. ATSDR recommends that owners inspect containers used to store fuels or volatile chemicals and seat them in a tray to capture spills and prevent vapors from intruding into heated buildings.

Additionally, ATSDR recommends that ADEC and contractors called out in response to fuel leaks from the community pipeline, consider and evaluate the vapor intrusion pathway for homes or buildings in close proximity to any spill.

5. Lakes: Safety of activities at Troutman and Nayvaghaq Lakes is uncertain.

There is insufficient information for ATSDR to determine the public health implications of swallowing water or ice from or recreating in Troutman and Nayvaghaq Lakes. Additionally, because complete removal of metallic debris and ordnance from these disposal sites cannot be assured, a small risk of physical hazards remains to those who recreate in the lakes.

Community members have expressed concern through ACAT about potential contamination of two major surface water bodies present on the Gambell spit: Troutman Lake and Nayvaghaq Lake. Troutman Lake covers approximately 574 acres and is roughly 10 feet deep. The lakes are large masses of water that are continually recharged from surface and groundwater [URS 1985]. Current exposure to Troutman Lake water is uncertain and may include ice blocks used in the winter for consumption, as was common prior to establishing the Gambell Village well as the public water source [ATSDR 2016b]. Additional exposure may include incidental ingestion of water or dermal contact by swimmers in the summer, as children have been known to swim in Troutman Lake [E & E 1992]. Use of the lakes as fisheries resources has not been reported [Georgette 1992; Fishingworks 2016].

Nayvaghaq Lake covers approximately 93 acres [URS 1985]. Nayvaghaq Lake is roughly 6 times smaller than Troutman Lake. Its depth and use as a resource has not been reported.

Contamination History

Approximately 25 years after the military left Gambell, the USACE began to investigate the two bodies of water as disposal sites: Site 15 - Troutman Lake Disposal Site and Site 12 - Nayvaghaq Lake Disposal Site. In 1985, USACE contractors tested one surface water sample from Troutman Lake and one surface water sample from Nayvaghaq Lake. The purpose of the sampling was to provide preliminary information about potential contaminants or parameters needing additional studies. Contractors obtained water from both lakes as discrete bulk samples from the upper foot of the water column and conducted no testing for fecal coliforms. In terms of primary and secondary water characteristics, no unusual parameters were apparent for either lake [URS 1985].

Total dissolved solids measured at 675 mg/l in Troutman Lake and 176 mg/l in Nayvaghaq Lake. Chloride concentration for Troutman Lake, 400 mg/l, was higher than the recommended drinking water limit of 250 mg/l and is attributable to saltwater intrusion; all other parameters were below EPA's recommended water quality limits. Oil and grease extraction yielded a value of 0.17 mg/l, and 0.22 mg/l respectively for both Troutman and Nayvaghaq Lakes. Testing for PCBs was negative for both samples. No testing for materials on EPA's Hazardous Substance List occurred.

In 1991, ADEC sampled water from Troutman Lake and Troutman Creek to determine the adequacy of these water sources for community use. However, the only sample from Troutman Lake was obtained from the well that at the time served the washeteria (laundromat) as the brackish water source. ADEC obtained two samples from Troutman Creek: one sample from one mile upstream of Troutman Lake, the other from 300 feet upstream of the point identified by ADEC/VSW for a proposed water intake location. Samples tested for herbicides, pesticides, PCBs, and volatile organic chemicals (VOCs) showed no detections. Trace amounts of lead and barium (below EPA's safe drinking water standards) were detected in one of the stream samples (farthest from Troutman Lake). ADEC concluded that Troutman Creek and Troutman Lake are not contaminated by chemicals. ADEC recommended further investigations before final selection, of either supply is used for potable water [ADEC 1991].

In 2000, contractors conducted a geophysical survey that confirmed the presence of miscellaneous metallic debris estimated at less than one ton including submerged ordnance and other debris at the north end of Troutman Lake at Site 15. Marsten matting, wire, 55-gallon drums, 1300 rounds of 0.30 ordnance, grenades and other metallic debris along the northern shore of Troutman Lake prior to removal efforts in 2001, 2007 and 2009 [NVG 2006, 2007, 2010]. Metallic debris and associated contaminated soils were removed from Nayvaghaq Lake Disposal Site (Site 12) during 2006 and 2007 [NVG 2006, 2007]. ATSDR could not find additional data on water or sediment to characterize the two lakes.

Public Health Implications

Before a body of water is determined to be safe for consumption or recreational purposes, water quality testing for many parameters must be performed, including an assessment of biological contamination. Additionally, surface water used for drinking water would require treatment. The sampling data from Troutman and Nayvaghaq Lakes are insufficient to determine the safety of these lakes for drinking water or recreational use. Therefore, before Troutman or Nayvaghaq Lakes can be safely used for consumption or swimming, ATSDR recommends the ADEC conduct additional water quality testing. In addition, because complete removal of metallic debris and ordnance from these disposal sites cannot be assured, a small risk of physical hazards remains to those who recreate in the lakes. Although the probability of encountering remaining metal debris is low, continued awareness of the hazard and education regarding reporting procedures for suspected items will reduce exposure to these physical hazards.

6. Discarded Drums: Health impact of contact with chemicals in drums is uncertain.

In the past, people might have directly touched chemicals leaking from the more than a thousand 55-gallon metal drums the military left on Gambell. The large amount of disposed material near areas used by children and adults increases the likelihood for exposure. However, no data are available on which to evaluate those types of exposures.

Transformers containing PCBs were used during the military operations. Soils, gravel, and groundwater were sampled for PCBs. None of the areas sampled at Gambell contained PCBs above EPA or ADEC cleanup standards.

Presently, no buried drums are known to remain after the removal actions completed by USACE and DOD contractors. However, buried drums remain a concern for community members who believe some drums are buried beneath homes and buildings constructed in the 1990s. If residents identify drums in the future, ADEC has requested the Village to notify them to facilitate testing, removal, and potential remediation.

Health Outcome Data Analysis

ATSDR contacted the Alaska Cancer Registry (ACR) about a cancer concern on St. Lawrence Island in 2013. This concern was voiced by residents of the communities of Savoonga and Gambell. In response to this request, ACR launched a cancer study of this area. Two reports were produced in January 2014 with the study results — one regarding cancer incidence and one regarding the types and counts of cancer cases and cancer deaths. The reports were updated in September 2015. According to that study, no statistically significant elevation in overall cancer incidence was found.

ACR conducted a third study to provide ongoing surveillance to address community concerns. The 2017 report appears in Appendix G and is similar to the cancer incidence study previously released, but focuses on overall cancer mortality and reviews cancer deaths on St. Lawrence Island. The study also specifically addresses lung cancer for both mortality and incidence since it was found to be the most common type of cancer in the community and the percentage of cases was higher than the state average for Alaska Native people.

While a study of cancer deaths was not part of the original request back in 2013, ACR felt that as part of updating the original cancer study with new data, understanding both cancer deaths as well as new cancer cases would be beneficial to the St. Lawrence Island community to guide cancer prevention efforts [ACR 2017].

The 2017 report presents the result of a cancer mortality study and a lung cancer study performed by the Alaska Cancer Registry (ACR) of the communities of Savoonga and Gambell on St. Lawrence Island in the Nome Census Area. The studies stem from the two communities' initial concerns about cancer. The number of expected cancer cases for these communities were calculated and then compared to the number of reported cases. The following observations were made:

• For cancer mortality for 1996-2014 for all types of cancer (cancer sites) combined, the number of observed cancer deaths for St. Lawrence Island was greater than the number of expected cancer deaths. These additional observed cancer deaths for Gambell alone and for St. Lawrence Island as a

whole were found to be statistically significant; these additional observed cancer deaths for Savoonga alone were not statistically significant.

• Based on these findings, ACR performed a study to explore whether the statistically significant additional cancer deaths on St. Lawrence Island could be attributed to any particular cancer site. ACR reviewed the number and types of cancer deaths for 1996-2014 and found that lung cancer was by far the most common type of cancer death, accounting for 45% of all cancer deaths (the statewide average for Alaska Native people is 28%). ACR found that the number of observed lung cancer deaths for St. Lawrence Island was greater than the number of expected lung cancer deaths. These additional observed lung cancer deaths for Gambell alone and for St. Lawrence Island as a whole were found to be statistically significant; these additional observed lung cancer deaths for Savoonga alone were not statistically significant.

• In an earlier report, ACR reviewed the number of new cancer cases for 1996-2013 for all cancer sites combined for St. Lawrence Island. Although the number of observed cases was greater than the number of expected cases, this difference was not statistically significant. But based on the finding from the mortality study, ACR also performed a study to explore whether the observed increase in newly diagnosed cancer cases on St. Lawrence Island could be attributed to any particular cancer site. ACR reviewed the number and types of new cancer cases for 1996-2013 and found that lung cancer was by far the most common type of cancer, accounting for 27% of all cancer cases (the statewide average for Alaska Native people is 16%). ACR found that the number of observed lung cancer cases for St. Lawrence Island was greater than the number of expected lung cancer cases. These additional lung cancer cases for St. Lawrence Island as a whole were found to be statistically significant; these additional lung cancer cases for Savoonga and Gambell individually were not statistically significant.

• As tobacco use is the greatest risk factor for lung cancer the smoking prevalence for St. Lawrence Island was reviewed and found to be more than twice the state average, with an estimated 53.4% of adults being current smokers.

• ACR also examined the known tobacco use history of people diagnosed with cancer on St. Lawrence Island. ACR compared people diagnosed with lung cancer versus all other types of cancer except lung. There was a higher percentage of people with any smoking history for people diagnosed with lung cancer (100%) compared to all other types of cancer (82%). Also, there was a much higher percentage of current smokers among people diagnosed with lung cancer (64.7%) compared to people diagnosed with other types of cancer (34%). This information is consistent with smoking being the leading risk factor for lung cancer.

This study found that there were statistically significantly higher numbers of observed lung cancer cases and lung cancer deaths than expected in the St. Lawrence Island community. The study suggests that lung cancer cases and deaths on St. Lawrence Island are correlated with smoking in this community. The higher than expected lung cancer cases and deaths are consistent with the high prevalence of smoking on St. Lawrence Island. The study's conclusion is an assumption based on the correlation with known smoking prevalence data but is not proven by the analysis. Correlating findings of increased lung cancer cases and deaths with an exceptionally high rate of smoking found in these communities indicates where efforts could be focused to decrease the burden of cancer for residents of St. Lawrence Island.

The increasing average age of the St. Lawrence Island population might also contribute to an increase in the perceived number of cancer cases by the community. Between 2000 and 2010, the number of persons aged 50 years and older increased 43.6% in Savoonga and 22.5% in Gambell [Thakkar 2014]. The incidence of cancer increases with age [American Cancer Society 2013]. With the exception of 4 cases younger than 50 and 3 cases older than 80, most cancer deaths in Savoonga and Gambell have occurred in people between the ages of 52 and 80. This age distribution did not change over the 16-year time period from 1996-2014. While the statistical analyses of the cancer data adjust for the difference in rates by age, members of the community would understandably look at the number of cases and not the rate.

Birth Defects

Birth defects are rare events. When they occur in a small population, rate calculations can be statistically unreliable. 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 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 follows. Appendix H includes the ADPH report.

The analysis completed by the Alaska Birth Defects Registry (2012), examined all major anomalies by summing the cases in 5-year intervals born during 1996 – 2011[10]. Even after summing the cases in 5-year increments, the confidence intervals were extremely wide, indicating a high level of uncertainty.

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 similar to census areas with predominately Alaska Native populations, as well as the Anchorage Native population group [Alaska Birth Defects Registry 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) 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 [Alaska Birth Defects Registry 2012]. Therefore, the Gambell FUDS does not appear to have impacted the incidence of birth defects in the Gambell community.

[10] Reported prior to January 1, 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.

Limitations

This health consultation attempts to define and evaluate the exposure of Gambell residents to hazardous substances released into the environment from the Gambell FUDS. ATSDR is committed to assisting the community and governmental authorities and agencies in understanding possible current exposures, past exposures, and those likely to occur in the future. However, several limitations increase the uncertainty of this evaluation.

