Health Consultation

Evaluation of Potential Exposure to Releases
from Historical Military Use Areas

PORT HEIDEN

LAKE AND PENINSULA BOROUGH, ALASKA

EPA FACILITY ID: AK8570028698

JANUARY 31, 2019

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

Health Consultation: A Note of Explanation

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

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

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Prepared By:

U.S. Department of Health and Human Services
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Table of Contents

Summary

The Native Village of Port Heiden Tribal Council asked the Agency for Toxic Substances and Disease Registry (ATSDR) to assess possible health effects from chemical contamination at areas and landfills formerly used by the military. The Council expressed specific concern about subsistence foods, groundwater, beach erosion, drums, and chemical vapors entering homes and buildings. This is the fifth ATSDR report discussing environmental exposures for Port Heiden since 2008. Port Heiden is on the northern side of the Alaskan Peninsula, on the coast of Bristol Bay.

ATSDR addressed the following questions in this document:

- Could people experience injuries from contacting surface debris at the beach and past use areas across the site?
- Could people have health problems from drinking the water from the Meshik School, residential, or community wells?
- Could contact with chemicals from the current and former historical use areas and landfills harm people's health?
- Could breathing chemicals in the air from vapor intrusion at the Meshik school, residences, or other buildings harm people's health?
- Could eating subsistence animals and plants with chemical contamination from the site harm people's health?

Key Findings:

- People could be injured by contact with items such as old scrap metal, wood, batteries, drums, munitions, medical waste, and asbestos-containing material at the beach and areas used in the past by the military.
- Children and adults are not likely to be harmed by drinking water at the Meshik School. With proper treatment, the school water meets drinking water quality standards.
- We don't have enough information to decide whether drinking water from area private wells, eating customary and traditional foods, or contacting soil could harm people's health.
- We also don't know if chemical vapors are moving indoors from contaminated groundwater detected in residential wells.

Our investigation led to six conclusions and the following recommendations:

HEALTH HAZARD

People may experience injuries from contacting surface debris at the beach and historical use areas across the site.

ATSDR recommends the owners of landfills and hazardous areas:

- Restrict current and future land use near areas with known landfills and debris.
- Place caution signs in areas with known physical hazards.
- Regularly inspect and maintain the landfills.

ATSDR recommends the Tribal Environmental Office:

- Provide health education to residents and visitors about potential hazards.
- Work with stakeholders to remove physical hazards.

ATSDR recommends residents and visitors:

- Avoid debris and banks made unstable from erosion.
- Report physical hazards to the Tribal Environmental Office.[1]

ATSDR will:

- Provide mapping files that can be used by the villagers, visitors, and tribal environmental office to locate over 900 historical use areas throughout Port Heiden.

NO HEALTH HAZARD

Currently children and adults are not likely to be harmed by drinking the water at the Meshik School, as long as treatment is maintained

ATSDR recommends the Lake and Peninsula School District:

- Continue routine monitoring for federal and state drinking water criteria and other water quality parameters as appropriate.
- Maintain and adapt water treatment systems to minimize arsenic, copper, and lead levels, as well as other contaminants.

[1] To find more information on contacting the Tribal Environmental Office, visit http://www.nativevillageofportheiden.com/local-environmental-observer-program.html

UNCERTAIN HEALTH HAZARD

We don't have enough recent information to conclude whether chemicals in residential and community drinking water wells could harm people's health.

ATSDR recommends the Army, Air Force, or other responsible party:

- Offer sampling of drinking water for residential wells where diesel range organic was found in the past and for nearby wells
- Offer the sampling of wells within 100 feet of historical use areas.

ATSDR recommends residents:

- Regularly test their own drinking water wells as recommended by the Alaska Drinking Water Program for all private wells in Alaska.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether contact with chemicals from the landfills or over 900 historical use areas could harm people's health.

ATSDR recommends the Air Force:

- Complete remediation of the Radio Relay Station area.
- Continue efforts to identify and delineate groundwater contamination that could compromise current and future potential water supplies.

ATSDR recommends the Army:

- Complete the additional soil and groundwater testing indicated from the remedial investigations and any follow-up remedial activities.

ATSDR recommends the owners of landfills and hazardous areas:

- Restrict current and future land use at known landfills.
- Regularly inspect and maintain the landfills.

ATSDR recommends Alaska Department of Environmental Conservation:

- Work with owners of the permitted landfills to restrict access and releases from landfills.
- Continue efforts to support characterization of contamination near the airport.

ATSDR recommends the Tribal Environmental Office:

- Provide health education to residents about the potential hazards of landfills and the over 900 historical use areas.

ATSDR recommends residents and visitors:

- Stay away from areas with soil or water discoloration or visible waste and report it to the Tribal Environmental Office.
- Avoid closed landfill areas and follow posted instructions at active landfills.
- Avoid landfill areas along the coast, especially where erosion is actively occurring.
- Use caution in the suspected historical use areas.

ATSDR will:

- Provide mapping files that can be used to identify information about over 900 historical use areas.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether vapor intrusion into the residence with diesel range organic in 2003 or unsampled nearby residences could harm people's health. Vapor intrusion is not expected to result in health effects at the Meshik school or airport buildings.

ATSDR recommends the Air Force, Army, and responsible parties:

- Evaluate buildings for potential vapor intrusion if retesting or monitoring indicate the presence of volatile chemicals greater than vapor intrusion screening levels.
- Continue monitoring the upper aquifer wells near the school for volatile and semi-volatile contaminants potentially related to the pipeline spill.
- Include methods to detect aliphatic and aromatic fractions appropriate for comparison with provisional vapor intrusion screening levels in future analyses.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether chemicals in traditional and subsistence foods could harm people's health.

ATSDR recommends the Tribal Environmental Office:

- Consider participating in the free Alaska Fish Monitoring program to evaluate how local fish and shellfish compare to specimens in other areas of Alaska.
- Complete the Alaska Fish Monitoring program's 10 question survey about the fish they catch and eat and any concerns about contaminants (https://dec.alaska.gov/eh/vet/fish-monitoring-program/).

ATSDR recommends residents:

- Eat subsistence foods from a variety of locations to avoid heavy consumption of foods from any one (or more) of the historical use areas.
- Report any unusually impaired wildlife (like fish kills) or stressed vegetation to the Tribal Environmental Office.
- Consult the report "Tribal Exposures to Environmental Contaminants in Plants" provided in the petition response in 2008. The report is available here: https://www.engg.ksu.edu/CHSR/outreach/tosnac/docs/NAreport_fnl032301.pdf .

ATSDR recommends the Army and Air Force:

- Work with the tribe to develop a sampling plan of traditional and subsistence foods impacted along the coastline and on land near historical use areas. Measure food for polychlorinated biphenyls (see past ATSDR recommendations) and metals.

This health consultation report explains these conclusions. An easy-to-read summary is available at https://www.atsdr.cdc.gov/HAC/PHA/index.asp. The website also contains a supplemental technical document with further details about methods and analysis of the site characteristics, exposure pathways, and potential for health effects in the Port Heiden population [ATSDR 2019].

If you have questions or comments, call ATSDR's region 10 office director, Rhonda Kaetzel, at 206-553-0530, ATSDR's regional representative for Alaska, Joe Sarcone, at 907-271-4073, or our toll-free number at 1-800-CDC-INFO and ask for information on Port Heiden.

About the Site

Chemical contamination was left during historical activities by U.S. Army, U.S. Air Force, and others.

Figure 1. Port Heiden, Alaska Location

Port Heiden, Alaska, is on the northern coast of the Alaskan Peninsula, near the mouth of the Meshik River on Bristol Bay (Figure 1). Before World War II, Port Heiden residents, mostly Alaska Native or part Native, lived in Meshik, the "Old Village" on the coast.

In December 1941, the War Department constructed Fort Morrow, an army air and ground base. The base included a marine terminal near the Old Village, approximately 450 inland structures, and two gravel air strips. Up to 2,000 military personnel lived on-base in the 1940's.

Supplies staged at the base included thousands of drums containing petroleum, oil, lubricating fluid, and other maintenance fluids [USACE 2012a]. A pipeline transferred fuel from the marine terminal to inland facilities for plane refueling.

Northeast of the airstrips, the U.S. Air Force (USAF) operated the communication stations, including a White Alice Communication System, and later a Radio Relay Station (RRS) between 1958 and 1978 [ADEC 2016a, ATSDR 2014b]. The Army and Air Force used six main landfills in the Port Heiden area for waste, structures, and equipment during decommissioning (Figure 2). Some of these landfills contain municipal waste as well.

The U.S. Coast Guard [NOAA 2007], Army, Air Force, Federal Aviation Administration, State of Alaska, and the Village have conducted numerous investigations and remedial activities since the 1980's. Army and Air Force removals included structures, aboveground storage tanks and drums, buried drums, and petroleum and polychlorinated biphenyl (PCB) contaminated soil at the Radio

Relay Station, airport, and marine terminal areas. Hazardous waste investigations and remediation continue [USAF 2009; USACE 2015]. The data sources reviewed in this evaluation come from the Air Force's remedial investigation [USAF 2006] and the Army's Triad Investigation [USACE 2013a]. The Air Force and Army made reports on its remedial investigation available after ATSDR completed this health consultation.[2] A timeline for the cleanup efforts is shown in Table 1.

[2] Note: At the time this report was developed, ATSDR did not have U.S. Air Force (USAF) or U.S. Army Corps of Engineers (USACE) documents more recent than 2014. USAF and USACE supplied the reports after data validation review of this health consultation. Those reports, identify that hot-spot removals of formerly used areas have occurred in some of the historical use areas investigated, with a high focus on petroleum and metals. There was some shallow water data, but no recent community drinking water data. To facilitate the release of this health consultation with the current recommendations to protect public health, ATSDR has not fully reviewed the new documents. ATSDR performed a limited review to note potential impacts to the summaries and conclusions herein. A health consultation on the new documents will be considered upon request. ATSDR considers the conclusions and recommendations herein valid based on preliminary review of the new reports.

Table 1. Port Heiden Remedial Action Timeline

Year(s)	U.S. Air Force (USAF) and U.S. Army Corps of Engineers (USACE) Event or Milestone
1981-1986	The USAF removes polychlorinated biphenyls (PCB)-contaminated soil and other hazardous materials from the former RRS facility.
1986-1988	USACE conducts site investigations and prepares bid documents for the complete demolition and restoration of the former RRS facility.
1990-1992	USACE and its contractors demolish the former RRS facility and remove hazardous wastes and soils contaminated with PCBs and petroleum.
1995	The USAF conducts a preliminary assessment and site inspection, including collecting soil samples from the former RRS facility.
1998	The Federal Aviation Administration removed an underground tank and potentially fuel-contaminated soils southwest of the main runway.
2000	The USAF collects additional soil samples at sites that were recommended for further investigation.
2003	USACE hires a contractor to sample every private drinking water supply well in the community of Port Heiden.
2004	The USAF begins a Remedial Investigation and Feasibility Study to identify remaining contamination at 18 sites and to evaluate risks associated with exposures to the identified contamination.
2005	The USAF completes its Remedial Investigation and Feasibility Study for 18 sites. The field investigation included extensive sampling intended to delineate the nature and extent of contamination present at the sites.
2007	The USAF awards a contract for the cleanup of sites remaining at the former RRS facility. The contract included a Proposed Plan, Record of Decision, and completing remedial actions.
2007	The USACE removed drums and petroleum contaminated soil. The U.S. Coast Guard and State of Alaska followed up by responding to reports of sheens and additional rusted drums left behind in the intertidal zone the following month. The on-scene commanders tasked the locals with continued monitoring of the area and removing remaining batteries and drum fluids.
2008	The USAF submits a proposed cleanup plan that identifies two preferred alternatives. For soil, the alternative was selected excavation, washing, and off-site disposal of PCB-contaminated soil in a permitted landfill. For groundwater, the alternative was natural attenuation with long-term monitoring.
2009	ADEC and the USAF sign a Record of Decision (ROD). For soil, the ROD requires excavation, soil-washing, and disposal of PCB-contaminated soil in an off-site landfill. For groundwater, the ROD requires long-term groundwater monitoring and institutional controls.
2010	ADEC issues a Compliance Advisory letter to the USAF for improperly disposing of soils contaminated with PCBs at levels above permitted limits.
2011	The USAF's contractor begins removing PCB-contaminated soil from the north landfill and sends it to a permitted facility outside of Alaska for disposal. The USAF also begins removing PCB-contaminated soil from the road between the airport and the former RRS facility.
2012	The USAF's contractor finishes removing PCB-contaminated soil from the landfill, and ADEC closes out its Compliance Advisory letter.
2013	The USAF's contractor finishes removing PCB-contaminated soil from Site Road. An estimated 5,000 cubic yards of contaminated soils are removed.
2014	The USACE performed some incidental removals of petroleum and lead contaminated soil during the remedial investigation of over 900 historical use areas across the site.
2015	The USAF performed removals of PCB-contaminated soils and asbestos-contaminated materials for the Radio Relay Station areas.

Source: Chronology taken from "History of the Cleanup Work" presented on Alaska Department of Environmental Conservation's (ADEC) Contaminated Sites Program website for the RRS, NOAA 2007; USACE 2013c, 2014, 2016; USAF 2016a.

In the mid-1980's, coastal erosion (Figure A.1) forced residents from the Old Village to move inland to the New Village in proximity to other former military use areas [BBNA 2016]. Residential areas include Port Heiden Estates, Meshik Estates, a five-house development near Meshik School, and other residences south of the airport. A new housing development was announced in fall 2015 for teachers and health-care workers [NVPH 2015].

The 2010 U.S. census counted 102 people [NVPH 2010], 85% of whom were Alaska Natives. The census reported 35 households, 15 of which had children less than 18 years old. Meshik School, a part of the Lake and Peninsula School District (LPSD), had 14 students in the 2016-2017 school year with ages ranging from preschool to high school [LPSD 2016].

Widespread commercial and subsistence fishing, hunting, and gathering of native food sources are important for the livelihood of Port Heiden residents. Visitors and tourists also use the greater Port Heiden area for outdoor sports and recreational purposes.