Lack of environmental data during the time when contamination was highest

Unfortunately, a large data gap exists from the time the military disposed of waste until the time environmental investigations began in 1985. During this 30-year period, the petroleum products (residual organics) most likely dissolved, broke down, and washed away, so that levels found during the remedial investigation were likely lower than in the years right after contaminants leaked or were disposed. Additional processes might include biologic degradation, migration, volatilization, and adsorption.

Studies of fuel spills find that the harmful fuel components, like benzene and toluene, more easily evaporate, dissolve, and degrade, leaving some of the heavier weight compounds like polycyclic aromatic hydrocarbons (PAHs) [Osu 2005, 2010; Osuji 2006]. Some components could be trapped into the freeze-thaw and permafrost areas, but at much lower concentrations than at the time of the spill. While the permafrost was not investigated for PAHs, the sub-surface soil, groundwater, and drinking water were –with low or no detections.

- *Chemical drums.* ATSDR cannot determine how many discarded drums were full, partially full, or empty from the time the drums were discarded to when they were actually removed from the areas around Gambell. Without records of what was disposed in each area and the amounts disposed, it is hard to even estimate how much material was dumped, retrieved, and attenuated, and any that might be in isolated areas. Tons of debris was removed, but many of the drums that might have contained hazardous substances, were empty. Additionally, thousands of drums were removed from Gambell during the remedial investigation and cleanup work conducted under the NALEMP program. The drums were in various states of decay and leaked into the surrounding gravel, sediment, and soil at different rates. Many villagers reported that military personnel intentionally poked holes in the sides of the drums to sink the drums [ATSDR 2013]. Whether people were exposed to the contents of buried and semi-buried drums and to what chemicals they may have been exposed to is also uncertain.

Additionally, ATSDR has no data to evaluate reports by community members that drums remain beneath area homes and structures built in the 1990s. However, thorough investigations and removal actions make it less likely for residents to contact discarded military drums. In September 2000, the U.S. Army Topographic Engineering Center completed a “GIS-Based Historical Time Sequence Analysis" that combined information from historical aerial photographs and other documents with current aerial maps of the Gambell area to identify previously unknown locations of past military equipment and operations. In December 2000, Montgomery Watson completed the Strategic Project Implementation Plan that included a questionnaire completed by Gambell residents to identify potentially contaminated areas not identified in previous investigations; many such sites were identified and investigated via geophysical surveys in 1999.

- *Troutman and Nayvaghaq Lakes Contaminant Characterization.* ATSDR has limited chemical sampling information for surface water and no data for the sediments for either of these lakes, located just south of Gambell. Munitions investigations have identified and removed small-arms ammunitions, but did not report on chemical findings. Other military sites have used lakes and bodies of water as disposal areas. Gambell residents have said they are concerned about contamination of these lakes, which have been used for swimming and as sources of drinking water. ATSDR is uncertain whether Gambell residents get fish, shellfish, or other types of food from the lakes. No reports provide usable details about these potential resources.

Cancer and birth defects evaluation limitations

Typically, cancer and birth defects evaluations rely on data collected by doctors, hospitals, and laboratories and reported to the state. Epidemiologists use the reported data to make comparisons of affected people based on location, age, sex, race, income, and other parameters. Epidemiological reviews of cancer and birth defects data have limitations and uncertainty. Several issues make identifying increases in birth defects and cancers difficult.

Epidemiological studies rely on findings for large numbers of people to find small differences. When there are fewer people in the study, differences are very hard to spot. This may be the case with the population at Gambell.

Additionally, the number of reported cases might be more or less than actually occurred. Cases are not always verified to ensure that reports of diagnosed cases are accurate. Delays in case reporting for isolated communities are also a concern. For that reason, reviewers use data sets that are a few years earlier than the current year to ensure completeness.

Conclusions

1. **Metal Debris:** Adults and children might be injured by coming in contact with remaining partially buried or unearthed FUDS-related metal debris while driving all-terrain vehicles or participating in other outside activities, including excavating for artifacts. This physical hazard is a public health hazard
2. **Cancer Concerns:** ATSDR found that contact with site contaminants is not occurring or was too infrequent to contribute to cancer rates. ADHSS's review of the cancer registry information for the period 1996 to 2014 found the number of cancers randomly distributed over time with no apparent clustering and the types of cancers were common, with no rare cancers that might be associated with environmental contaminant exposures. For cancer mortality from 1996-2013 for all types of cancer (cancer sites) combined, the number of observed cancer deaths for Gambell was greater than the number of expected cancer deaths due to lung cancer of smokers.
3. **Birth Defects Concerns:** To address the community's concerns about birth defects, ATSDR evaluated ways in which people could contact chemical contaminants. Additionally, ATSDR requested ADHSS review the birth defects registry information specific for Gambell residents. ATSDR found that contact with site contaminants was not occurring or was too infrequent to contribute to birth defects rates. ADHSS reviewed data from the Alaska Birth Defects Registry covering the period 1996 through 2011 and found the results for St. Lawrence Island to be similar to other Native Alaskan communities.
4. **Drinking Water:** Public drinking water in the village of Gambell is not expected to harm people's health.
5. **Ground Surface:** Exposure to soil and gravel contaminants related to the Gambell FUDS is currently not occurring and is therefore not expected to harm people's health.
6. **Indoor Air:** ATSDR cannot determine whether residents are exposed to volatile vapors in indoor from subsurfaces sources without indoor air measurements.
7. **Lakes:** There is insufficient information for ATSDR to determine the safety of activities at Troutman and Nayvaghaq Lakes. Because of limited samples, the possible health effects from swallowing water or ice from or recreating in Troutman and Nayvaghaq Lakes are not known. Additionally, because ATSDR, USACE, and NALEMP cannot ensure the complete removal of metallic debris and ordnance from these disposal sites, a small risk of injury from physical hazards remains for those who recreate in the lakes.
8. **Discarded Drums:** ATSDR cannot evaluate the exposure of adults and children who had direct contact with the contents of leaking 55-gallon metal drums, or adjacent sludge because the contents of the drums and sludge are not known and sampling data are not available for all areas where drums were found.

Recommendations and Public Health Action Plan

1. ATSDR recommends that the Village leaders inspect the Village for resurfaced metal debris at least once each year after the spring thaw and/or after storms. We also

recommend removal of hazardous debris and continued education on hazard awareness and reporting procedures for suspected items.

2. Before surface water bodies Troutman and Nayvaghaq Lakes can be safely used for drinking or recreation, ATSDR recommends ADEC conduct additional water quality testing based on use.

3. If drums are identified in the future, ADEC has requested the Village avoid contact and notify the department to facilitate testing, removal, and potential remediation.

4. Scheduled monitoring of the water system helps ensure its safety. ATSDR recommends that the village of Gambell, in accordance with the Alaska Department of Environmental Conservation (ADEC) Division of Water Quality/Village Safe Water Program and Division of Environmental Health/Drinking Water Program test, all water sources used for drinking on Gambell, including the non-regulated traditional sources, to ensure safety.

5. ATSDR recommends that residents seat containers used to store fuels or volatile chemicals in a tray to capture spills and inspect them monthly to prevent vapors from intruding into heated buildings.

6. ADEC needs to evaluate residential exposure to vapors that migrate into indoor air from pipeline fuel leaks and spills.

7. 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 mobile clinics for early detection and treatment of common cancers such as lung, colorectal, breast, and prostate.

Author and Technical Advisor

Carole Hossom, BS, Environmental Health Scientist, Division of Community Health Investigations (DCHI), Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy, MS E-56, Atlanta. GA, 30341
P: 770-488-0725 | E: chossom@cdc.gov

Joe Sarcone, MSPH, Regional Representative (Retired), Region 10 Alaska, DHCI, ATSDR
222 W. 8th Avenue, Stop 45, Room 261, Anchorage, Alaska 99513
P: 907-271-4073 | E: jsarcone@cdc.gov

Gregory M. Zarus, BS, MS, MS, Atmospheric Scientist and Geophysicist, Division of Community Health Investigations, Western Branch, ATSDR

Reviewers

LCDR Kai Elgethun, Ph.D. MPH, Western Branch Associate Director for Science Division of Community Health Investigations, ATSDR

Yulia Iossifova, PhD MD, Medical Officer, Office of the Associate Director for Science, ATSDR

Michelle Watters, MD, PhD, MPH, Medical Officer, Acting Western Branch Associate Director of Science, DCHI, ATSDR

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Appendices

Appendix A. Gambell Population and Demographic Data

Gambell Population Data	
POPULATION (As of July 1, 2014)	
Total Population	693
Population in Families	617
HOUSEHOLDS	
Total Households	168
Average Household Size	4.13
Family Households	130
Average Family Size	5
HOUSING	
Total Housing Units	206 (100%)
Owner Occupied HU	139 (67.5%)
Renter Occupied HU	29 (14.1%)
Vacant Housing Units	38 (18.4%)
Median Home Value	$143,750
Average Home Value	$218,796
Housing Units Pre-1950	23
INCOME	
Median Household Income	$29,038
Average Household Income	$40,472
Per Capita Income	$9,884

Source: http://alaska.hometownlocator.com/

Gambell Demographic Data				
Demographics	Year 2000	Year 2010	Percent Change	Percent of Total 2010 Population
Total Population	649	681	+4%	
American Indian/ Alaska Native alone	621	651	+4%	95.6%
Asian alone	3	1	-66%	0.15%
White alone	23	26	+4%	4%
Black alone	0	0	+0%	0%
Native Hawaiian & Other Pacific Islander alone	0	0	+0%	0%
Some Other Race alone	0	0	+0%	0%
Two or More Races	2	3	+50%	0.46%
Hispanic or Latino	2	3	+50%	0.46%
Children Aged 6 and Younger	83	113	+36%	17.4%
Adults Aged 65 and Older	38	38	+0%	5.84%
Females Aged 15 to 44	120	125	+4%	19.2%

Source: http://alaska.hometownlocator.com/

Appendix B. Areas of Concern Description

Area of concern	Description	Soil and or metal debris removal actions	ATSDR evaluation
1A North Beach (Army)	Sites 1A–1C are located along North Beach, where two well-established all-terrain vehicle (ATV) trails intersect. The site consisted of exposed surface debris, including engine pieces, Marston matting, Weasel vehicle tracks, steel cables, a partially buried 100-foot crane, and other buried metallic debris that are periodically exposed and reclaimed by shifting gravels along the beach area.	1997/2005	Although a large amount of metal debris has been removed, some metal debris might remain and rise to the surface after freezes/thaws, creating a physical hazard to residents riding ATVs or digging. ATSDR recommends inspections after freezes/thaws to identify potential hazards.
1B North Beach (Air Force)	The Army landing area was located on North Beach east of an area now used by local residents to land or launch whaling boats.	1997	Same as for 1A.
1C North Beach	Site 1C covers the entire length of North Beach and consists of underwater metallic debris located just offshore. The majority of the debris is thought to be Marston matting used to construct the two military landing areas.	1997	Same as for 1A.
2 Military Burial Site	Site 2 is located approximately 1,000 feet south of the former Air Force landing area on North Beach, and just west of the base of Sevuokuk Mountain. Facilities associated with military housing/operations and a power plant were reportedly demolished and buried at this site. Ordnance was potentially buried here as well, but investigations did not find any. Exposed debris was present, including remnants of a rock fireplace, partially buried concrete pad, burned wood, scattered metal debris/gear, and discolored gravel.	1997/1999/2006	Same as for 1A.
3 Communications Facility	Site 3 is located approximately 700 feet south of the North Beach, near the base of Sevuokuk Mountain. The preliminary assessment indicated the possible burial of Jamesway huts, power plant generators, transformers, oils, batteries, and sulfuric acid. Exposed aboveground debris included Weasel vehicle tracks, Marston matting, pipe, empty drums, and anchors for guy wire.	1997/1999/2006	Same as for 1A.
4A Former Quonset Huts	Site 4A consisted of collapsed Quonset hut frames and empty transformer casings on the top of Sevuokuk Mountain.	1997/1999/2007	No Exposure.
4B Air Force Radar Site	Site 4B was a U.S. Air Force radar station, located on top of Sevuokuk Mountain. The site is dominantly boulders and bedrock, and very little soil is present. The site covered an area approximately 375 feet by 500 feet. The radar station consisted of buildings that burned and caused ordnance to explode and scatter debris.	1999	No Exposure.
4C Discarded Drums	Site 4C is located at the south end of Sevuokuk Mountain, and contained discarded drums along an ATV trail.	1999	Same as for 1A.
4D Former Transformers	Site 4D is located near the top of Sevuokuk Mountain. Three empty transformer casings and miscellaneous debris were seen in the mountainside drainage above the pump house.	1999	Same as for 1A.
4E Western Face of Sevuokuk Mtn	Various types of cable and wire were present on the ground surface along the sloped western face of Sevuokuk Mountain. The Native Village of Gambell identified this area as an impacted site during preparation of a strategic project implementation plan for the Native American Lands.	NALEMP (2006/2007)	Same as for 1A.

5 Former Tramway Site	Site 5 is located near the base of Sevuokuk Mountain. Site 5 is the former tramway corridor that provided access to the radar site on top of the mountain. The site also includes the current village water supply well at the base of the mountain and an associated groundwater monitoring wells. This site includes two disposal areas, the Cable Burial Area and the Secondary Transformer Burial Area [E&E, 1993]. The Secondary Transformer Burial Area was investigated in 1997 and found to contain steel cable, not transformers. The cable was removed at the time of excavation.	1997/2006	Same as for 1A.
6 Military Landfill	Site 6 is located north of the Gambell High School and east of the new housing area. This landfill was used to dispose of building materials, vehicles, machinery, drums of latrine waste, and miscellaneous debris. A geophysical survey to delineate the extent of buried debris was completed in 1994.	1999/ 2003	Same as for 1A.
7 Former Military Power Facility	Site 7 is located north of the Gambell Municipal Building, and west of the Gambell School. A military power facility was reportedly demolished and buried in this location. A military motor pool building was also believed to be located in this vicinity. The site contained a concrete pad.	1996/2003/2006/2010	Vapor Intrusion is a concern at this site. No soil gas collected after 1995 homes installed. Future leaks and spills a concern. ADEC needs to consider vapor intrusion when responding to leaks and spills in this area.
8 A Marston Matting	Site 8 includes the area surrounding the airstrip from west beach (north of the airfield), east to the western edge of Troutman Lake, and 3 miles south to the northern shore of North Nayvaghaq Lakes. Exposed Marston matting debris (8A) is located along the eastern side of the airstrip.	1999/2006	Marston matting at Site 8A was left in place when the military demobilized from the area in the 1960s. Exposed Marston matting debris is located in an area heavily traveled by local residents using ATVs and snowmobiles. The debris poses a clear danger to local residents who frequently cross the area on ATVs and snowmobiles. The debris has sharp and jagged edges that stick above the ground. Large piles of debris create a navigation hazard during the winter when partially covered by snow. Although a large amount of metal debris has been removed, some remains that is close to the water tower structures. Removal is thought to pose a concern for the structural integrity of the tower. ATSDR recommends inspections after freezes and thaws to identify potential hazards.
8 B Buried Debris	Buried miscellaneous metallic debris (8B) has been reported south of the old village area, including numerous 55-gallon drums and a Jeep.	2006	Same as 8A.
8 C Navy Landfill	A Navy landfill (8C) is located northwest of the former Civil Aeronautics Administration (CAA) housing area and south of the village landfill. The Navy	2008/2009	No Exposure.

	reportedly built this landfill during their use of the former CAA housing area. The Navy landfill might have asbestos-containing materials.		
8 D Beach Ammo	Buried small-arms ammunition debris, including intact approximately 1300 rounds of 0.30 caliber ammunition, were located along the beach (8D) southwest of Troutman Lake. Additionally, unexploded grenade was found by the NALEMP workers who contacted the USACE and DOD.	2000/2004/2006	Same as 8A. Any remaining unexploded ordnance poses additional potential physical hazards. However, the likelihood of encountering more is low due to geophysical analysis and removal actions.
9 Asphalt Barrel Cache	Site 9 is located on the east side of the local airport runway. Drums of leaking tar were present in two areas.	1999	Same as for 1A.
10 Sevuokuk Mtn Trail	Site 10 consists of a trail system that originates at the southeast end of Troutman Lake and separates into individual trails to the north, south, and east. Two trails lead to the top of Sevuokuk Mountain. Empty 55-gallon drums, located approximately 250 feet apart, marked the trails. Other debris at the site included Marston matting and Weasel vehicle tracks. No staining or stressed vegetation were observed during the initial remedial investigation, and the drums were either empty or contained gravel.	1999	Same as for 1A.
11 Communications Cable Route	Site 11 contained a sonar cable going up Sevuokuk Mountain, abandoned cable spools, and a remnant of braided metal cable on top of the mountain.	1999	No exposure.
12 Nayvaghaq Lake Disposal Site	Site 12 is located north of Nayvaghaq Lakes on the southwest side of an ATV trail. The site is divided into a north and a south area. The north area contained approximately 120 metal drums, battery remnants, and miscellaneous metal debris. The south area contained approximately 50 drums. The area south of Troutman Lake is within the City of Gambell boundary. The area is now used primarily for recreation, subsistence food gathering, and as a gravel borrow source. However, this site has the potential to be developed for residential use, given the flat topography and close proximity to a potentially new drinking water source.	1999/2001/2009	Metallic debris and potential UXO presents a low risk for physical hazard to those who recreate on and in the lake during the summer months. Troutman Lake water quality for drinking or recreating must be evaluated further by ADEC before the lake can be used safely for drinking or recreating.
13 Former Radar Power Station	Site 13 is located east of the pond between Troutman Lake and North Nayvaghaq Lake. The radar power station consisted of two wooden Quonset huts, one long wooden building, and several 150-foot towers that were reportedly demolished and buried on-site. Stained soils and miscellaneous surface debris such as steel wire, pipes, and Marston matting were present at the site.	1999/2006	Same as for 1A. ATSDR is also concerned that some of the wooden material might have been used at one in the homes of village residents contributing to the lead paint concern.
14 Navy Plane Crash Site	Site 14 is located approximately 7 miles south of the Village of Gambell. A Navy P2V-5 Neptune reconnaissance plane crashed at this location in June 1955. The aircraft's gasoline tank exploded and most of the fuels burned, leaving no apparent stains or any stressed vegetation at the site. Debris remains on the tundra, in the area immediately surrounding the crash site.	NA	Remains potentially pose a physical hazard.
15 Troutman Lake	Site 15 is located along the northern edge of Troutman Lake. A USAED geophysical survey performed in 2000 confirmed the presence of miscellaneous metallic debris estimated at less than one ton including Marsten matting, wire, 55-gallon drums, 1300 rounds of 0.30 ordnance,	2000/2001/2006/2007	Metallic debris and potential UXO presents a low risk for physical hazard to those who recreate on and in the lake during the summer months. Troutman Lake water quality for drinking or

	grenades and other metallic debris were submerged along the northern shore of Troutman Lake prior to removal efforts.		recreating must be evaluated further by ADEC before the lake can be used safely for drinking or recreating.
16 Gambell Municipal Bldg. Site	Site 16 consisted of a 35-foot by 55-foot area of stained gravel, located immediately west of the Municipal Building. The origin of the stain is unknown, and staining is most visible after a rainfall event. A geophysical survey was conducted in 1994. The survey revealed four small irregularities that might be related to buried materials. The buried debris was cleaned up under the NALEMP.	1994/2001/2009/2010	Numerous sampling removal actions. No Exposure.
17 Army Landfills	The Army landfills are located between the North Beach and Site 6 Military Landfill, which is north of the Gambell School and Municipal Building. The two landfills reportedly contained buried debris and/or trash, as well as exposed surface debris, such as 55-gallon drums, Marston matting, and scrap metal. A geophysical survey of the area was conducted in 1994. The survey indicated the potential for buried debris associated with the reported landfills. The buried debris was cleaned up under the NALEMP.	1999/2005/2007	No known exposure.
18 Main Camp	Site 18 is located at the northeast end of Troutman Lake, between the current Municipal Building and the Gambell School. A geophysical survey was conducted in 1994 to determine the presence of buried debris between the high school and self-service laundry (washeteria) thought to represent water delivery lines for the existing power plant. The buried debris was cleaned up under the NALEMP.	2005	No known exposure.
19 Diatomaceous Earth	Site 19 was identified as a separate area of concern by the Native Village of Gambell under the NALEMP program. This area description matches that of Site 18. A white powdery material in a berm that borders Troutman Lake was determined to be inert, diatomaceous earth, a nonhazardous material previously used for water filtration by the military.	NA	No exposure.
20 Schoolyard	Site 20 is located north of the former Main Camp (Site 18) near the current Gambell School. The schoolyard contained two rubble piles that primarily contained concrete and rebar, plus a partially exposed concrete slab.	2003/2007	The piles presented a physical hazard to local residents such as children attending school, ATV and snow machine traffic.
21 Base of Sevuokuk Mountain	Site 21 is located at the base of Sevuokuk Mountain and southwest of Site 5. It is thought to contain buried miscellaneous wire and metallic debris from military activities. The buried debris was cleaned up under the NALEMP.	2006	No exposure.
22 Former CAA Housing	Former CAA housing units are located near the northeast edge of the Old Gambell section of the village. The CAA housing area consists of six homes and one lodge originally built as a weather data collection facility to help guide Russian pilots during World War II. The Navy and Army also reportedly used the housing area in the Cold War era during their efforts to lay submarine detection cables off the coast of St. Lawrence Island. This site was identified as a concern under the NALEMP program because of the possibility that asbestos-containing materials might have been present in the structures.	2007/2009	No known exposure.
23 High School Construction Debris	Site 23 was identified by local residents as a concern in the Strategic Project Implementation Plan produced for the NALEMP program. The area is located	2008	No known exposure.

	due east of the Gambell landfill. It contained metallic debris that was originally unearthed during the construction of the Gambell High School. The City of Gambell moved the excavated debris to the local landfill for reburial.		
24 South of Municipal Building	Site 24 is located south of the municipal building along the northern shore of Troutman Lake. A geophysical survey of the site was conducted in 2000, and subsurface irregularities consistent with metallic debris were found. The buried debris was cleaned up under the NALEMP.	2006	No exposure.
25A South Housing Units	During the 2001 investigation, local residents identified Site 25A, located just north of Troutman Lake, as an area that might be contaminated by fuel-related products used by the military. During construction work performed in 1997 by Alaska Village Safe Water, oily soils were encountered at the permafrost interface. Residents are concerned that the military might have dumped barrels of oil directly on the ground in this area.	2001/2008	No known exposure.
25B Low Drainage Area	Local residents identified Site 25B during the 2001 supplemental investigation as an area where contaminants might migrate and accumulate. The site is located west of the Sivuqaq Lodge, southeast of the Gambell store and fuel storage tanks, and near a local church and Army guard building.	No Removal. Contamination was not found.	No known exposure.
26 Debris Burial Site	Site 26 was identified from a 1953 aerial photograph as a possible debris burial feature. The site is located east of the Gambell School near the former main camp (Site 18). Local residents reported finding metal debris, machinery, oily debris, and transformers in this vicinity.	2001	No known exposure.
27 Drum Storage Area	The site is located north of the former military power facility (Site 7), within the new housing area. Analysis of an aerial photograph from 1955 indicated that this had been a container drum storage area. The community was also concerned about an area of rust-stained soil at this site. The drums stored at this site have been removed.	2001/2010	Vapor Intrusion is a concern at this site. No soil gas collected after 1995 homes installed. Future leaks and spills a concern. ADEC needs to consider vapor intrusion when responding to leaks and spills in this area.
28 Disturbed Ground	Site 28 was identified from a 1972 aerial photograph as a disturbed area. This site is located south of Troutman Lake and west of an unnamed pond. The U.S. Army leased this area from January 1955 to May 1958, and used the area for communications.	2001	No exposure.

Appendix C. Map of Areas of Concern

Site Location Map (with areas of concern numbered)

Source: USACE 2005 and Wikipedia.org (Gambell 2015).

Appendix D. Summary of Native Village of Gambell Key Information Interviews

Agency for Toxic Substances and Disease Registry (ATSDR)
Summary of Native Village of Gambell Key Resident Interviews on the
Gambell Formerly Used Defense Sites

April 18, 2013

In February 2012 the Agency for Toxic Substances and Disease Registry (ATSDR) accepted a petition from the Native Village of Savoonga to perform a health assessment of environmental data collected at the sites of former military use on St. Lawrence Island at Gambell and Northeast Cape. ATSDR conducted qualitative in-depth interviews with ten residents in Gambell, March 6 through March 8, 2013 to collect information on the historic use of the Gambell sites and to document health concerns expressed by the residents related to exposure to contaminants which originate from the former military sites.