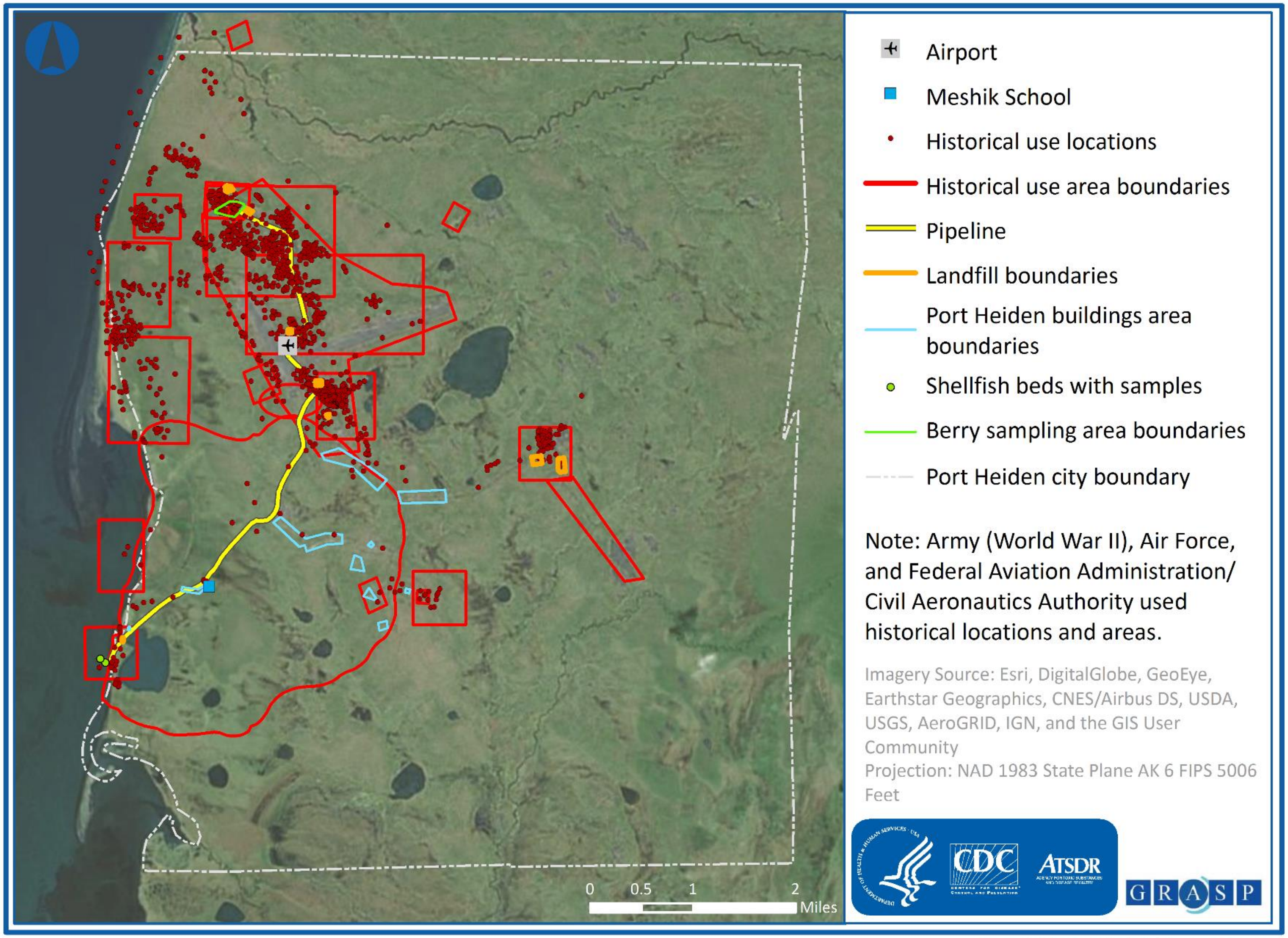
Port Heiden encompasses a wide area with many small locations used historically by the military. Figure 2 shows homes and buildings (light blue-green markers) near large (red rectangles) and small use areas (small red points) used by the military in the past. All areas are accessible by residents and only a few of the major cleanup sites have warning signs or restricted access.

ATSDR involvement at the site

In 2008, the Port Heiden Tribal Council petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate potential health impacts of contaminants released from past Army and Air Forces activities [NCPH 2008]. The petition expressed concern about cancer, ear and skin infections, and upper respiratory conditions including asthma. It also discussed contaminants including various petroleum products, lead battery waste, solvents, polychlorinated biphenyls, asbestos, pesticides, and over 2,000 drums with unknown contents left in the landfill along the beach. Contamination of the following subsistence foods were a concern: clams, ducks, shrimp, fish, beach greens, tundra tea, fireweed, moose, porcupine, rabbits, sea gull, and eagles. Vapor intrusion was also a concern.

ATSDR worked with the Port Heiden Tribal Council, the Alaska Department of Environmental Conservation (ADEC), and the Department of Defense to respond to outstanding concerns from the Tribal Council's 2008 petition. Since then, ATSDR reviewed reports from the military remedial investigations, landfill inspections, and other supporting documents to gather data and information about other chemicals at the site. In particular, ATSDR identified over 900 "use areas" (small red points in Figure 2) where the military may have potentially left contamination. Examples of activities at these use areas range from airfield activities to munition bunkers to pipeline activities to leftover buried materials.

Figure 2. Port Heiden, Alaska Site Overview Map*



Geospatial Research, Analysis & Services Program
PRJ ID 04744 | AUTHOR: N. Dutton

* An interactive and customizable version of this map (which can be used with Google Earth) will be made available to the Tribal Environmental Office. This map only includes some of the areas that may pose hazards. Many areas were not thoroughly tested, and ATSDR could not include all areas from the large volume of historical documents.

ATSDR's previous responses on the site:

ATSDR Letter to the Native Council of Port Heiden. Jun 18, 2008 [ATSDR 2008]

The letter responded to the March 24, 2008 petition letter. The letter stated the intent of ATSDR to perform a public health assessment. ATSDR also enclosed a copy of "Tribal Exposures to Environmental Contaminants in Plants" and stated that some concerns were beyond the scope of ATSDR's authorities.

ATSDR Technical Assistance Provided to the Native Village of Port Heiden. 2008.

ATSDR provided health education materials to the environmental director and a health aide during a 2008 site visit. The material included information about susceptibility to asthma attacks from breathing cold air.

*ATSDR letter to Stakeholder*s. Jan 14, 2010. [ATSDR 2010a]

The letter provided technical assistance describing ATSDR's data needs for evaluating the drinking water and vapor intrusion pathways at Port Heiden.

Public Health Consultation: Potential Exposure to Asbestos in Clams, Port Heiden, Alaska. May 14, 2014 [ATSDR 2014a]
https://www.atsdr.cdc.gov/HAC/pha/PotentialExposuretoAsbestos/Revisons%202_20_2014Public%20Health%20Consultation%20Port%20Heiden%20Clams%20FN3%205_201.pdf

ATSDR concluded that the benefits of eating clams outweighed any risks from consuming asbestos present in some clams. ATSDR recommended collecting clams in beds other than near the Old Meshik landfill or military use areas, checking the clams for any signs of unusual odor or damage, and cooking them thoroughly before eating. ATSDR recommended developing a shellfish monitoring program. Current information regarding chemicals or asbestos in clams is not available.

Public Health Consultation: Evaluation of PCBs Associated with the Former Radio Relay Station Area, Port Heiden, Alaska. September 18, 2014 [ATSDR 2014b]
https://www.atsdr.cdc.gov/HAC/pha/PortHeiden/Port%20Heiden%20AK%20_PCBs_HC_09-18-2014_508.pdf

ATSDR found that site-related exposures from PCBs were not expected to cause health effects. However, to reduce exposures, we recommended against collecting berries near the Radio Relay Station area and eating berries and plants grown in places away from historical use areas. ATSDR supported the planned removal of PCB-contaminated soils. ATSDR recommended sampling of marine subsistence foods for PCBs.

The sections below provide a guide to how people may be exposed, an overview of the data that ATSDR reviewed, and a summary of the main concerns for exposures and public health. This health consultation, combined with the prior health consultations, completes the public health assessment process from the 2008 petition. ATSDR will consider additional data review and health assessment upon request.

Exposure Overview

In this health consultation, ATSDR evaluated how physical hazards and chemical contamination could affect the health of individuals. Methods established by ATSDR were used to evaluate how chemical exposures could affect the health of people based on their activities now or in the future [ATSDR 2005]. As an initial screen, the water, and soil sampling data for Port Heiden were compared to ATSDR's comparison values to determine if any chemicals were present at levels of potential concern to public health. Comparison values are ATSDR's health-based screening levels. If a chemical was found to have a concentration above the comparison value, ATSDR further evaluated whether people may have sufficient contact to the chemical to cause health problems. If a chemical did not have a comparison value then ATSDR further evaluated the exposure. The exposure pathways assessed for Port Heiden are summarized in Table 2. Appendix A presents figures that illustrate potential exposure pathways.

Table 2. How people could be exposed to physical and chemical hazards at Port Heiden.

Who?	Doing what?	Where/When?	Health risk[3]
People who spend time outdoors	Touching beach sediment/soil or surface water contamination while fishing or recreating on the coast	Coastal areas: Old Village Landfill, Marine Terminal and Drum Storage Areas Now and in the future	**Physical hazards likely present** Chemical hazards unknown
People who spend time outdoors	Accidentally touching contamination while hunting, gathering, or recreating	Historical use areas inland Now and in the future when there is no snow or ice cover	**Physical hazards likely present** Chemical hazards unknown
Children and teachers who spend time at Meshik School	Drinking water	Meshik School Now and in the future	**Chemicals found in water**
Children and teachers who spend time at Meshik School and people who spend time in residences and community buildings	Breathing air	Meshik School and some residences Now and in the future	Vapor intrusion exposure is unknown
People who spend time in residences and community buildings	Drinking water	Residences and Community Buildings near former military use areas Now and in the future	Levels of chemicals found in water are unknowm
People who spend time outdoors	Touching soil while recreating, hunting, gathering, or fishing	Inland landfills and former large and small military areas with historical use Now and in the future when no snow or ice cover	Chemical hazards at these locations are unknown
People who eat customary and traditional subsistence foods	Eating foods obtained by subsistence hunting, gathering, or fishing	Site-wide Now and in the future	Chemical hazards in animals and plants living throughout the area is unknown

[3] See Data Review section of this document and the supplementary document [ATSDR 2019] for more detailed discussion of the potential physical and chemical hazards.

Data Review

As part of our environmental health consultation process, we review U.S. Environmental Protection Agency (EPA) and other agency's data and evaluate it to find out which chemicals could harm people's health. For those chemicals, we estimate the amount of contact people could have (the dose) with the chemical at the site. Then we compare that dose with the health effects levels from scientific studies.

Physical Hazard Information

ATSDR reviewed information on places where potential physical hazards may remain from past military uses. Sources of this information included: the Air Force, Army, ADEC, National Oceanic and Atmospheric Administration (NOAA), and Lake and Peninsula Borough. ATSDR identified historical landfills and other areas in particular that may contain physical hazards if exposed. In the records, ATSDR found over 900 areas used in the past in ways that may have left physical hazards behind. Unidentified areas may also have physical hazards. The physical hazards can result from a wide range of debris, refuse, and former building materials (including asbestos-containing materials).

Key Results

Physical hazards such as old scrap metal, wood, batteries, drums, munitions, medical waste, and asbestos-containing material may continue to surface at landfills and historical use areas. Proper handling, removal, and disposal are key to preventing hazardous outcomes.

Note: The nature and extent of site-wide hazards are difficult to characterize for such a large and historically complex site. While many physical hazards were found and removed, others may remain to be discovered.

What is a physical hazard?

A physical hazard is one in which a person may be harmed by physical (instead of chemical) means. Examples include

- Cuts or scrapes from sharp debris
- Blunt trauma from an unstable falling object
- Broken bones or sprains from tripping over objects
- Breathing dangerous asbestos fibers
- Burns from fires or explosions

A wide variety of materials from landfills and waste areas across Port Heiden may cause physical hazards if wastes become exposed. The Army performed maintenance in 2012 on inland landfill A that previously lacked adequate vegetation cover and warning signs [USAF 1996, 2006; ADEC 2016b,c; USACE 2005, 2012c; Colton 2015; NOAA 2007]. Appendix B contains more detailed descriptions of the landfills and waste areas. The inland landfills contain items such as scrap metal, wood, paint, drums, barrels, and abandoned vehicles.

The coastal area near the old village landfill, tank farm, and drum cache had a wide variety of exposed items from erosion in 2007 (Figure 3). The items included building materials, septic tanks, metal scraps, medical waste, and asbestos-containing materials and more eroding into the ocean [Iliaska 2008; NOAA 2007; USAF 2006; USACE 2007a,b]. While not representative of current conditions, the figure demonstrates the types of historical waste released at the site.

Figure 3. Previously Eroded Material from the Old Meshik Village Landfill, Port Heiden, Alaska [ADEC 2012] Note: Not representative of current conditions.

The Port Heiden community cleaned up a **village "boneyard"** of scrap metal and debris located south of the air strip (Figure 4) [ADEC 2014].

The Radio Relay Station (RRS) area, north of the Port Heiden Airport, contained remnants of the military facilities, operations, and decommissioning. Debris burial sites, lagoons, equipment, and soil and groundwater contamination were present in the Radio Relay Station area. The USAF is remediating the Radio Relay Station area [USAF 2016a].

Site-wide remedial investigation by the Army evaluated potential metallic debris at former military use areas such as former administrative, housing, and military operations structures; antennae, storage, trench, transformer, dump, burn, and spill sites; and mounded material areas (Figure 5). The Army recently identified mounded material near commercial buildings of the village for further investigation due its close proximity to villagers and greater potential for exposure [USACE 2016] (Figure 6). Other areas may be addressed as physical hazards are identified.

Figure 4. Prior Bone Yard Refuse that was Cleaned Up by the Village [ADEC 2012] Note: Not representative of current conditions.

ATSDR worked with the military to develop map files that show over 900 features of past military activities (Appendix C). These maps can be used by the Tribal Environmental Office to identify known and suspected past use areas and communicate hazards with villagers and visitors. Each location marked on the map is linked to a description and information about the historical use of that area.

Figure 5. Site-wide Areas with Subsurface Metals or Metallic Debris [USACE 2016]

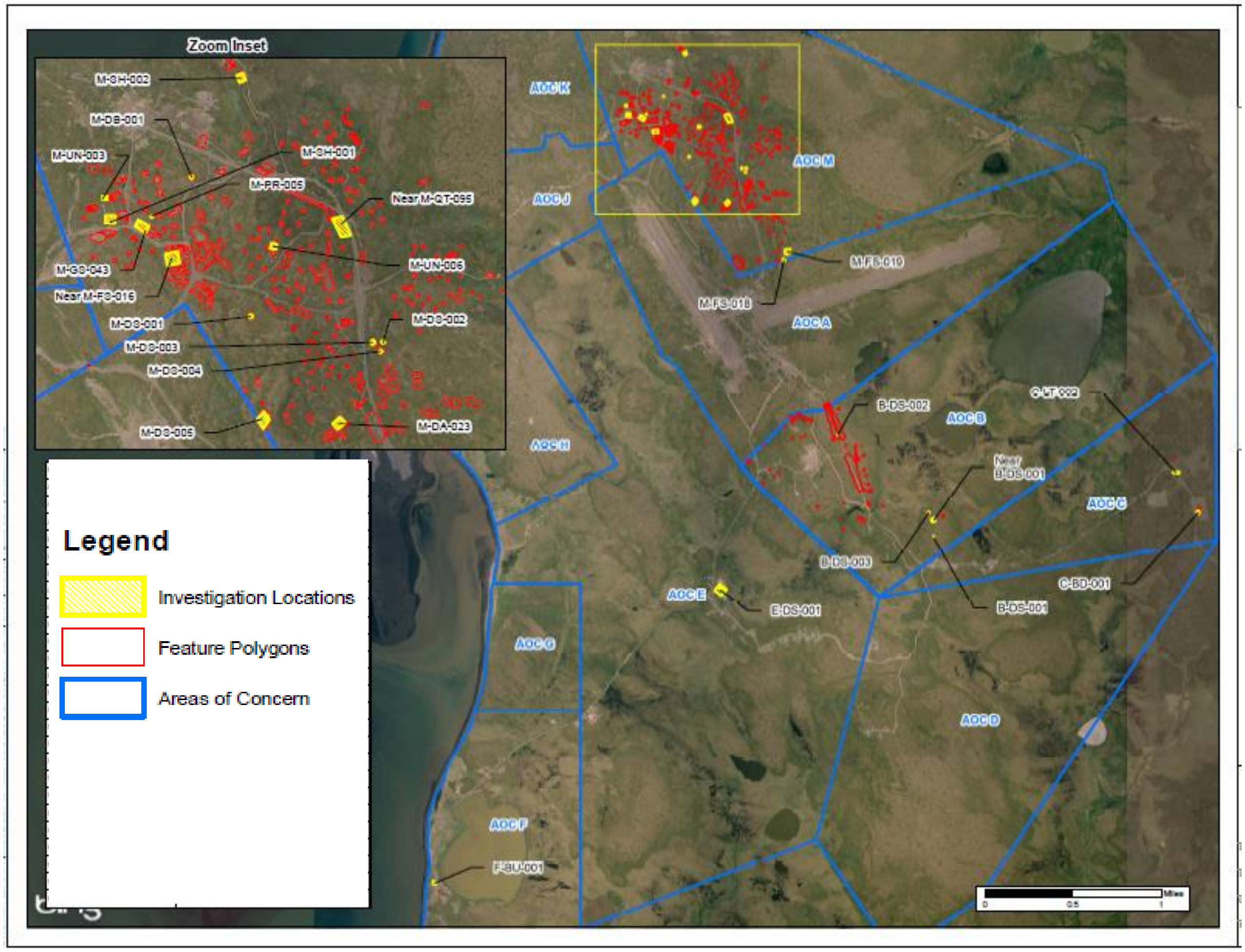
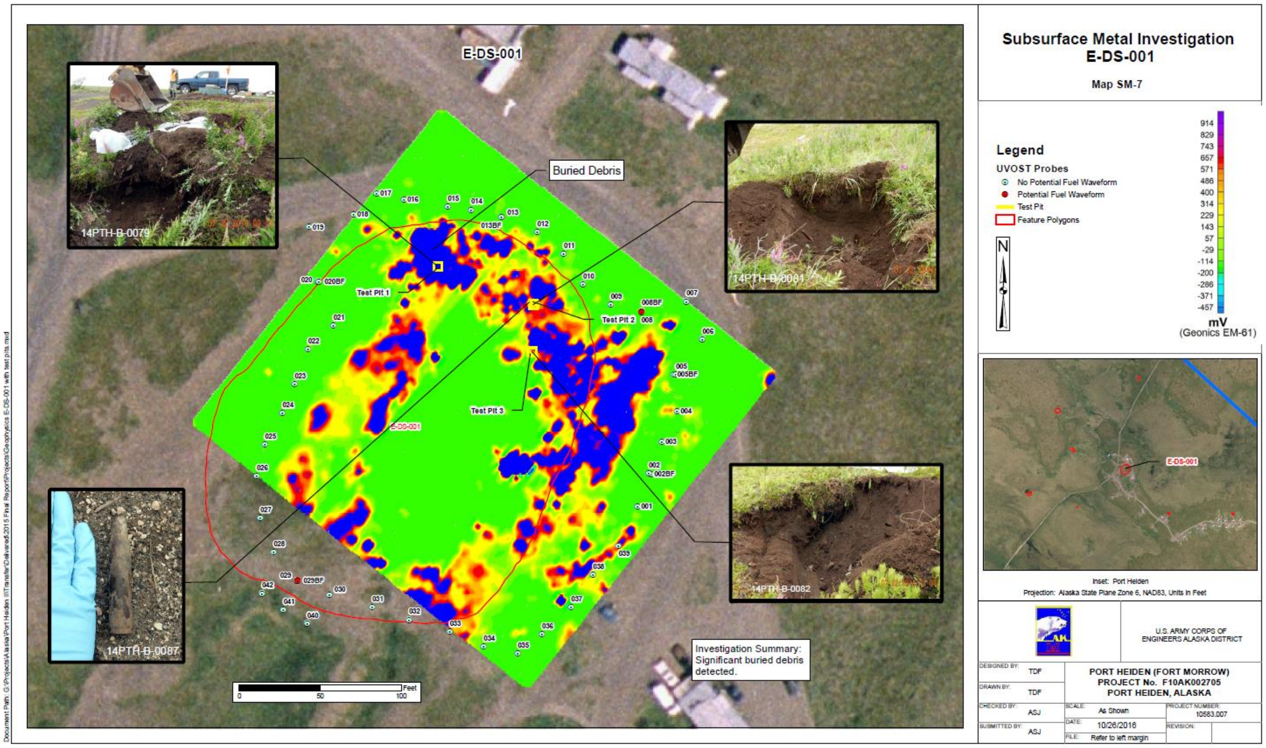


Figure 6. Subsurface Metal Investigation Near Commercial Buildings in Area of Concern E [USACE 2016]



Meshik School Drinking Water Data

The school district regularly tests the Meshik School's water for inorganics, organics, nitrates, and coliform [ADEC 2017a]. In addition, the Air Force tested the Meshik School tap water in 2003 because it was located near a pipeline petroleum spill and old drum storage areas [Keres 2003]. The school well is 202 feet deep and draws from the secondary aquifer. Regular testing does not include some of the petroleum-related contaminants, but the petroleum plume is not likely to reach the school well because it is so deep. Currently, the Meshik School's tap water meets EPA's legally enforceable maximum contaminant levels (MCLs) for arsenic [EPA 2017a]. The water is treated using a combination of permanganate, greensand, and cartridge filtration. Regular maintenance of the treatment system is necessary to maintain the water quality.

Key Results

Drinking water data findings

- Heavy metals, pH, and color criteria of EPA were not met in some samples.
- Adjustment of the treatment system in 2016 appears to have improved the tap water quality.

In the past, heavy metals were detected greater than EPA's enforceable maximum contaminant levels (MCLs) in the tap water. Some metals were at levels higher than ATSDR's health-based comparison values. While not enforceable, ATSDR's levels are used in the process of public health assessment and to guide recommendations to protect public health.

Figure 7 shows trends of heavy metals detected greater than the EPA MCL and action level and the ATSDR comparison value.

Arsenic commonly leaches from soil and rock into groundwater. Arsenic is naturally occurring in volcanic areas and often associated with high iron levels [USGS 1999]. Arsenic can be found in wells throughout Alaska due to the geology [USGS 2001, ADHSS 2016]. Commercially, arsenic has been used as a wood preservative; an alloy in ammunition and solder; a pesticide, herbicide, medicine, and animal feed; and to strengthen lead-acid storage battery grids [ATSDR 2007a]. In the site-wide analysis, arsenic did not appear to be associated with any specific feature type, except possibly mounded material features [USACE 2016].

Arsenic concentrations varied over time and ranged from 1.4–13.0 micrograms per liter (µg /L) (Figure 7a). Concentrations were greater than EPA's MCL (10 µg/L) in 5 of 19 samples since 1998. With the measured increase in arsenic levels in the past few years, the Lake and Peninsula School District changed the filters in 2016 and levels have decreased below EPA's MCL [LPSD 2017]. These levels are higher than ATSDR's health-based non-cancer chronic[4] comparison value of 2.1 µg/L and cancer comparison value of 0.016 µg/L. Since the levels are greater than comparison values, ATSDR evaluated how much arsenic people will come into contact with in the following pages.

The arsenic concentrations in the Meshik School water appeared to be greatest between 2012 and early 2016, before the treatment system was adjusted. However, no data was available between 2004 and 2012. The concentration dropped to its lowest after the treatment system was adjusted in 2016, but concentrations steadily rose and appear to be approaching the EPA's MCL (shown by the black arrow in Figure 7a). This indicates that regular maintenance of the treatment system is needed.

[4] ATSDR uses "chronic" to describe exposures lasting more than one year. "Intermediate" refers to exposures lasting between one year and two weeks, and "acute" refers to exposures less than two weeks.

Figure 7: Meshik School Drinking Water Data [ADEC 2017a]

Figure 7a. Meshik School Arsenic Trends (1998-2017)

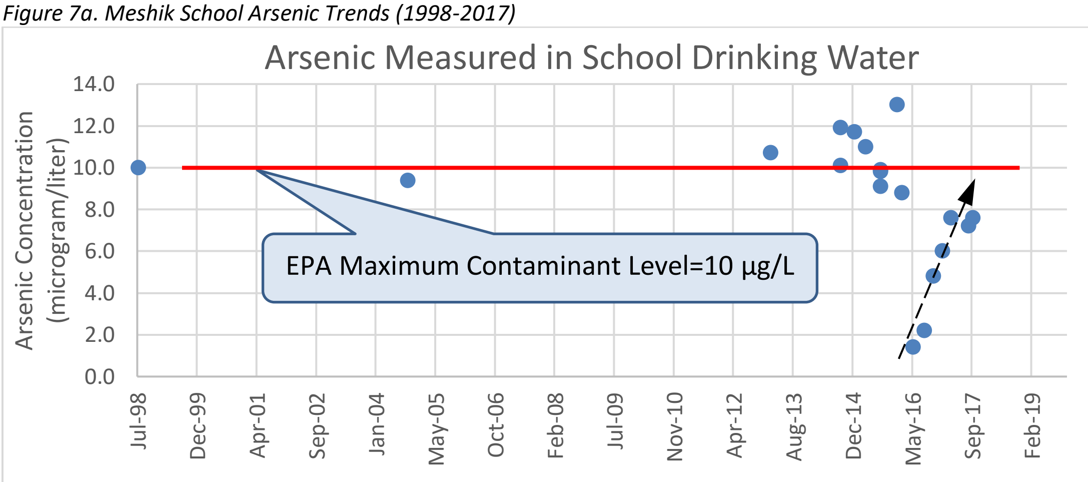


Figure 7b. Meshik School Copper Trends (1993-2016)

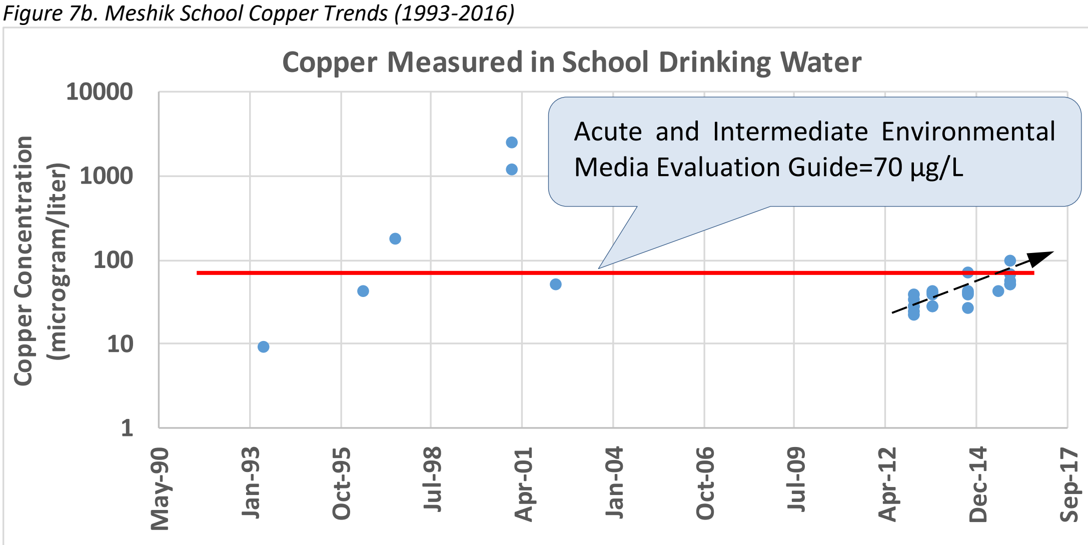
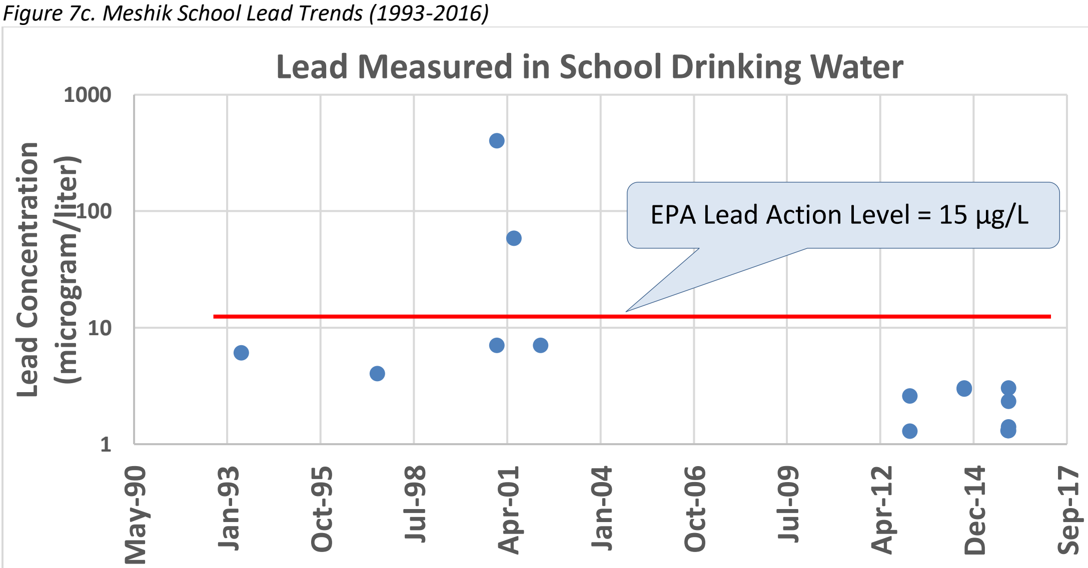


Figure 7c. Meshik School Lead Trends (1993-2016)



Minimizing arsenic exposure may decrease the likelihood of the most common arsenic-related cancer (lung, bladder, and skin) and non-cancer effects (skin lesions) [ATSDR 2007a]. ATSDR estimated that drinking school water may result in an average of around 7 extra cancer cases if 1,000,000 students were exposed and 2 extra cancer cases if 100,000 teachers were exposed. The average arsenic doses estimated for drinking school water (0.000027 mg/kg-day for students and 0.000034 mg/kg-day for the teacher) were less than those showing effects in the most sensitive study of ATSDR's toxicological profile (0.0012 mg/kg-day) [ATSDR 2007a]. The sensitive study found increased pre-cancerous darkening of the skin called melanosis and thickening of the skin on the palms of the hand and soles of the feet in people drinking water with naturally occurring arsenic in Bangladesh [Ahsan 2006].