The Native Village of Gambell and the Gambell Formerly Used Defense sites have a rich history. This is a summary of the information provided by the interviewees only. “The people of the village used to be at the old village site and this area was pretty much occupied (by the military).” In the “spring and summer, June (there was) fishing here (at) the point.” People “used to go up hill (for) green picking, berry picking.” “We used clams whenever they were/are available, they wash up sometimes or we get them from walrus stomach, still alive no shells, the walrus spit out the shells, all of the types of clams they (the walrus) eat.” It used to be that “Eskimos travelled between here and Siberia, but once the cold war started people didn’t travel anymore.”

“The U.S. Navy, Air Force and Army were here for a total of six or seven years around the time of the Korean war, around 1951-1957.” The Air Force radar site was on the top of the mountain and the Army built a camp at the base of the mountain. “The Army had over 1,000 troops (another inviewee reported 200 troops) and the Air Force maybe around 50.” “The U.S. and Russia were about to go to war.” There used to be a lot of Russian MIGs flying around out there and “they even shot down one of our (navy patrol) planes,” the wreck is still there about seven to eight miles down the coast. “Glad they (the Russians) didn’t take over Gambell.” The Army also had restricted areas, for example “a communication listening site” at the end of Troutman Lake.

The military hired a few people from the village, and “70 to 80 young men (from Gambell) were in the Army National Guard. They “helped out with clean-up when the general was coming.” “Some Gambell people went over to the Northeast Cape site to build it.”

“Back in my days (before the military) transportation was not so much.” It took as long as one year for mail to reach Gambell. The Army used to air drop food before there was an air strip. The lake served as a winter airstrip “clear off the snow” and in the summer it was used by float planes. The Army used Marston matting before a runway was paved in 1963. Before there was bulk fuel there were many fuel drums. The military had to haul fuel and gas to the top of the mountain.

“(I) worked in the motor pool, it used to be right in front of the (current) school where the playground is. “There were lots of spills (of) oil and what not, solvents, cleaning liquids, (it) was hard to keep

metals from not rusting in a salt environment, don't know whatever they do with waste oil from vehicles and power plant," and "whatever happened to transformers with PCBs buried somewhere back then." "Before they left they dumped a lot of stuff in the lake, may have thought it would dissolve," "started to blast ice (Troutman lake) to dump ordinance 50 caliber ammunition, hand grenades," "30 caliber, M-1 ammunition securely packed," "what all they dumped in lake, ammunition and other stuff…didn't know." Military "built latrines of barrels cut in half and used lots of lye" buried in the area of the (current) windmills. "Believe there were toxic spills on hill radar site and over here that we don't know."

"When they pulled out they didn't take nothing but (their) rifles and rucksacks." "Not very many of us know what happened back then." Around 1962 there was an Army exercise to clean-out debris, some drums with stuff inside (were) emptied on the ground, put holes in them so that they would sink," "LST brought in (and) filled with empty barrels…300 barrels dump in ocean, mountain of empty materials." "What they didn't haul out they buried." "Tried to clean up a little bit, but not all of it, some of the dump sites they didn't want to dig up, probably know contamination in it so didn't want to touch." A portion of the current housing, the school, a city building, and the water plant are located in the area where the Army had its camp, "don't know how much percentage of debris taken out, some debris under housing, school, and water tanks."

On March 6, 2013 ATSDR participated in a meeting with a quorum of the Native Village of Gambell tribal council. The council does not agree with the U.S. Army Corps of Engineers decision to close out the remediation of the Gambell former military sites, "they say they finished the site and that's why they closed it, (there are) more sites to be looked at and analyzed." The council members stated that they were misled by the U.S. Army Corps of Engineers (Corps). That they were told they were signing an upcoming year cooperative agreement when in fact the document they signed was the record of decision for closing out the Corps work at the Gambell sites, "we didn't know about it until the following year: we wanted to be part of the decision." The council would like to have continued dialogue with the Corps on the Gambell sites.

A member of the Corps also told the council that the Corps couldn't take samples less than 30 feet from buildings. Only later did the council find through an inquiry with Corps management that the Corps did not have such a "regulation." The council was also concerned that the Corps removed five monitoring wells "deepest 22 feet and shallowest 10 to 12 feet" about a year after they had been installed in the area of the village drinking water source. The council was not told the wells were going to be removed and wanted the monitoring wells to remain in place for future use.

Several interviewees expressed concern about the impact of contaminants from the former military activity on the ground water. The community ground water source is at the base of the hill "where water gathers from the hill." Interviewees described a dynamic fresh water-salt water hydrogeology and changing permafrost conditions. The Native American Lands Environmental Mitigation Program (NALEMP) crew in the course of their clean-up activities "found rust colored rocks that smelled of stove oil and black sludge, next time, the following year, they looked for it at the exact same place it was gone." , "(while) excavating the water and sewer lines (1992-1994) encountered oil spill and

discoloration of stones," "oil spill migration throughout." The Gambell hydrogeology and permafrost conditions were described as, "land (is) all gravel on permafrost," "fresh water flows on top permafrost out towards the sea," "anything sits on top of permafrost…always shifting down there," "all the spills, fuel migrating all over the top of permafrost," "(if) storm surge is too great then contamination pushes back to water source." "The top of Troutman Lake is fresh water lies on salt water and is influenced by salt water," "high tides Pacific swells come in and go over runway, twice this happened." Also, "water plant, Quonset hut, on Shore of Troutman Lake full of chemicals used for water treatment."

A number of the interviewees expressed concern about military debris that surface after freeze-thaw periods (in the area of the high school and the new housing). Sharp objects puncture four wheeler tires, and, 'sometimes something that was buried comes out and we run into it while dog teaming and break our sleds.' "Global warming, summers warming materials, waste emerging from warming." "Every spring permafrost thaws and something comes out of the ground, looks like wisp of smoke." Other concerns include rusty ground, rust colored pebbles or rocks at Project 12. "When Army Corps was working some locals say they unearthed some human waste storage area, unearthed at the back of project 12, and covered back up."

An event that occurred in the past was recounted as follows, "something in lake they dump floated into the beach make people sick… people used to have no cancer, people now dying of cancer." Another event was described as, "twenty miles north of NE cape in water before the ice came in, over two hundred dead walrus, some look like their skin was burned, around 1951, 1952 or 1953 atomic bomb blown up…every once in a while people get sick from cancer and dies even from here." Also, "doctors experimenting give people radioactive iodine."

In regard to the general health of the people: "In those days no one told us these were toxic (buried military waste and debris)," "don't know something is bad and later find out it is bad," "notice after they left, seems to me in my own opinion, sickness get around in the village, cancer go up more than at time when the military had properties here," "people never encountered or experienced sickness like cancer before the Army, Air Force, and FAA," "people seen at clinic misdiagnosed sent home with Tylenol, by the time they are real sick cancer gets to point where it is terminal," "(whether) it is cigarettes, military, our lifestyle cancer is coming up, five to ten just in a year and very quick in thirty to forty percent of people (diagnosed with cancer)" "the elders are gone (but) the young are around drinking the water," "growing up getting colds in the spring and the fall, now common cold whenever," "lots of colds," "school and FAA asbestos toxic materials." Several interviewees said that cancer occurred in Savoonga at an even more alarming rate.

When we were ordered to clean the camp "when I was in the army we were instructed by the commander 'pick up everything that doesn't grow,' I would like to see this place cleaned up of everything that doesn't grow even the not hazardous stuff."

Joe Sarcone
Regional Representative - Alaska
Agency for Toxic Substances and Disease Registry (ATSDR)

U.S. Department of Health and Human Services
222 W. 8th Avenue Stop 45, Room 261
Anchorage, Alaska 99513
907-271-4073
jsarcone@cdc.gov

Appendix E. Letter From the Native Village of Savoonga Requesting an ATSDR Health Assessment & Health Consultation on St. Lawrence Island FUDS

NATIVE VILLAGE OF SAVOONGA • P.O. BOX 120, SAVOONGA, AK 99769 • PHONE 984-6414 • FAX 984-6027

October 21, 2011

Joe Sarcone
Regional Representative
ATSDR Alaska Office
222 W. 8"' Avenue Room 261, Stop 45
Anchorage, AK 99513

Mr. Sarcone,

Thank you for your interest in assisting us with a Public Health Assessment & Health Consultation here on St. Lawrence Island. At this time we are making a formal request for the Agency for the Agency for Toxic Substances & Disease Registry to conduct a Public Health Assessment or Health Consultation to assess health implications from the two Formerly Used Defense Sites on our Island. This Consultation should also look beyond these sites and include levels of global distillation of Persistent Organic Pollutants and all sources of toxic exposures that Arctic Indigenous Peoples are being disproportionately exposed to.

ATSDR needs.to learn what people on our Island know about FUDS and what concerns they may have about the sites' impact on the health of our Yupik people. We want to ensure that ATSDR gathers information and comments from the people who have lived or worked near the sites, including residents of the area and our villages, our leaders, health professionals and ACAT research team members with whom we have collaborated on a community based research project.

To ensure that the said report responds to our community's health concerns, we also want to ensure that it is distributed to the communities received for our comments. We understand that the final version of the report will reflect comments received from our communities. Thank you in advance for your assistance.

Sincerely,

Kenneth Kisanuk for Ronnie
Ronnie Toolie, President

Appendix F. Letter from ATSDR to Native Village of Savoonga Accepting Request for an ATSDR Evaluation on St. Lawrence Island FUDS

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

FEB 22 2012

Mr. Ronnie Toolie
President, Native Village of Savoonga
P.O. Box 120
Savoonga, Alaska 99769

Dear Mr. Toolie:

This letter is in response your October 21, 2011, letter to the Agency for Toxic Substance and Disease Registry (ATSDR) describing your concerns about the residents of Savoonga, Alaska on the St. Lawrence Island, and our previous January 13, 2012, letter describing the ATSDR Petition Program. In your letter, you indicated that the health of residents may be affected by environmental contaminants from two Formerly Used Defense Sites (FUDS) on the island; persistent organic pollutants deposited on the island through the process of global distillation, and other sources to which Arctic Indigenous Peoples are disproportionately exposed. Because of your concerns, you asked that ATSDR conduct a public health assessment that considers all possible sources of exposure. This letter describes how your request will be addressed.

ATSDR worked with the U.S. Army Corps of Engineers (ACE). U.S. Environmental Protection Agency (EPA), Alaska Department of Environmental Conservation (ADEC), Alaska Department of Health and Social Services (ADHSS), and the Alaska Community Action on Toxics to gather and review the available environmental sampling data Collected at the Gamble and Northeast Cape (NBC) sites. The available reports include Results of soil, groundwater and surface water sampling conducted at specific sites for both Gamble and NEC, and descriptions of the remedial actions completed or planned for the sites. ATSDR has determined that these data can be used to evaluate community exposure, and ATSDR will assess the public health impact for both Gamble and NEC. We expect to initiate these assessments in 2013.

It is important to note that our public health assessments are conducted to determine whether people have been, or are currently being, exposed to hazardous substances released into the environment from a hazardous waste site or facility. Our goal is to determine whether exposure to contaminants from Gamble or NEC sites may be harmful to St. Lawrence Island residents. Our evaluation will not be able to determine the cause of a disease, or medical condition, experienced by the island's residents.

Additionally, we will focus on evaluating the community's exposure to the contaminates that have been measured in the environment on St. Lawrence Island. We will not be able to determine whether the contaminants are the results of past military activity, global transport and deposition, or are naturally occurring in the environment. Where we find harmful exposures, we will make appropriate recommendations to reduce, or eliminate, the exposures.

Page 2 - Mr. Ronnie Toolie

If you have questions about the planned public health assessments, please contact Mr. Greg Zarus, lead environmental health assessor, at (770) 488-0778 or email at GZarus@cdc.gov. If you have any additional questions regarding ATSDR's process to review your request, please contact CAPT Susan Neurath, ATSDR Petition Coordinator, at (770) 488-3368 or email at SNeurath @cdc.gov.

Sincerely,

William Cibulas Jr.

William Cibulas Jr., Ph.D.
CAPT, U.S. Public Health Service
Director
Division of Health Assessment and Consultation

Appendix G. Alaska Cancer Registry Cancer Study

Cancer Mortality Study & Lung Cancer Study of St. Lawrence Island, Alaska: Communities of Savoonga and Gambell

David O'Brien, PhD, GISP
Alaska Cancer Registry
July 19, 2017

Executive Summary

This report presents the result of a cancer mortality study and a lung cancer study performed by the Alaska Cancer Registry (ACR) of the communities of Savoonga and Gambell on St.

Lawrence Island in the Nome Census Area. The studies stem from the two communities' initial concerns about cancer. The number of expected cancer cases for these communities were calculated and then compared to the number of reported cases. The following observations were made:

- For cancer mortality for 1996-2014 for all types of cancer (cancer sites) combined, the number of observed cancer deaths for St. Lawrence Island was greater than the number of expected cancer deaths. These additional observed cancer deaths for Gambell alone and for St. Lawrence Island as a whole were found to be statistically significant; these additional observed cancer deaths for Savoonga alone were not statistically significant.

- Based on these findings, ACR performed a study to explore whether the statistically significant additional cancer deaths on St. Lawrence Island could be attributed to any particular cancer site. ACR reviewed the number and types of cancer deaths for 1996-2014 and found that lung cancer was by far the most common type of cancer death, accounting for 45% of all cancer deaths (the statewide average for Alaska Native people is 28%). ACR found that the number of observed lung cancer deaths for St. Lawrence Island was greater than the number of expected lung cancer deaths. These additional observed lung cancer deaths for Gambell alone and for St. Lawrence Island as a whole were found to be statistically significant; these additional observed lung cancer deaths for Savoonga alone were not statistically significant.

- In an earlier report,[1] ACR reviewed the number of new cancer cases for 1996-2013 for all cancer sites combined for St. Lawrence Island. Although the number of observed cases was greater than the number of expected cases, this difference was not statistically significant. But based on the finding from the mortality study, ACR also performed a study to explore whether the observed increase in newly diagnosed cancer cases on St. Lawrence Island could be attributed to any particular cancer site. ACR reviewed the number and types of new cancer cases for 1996-2013 and found that lung cancer was by far the most common type of cancer, accounting for 27% of all cancer cases (the statewide average for Alaska Native people is 16%). ACR found that the number of observed lung cancer cases for St. Lawrence Island was greater than the number of

expected lung cancer cases. These additional lung cancer cases for St. Lawrence Island as a whole were found to be statistically significant; these additional lung cancer cases for Savoonga and Gambell individually were not statistically significant.

- As tobacco use is the greatest risk factor for lung cancer the smoking prevalence for St. Lawrence Island was reviewed and found to be more than twice the state average, with an estimated 53.4% of adults being current smokers.

- ACR also examined the known tobacco use history of people diagnosed with cancer on St. Lawrence Island. ACR compared people diagnosed with lung cancer versus all other types of cancer except lung. There was a higher percentage of people with any smoking history for people diagnosed with lung cancer (100%) compared to all other types of cancer (82%). Also, there was a much higher percentage of current smokers among people diagnosed with lung cancer (64.7%) compared to people diagnosed with other types of cancer (34%). This information is consistent with smoking being the leading risk factor for lung cancer.

This study found that there were statistically significantly higher numbers of observed lung cancer cases and lung cancer deaths than expected in the St. Lawrence Island community. The study suggests that lung cancer cases and deaths on St. Lawrence Island are correlated with smoking in this community. The higher than expected lung cancer cases and deaths are consistent with the high prevalence of smoking on St. Lawrence Island. The study's conclusion is an assumption based on the correlation with known smoking prevalence data but is not proven by the analysis. Correlating findings of increased lung cancer cases and deaths with an exceptionally high rate of smoking found in these communities indicates where efforts could be focused to decrease the burden of cancer for residents of St. Lawrence Island.

Introduction

Mr. Joe Sarcone of the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services, had previously contacted the Alaska Cancer Registry (ACR) about a cancer concern on St. Lawrence Island in 2013. This concern was voiced by residents of the communities of Savoonga and Gambell. In response to this request, ACR launched a cancer study of this area. Two reports were produced in January 2014 with the study results — one regarding cancer incidence and one regarding the types and counts of cancer cases and cancer deaths. The reports were updated in September 2015. According to that study, no statistically significant elevation in overall cancer incidence was found.

The following study was conducted to provide ongoing surveillance to address community concerns. This current report is similar to the cancer incidence study previously released, but focuses on overall cancer mortality and reviews cancer deaths on St. Lawrence Island. The study also specifically addresses lung cancer for both mortality and incidence since it was found to be the most common type of cancer in the community and the percentage of cases was higher than the state average for Alaska Native people. While a study of cancer deaths was not part of the

original request back in 2013, ACR felt that as part of updating the original cancer study with new data, understanding both cancer deaths as well as new cancer cases would be beneficial to the St. Lawrence Island community to guide cancer prevention efforts.

Background

St. Lawrence Island is located in the Nome Census Area, off the western Alaska coast in the Bering Sea, approximately 130 miles southwest of the city of Nome. The community of Savoonga is located on the northcentral coast of the island, and the community of Gambell is located on the island's Northwest Cape. At the time of the 2010 U.S. census, Savoonga had a population of 671 and Gambell had a population of 681. Both communities have expressed concerns about apparent elevated rates of illnesses, including cancer, and that such illnesses may be caused by waste materials left behind from former military installations on the island. These facilities are specifically an Air Force station previously located on Northeast Cape, and an aircraft control and warning station, previously located in Gambell. The waste materials of concern are mostly petroleum, dioxin, and polychlorinated biphenyls (PCBs). In 2003, all military structures were removed from the island. Contaminated site remediation for Gambell was completed in 2008; remediation activities for the Northeast Cape area are still ongoing.

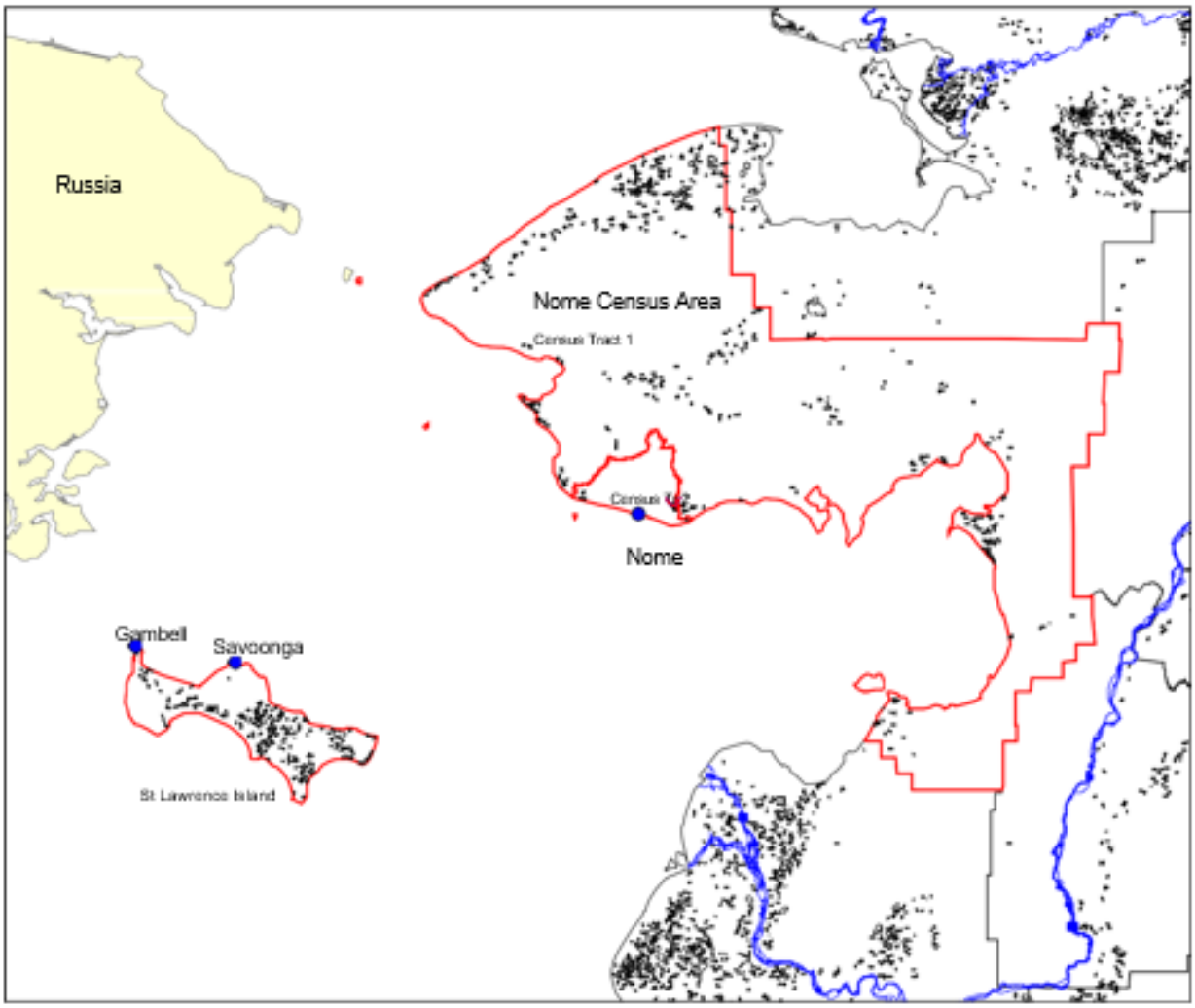
Methods

Geography

ACR consulted maps and census listings of the area. The Nome Census Area is divided into two tracts. Census Tract 2 contains the city of Nome and the surrounding area. Census Tract 1 contains all other communities of the Nome Census Area. Given that Savoonga and Gambell are combined with other communities in Census Tract 1, we used the individual community population estimates from the U.S. Census for this study.

ACR uses state mortality data maintained by the Alaska Health Analytics and Vital Records Section (HAVRS) to determine the date and cause of death for cancer cases in the ACR database. The state mortality database contains death information about Alaska residents recorded on death certificates. We determined the age-adjusted mortality rate for Alaska residents for all malignant cancer sites combined for the state of Alaska based on data in the state mortality database. Age adjusting rates is a way to make fairer comparisons between groups with different age distributions. Using the population of the communities of Savoonga and Gambell from the 2000 and 2010 U.S. census, an expected number of cancer death cases were determined and compared to the observed number of cancer death cases.

The following map illustrates the location of Savoonga and Gambell within the Nome Census Area.



Nome Census Area (outlined in red) showing locations of Savoonga and Gambell. Rivers and lakes shown for reference.

Statistics

In order to determine whether cancer mortality in a community was occurring at a higher or lower rate than expected, a statistic called the **standard mortality ratio** (SMR) was calculated. More specifically, the SMR is the number of observed cancer death cases in a community divided by the number of expected death cases based on the population of the community and the state's cancer mortality rates, and then multiplied by 100. An SMR greater than 100 means that more cancer death cases occurred than expected; an SMR less than 100 means that fewer cancer death cases occurred than expected. For example, an SMR of 150 is interpreted as 50% more deaths occurred than were expected; an SMR of 90 indicates 10% fewer deaths occurred than were expected. Here are example equations illustrating these concepts:

150 observed deaths

---------- X 100 = SMR of 150 (50% more deaths occurred than expected) 100 expected deaths

90 observed deaths

---------- X 100 = SMR of 90 (10% fewer deaths occurred than expected) 100 expected deaths

To determine if the observed number of deaths was significantly different from the expected number or if the difference may have been due solely to chance, a 95% confidence interval (CI) was calculated for the SMR. A 95% CI assesses the magnitude and stability of an SMR. Specifically, a 95% CI is the range of estimated SMR values that has a 95% probability of including the true SMR for the population. If the 95% CI range does not include the value 100, then the study population is significantly different from the comparison or "normal" population. "Significantly different" means there is less than 5% chance that the observed difference is the result of random fluctuation in the number of observed cancer deaths. Thus if the 95% CI range does not include 100, it can be concluded that the observed number of deaths is not the result of chance and reflects a real cancer mortality increase or decrease. However, if the 95% CI range includes 100, then the true SMR may be 100, and it cannot be concluded with sufficient confidence that the observed number of deaths reflects a real cancer mortality increase or decrease. A similar concept, **standard incidence ratio** (SIR), is used for cancer incidence data.