- **Copper** enters drinking water primarily through corrosion in plumbing and erosion of natural deposits [EPA 2017a]. Copper was detected at 176.5 µg/L in 1997 and 2,524 µg/L the next time it was measured in 2001 (Figure 7b). The EPA's maximum contaminant level is 1,300 µg/L. Five (177, 1200, 2524, 71, and 100 µg/L) out of twenty eight results were greater than ATSDR's acute and intermediate non-cancer comparison value of 70 µg/L [ATSDR 2004] between 1993 and 2016. The black arrow in Figure 7b shows the concentrations are increased from 2013 to 2016. ATSDR did not have access to copper data following the adjustment of the treatment system in 2016.
  The study showing the lowest observable effect level in ATSDR's toxicological profile found people were nauseated after drinking 200 milliliters with 4,000 µg/L of copper following an overnight fast [Olivares 2001]. Since the next lowest level tested had 2,000 µg/L and most people at Port Heiden drink more than 200 milliliters, it's possible that people drinking the higher levels of copper detected at the Meshik School (around 2,524 µg/L) were nauseated from the copper. People with rare conditions that prevent them from metabolizing copper (such as Wilson's disease) may experience liver effects [ATSDR 2004] and should consult their physician about concerns for continued presence of copper in their drinking water at Port Heiden. People who experience frequent nausea may wish to talk to and share this health consultation with their personal physician due to the recent levels approaching acute effect levels.

- **Lead** enters drinking water primarily through corrosion in plumbing and erosion of natural deposits [EPA 2017a]. Lead concentrations exceeded EPA's action level of 15 µg/L, with sample results of 398 µg/L and 7 µg/L in January 2001 and 58 µg/L in July 2001, but were otherwise less than EPA's action level when measured (Figure 7c). Data is not available from 1997 to 2001 or 2002 to 2013, nor is the location of the tap sampled within the Meshik School known. The cause of the increased concentrations is unknown. ATSDR cannot estimate the blood lead levels of people who occupied Meshik School and consumed the water from 1997 to 2001 or 2002 to 2016.
  Lead has no known safe exposure level [CDC 2012]. Increased exposure to lead in children and adults could have increased risks for health effects to the nervous system, brain, kidneys, and reproductive systems; caused weakness and anemia; or increased blood pressure [ATSDR 2007b]. Children's brains are particularly susceptible to lead's effects on learning and behavior. ATSDR recommends minimizing exposure to lead as much as possible. The most recent data

show concentrations in the water are below EPA's action level. ATSDR did not have access to lead data following the adjustment of the treatment system in 2016.

- The tap water **pH** ranged from 6.3 in 2004 to 9.1 in 2015 (Table D.1). EPA's secondary maximum contaminant level range is 6.5 to 8.5. EPA's secondary levels are non-enforceable. Low pH may result in a bitter metallic taste and corrosion of pipes. High pH may be associated with dissolution and mobility of arsenic in reducing conditions [USGS 1999]. High pH may cause a slippery feel or soda taste to tap water. Fluctuations of pH in tap water may occur as a result of natural changes in the aquifer or the treatment system. Bulk soil pH of petroleum contaminated soils may be lower than similar but uncontaminated soils [Aislabie 2004].
- In 2015, the **color** indicator was up to 90 (greater than EPA's secondary MCL of 15). All the more recent samples ATSDR reviewed were less than EPA's limit.

ADEC found the overall vulnerability of the Meshik School's drinking water aquifer to volatile organic chemical and petroleum contamination to be high [ADEC 2017a]. ATSDR cannot determine the source of contaminants, if they show up in the well, with the available information. Changes in water quality parameters, such as pH or the presence of other chemicals, can influence the leaching of metals, such as copper, lead or arsenic into water. Petroleum biodegradation can make groundwater more acidic, which may affect inorganic chemical solubilities. A study at a hydrocarbon spill site in Minnesota found arsenic within a hydrocarbon-contaminated plume at 230 µg/L whereas background was 5 µg/L [Cozzarelli 2016]. The school drinking water aquifer is currently much deeper than the spill's position as vertically delineated by only one well. The large distance between the spill and the drinking water aquifer appear to make the connection unlikely [ADEC 2018c]. The school tap water is just tracked for those petroleum analytes required under the safe drinking water act. The spill threat could be better determined by either: (1) sampling and analysis for aliphatic and aromatic fractions of total petroleum hydrocarbons, polar metabolites, naphthalene, and methyl tert-butyl ether or (2) performing vertical and horizontal delineation of contamination from the nearby pipeline spill would be needed to confirm. Petroleum fractions, polar metabolites, naphthalene, and methyl tert-butyl ether are not monitored under the safe drinking water act. The school water treatment system may remove petroleum-related contaminants, but efficiency would depend on the system specifications and maintenance.

Residential and Community Well Water Data

In 2003, Keres Environmental sampled 42 private water wells in Port Heiden under the Native American Lands Environmental Mitigation Program and the USACE Pacific Ocean Alaska district [Keres 2003]. Samples were not collected for ten additional wells because they were not accessible or not functional. Keres sampled two drinking water wells at the airport,[5] two wells near the Meshik School, and one well at the Meshik School. The residential wells screened from 40 to 110 feet deep drew from the one primary aquifer in the area. Static water levels ranged from 8 to 22 feet deep.

ATSDR cannot make a current health determination based on samples collected so far in the past. However, several chemicals present in the 2003 samples that exceeded ATSDR's comparison values are noted below.

Key Result

The testing found several chemicals and mixtures greater than screening values. A table summarizing the testing results is provided in Table D.2.

Note: The Alaska Drinking Water Program recommends annual testing of private drinking water wells by the well owners. More frequent testing is encouraged if there are indicators of poor water quality.

Arsenic concentrations ranged from non-detect to 8.7 µg/L in residences and 2.1 to 8.2 µg/L in public or commercial buildings. Twenty five of the 47 water samples were above the ATSDR's health-based non-cancer chronic comparison value of 2.1 µg/L and cancer comparison value of 0.016 µg/L. All samples were below the current EPA MCL of 10 µg/L. ATSDR estimated that residents drinking their well water may result in around 6 extra cancer cases if 100,000 children were exposed and 2 extra cancer cases if 10,000 adults were exposed. The average arsenic doses estimated for residents drinking their well water ranged from 0.000094 to 0.00056 mg/kg-day (Table A2 of ATSDR's supplemental document [ATSDR 2019]). These doses were less than those showing skin effects in the most sensitive study of ATSDR's toxicological profile (0.0012 mg/kg-day) [ATSDR 2007a].

Cadmium was detected at 1.2 µg/L in one residential well. This was greater than ATSDR's chronic non-cancer comparison value of 0.7 µg/L. Toxicology studies found low risk of kidney and bone density effects from levels three times greater than the comparison value. The detected level in the Port Heiden well is less than three times the comparison value, so it is not likely to cause health effects. [ATSDR 2012a].

Copper was detected in three residential wells at 86.2 µg/L, 82.4 µg/L, and 124 µg/L. They were greater than the intermediate and acute non-cancer comparison value of 70 µg/L, but below the EPA MCL of 1,300 µg/L. Toxicology studies found nausea, vomiting, and diarrhea did not occur from drinking water with copper three times greater than the comparison value. The detected

[5] Though airport well water samples were collected in 2003, this source is not used daily for drinking.

levels in the Port Heiden wells were less than three times the comparison value, so they are not likely to cause health effects in most people. People with rare conditions that prevent them from metabolizing copper (such as Wilson's disease) may experience liver effects and should consult their physician about concerns for copper in their drinking water at Port Heiden [ATSDR 2004].

Iron was greater than the 300 µg/L EPA secondary MCL in 27 of the 42 domestic wells sampled. The tests found up to 7,220 µg/L in residences, up to 3,180 µg/L at the airport, up to 16,400 µg/L in a currently unoccupied building near the Meshik School, and 495 µg/L at the Meshik School. Water greater than the secondary MCL has a bad taste (metallic) and may stain clothes or dishes after washing [EPA 2016]. EPA's provisional toxicity value is 14,000 µg/L, based on reversible gastrointestinal effects (obstipation, i.e. severe constipation) that are not considered to present a serious risk to human health [EPA 2017b]. The toxicity value was based on a study of iron supplementation for one month in 48 blood donors and found people experienced constipation, nausea, abdominal pain, or diarrhea at a dose (21,000 µg/L) about 1.5 times greater than the EPA value [Frykman 1994]. People with rare conditions that cause them to absorb too much iron, prevent their red blood cells from incorporating the iron into hemoglobin, or receive frequent blood transfusions may experience iron overload. This condition could affect their liver, heart, endocrine glands, or pancreas. People with conditions that cause iron overloading and people experiencing frequent nausea, vomiting, or diarrhea should consult their physician about concerns for iron in their drinking water at Port Heiden and provide this health consultation.

1,2-dichloroethane was detected in drinking water in a currently unoccupied building near the Meshik School at 0.7 µg/L, which is slightly above ATSDR's cancer screening value of 0.27 µg/L. Drinking this water daily could have presented a very low risk of a type of blood vessel cancer called hemangiosarcoma [EPA 1987]. The well for this location is 107 feet deep and lies north of an old drum storage area. However, adequate data is unavailable to determine if the drum storage area was the source [Keres 2003]. EPA's enforceable MCL for 1,2-dichloroethane is 5 µg/L [EPA 2017a].

Manganese was not included in the analysis of residential drinking water samples in 2003. The old village wells had manganese up to 1,200 µg/L [USGS 1995]. ATSDR's comparison value is 350 µg/L. Drinking water with large amounts of manganese can lead to neurological effects in children [ATSDR 2012b].

Petroleum (diesel range organic, DRO) was detected in one residential well at 438 µg/L [Keres 2003]. Surrounding wells closer to the former pipeline were not sampled. The Keres report recommended retesting this well and follow-up investigation, as needed but ATSDR did not identify any more data.

No federally established regulatory limits or comparison values for diesel range organic exist. The ADEC cleanup level for diesel range organic in groundwater using default assumptions is 1,500 µg/L [ADEC 2018a]. Because a

Diesel range organics (DRO) are a family of chemicals that make up diesel fuel. Because there are so many different chemicals in DRO, it is not practical to measure each one separately. So scientists have developed ways to measure DRO as a group of chemicals with similar properties to diesel in soil and water. Naphthalene is one of the chemicals often found in DRO.

full characterization of the individual constituents of diesel range organic at the site is not available, ATSDR used the conservative Minnesota and EPA total petroleum hydrocarbon (TPH) health-based screening level of 200 µg/L, which is based on pyrene toxicity to the kidneys from long-term exposure as a surrogate [MDH 2016] and provisional toxicity criteria for the aromatic medium weight fraction of petroleum [EPA 2016; ATSDR 2010b]. The lack of specific petroleum aliphatic and aromatic hydrocarbon fraction data limits our ability to assess potential resulting health effects from exposure. Follow-up analysis of the diesel range organic-containing well and other untested wells nearby is needed to aid the assessment of health risks associated with Port Heiden well water.

Site-wide Soil, Surface Water, and Groundwater Data

ATSDR compiled sampling data that the Air Force and Army collected from areas where people are most likely to contact contamination.

Direct exposure to chemicals could occur in soil and surface water. People may contact groundwater contamination if it discharges to the surface or if a well becomes contaminated.

Site conditions likely change over time from erosion, leaching, or other fate and transport methods. Releases from degenerating containers could also result in exposures. ATSDR provides a brief summary and overview of the data below.

Large complex sites with heterogeneous properties like this 21 square mile area of Port Heiden are difficult to fully characterize.

This section highlights the main areas and chemicals found.

- People who spend time outdoors contacting soil or surface water should maintain awareness of potential chemical hazards.
- ATSDR is providing mapping (GIS) files and a map (Figure 2) that shows where people should be aware of potential hazards and use caution to avoid injury or chemical exposures.

Key Results

The Air Force's 2004 and Army's 2012 and 2016 remedial investigations found that some inorganic and organic chemicals exceeded screening criteria in various locations near the areas of main activities (Appendix D) [USAF 2006]**.** The Army began a remedial investigation and performed incidental removals of surface soil based on field screening for petroleum and lead in 2012 [USACE 2012a,b; 2013a,b,c,d; 2014; 2015; 2016]. The following is an overview of the findings from these studies.

Note: Air Force and Army incidental removals of surface contamination decreased the likelihood of exposure. However, review of historical records and aerial photos may not have identified all contamination from the decades of military activity. Contamination could remain across the site and may become exposed by site changes. Characterization may not be sufficient to identify and predict all such potential hazards.

Focused areas:

The North Landfill and Radio Relay Station area groundwater contained petroleum at high concentrations including diesel range organic (15,600,000 µg/L) and other petroleum residual range organics (1,890,000 µg/L). Chlorinated solvents such as trichloroethylene (690 µg/L) and its breakdown products were measured in groundwater at the drum storage area within the North Landfill. Groundwater is not currently in use and use is not planned for the future in the North Landfill and Radio Relay Station areas [USAF 2009].

ATSDR reviewed the cleanup levels for select organic chemicals in soil at the Radio Relay Station (Table D.3). The cleanup levels for soil and groundwater do not exceed ATSDR's non-cancer comparison values or EPA maximum contaminant levels, and they are within EPA's cancer risk management range. Intermittent contact with these chemicals in soil after the cleanup of the North Landfill is permitted by ADEC and is not expected to cause health effects if properly maintained.

Landfills A and B were created in 1990-1992 from the construction and demolition project for site restoration. Construction and demolition generally includes lead-based paint, asbestos, mercury, chlorofluorocarbons, polychlorinated biphenyls, and chemicals such as found in paints, cleaning substances, and pesticides [ADEC 2018b].