Observed Number of Cancer Death Cases

To determine the observed number of cancer death cases for this study, we needed to determine which death cases fell within the study area. For this process, we queried the HAVR mortality database for malignant cancer death cases that were recorded for residents of the communities of Savoonga and Gambell. Note that death certificates include the location of a person's residence as well as the location of where they died. This study used the residence location, not the death location. In the 19-year period from 1996 to 2014, there were 24 death cases from Savoonga and 31 death cases from Gambell, for a total of 55 cancer death cases.

Population

Next we determined the population of Savoonga and Gambell by age for the 2000 and 2010 census to calculate the expected number of death cases for the 19-year period of 1996-2014. The 2000 census population was used for calculations covering the death years of 1996-2005, and the 2010 census population was used for calculations covering the death years of 2006-2014. The "indirect aged-adjustment method" was used to make this calculation.[2] This method is useful when age-specific rates for age groups of the population of interest are not available, or when there are small numbers of deaths within each age group making it difficult to calculate stable age-specific rates.

Note that although mortality rates were only available through 2013 at the time of this report, mortality counts were available through 2014. Therefore, mortality rates for 2006-2013 (8 years) were used to calculate the expected number of death cases for 2006-2014 (9 years).

The expected number of cancer death cases was determined to be 19 for Savoonga and 17 for Gambell, rounded to the nearest whole number.

Results

1) Deaths For All Cancer Sites Combined

The results of these calculations are summarized in the following table and compared to the number of observed death cases.

Cancer Type	Location	Number of Observed Cancer Deaths 1996-2014	Number of Expected Cancer Deaths 1996-2014	Difference (Observed minus Expected)
All Cancer Sites Combined	Savoonga	24	19	+ 5
	Gambell	31	17	+14
	St. Lawrence Is.	55	36	+19

As illustrated in the above table, the number of observed cancer deaths exceeds the number of expected cancer deaths for Savoonga and Gambell over the 19-year period of 1996-2014. However, to determine if this excess is not just due to chance, we must apply the SMR statistical significance test. We have calculated the SMR and the upper and lower confidence intervals. The results are summarized in the following table.

Cancer Type	Location	Standard Mortality Ratio (SMR)	Lower Confidence Interval	Upper Confidence Interval
All Cancer Sites Combined	Savoonga	129.6	77.7	181.4
	Gambell	186.6	120.9	252.3
	St. Lawrence Is.	156.5	115.2	197.9

The SMR suggests that there are 29.6% more cancer deaths in Savoonga than expected. When the upper and lower confidence intervals are taken into consideration, this result is not considered to be statistically significant for Savoonga because the confidence interval includes the value 100. A SMR of 100 would indicate that the observed and expected number of cancer deaths is the same. Therefore, it cannot be concluded with sufficient confidence that the additional observed number of deaths for Savoonga reflects a real increase in cancer mortality.

The SMR suggests that there are 86.6% more cancer deaths in Gambell than expected, and 56.5% more cancer deaths for the total St. Lawrence Island population than expected. Also, the upper and lower confidence intervals for Gambell and for St. Lawrence Island as a whole do not include the value 100. Therefore, the additional observed number of cancer deaths for these locations is considered to be statistically significant, suggesting a real increase in cancer mortality and not just due to chance.

2) Lung Cancer Deaths

We decided to explore whether the significant increase in cancer deaths on St. Lawrence Island could be attributed to any particular cancer site. When we reviewed the number and type of cancer deaths on St Lawrence Island in the previously released report in September 2015, we noted that lung cancer is by far the most common type of cancer death on St. Lawrence Island, accounting for 45% of all cancer deaths. For a comparison, we examined statewide lung cancer statistics for Alaska Native people as they represent over 95% of the population of St. Lawrence Island. Statewide lung cancer deaths for Alaska Native people make up only 28% of all cancer deaths. We therefore decided to determine if lung cancer was responsible for the statistical significance in cancer deaths.

We repeated the calculations performed above for all lung cancer deaths, and for all cancer deaths that were not lung cancer. The results of these calculations are summarized in the following table and compared to the number of observed death cases.

Cancer Type	Location	Number of Observed Cancer Deaths 1996-2014	Number of Expected Cancer Deaths 1996-2014	Difference (Observed minus Expected)
Lung	Savoonga	11	5	+ 6
	Gambell	14	5	+ 9
	St. Lawrence Is.	25	10	+15
All Cancer Sites Combined Except Lung	Savoonga	13	13	0
	Gambell	17	12	+ 5
	St. Lawrence Is.	30	25	+ 5

As illustrated in the above table, the number of observed lung cancer deaths exceeds the number of expected cancer deaths for Savoonga and Gambell over the 19-year period of 1996-2014. Also, the number of observed cancer deaths from all sites combined except lung exceeds the number of expected deaths for just Gambell. However, to determine if these excesses are not just due to chance, we must apply the SMR statistical significance test. We have calculated the SMR and the upper and lower confidence intervals. The results are summarized in the following table.

Cancer Type	Location	Standard Mortality Ratio (SMR)	Lower Confidence Interval	Upper Confidence Interval
Lung	Savoonga	206.2	84.3	328.1
	Gambell	300.7	143.2	458.3
	St. Lawrence Is.	250.3	152.2	348.4
All Cancer Sites Combined Except Lung	Savoonga	98.6	45.0	152.1
	Gambell	142.2	74.6	209.8
	St. Lawrence Is.	119.3	76.6	162.0

The SMR suggests that there are 106.2% more lung cancer deaths in Savoonga than expected. When the upper and lower confidence intervals are taken into consideration, this result is not considered to be statistically significant for Savoonga because the confidence interval includes the value 100. A SMR of 100 would indicate that the observed and expected number of lung cancer deaths is the same. Therefore, it cannot be concluded with sufficient confidence that the additional observed number of lung cancer deaths for Savoonga reflects a real increase in cancer mortality.

The SMR suggests that there are 200.7% more lung cancer deaths in Gambell than expected, and 150.3% more cancer deaths for the total St. Lawrence Island population than expected. Also, the upper and lower confidence intervals for Gambell and for St. Lawrence Island as a whole do not include the value 100. Therefore, the additional observed number of lung cancer deaths is considered to be statistically significant, suggesting a real increase in lung cancer mortality and not just due to chance.

The SMRs for deaths for all cancer sites combined except lung are much lower than for lung cancer deaths alone. The upper and lower confidence intervals include the value 100, so the additional number of cancer deaths is not considered to be statistically significant. So although there are slightly more of these cancer deaths than expected for Gambell, it cannot be concluded with sufficient confidence that the additional observed number of deaths from all cancer sites combined except lung reflects a real increase in cancer mortality.

We also reviewed other types of cancer deaths on St. Lawrence Island besides lung cancer between 1996 and 2014. After lung, which is the most common type of cancer death, the next most common types are colorectal, pancreas, and stomach at 4 deaths each. All other types of cancer deaths have only 1 or 2 occurrences. These 4 types of cancer deaths are 4 of the 5 most common types of cancer deaths for Alaska Native people statewide. The following table compares the percentage of these cancers occurring on St. Lawrence Island (SLI) and for Alaska Native people statewide:

Cancer Type	Number of SLI Cancer Deaths	Percentage of SLI Cancer Deaths	Percentage of Cancer Deaths for AK Native people Statewide
Lung	25	45.5%	27.8%
Colorectal	4	7.2%	13.4%
Stomach	4	7.2%	7.1%
Pancreas	4	7.2%	5.8%

The percentages of these other types of cancer deaths are about the same or less than those observed for Alaska Native people statewide.

3) Lung Cancer New Cases

In addition to reviewing cancer deaths, we also decided to explore whether the observed increase in newly diagnosed cancer cases on St. Lawrence Island could be attributed to any particular cancer site. When we reviewed the number and type of cancer cases on St. Lawrence Island for 1996-2013 in the previously released report in September 2015, we noted that lung cancer is the most common type of cancer on St. Lawrence Island, accounting for 27% of all cancer cases. In comparison, lung cancer cases statewide for Alaska Native people make up only 16% of all cancer cases. We therefore decided to determine if lung cancer was responsible for the statistical significance in cancer cases.

We repeated the calculations performed above for all lung cancer cases, and for all cancer cases that were not lung cancer. The results of these calculations are summarized in the following table and compared to the number of observed cancer cases.

Cancer Type	Location	Number of Observed Cancer Cases 1996-2013	Number of Expected Cancer Cases 1996-2013	Difference (Observed minus Expected)
Lung	Savoonga	10	7	+ 3
	Gambell	13	6	+ 7
	St. Lawrence Is.	23	13	+10
All Cancer Sites Combined Except Lung	Savoonga	31	33	- 2
	Gambell	31	31	0
	St. Lawrence Is.	62	64	- 2

As illustrated in the above table, the number of observed lung cancer cases exceeds the number of expected cancer cases for Savoonga and Gambell over the 18-year period of 1996-2013, while the number of all other types of cancer does not. To determine if the lung cancer excesses are not just due to chance, we must apply the standard incidence ratio (SIR) statistical significance test. We have calculated the SIR and the upper and lower confidence intervals. The results are summarized in the following table.

Cancer Type	Location	Standard Incidence Ratio (SIR)	Lower Confidence Interval	Upper Confidence Interval
Lung	Savoonga	147.8	56.2	239.4
	Gambell	215.4	98.3	332.5
	St. Lawrence Is.	179.7	106.2	253.1
All Cancer Sites Combined Except Lung	Savoonga	93.3	60.4	126.1
	Gambell	99.3	64.3	134.3
	St. Lawrence Is.	96.2	72.2	120.1

The SIR suggests that there are 47.8% more lung cancer cases in Savoonga than expected, and 115.4% more lung cancer cases in Gambell than expected. When the upper and lower confidence intervals are taken into consideration, these results are not considered to be statistically significant because the confidence interval includes the value 100. A SIR of 100 would indicate that the observed and expected number of cancer cases is the same. Therefore, it cannot be concluded with sufficient confidence that the additional observed number of cancer cases for Savoonga and Gambell reflect a real increase in cancer incidence.

The SIR suggests that there are 79.7% more lung cancer cases for the St. Lawrence Island population as a whole than expected. The upper and lower confidence intervals for St. Lawrence Island do not include the value 100. Therefore, the additional number of lung cancer cases is considered to be statistically significant, suggesting a real increase in lung cancer incidence and not just due to chance. The reason why this is seen for the populations of both Savoonga and Gambell together rather than separately is due to how this statistical test works with populations. The larger the population of interest, the more precise the statistics become and thus the confidence intervals becomes smaller. The confidence intervals for the St. Lawrence Island statistics will be smaller than for each village individually.

The SIRs for all cancer sites combined except lung are all below 100 and the number of observed cases does not exceed the number of expected cases. Therefore, cancer incidence for all other cancer sites except lung appears to be what is normally expected for the St. Lawrence Island population.

We also reviewed other types of cancer cases on St. Lawrence Island besides lung cancer between 1996 and 2013. After lung, which is the most common type of cancer, the next most common types are colorectal (15 cases), breast (8 cases), and stomach (7 cases). All other types of cancer cases have only 3 or fewer occurrences. These 4 types of cancer cases are 4 of the 5 most common types for Alaska Native people statewide. The following table compares the percentage of these cancers occurring on St. Lawrence Island (SLI) and for Alaska Native people statewide:

Cancer Type	Number of SLI Cancer Cases	Percentage of SLI Cancer Cases	Percentage of Cancer Cases for AK Native people Statewide
Lung	23	27.1%	16.2%
Colorectal	15	17.6%	17.7%
Breast	8	9.4%	15.6%
Stomach	7	8.2%	4.4%

With the exception of stomach cancer, the percentages of these other types of cancer cases are about the same or less than those observed for Alaska Native people statewide. Stomach cancer incidence is known to be especially high for Alaska Native people in northern and western Alaska compared to other parts of the state. When the percentage of all stomach cancer cases for the Nome Census Area, Northwest Arctic Borough, and North Slope Borough are taken together as a group, stomach cancer cases are 8.3% of all cancer cases, which is about the same as observed on St. Lawrence Island.

4) Smoking Prevalence

Cigarette smoking has been found to be by far the leading risk factor for lung cancer.[3] With this in mind, we evaluated the smoking prevalence for these communities as a whole and looked specifically at smoking prevalence for individuals with lung and other cancers.

The Alaska Department of Health and Social Services conducts an annual survey called the Behavior Risk Factor Surveillance System (BRFSS), part of a nationwide health program of the U.S. Centers for Disease Control and Prevention (CDC). According to the Alaska BRFSS data for St. Lawrence Island for 2010-2014, the smoking prevalence for St. Lawrence Island is more than twice the state average, with an estimated 53.4% of adults being current smokers. Of all the boroughs and census areas in Alaska, the Nome Census Area that includes St. Lawrence Island, has the second highest smoking prevalence in the state with about 42.3% current smokers. The state average for current smokers is 21.6%; it is 38.2% for Alaska Native people.

We queried the Alaska Cancer Registry database for cigarette smoking history of the people diagnosed with lung cancer on St. Lawrence Island. There are 17 of these people whose smoking history is known. Of those, 100% are current or former cigarette smokers (64.7% current, 35.3% former). As a comparison, we looked at the cigarette smoking history of the people diagnosed with any type of cancer except lung cancer. There are 50 of these people whose smoking history is known. Of those, 82% are current or former cigarette smokers (34% current, 48% former). The remaining 18% were non-smokers. This information is summarized in the following table:

Smoker category	Lung cancer diagnosis	Non-lung cancer diagnosis
Current or former smoker	100.0%	82.0%
Current	64.7%	34.0%
Former	35.3%	48.0%
Non-Smoker	0.0%	18.0%

There is a much higher percentage of current smokers and those with any history of smoking for people diagnosed with lung cancer compared to people diagnosed with other types of cancer. This information is consistent with smoking being the leading risk factor for lung cancer.

Discussion

Community members have expressed concern of high cancer rates on St. Lawrence Island. Although cancer incidence rates as a whole are not significantly elevated, there are significant findings related to lung cancer. Findings indicate significantly higher numbers of lung cancer cases and deaths for St. Lawrence Island residents than expected, though they tended to be higher for residents of Gambell. Cigarette smoking prevalence was also found to be significantly higher than expected for these communities.

The communities of St. Lawrence Island have both a significantly higher number of lung cancer cases and an increased smoking prevalence — the leading risk factor for this cancer. In addition, the people in these communities diagnosed with lung cancer have a higher prevalence of current smokers and those with any history of smoking than people diagnosed with other types of cancer.

Correlating the high rates of lung cancer with the cigarette smoking prevalence suggests a likely cause of the higher than expected incidence and mortality patterns. Although these findings indicate a behavioral aspect is associated with the high lung cancer rates, the analysis is focused at the population level and is not meant to imply that individuals are to be blamed for their cancer. The findings do indicate where efforts could be focused at the community and organizational level to decrease the burden of cancer for residents of St. Lawrence Island. Further exploration of effective strategies to reduce lung cancer rates could be identified by partnering with organizations such as the State of Alaska's Tobacco Prevention and Control Program, Alaska Native Tribal Health Consortium, and Norton Sound Health Corporation.

Conclusions

This report presents the results of a cancer mortality study and a lung cancer study of the communities of Savoonga and Gambell on St. Lawrence Island. Lung cancer was found to be of concern, as shown by the statistically significant difference between the additional lung cancer incidence and death cases compared to the number of expected lung cancer incidence and death cases for Gambell and St. Lawrence Island as a whole. The greatest risk factor for lung cancer is tobacco use. Smoking prevalence for St. Lawrence Island is more than twice the state average, with an estimated 53.4% of adults being current smokers. The extent to which smoking may be a co-factor along with certain environmental exposures on the risk of lung cancer is unknown and was not explored within this study. Correlating findings of elevated lung cancer cases and deaths with an exceptionally high rate of smoking found in these communities is suggestive of one direction for preventive efforts to reduce the impact of cancer and improve the overall health of community members of St. Lawrence Island.

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Study Limitations

Cancer mortality data are derived from death certificates compiled by the Alaska Health Analytics and Vital Records Section (HAVRS). The mortality data are as accurate as the information certified by the funeral director and physician/medical examiner, and coded by the National Centers for Health Statistics. Although rare, a deceased person without a death certificate will not be in the mortality dataset. To determine the location of cancer deaths for this report, the decedent's usual residence address at the time of death was used, not the address of the hospital or other location where the death occurred.

Cancer incidence data are based on patient data reported to the Alaska Cancer Registry (ACR) from a variety of sources, including hospitals, physicians, pathology laboratories, and other state cancer registries, as per public health reporting laws. However, there are certain circumstances when people may not be counted as a community member for cancer rate calculations or may not be in the ACR database:

- If a healthcare provider does not report a cancer patient and that patient was not seen by any other healthcare provider, then that patient will not be in the ACR database.
- ACR uses the person's residence address at the time they were diagnosed with cancer. Therefore:
    - If a person from one community is diagnosed with cancer and then later moves to another community, then that person is still considered a resident of the old community.
    - If a person from one community moves to another community and is later diagnosed with cancer, then that person is considered a resident of the new community.

The people who are diagnosed in one community with a particular cancer are not necessarily the same people who die of that cancer in that community. Some original residents may move to a different community, and people diagnosed elsewhere may move to the community.

Cancer mortality is due to other factors besides exposure to cancer risk factors. Those factors are outlined below:

- The choice of a particular type of treatment is a factor that is not examined here.
- Some people with exposure to cancer risk factors never develop cancer.
- Some people diagnosed with cancer may die of another cause, such as an accident or a stroke. Such people die *with* cancer but not *of* cancer.

Health care statistics, such as cancer rates, are not exact figures. The actual figure may be slightly higher or slightly lower, and we can calculate what this range is most likely going to be in the form of a "confidence interval." The size of the confidence interval depends on the population of the group being evaluated. The larger the group, the smaller the confidence interval, and the more precise the statistic will be. The population of the entire state of Alaska would have a relatively small confidence interval compared to that of a rural village. Therefore, large confidence intervals for small groups make it difficult to precisely predict the number of expected cancer cases.

ACR data continuously undergo quality assurance reviews for data accuracy and completeness. ACR data are reviewed annually by the North American Association of Central Cancer Registries and CDC's National Program of Central Cancer Registries and certified to be over 95% complete.

Incidence and mortality rates are based on calculations using Alaska population data by borough and census area. These data are originally from the U.S. Census Bureau, compiled by the National Center for Health Statistics, and provided to ACR by the National Cancer Institute's SEER (Surveillance, Epidemiology, and End Results) Program. The population data are as accurate as the information provided to the U.S. Census Bureau.

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- Arthur Wendel, Division of Community Health Investigations, Agency on Toxic Substances and Disease Registry

Appendix H. Alaska Department of Public Health - Birth Defects Study

Alaska Department of Public Health - Birth Defects Study

MEMO

TO: Ali Hamade, Section of Epidemiology

FROM: Yvonne Goldsmith, MCH-Epidemiology Unit, Section of Women's, Children's and Family Health, Division of Public Health

DATE: November 26, 2012

RE: Prevalence of Birth Defects, St. Lawrence Island. *Revised Preliminary Analysis*.

This is in response to your request for information regarding prevalence of birth defects on St. Lawrence Island, Gambell and Savoonga. You indicated that residents are concerned about potential health effects associated with some chemical exposures. I did an analysis of data from the AK Birth Defects Registry, 1996-2011.

Data Source & Background: The Alaska Birth Defects Registry is an enhanced passive surveillance system.

The National Birth Defects Prevention Network (NBDPN) has defined 45 birth defects that are considered major congenital anomalies. These include the following defects: cardiovascular, alcohol-related, alimentary tract, genitourinary, central nervous system, musculoskeletal, chromosomal, and eye & ear.

During birth years 1996-2011, major congenital anomalies, including alcohol-related anomalies, affected approximately 6% of Alaska live births annually. This is twice the national average.

The prevalence of major congenital anomalies was higher among Alaska Native children when compared to non-Native children

Data Limitations

Some conditions undergo medical records abstraction and case verification. For the purposes of this analysis, prevalences are based on all cases reported under qualifying ICD-9 codes, regardless of case verification.

Birth defects are rare events, and when occurring in a small population base, rate calculations can be statistically unreliable. For this analysis, all major anomalies summed by five-year intervals were examined. Even so, the confidence intervals are extremely wide.

Data is subjected to diagnostic bias - some health care providers may have more sophisticated equipment or clinical specialists to better report some birth defects.

Birth defects are reportable up to age six years. The prevalences presented in this memo include all reports for children born during 1996-2011 that were received before January 1, 2012. Since some birth defects are not diagnosed until later in life, rates beyond 2007 (2008 through 2011) are underreported.

Analysis

Table 1. Prevalence of Major Congenital Anomalies, Alcohol-related Anomalies Excluded, by St. Lawrence Island and Region, Alaska, 1996-2011

Epi Region	Prevalence per 10,000 Live Births	Lower CI	Upper CI
Gulf Coast	309.9	282.6	337.2
Southeast	325.6	295.8	355.3
Anchorage/Mat-Su	385.9	372.8	399.1
Interior	402.2	378.9	425.5
Northern	598.3	547.9	648.8
Southwest (incl. SLI)	602.3	560.5	644.1
St Lawrence Isl (SLI)	666.7	457.4	875.9

St. Lawrence Island is within the Southwest Region. From 1996-2011, the prevalence of major, non-alcohol-related anomalies among infants born to St. Lawrence Island residents was higher than the prevalence rate for the remainder of the Southwest Region (599.3, CI: 556.7 - 641.9), however, the difference is not statistically significant. (Table 1)

Table 2 lists prevalences of non-alcohol-related birth defects during 2002 - 2006, for census areas having a number of events ≥ 20. The number of events for St. Lawrence Island is < 20. While the confidence intervals for St. Lawrence Island fits within the confidence intervals of those other census areas, indicating no statistically significant difference, we can still see that the St. Lawrence Island prevalence is more similar to census areas with predominately Alaska Native populations, as well as the Anchorage Native population group.

According to staff at the Dept. of Fish & Game, in general, communities in the census areas of Dillingham, Nome, North Slope Boro and Wade Hampton have diets more similar to communities on St. Lawrence Island with respect to specific types of marine mammal subsistence foods (whales vs. seals). This is a complex issue, but the birth defects data indicate that there isn't a statistically significant difference in overall prevalence among those communities.

Table 2. Prevalence of Major Congenital Anomalies, Alcohol-related Anomalies Excluded, by St. Lawrence Island, Selected Census Areas and Anchorage, Alaska, 2002-2006

Census Area	Prevalence per 10,000 Live Births	Lower CI	Upper CI
Ketchikan Gateway	241.7	138.3	345.0
Kodiak Island	285.7	183.5	388.0
Kenai Peninsula	351.1	285.5	416.7
Anchorage	381.5	355.4	407.5
Juneau	385.2	297.4	473.0
Anchorage non-Native	385.5	331.2	385.9
Fairbanks NSB	386.8	343.0	430.6
Matanuska Susitna	402.1	347.1	457.2
Sitka	404.9	239.4	570.4
SE Fairbanks	462.8	273.6	651.9
North Slope	503.6	351.3	655.9
Anchorage Native	513.3	434.7	591.9
Bethel	603.9	498.0	709.7
St. Lawrence Isl.	613.5	233.2	993.7
Wade Hampton	700.0	543.6	856.4
Northwest Arctic B.	702.0	525.8	878.1
Nome	732.8	571.2	894.4
Yukon-Koyukuk	**756.5**	**494.4**	**1018.6**

Appendix I. Summary of Public Comment and ATSDR's Responses

ATSDR received 193 comments from Alaska Community Action of Toxics (ACAT) in November 2017; the comments fall into 11 categories. Some of those comments included individual names. To protect the privacy of those individuals, we are providing summaries to the questions here by category. ACAT's comment appears in indented *italics.* ATSDR's response follows.

ATSDR's Foreword: ACAT offered several comments about the foreword. Several pertain to specific topics that were addressed in other sections of the document. All of those were addressed in the specific sections where they apply (see remaining topics below).