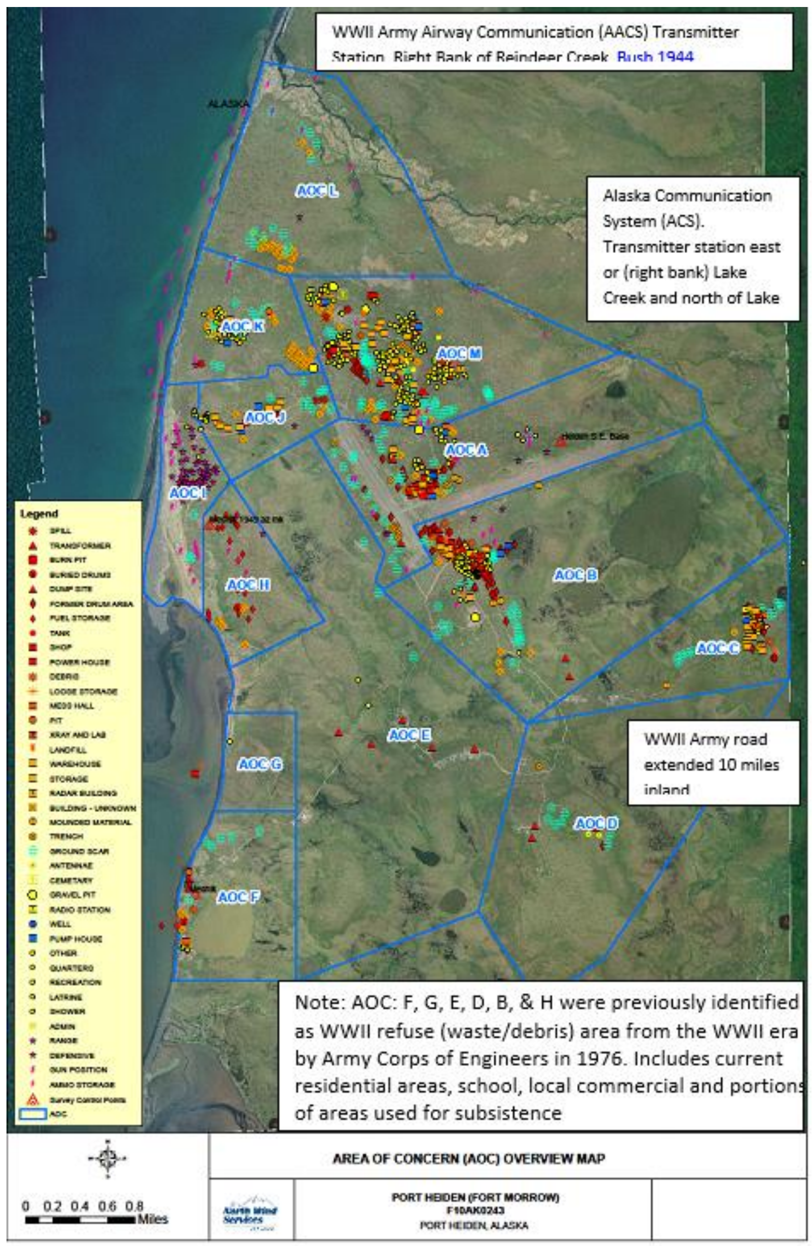
Landfill A contains asbestos, asphalt, scrap metal, wood, paint, and empty barrels, and soil with limited polychlorinated biphenyls (<10 mg/kg) and petroleum (<5,000 mg/kg). The vegetative cover was not well-maintained in the past and no warning signs were visible to visitors [USAF 1996, 2006; USACE 2005; ADEC 2016b]. In 2012 the Army added (1) clean fill and vegetation to control erosion and stabilize the soil on the cap, and (2) new asbestos caution signs [USACE 2012c]. The Alaska Department of Environmental Conservation found the Army's response to meet the permit requirements satisfactory and stated yearly visual monitoring reports should continue [ADEC 2013a]. No surface, or groundwater data are available to determine if landfill-related contamination was released before the landfill maintenance [USACE 2012c].

Landfill B contains construction debris, crushed barrels, abandoned vehicles, drums, and petroleum-contaminated soil. Efforts were made to control contamination put into the landfill, such as draining the oil from vehicles before disposal [ADEC 2016c]. The vegetative cover has been maintained and signs still prohibit entry [USAF 1996, 2006; USACE 2005; ADEC 2016c]. No soil, surface, or groundwater data are available within 1,000 feet of Landfill B to confirm that landfill-related contamination was not released in the past [USACE 2012c]. Residences are about 1,000 feet from Landfill B.

ATDSR did not identify any soil, surface water, or groundwater chemical sampling data from the Former Port Heiden Municipal Landfill, Current municipal landfill, or Village Boneyard. Potential for contaminant exposure from the landfills depends on the contents and maintenance and management of the landfill caps. ATSDR is not aware of the nature of potential contamination from the Village Boneyard and does not have any written reports to describe the village-led removal. The Alaska Department of Environmental Conservation does not require chemical sampling of the surfaces, groundwater, or surrounding areas of these landfills.

Petroleum products were detected in soil, groundwater, and surface water samples near the marine terminal area, old village and the nearby former pipeline in 2004 (Appendix D. Tables D.5, D.6, and D.7). Wells in the old village are no longer used and exact locations were unavailable. Some elevated concentrations of metals (arsenic, iron, and manganese) were also detected. These could be due to natural or site-related sources. Chlorinated solvents were not analyzed for in any of these samples. Sampling and analysis from a monitoring well near the Port Heiden Airport detected diesel range organic up to 12,000 µg/L (Table D.7). More detailed description of potentially contaminated areas and related exposure pathways is provided in Appendix B and section 2.2 of the health consultation supplemental material [ATSDR 2019].

Figure 8. U.S. Army-identified Areas of Concern, Port Heiden, Alaska [USACE 2012b, 2013c, Bush 1944]



Site-wide Areas of Concern:

ATSDR reviewed data for 18 areas where the Air Force tested soil and groundwater in 2004 (Tables D.8 and D.9). Solvents, petroleum, pesticides, polycyclic aromatic hydrocarbons, and metals exceeded comparison values.

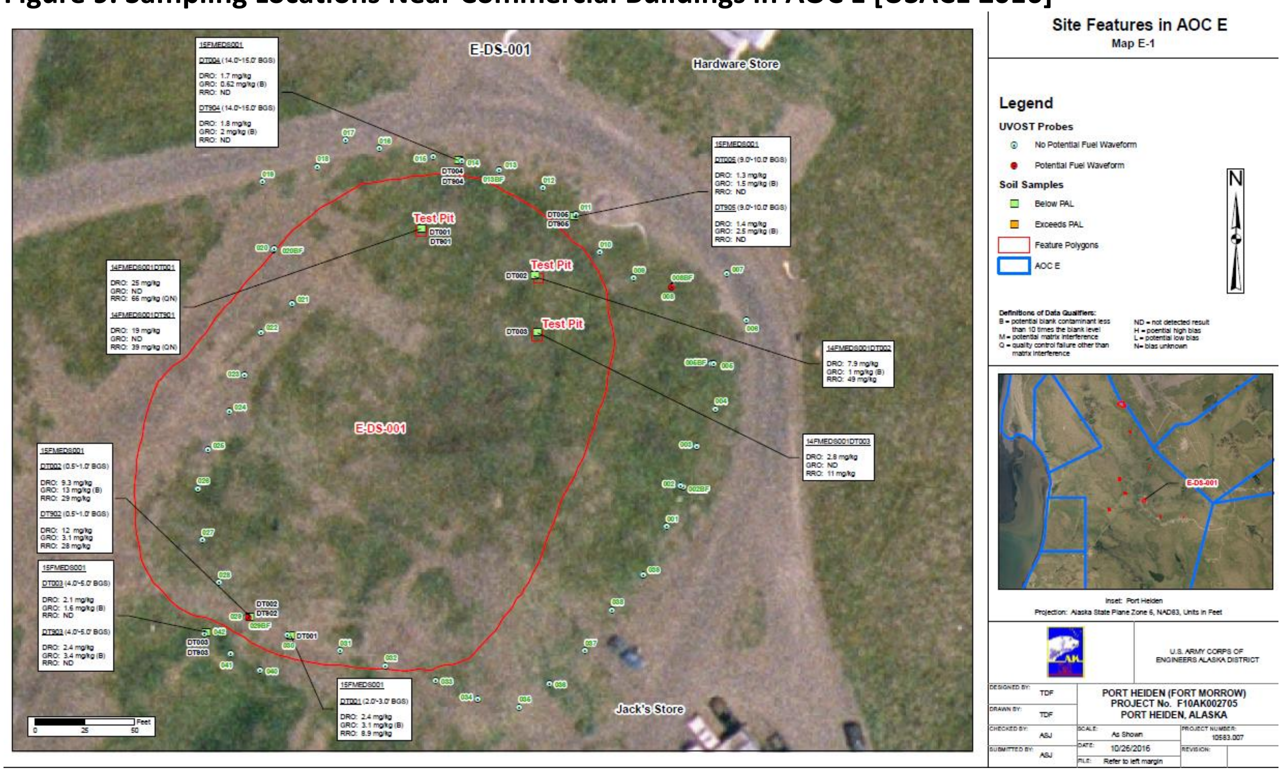
The Army's remedial investigation that began in 2012 identified 13 Areas of Concern (AOCs) (**Figure 8**). A portion of these AOCs were screened for petroleum, lead, and radiation using field techniques. Some areas were tested for volatile chemicals, pesticides, dioxins, and metals (see Figure 2.1 of the supplemental material to this health consultation [ATSDR 2019]) [USACE 2013e, 2016]. Appendix D, Tables D.10 and D.11 show that petroleum and metals were greater than ATSDR's comparison values for soil and groundwater [USACE 2012b, 2013a, 2014; USAF 2006]. ATSDR wishes to draw particular attention to the potential for lead contamination. The army detected lead up to 4,300 milligrams per kilogram (mg/kg) in soils in the site-wide testing

[USACE 2013a]. During the 2016 work, the USACE removed and disposed of the 4,300 mg/kg lead contaminated soil northwest of the airport, but some contamination remains [USACE 2016]. Potential lead sources include leaded fuel, lead-acid batteries, and lead-based paint. EPA's action level is 400 mg/kg for lead.

Buried debris from test pits near commercial buildings in AOC E [Figure 9] appeared to be construction debris and could have been left by the military or others [USACE 2016]. Village elders remember seeing vehicles, batteries, scrap metal, drums, and household trash in the landfill and expressed concern about five drinking water wells nearby [ADEC 2016e]. Soil screening here did not include x-ray fluorescence screening for lead [USACE 2016]. Measured soil levels of diesel range organics were 25 mg/kg, gasoline range organics were 13 mg/kg, and residual range organics were 49 mg/kg were less than ADEC's cleanup levels but greater than EPA's range of low and medium total petroleum hydrocarbon regional screening levels for migration to groundwater (0.017 – 8.8 mg/kg). One test pit near the commercial buildings in AOC E showed soil arsenic (25 mg/kg) and chromium (35 mg/kg) greater than Alaska project action levels (PALs: arsenic= 3.9 mg/kg and chromium= 25 mg/kg) and background [USACE 2016]. However, there was a data quality issue with the measurement. The arsenic was greater than ATSDR's non-cancer chronic environmental media evaluation guide of 17 mg/kg and cancer risk evaluation guide of 0.25 mg/kg. Chromium was less than ATSDR's comparison values. EPA's soil to groundwater migration regional screening levels are 0.0015 mg/kg for arsenic and 0.00067 mg/kg for chromium (VI).

The Army's remedial investigations indicated further testing is needed to evaluate petroleum and potentially other contaminants in soil at AOCs E, M, and K and in groundwater in AOCs B and C [USACE 2016]. Additional soil removals may be needed in AOC J.

Figure 9. Sampling Locations Near Commercial Buildings in AOC E [USACE 2016]



Whether or not people may be harmed by these contaminants depends on how and if people come into contact with the contaminated soil, groundwater, or surface water. Factors that are difficult to assess, such as how frequently people come into contact with the contaminated material, affect estimates of people's exposures at Port Heiden.

ATSDR worked with the military to develop map files that show over 900 locations of past military activity features. The Tribal Environmental Office can consult the maps to identify concerning areas and to communicate hazards to villagers or visitors. For the maps, each location marked is programmed with a description and information about the historical use of that area. Note that historic records may not identify all past disposal and release activities, i.e. unidentified contamination may remain.

Appendix B contains more detailed descriptions of the larger areas of historical use. Given the widespread nature of potential hazards and discovery of new areas of concern in the past, additional hazards likely exist that are not yet discovered.

Vapor Intrusion Data

The Army found diesel range organics at a level of concern (438 µg/L) for vapor intrusion in one **residential well** in 2003 (Table D.2) [Keres], but ATSDR does not have any more recent data to evaluate current concerns. The Air Force tested monitoring wells from pipeline spills near the **school** and **airport** in 2004. Shallow sentinel well samples about 100 feet from the Meshik School indicate vapor intrusion is not a concern at the school (Figure A.8). People do not occupy buildings at the airport near diesel range organic contamination (Table D.7) enough for the buildings to be a concern for people breathing chemicals from vapor intrusion. Future building over volatile contamination at the pipeline, airport, or Radio Relay Station areas may be a concern if preemptive vapor mitigation construction methods are not used, but there are no current plans to build in these areas.

Key Results

ATSDR cannot evaluate the potential for vapor intrusion at one residence with potential petroleum contamination and surrounding residences due to lack of recent data.

What is Vapor Intrusion?

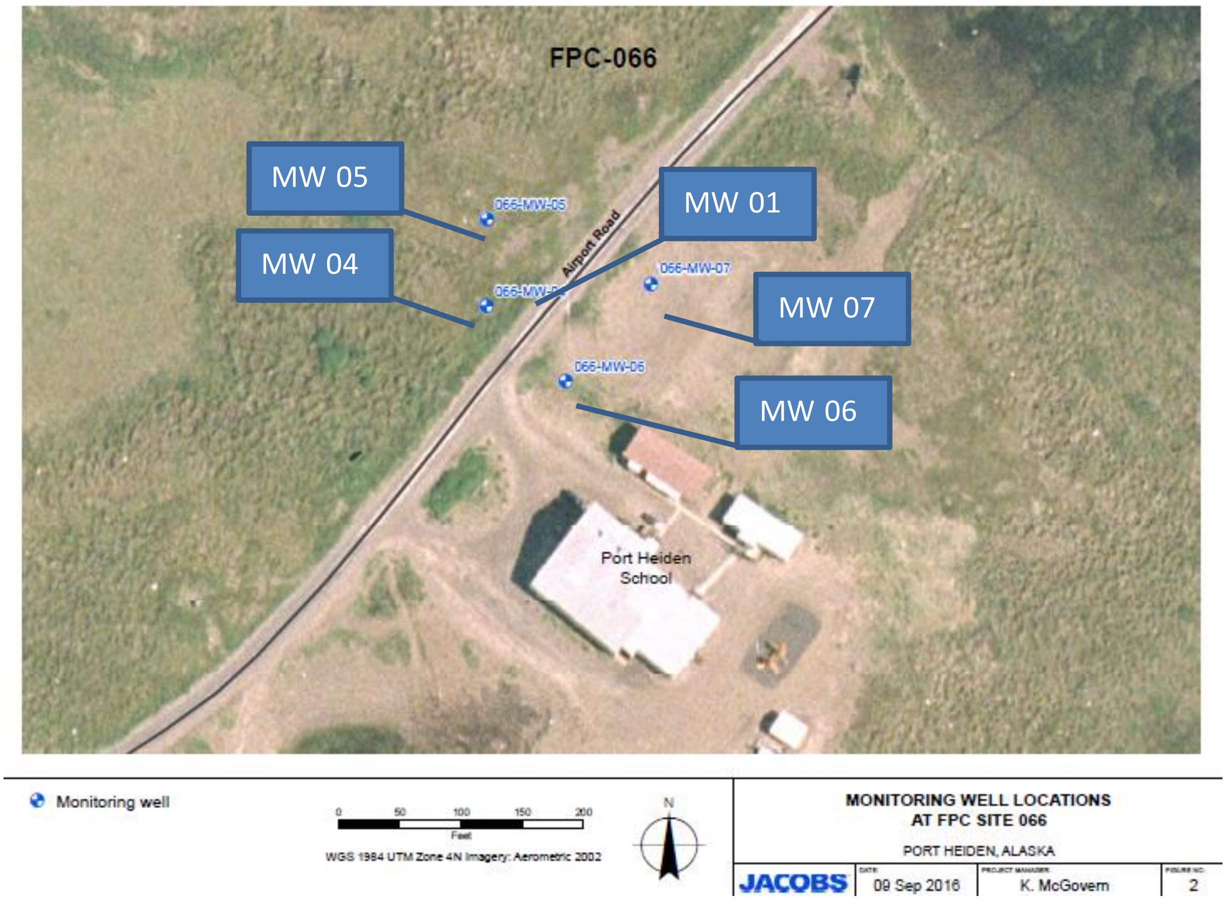
Vapor intrusion is the migration of volatile chemical vapors from the subsurface into buildings where people may breathe them.

Note: No follow-up data from the residence with diesel range organics in 2003 are available for ATSDR to evaluate the vapor intrusion pathway.

Testing showed diesel range organics at 438 µg/L in one residential drinking water well [Keres 2003]. The lab analyst could not tell whether the chemicals detected were from weathered diesel fuel or natural organic matter. The Keres report recommended resampling this well to confirm contamination. If confirmed, the report recommended follow-up investigation of the magnitude and extent of the contaminant source in soil and groundwater. ATSDR did not find any follow-up sampling for this well. The residence with 438 µg/L and residences nearby that were not sampled may have been and may continue to be at risk for vapor intrusion.

Diesel range organics were detected up to 8,100 µg/L along the pipeline (MW-01) about 200 feet from the **Meshik School** (Figure 10) and at 12,000 µg/L near the airport (Figure 11) in 2004.

Figure 10. Pipeline Spill Monitoring Wells Near the School [USAF 2016b].



Groundwater monitoring since 2009 at the pipeline spill (MW-05) about 250 feet from the Meshik school shows fluctuation in the levels of diesel range organics from 1,300 to 4,500 µg/L with a most recent sample of 3,100 µg/L [USAF 2016b]. However, sentinel wells (MW-04, MW-06, and MW-07) were located between the school and MW-05. The sentinel wells had estimated concentrations ranging from 18 to 32 µg/L in 2013-2014. These sentinel wells were not monitored after 2014 because they were less than the Alaska program's current cleanup level of 1,500 µg/L [ADEC 2018a].

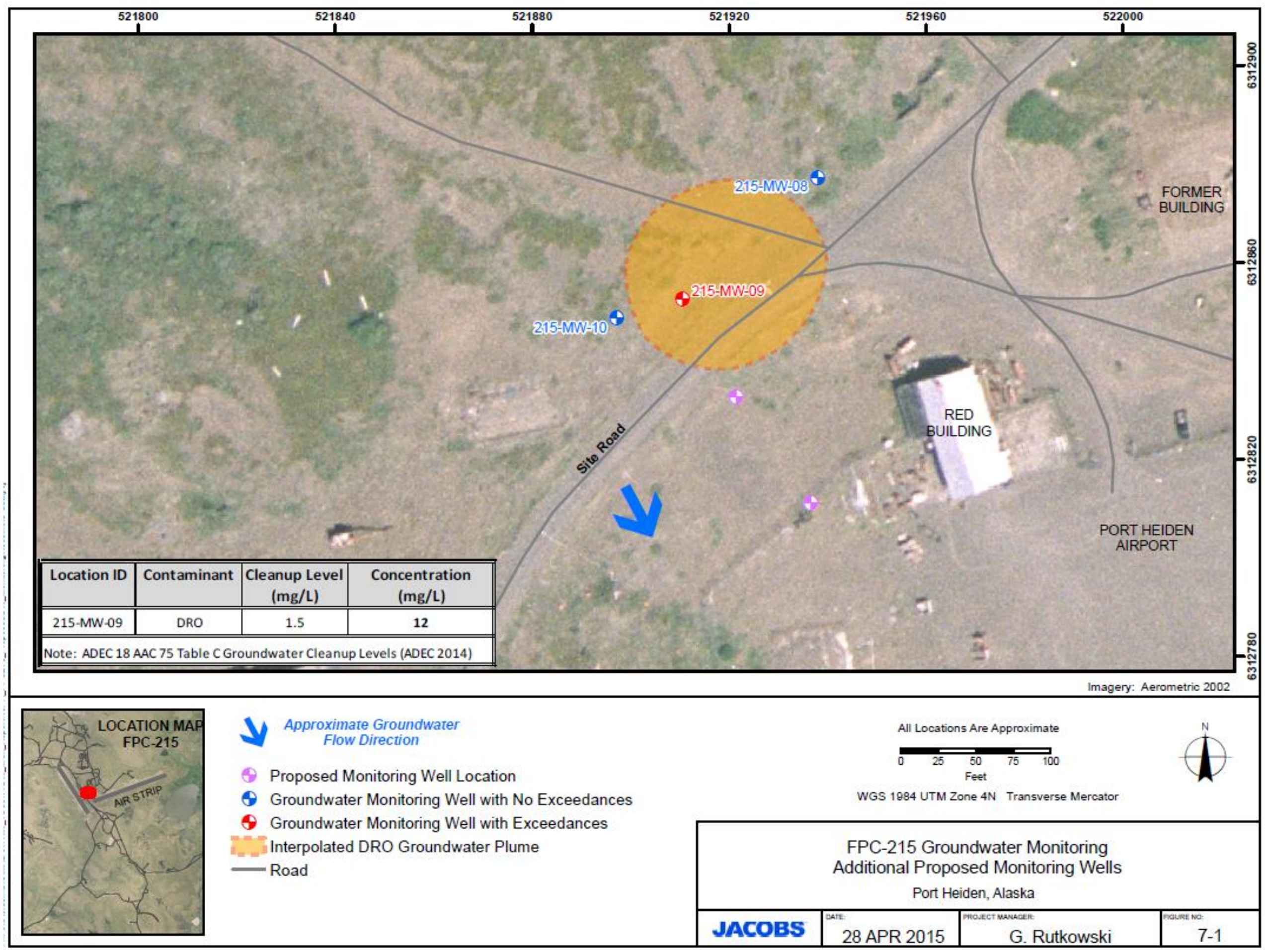
Recent studies have raised awareness of potential concerns from petroleum vapor intrusion and led to the use of provisional toxicity criteria in health assessments [Brewer 2013, 2015]. Provisional vapor intrusion comparison values for medium fractions (9 to 18 carbons or C9-C18) are most appropriate for diesel range organics and range from 0.75 to 160 µg/L. Though the estimated sentinel well diesel range organic concentrations exceed the lower end of the provisional range, the composition of the mixture is unknown. The substantial decrease from MW-

05 to the sentinel wells indicates that the petroleum plume is likely attenuating and not reaching the school building. Telephone and electric utility lines are supplied by poles and there are no public septic or water lines to serve as preferential pathways [L&PB 2002]. These comparison values do not account for degradation from soil microorganisms that may further attenuate the plume and soil gas migration.

Future sampling of MW 05 and the sentinel wells using improved analytical methods would allow for more specific health-based screening. The improved analytical methods test for low, medium, and high aliphatic and aromatic fractions suitable for comparison to provisional vapor intrusion comparison values. ATSDR notes that new methods are being developed by Alaska for improved investigation techniques for petroleum.

The **airport** buildings are only used for occasional short-term purposes and do not pose a vapor intrusion concern [ADEC 2018c].

Figure 11. Diesel Range Organic Plume Near the Airport [USAF 2015].



Subsistence Food Data

In 2004, the Air Force tested crowberries and two composite samples of cockles (Appendix E). They collected the crowberries from the Radio Relay Station area, which has subsequently undergone cleanup. They collected the cockles from a shell fishing area near where the U.S. Coast Guard responded to reports of large amounts of waste from the old village landfill, drum cache, and tank farm eroding into the bay. The fishing area also exhibited signs of contamination such as fuel sheens and stained soils. Surface water along the pipeline could run off into fishing areas. No other subsistence wildlife or plant data is available that can be used to evaluate site-related exposures.

Data Quality and Availability.

- Samples of cockles and crowberries from 2004 are not currently useful to assess health.
- Several data quality issues limited the usability of the cockles data.
- The conditions have likely changed since the Air Force tested cockles at Port Heiden.
- Cleanup efforts in the area where crowberries were collected likely make that data unrepresentative now.

Previously ATSDR addressed concerns about asbestos in clams and polychlorinated biphenyls in crowberries in earlier health consultations [ATDSR 2014a,b].

Key Results

The cockle and crowberry samples collected in the past were too limited to make a health determination on subsistence food. Cockle data collected near the Marine Terminal Area does not represent current conditions, since substantial erosion has occurred. Crowberry data collected near the Radio Relay Station area does not represent current conditions, since cleanup has changed the characteristics of that area. These two food sources likely constitute a small portion of the subsistence food that could be affected by residual waste at Port Heiden [BOEM 2012]**.**

Note: Of the 21 chemicals sampled (20 metals + phenanthrene) in cockles, 12 had potential bias, 3 had detection limits greater than EPA's screening level, 4 had no screening levels, and 1 was less than the screening level. ATSDR could not determine if the cockle sample results were based on a wet or dry weight basis [USAF 2006]. There is uncertainty in the crowberry data due to high detection limits and unknown background locations.

ATSDR reviewed the cockles results from 2004 that included metals and phenanthrene (Table E.1). The analysis found one composite sample that exceeded an EPA screening level. The cadmium concentration of 0.55 mg/kg exceeded the EPA screening level of 0.33 mg/kg. The site-specific background was 0.38 mg/kg (based on 7 samples). The current Alaska Fish Monitoring Study average is 0.068 mg/kg (based on 5 samples). The cadmium in the 2004 cockle sample supports the need for collecting additional data. Arsenic and manganese were above EPA screening levels for consuming fish and drinking from surface water from the pipeline (Table D.6).

ATSDR reviewed data from two composite samples of crowberries collected from the Radio Relay Station area, plus background sampling. All concentrations in the crowberries from the Radio Relay Station area were below the reporting limit, below background, or at very low concentrations (Table E.2). Chemical concentrations in crowberries may have decreased since 2004, due to ongoing site clean–up activities.

Conclusions

After reviewing the data and supporting information, ATSDR came to six conclusions about this site. The basis for each conclusion is provided. Recommendations and next steps for each conclusion can be found in the front pages of this health consultation.

HEALTH HAZARD

People may experience injuries from contacting surface debris at the beach and historical use areas across the site.

Basis for Conclusion

ATSDR reviewed reports from the Air Force, Army, and Alaska Department of Environmental Conservation to find information on remaining physical hazards at Port Heiden.

Physical hazards such as old debris, drums, munitions, medical waste, and asbestos-containing materials may continue to surface on the beach. Similar materials that may not have been discovered yet may also arise at landfills and over 900 historical use features as natural erosion and weathering of the land occur. Inspection after recent addition of fresh fill and seeding found Landfill A and B caps in good condition.

NO HEALTH HAZARD

Children and adults are currently not likely to be harmed by drinking water at the Meshik School as long as treatment is maintained.

Basis for Conclusion

Current conditions: ATSDR reviewed data from monitoring the drinking water at the Meshik School performed by the Lake and Peninsula School District. Treatment of the drinking water appears to be critical to maintaining acceptable drinking water quality at the Meshik School. Recent data showed that contaminants are below EPA's screening levels, but arsenic and copper are gradually increasing.

Past conditions: Past levels of arsenic, copper, and lead measured in Meshik School drinking water varied and were sometimes greater than EPA and ATSDR screening and action levels. The source of the elevated metal concentrations are unknown. Some metal concentrations above drinking water standards can be found naturally at wells in Alaska and elsewhere due to geology. Arsenic is naturally occurring in other volcanic areas and often associated with high iron.

- Arsenic concentrations varied over time and ranged from 1.4–13.0 µg/L, which was greater than EPA's maximum contaminant level (MCL) (10 µg/L) and ATSDR's health-based comparison values for cancer (0.016 µg/L) and non-cancer (2.1 µg/L) health effects. Chronic exposures have been associated with health problems, such as cancer or changes to the skin.
- Copper and lead levels were below EPA's MCLs in recent years, though some levels were greater in the past.
    - People who drank water between 1997 and 2001 at the school may have had an upset stomach from copper. Copper was detected at 176.5 µg/L in 1997 and 2,524 µg/L the next time it was measured in 2001. The EPA's MCL is 1,300 µg/L.
    - People may have had greater than normal exposure to lead from the water in 2001. Lead sample results exceeded EPA's MCL of 15 µg/L twice in 2001 at 398 µg/L and 58 µg/L. Lead data was not available from 1997 to 2001 or 2002 to 2013. Children are particularly susceptible to lead and may have had extra challenges with learning and behavior if they drank water with these lead levels over extended periods of time (months to years).
- The tap water pH ranged from 6.3 in 2004 to 9.1 in 2015. EPA's secondary MCL range is 6.5 to 8.5. Low pH can result in corrosion from the pipes and release of contaminants. High pH can result in deposition onto the pipes and increase arsenic mobility. Note: These interactions are also dependent on electrical conductivity of the water (a function of biodegradation and mineral content).

UNCERTAIN HEALTH HAZARD

We don't have enough recent information to conclude whether chemicals in residential and community drinking water wells could harm people's health.

Basis for Conclusion

The Army performed sampling of drinking water for residential, commercial, and Meshik school buildings in 2003. Twenty percent of the residential wells were not sampled, including some near the former pipeline. ATSDR reviewed the data from 2003 and noted some chemicals and water quality parameters were greater than ATSDR comparison values: arsenic, cadmium, copper, 1,2-dichloroethane, and petroleum (diesel range organics). ATSDR cannot make a health determination based on data collected at one time so far in the past.

One home had diesel range organics greater than the provisional screening value. The report recommended retesting this well and follow-up soil and groundwater investigation, if indicated by retesting. Several other homes nearby are also in the vicinity of the pipeline and were not tested in 2003.

One area in AOC E near commercial buildings has buried metallic debris and diesel range organics, arsenic, and chromium levels in soil greater than screening values for migration to groundwater. The Army remedial investigation report indicated further testing of this area is needed.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether contact with chemicals from the landfills or over 900 historical use features could harm people's health.

Basis for Conclusion

ATSDR reviewed data from the Air Force remedial investigation in 2004 and from the Army's field testing performed between 2011 and 2014. The investigations included landfills and other areas of historical use activities.