> *This Foreword is a deceitful boiler plate that is used over and over, until the staff at ATSDR are brainwashed sufficiently into accepting their roles as defenders of polluters. It does not fool us. Page iii, paragraph 3; Page 3, Section 3, Row 2, column 4, Comments. Comment: Simply because no data are available from when people were exposed to piles of drums and disposed wastes, the ATSDR must not conclude that public health has not been impacted. The health impacts to children and to other high-risk groups were not considered in this Health Assessment. Page iii, paragraph 5; continued Health Effects. There is enough evidence today to show links such as what we are seeing on SLI. Pages iii & iv, paragraph 7, Conclusions. In response to ATSDR's claim that they can recommend "full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances," we note that both SLI military sites and the residents need these services, but they are being withheld.*

The Foreword is an agency-approved standard explanation of when ATSDR engages in the various activities authorized under law. Because of these comments, the Foreword was revised in this final report to state the process more directly while including some of the items listed in the law and in our guidance documents. ATSDR often uses the health assessment as the means to identify other agency activities. The health assessment uses child exposure information to be protective of the community. Health Comparison values for children are provided in Table 2 and the available health statistics data for children are reported in the Appendix A. Other specific science, process and accountability are addressed below.

ATSDR Recommendations and Accountability:

> *ATSDR indicates some particular types of sampling data that are warranted, however must make it explicit what agency/agencies are responsible (e.g. evaluation of lead in homes, blood lead levels, monitoring of all drinking water sources). Page iii, paragraph 1. The U.S. Environmental Protection Agency (EPA) provided no proper oversight. ATSDR recommends that homes be evaluated for lead hazards and also blood lead testing for children, yet makes no provision for agency accountability to ensure that this is carried out.*

ATSDR has modified some recommendations to include the agencies who may be responsible for future sampling. While ATSDR is not a regulatory agency (like EPA) that can fine or force an action, we advise agencies on prudent public health practice, and most other agencies take that advice. EPA, as an enforcement agency has unique responsibilities at FUDs sites. Some information is available at: https://www.epa.gov/fedfac/epa-policy-towards-privately-owned-formerly-used-defense-sites

Sampling Limitations: Several comments and questions reflect the fact that sampling is limited by date, sample number, and location, or by laboratory analysis. The following comment comprehensively reflects the issue:

ATSDR must evaluate and explicitly state the limitations of the Corps of Engineers' (and Corps' contractors) data used in the assessment. These sampling data are inadequate and outdated. Tribal and community leaders, RAB members, the TAPP scientist, and ACAT have consistently asserted that the nature and extent of contamination associated with the FUD site at Gambell has not been properly characterized. Therefore, these limitations result in inherent bias and minimization of health hazards associated with the site.

ATSDR indicates the limitations of the data collected by ACOE and others in each section and at each location where contact with a contaminated medium is likely, for example, Troutman Lake, etc.

- ACOE used a tier method to select areas to sample based on known past use or aerial photographic evidence of military use. Initial sampling was limited. For areas that showed contamination, more detailed sampling was conducted in later sampling events. Initial sampling results that did not indicate contamination were not investigated further.

- ATSDR identified Troutman Lake as an area with limited data that needs additional contaminant characterization based on its current recreational and potential drinking water source use.

- Outdated data: While using recent data to evaluate current human exposures is ideal, older data can provide useful information and indicate where contamination travels and how fast it degrades. Because no data were collected in the last year (2017), we must rely on the most recent of the older data. ATSDR indicates where these data are insufficient to make a health call about current conditions—as we did regarding Troutman Lake. We have added emphasis to the text to identify uncertainty.

Global Transport and Deposition and Synergism:

ATSDR must address health implications of multiple sources of exposure to contaminants, including the FUDs sites as well as global contamination. The assessment should assess cumulative and synergistic effects of these multiple sources of exposure. It is scientifically incorrect to state that it will not be possible to definitively determine the source of the contaminants or to determine the global transport and deposition of other pollutants in the environment. There are data available on levels of environmental contaminants in this region of the Bering Sea that have been published in the peer-reviewed literature and by other agencies. These should be thoroughly reviewed and included in the health assessment.

ATSDR assessed all likely exposures associated with chemicals measured near the community regardless of their source, consistent with our mandate. We included peer-reviewed literature directly associated or relevant to exposure conditions of this community. As the lead agency within the Public Health Service for implementing the health-related provisions of CERCLA, ATSDR is charged with assessing the presence and nature of health hazards at specific sites to help prevent or reduce further exposure and the illnesses that result from such exposures. While Congress was clear that the mandate was site-focused, it did not limit the ability to include any toxic substance that was measured on site, regardless of the source as part of the health assessment –which was done in this assessment. This included the assessment of combined exposures where data was available.

Synergism is addressed in the assessment by adding risk of chemicals when are known to be additive. ATSDR publishes interaction profiles https://www.atsdr.cdc.gov/interactionprofiles/index.asp for

several chemicals for which interaction is understood. Many of these suggest less than directly additive synergism. In cases where interaction is unknown, ATSDR assumes additive synergism for the chemicals that are measured in the environment. We also include data on populations that are more susceptible to or behaviors that increase exposure, as we did here.

In this report, we did not identify whether any substances measured were from a local or global source. We had no local data on persistent organic pollutants (POPs) in marine mammal tissue in this situation, and we did not have other local data that separated global from local contamination. We assessed the environmental data collected on the FUD site, which is a requirement for ATSDR's site-specific assessments.

Residents of St Lawrence Island are known to have exposures to certain POPs that are higher than those for most of the US population, as do other indigenous Arctic nation communities (much lower than Greenland and Russia, but in line with Scandinavia indigenous peoples). Whether these POPs at the level of exposure in St. Lawrence Island residents have associated risks that outweigh the benefits of hunting and eating these animals is unknown. However, there is no evidence that they are associated with adverse health outcomes in this community [Hamade 2016].

Groundwater:

> *ATSDR has made speculative assumptions concerning hydrology as it relates to contaminants, especially that contaminants "…move quickly down through the gravel to the groundwater and out to sea." There are no hydrological data or studies cited to substantiate this. In fact, this contradicts observations in the community that indicate the vulnerability of the water sources with increasing effects of climate change.*
>
> *Knowledgeable leaders in Gambell have stated that saltwater intrusion is occurring with increasing storm surges associated with climate warming, with the likelihood that contaminants in the subsurface are forced toward the drinking water sources and making the drinking water sources more vulnerable to contamination now and in the future. It is also highly possible that contaminants have been temporarily sequestered in permafrost below the gravel. With climate warming, the melting of permafrost will release contaminants and possibly result in exposure through groundwater sources of drinking water, vapor intrusion, and/or direct exposure at the surface. The health consultation's inaccurate assumptions result in questionable conclusions.*

We added additional explanation from our cited references to the drinking water section. Our description of how volatile chemicals from oil spills move through gravel is based on physical chemistry and hydrology principles (i.e.; solubility, volatility, surface tension, adhesion, shallow groundwater, and tidal flux). These principles do not contradict the community's observations of how their climate has changed. On the contrary, community observations are especially important at Gambell because air and sea temperature sampling there is limited.

While direct local sampling is limited, the data do agree with the community's observations – great temperature variability from year to year and a warming trend occurring after 1976 [NOAA 2016; Timmermans et al. 2017; NOAA 2018]. Warming is one factor. It makes chemicals more mobile and makes them dissolve faster and volatilize much faster. Therefore, any current-day spills will volatilize and dissolve faster, on average, than in the past.

We do agree that there is a future risk of vapor intrusion and have made recommendations that address this issue. However, the village groundwater has undergone several freeze-thaw cycles over the years, and the groundwater beneath the village is shallow and highly influenced by tidal flux of seawater. Thus, past spills have undergone several flushes. The bedrock is of gravel, which is porous, allowing water to move through it 10,000 times faster than through silt and 100,000 times faster than through clay.

ATSDR remains concerned about the possibility of groundwater contamination by some chemicals that might be trapped by ice. However, samples collected near the permafrost indicate low levels. (See the additional explanation provided in the text.)

Vapor Intrusion:

> *ATSDR must also assess vapor intrusion as a possible source of exposure. Hazardous substances were buried in areas where there are now homes, the school, and community buildings. People have described odors and health conditions that may result from exposure to contamination beneath the homes/buildings.*

The available data and information does not indicate the presence of volatile chemicals in the subsurface at level suitable for vapor intrusion at Gambell FUDS sites 7, 16, and 27. However, we have revised our vapor intrusion section to address ACAT's and the community's concerns.

The freezing surface of porous gravel and the need to heat and insulate indoor spaces increases the possibilities for current spills to intrude into buildings. Buried hazardous waste or current spills could enter that pathway until the next thaw cycle.

Because of the potential for future spills, we recommend placing fuels and hazardous substances on a spill pan to prevent migration into the groundwater. We also recommend removing any known hazardous waste. Since the publication of the public comment ATSDR report (with the concern for vapor intrusion), a spill has occurred associated with the school pipeline. Because of this spill and the comment, ATSDR has added additional information regarding the vapor intrusion pathway.

Cancer:

> *The analyses of cancer and birth defects rates are inadequate. The equations used underestimate cancer and birth defects. This "ham handed" approach cannot provide an accurate assessment of cancer and birth defects. This contradicts health observations in the community that witness increasing rates of cancer, including among younger people.*

ATSDR requested Alaska Department of Public Health's input and analysis of cancer and birth defect data collected on Gambell residents. ADPH analyzes statistics of clinical cases diagnosed and reported by physicians. This epidemiological methodology is used throughout the US and the world as a way to provide standard measurements so that like-cases can be compared with other like-cases. The method also reduces bias. Health observations in the community can be reported in community surveys. Neither ATSDR nor ADPH is aware of any community surveys that have been conducted for Gambell residents.

Knowledge of People of Gambell: *This assessment is patronizing and ignores the knowledge, experience, and observations of the people of St. Lawrence Island. This and the inaccurate assumptions addressed above leads to false or at least inconclusive determinations that the military*

contamination poses no real threat to the health of people in Gambell. This process was not inclusive or transparent.

Community knowledge is included within 10 sections of the final report (Site Description, Land Use and Natural Resource Use, Climate and Weather, Geology, ATSDR Site Visits and Community Outreach, Community Health Concerns, Discussion, Summary of Exposure Evaluations, Limitations, and in the Summary of Native Village of Gambell Key Information Interviews). We gained this knowledge by written and face-to face communication.

ATSDR's visits were planned through the Tribal Council months ahead of the visits. Each visit involved contacting the Tribal Council President to ask about the best time to visit in the coming months. We set a date based on their input. Then, our regional representative in Alaska followed up with a letter, e-mail, and/or fax with the agreed upon time and purpose for the visit. About two weeks before each of the visits, we called or sent an e-mail and/or fax to remind the Tribal Council Presidents of the upcoming visit. We asked that a meeting announcement be posted around the village prior to the visit.

When visiting, our staff would spend Monday through Wednesday in Savoonga and then Wednesday through Friday in Gambell. During the community meetings, we left the community engagement format up to the Tribal Council Presidents. This included some combination of council meeting, community meeting, elders' lunch, informal focus groups, and key informant interviews conducted as public availability sessions at the Tribal Council office and home visits for elders that could not make it to the office.

On two of the Friday afternoons, the weather permitted our representative to meet with Norton Sound Health Corp. in Nome. The data received informed the quantitative analysis of exposure and human health risk.

ATSDR uses both quantitative and qualitative methods to evaluate community exposures. The quantitative methods are very similar to the risk assessment or hazard assessment methods used by EPA. However, ATSDR adds in behavior or preference information provided by the community. The quantitative assessment methods have been peer reviewed and are widely accepted in the scientific community.

Universities and other organizations are developing new methods to suggest exposures or to suggest food-chain magnification potential. These show great promise. Some effectively serve as warning signs that pollutants are getting into the food chain. However, these methods do not help to calculate human exposure dose used to evaluate health risk.

Our methodology and process are both published in the Federal Register and at the following links:

- https://www.federalregister.gov/agencies/agency-for-toxic-substances-and-disease-registry

- https://www.federalregister.gov/documents/2005/03/02/05-3983/availability-of-public-health-assessment-guidance-manual-update