- At the Old Village Landfill, soil and groundwater data from the Air Force in 2004 showed some fuel and metals greater than health-based comparison values. No one is drinking groundwater in the coastal landfill area, but the groundwater can discharge to surface water. The data reviewed likely does not represent current conditions, since substantial erosion has occurred since then. People may be exposed if contaminants released by erosion remain accessible long enough before being washed out to sea.
- While efforts were made to control contamination put into the landfill, such as draining the oil from vehicles before disposal, some chemical contamination is normally associated with construction and demolition debris and may have been introduced into Landfills A and B. No sampling was done at landfills A or B to confirm that landfill-related contamination was not released at levels of concern during the time the landfill cap lacked adequate vegetation to prevent erosion and cap destabilization.
- The Air Force testing of the groundwater in 2004 along the former pipeline near the Meshik School and airport found petroleum, iron, and manganese above drinking water comparison values. ATSDR cannot determine whether people may come into contact with these chemicals in the future.
- Air Force groundwater and soil data from 2004 showed petroleum, trichloroethylene, other organic chemicals and metals (including lead) greater than comparison values at the Radio Relay Station Area.
- The Air Force (2004) and Army (2011-2014) tested a subset of over 900 historical use features across the site and found metals, petroleum, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons in soil,

groundwater, and surface water in some areas. The Army's field testing found lead much greater than EPA's action levels in soil. ATSDR did not have precise sample locations upon authoring this report. Only a portion of known features were tested, an agreed upon approach was utilized to prioritize and conduct field screening and sampling.

Landfills with poorly maintained vegetative covers were recovered with clean fill and vegetation in 2012 to prevent erosion and stabilize the cap. New sturdier asbestos caution signs were placed adjacent to Landfill A. Future maintenance of landfills is necessary to prevent release of chemicals from the current and former permitted landfills. Site conditions likely change over time from erosion, leaching, or other fate and transport methods. Releases from deteriorating drums, such as found at the Marine Terminal Landfill, could also result in exposures.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether vapor intrusion into the residence with diesel range organics detected in the well in 2003 or unsampled nearby residences could harm people's health. Vapor intrusion is not expected to result in health effects at the Meshik school or airport buildings.

Basis for Conclusion

Testing in 2003 showed diesel range organics at 438 µg/L in a residential drinking water well. The lab analyst could not tell whether the chemicals detected were from weathered diesel fuel or natural organic matter. The report recommended resampling this well to confirm contamination. ATSDR did not find any follow-up sampling for this well. Analysis of aliphatic fractions, which are the most hazardous portion of diesel contaminants for vapor intrusion, was not common in 2003. The residence with 438 µg/L diesel range organic and residences nearby that are also near the former pipeline were not sampled, may have been, and may continue to be at risk for vapor intrusion.

Diesel range organics about 250 feet from the school attenuated substantially in sentinel wells between the school and a pipeline spill in the 1980's or 1990's. The sentinel wells did contain estimated diesel range organic greater than provisional vapor intrusion screening values for medium aliphatic fractions when last measured in 2013-2014. Resampling the source and sentinel wells for aliphatic and aromatic fractions may confirm attenuation of the hazardous volatile fractions as the plume approaches the school.

Airport buildings are only occupied for short periods of time. The potential for breathing vapors in buildings at the airport from the nearby diesel range organic plume is not expected to cause health effects.

UNCERTAIN HEALTH HAZARD

We don't have enough information to conclude whether chemicals in traditional and subsistence foods could harm people's health.

Basis for Conclusion

Other than older cockle and crowberry data, ATSDR did not identify data on any of the other subsistence foods of concern listed in the Council's petition. These data are limited by kinds of food, numbers of samples, areas sampled, data quality, and chemicals analyzed.

- The Air Force tested metals and phenanthrene in two composite samples of cockles collected near the old village landfill on the coast in 2004. ATSDR could not use most of the data because of data quality issues. One of the samples had cadmium levels slightly greater than EPA's screening and background levels, but more information is needed to determine health impacts. Cadmium is a cumulative toxin in the body that can cause fragile bones and affect kidney function.
- The Air Force sampled crowberries near the Radio Relay Station in 2004. All concentrations in the crowberries from the Radio Relay Station were below the reporting limit, below background, or at very low concentrations. These crowberry data do not represent current conditions, since the site is being cleaned up.

Limitations of Conclusions

Limitations include the following:

Limitation 1

Determining whether or not diseases are caused by chemical exposures usually cannot be done with great certainty, because there are many other causes of disease that cannot be ruled out. There are also uncertainties in accurately determining peoples' exposures. Personal behavior factors, such as using water filtering devices in their homes that reduce heavy metals, also affect exposures. The lifetime probability that residents of the United States will develop cancer (includes all cancer types) at some point in their lifetime is about 42 cases per 100 men and 38 cases per 100 women [ACS 2017]. Cancer risks identified in this report are on a much smaller scale.

Limitation 2

Recent residential land use and subsistence surveys are not available. Activity patterns can change significantly over time. Behaviors are not adequately characterized to understand frequency and duration residents spend at the areas that may have contamination.

Limitation 2

Some of the data sets did not include analysis of the full set of organic and inorganic chemicals following detections from more focused sampling. Chemical contaminants analyzed in many areas were limited to petroleum sources and inorganic chemicals. Evaluations did not assess fluctuations over time in the domestic wells. The nature and extent of contamination and hydrology of the area are not sufficiently characterized to evaluate well head protection zones. Groundwater flow may not always follow topography at Port Heiden.

Parameters needed to help interpret the data collected such as soil texture and pH were often not available for ATSDR to review. Diesel range organics and residual range organics analyses do not provide a fingerprint of fuel waste. The photoionization detection and ultraviolet optical screening field techniques used to guide petroleum investigation are not sensitive to the toxic aliphatic compounds that are less soluble and may partition and persist differently than petroleum aromatics.

Limitation 3

Other than the Radio Relay Station area, full characterization and delineation of historical use areas was typically not performed. "Judgmental" sampling strategies were used in site-wide screening to target what are believed to be the most contaminant-prone features. This is different than unbiased techniques that can be statistically extrapolated across and between sites. The result is that the available data clearly indicate contaminant releases have occurred, but do not necessarily reflect current conditions, or support confident identification of sources or define the nature, extent, or transport pathways of contamination. Various investigations found contamination potentially released by a specific stakeholder in small areas rather than evaluating all areas of contamination. Potential environmental contamination at the airport was not characterized by military investigations, because it is now controlled by the Alaska Department of Transportation.

ATSDR cannot determine areas potentially impacted by fate and transport of site-related contaminants. Wind-blown dust, runoff and leachate from the landfills could spread contamination through surface water and surface erosion if the landfill cap is not properly maintained. Though visual inspection in 2011 did not note active erosion and pooled water, the landfill cap was found susceptible enough to require additional fill and vegetation to prevent erosion and cap destabilization. The first few feet of soil were sampled rather than the first few inches where people are most exposed. While no surface water bodies or inhabited structures were noted within 1,000 feet of landfills, plants and animals used for subsistence or traditional purposes could contact contamination that may be released if landfills are not properly maintained.

Limitation 4

Toxic polar compounds were not analyzed for in groundwater samples. Recent studies found that the majority of polar chemicals at petroleum cleanup sites come from biodegradation of the petroleum instead of background organic sources [Zemo 2016]. In many cases these polar chemicals are removed by a silica gel cleanup step. The silica gel cleanup step is not recommended for groundwater samples unless background samples can differentiate between polar petroleum degradation products and natural organic matter [WADOE 2016]. A way to assess the risk from polar degradation products such as organic acids, alcohols, phenols, ketones, and aldehydes is to assume they are detected within the other fractions being assessed and they are toxicologically similar. These polar products are thought to have low to moderate toxicity, i.e. oral reference dose 0.1 to 0.001 mg/kg-day. Polar degradation products tend to persist as long as residual hydrocarbons are present in the smear zone.

Limitation 5

ATSDR did not have recent reports from the USAF and USACE for the initial preparation of this document (Appendix F). While those documents may be cited herein, a full analysis of the recent data was not performed. ATSDR will consider a full assessment of these reports upon request.

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Appendices

Appendix A: Figures that Illustrate Potential Exposure Pathways

Figure A.1. Coastal Erosion of the Old Meshik Village Area, Port Heiden, Alaska [Kinsman 2014]

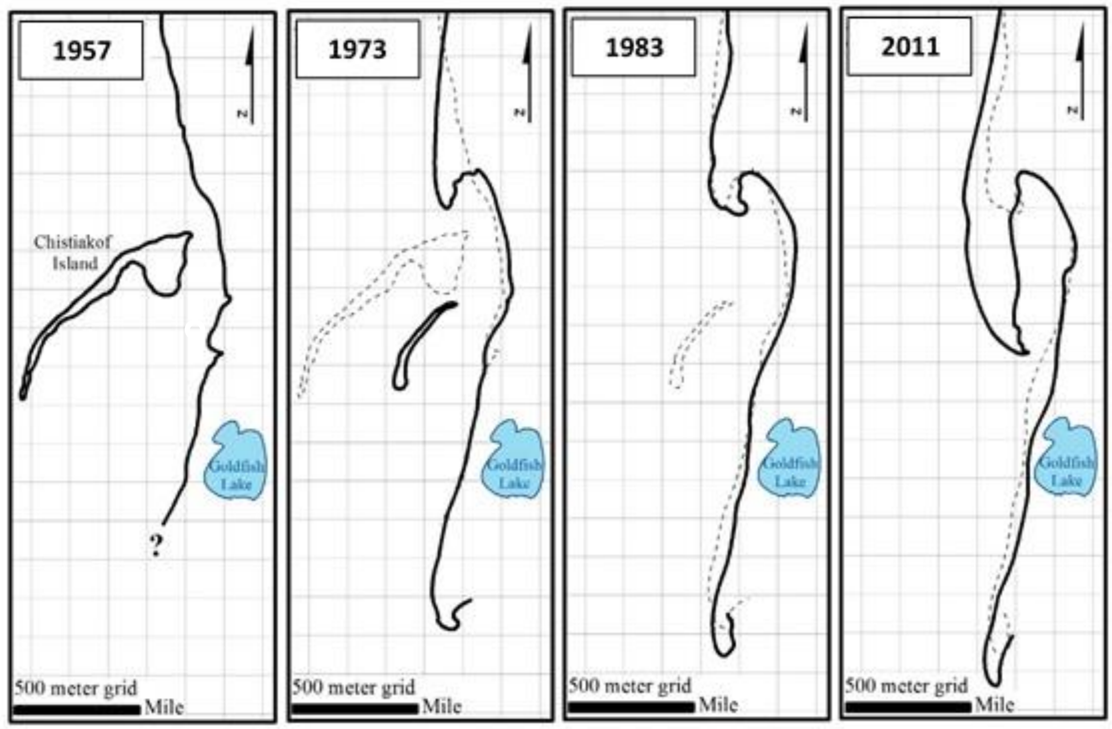


Figure A.2. Location of creeks, lakes, general berry picking areas, landfills (purple), boneyard, city maintenance shop, pipeline (red), marine terminal, and Old Meshik Village in Relation to Housing (yellow) and Meshik School, Port Heiden, Alaska. [NOAA 2004, USACE 2013c, USAF 2006, USAF GIS database, Google Earth]

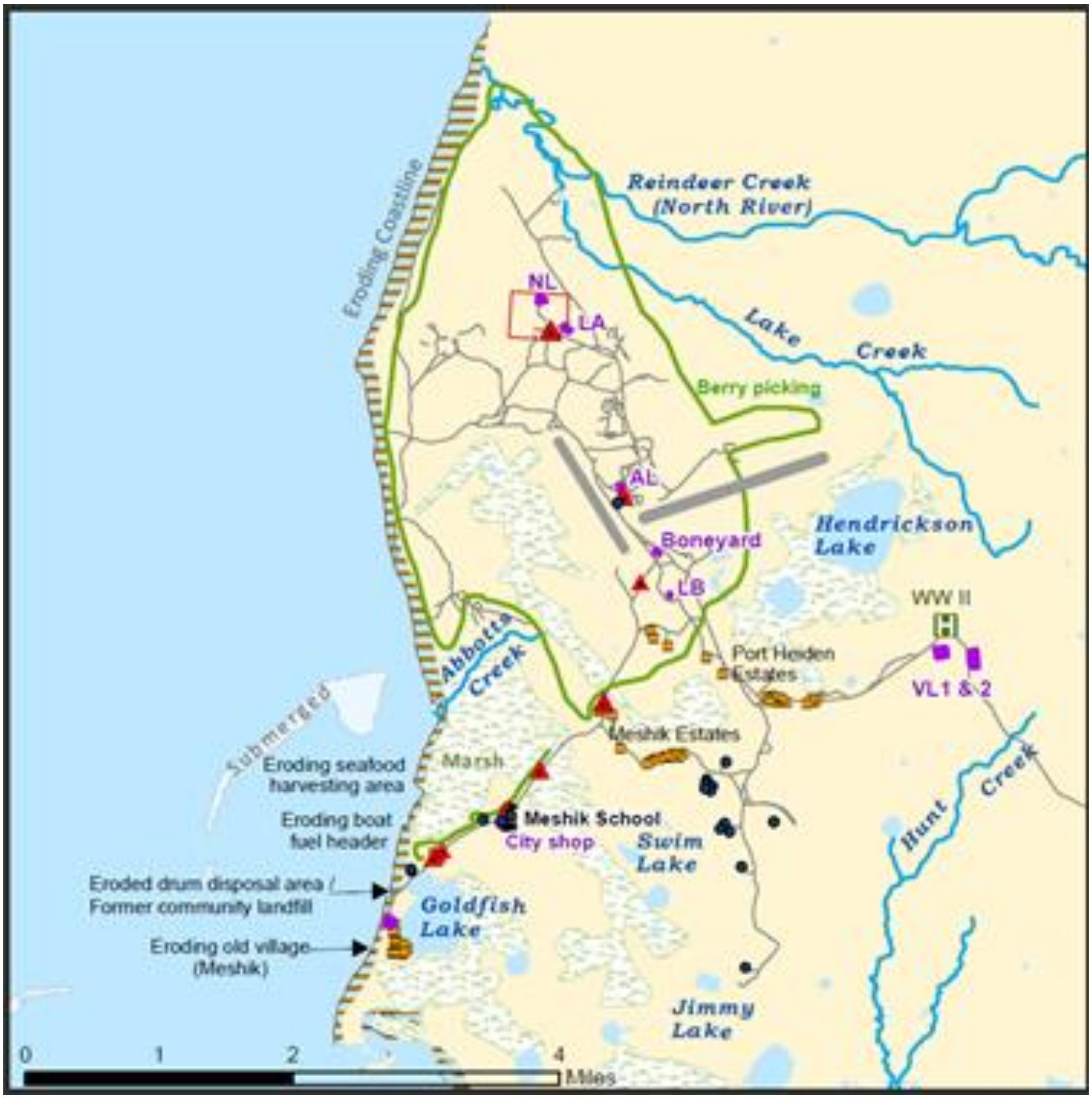
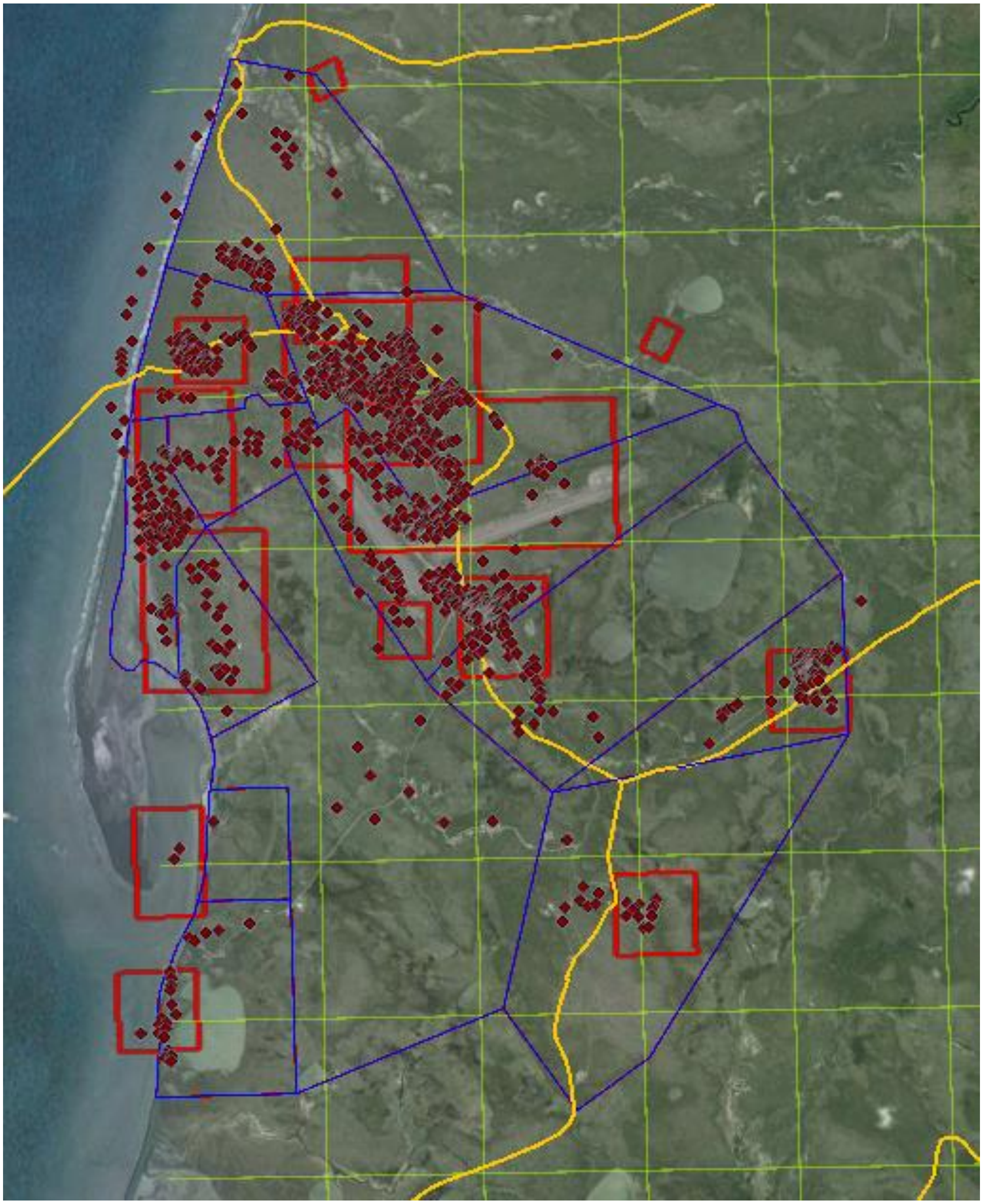


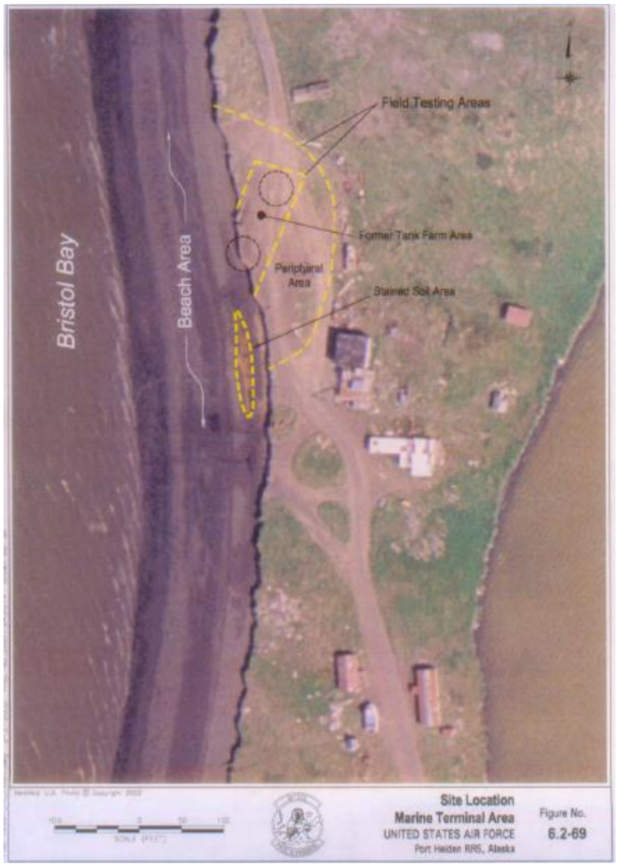
Figure A.3. Historical Site Features with Possible Contamination Identified by the Army (red square outlines), Watersheds (yellow), and landfills or waste areas (diamonds), Port Heiden, Alaska [USGS 2016, USACE 2013c, Bush 1944, Google Earth 2016]*



* The red squares mark historical features of interest and the yellow lines mark USGS watershed divides.

Figure A.4a. Former Marine Terminal Area Tank Farm, near Old Meshik Village. [USAF 2006]

Figure A.4b. Former Marine Terminal Area in Relation to Main Historical Use Areas, Port Heiden, Alaska. [USAF 2006]



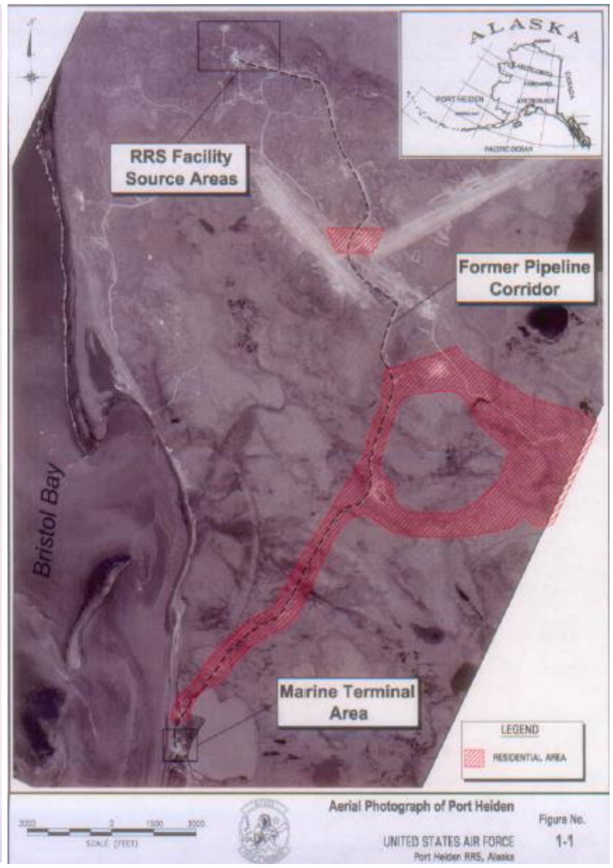


Figure A.4c. Former Meshik Village near Marine Terminal Area. [USAF 2006, [L&PB 2002](L&PB 2002)]

Figure A.5. Prior Drum Disposal Cache Area near Old Meshik Village, Port Heiden, Alaska. [[NOAA 2007](#)]

Figure A.6. Former possible World War II Munitions Storage Areas and other sites of interest relative to land use, Port Heiden, Alaska. [USGS 1963; References in Appendix C]

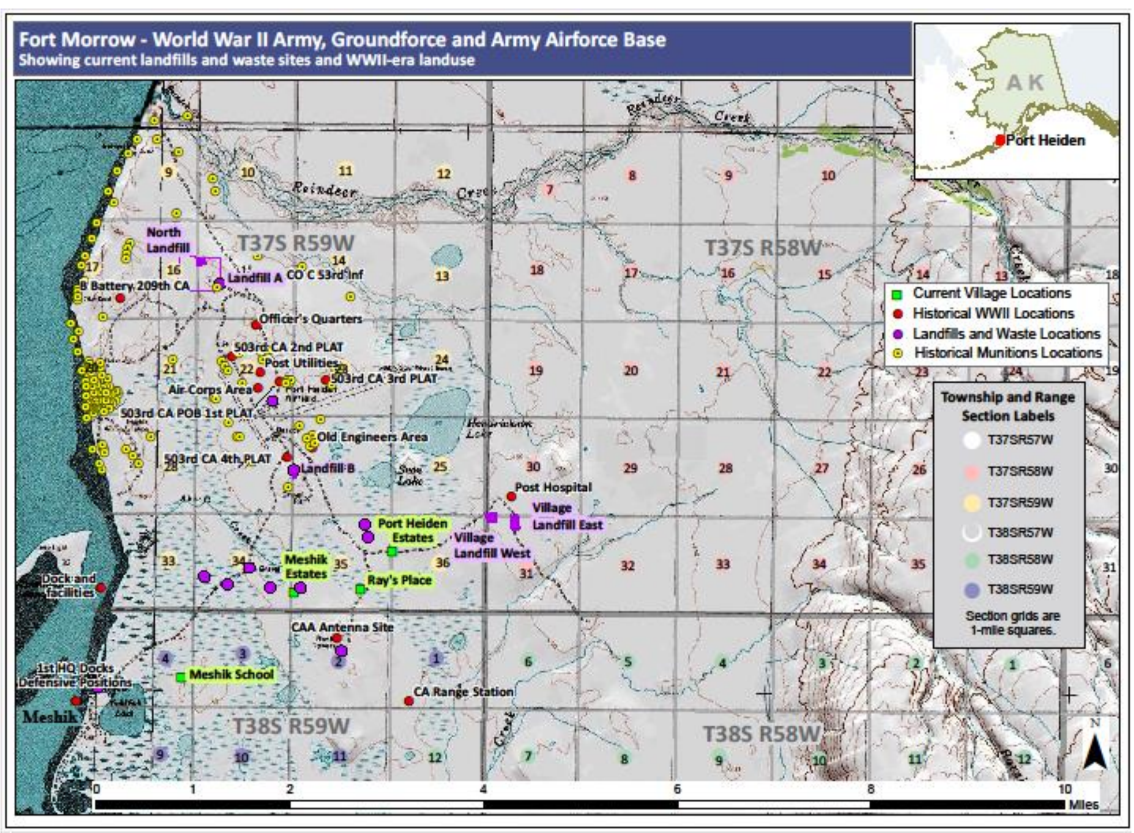


Figure A.7. Former Pipeline Corridor (FPC) Surface Water and Groundwater Sampling Locations that Exceeded Screening Values (Table D.4) [USAF 2006]

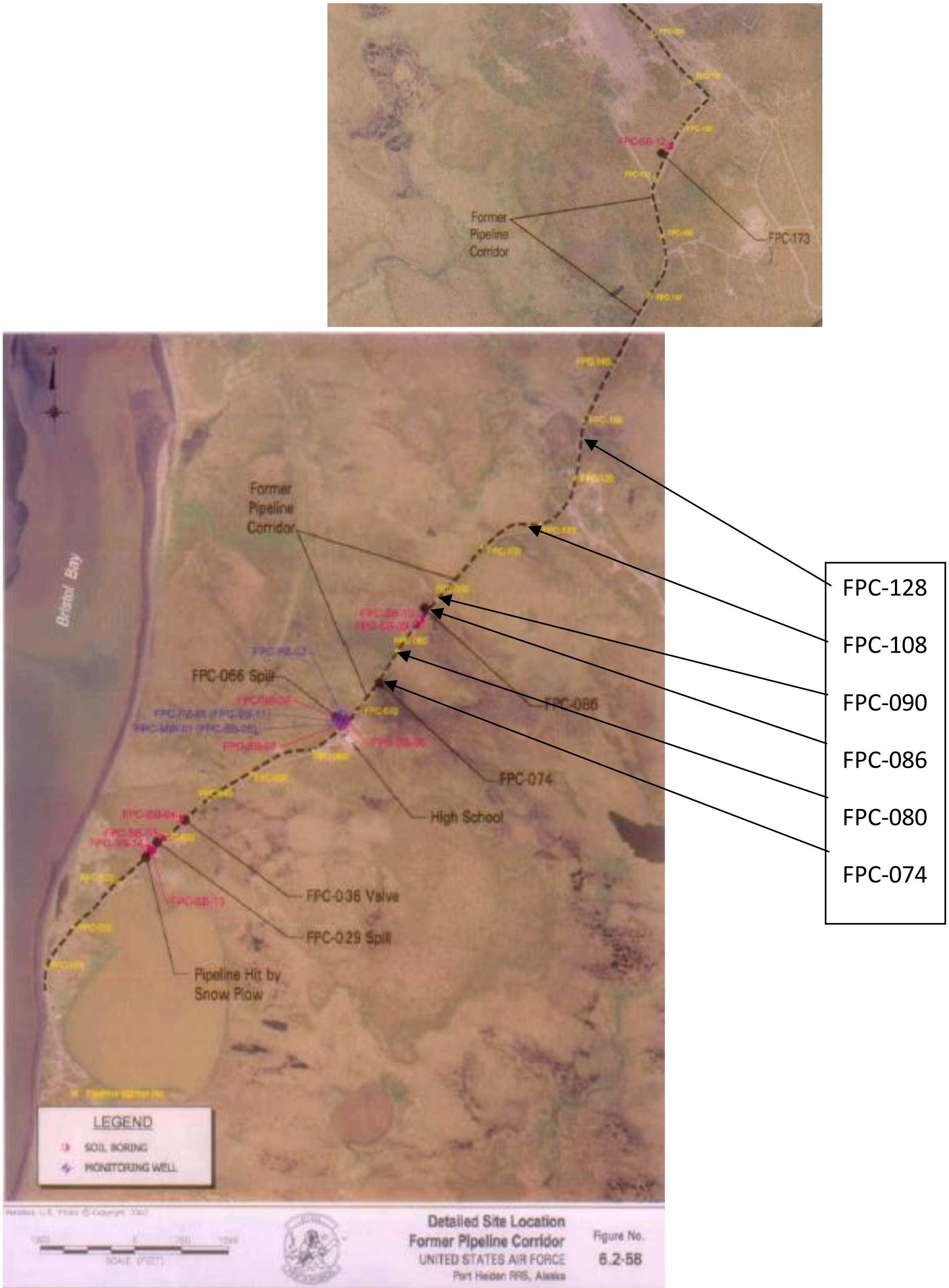


Figure A.8. U.S. Air Force Monitoring Well Locations Near Meshik School, Port Heiden, Alaska. [USAF 2016b]

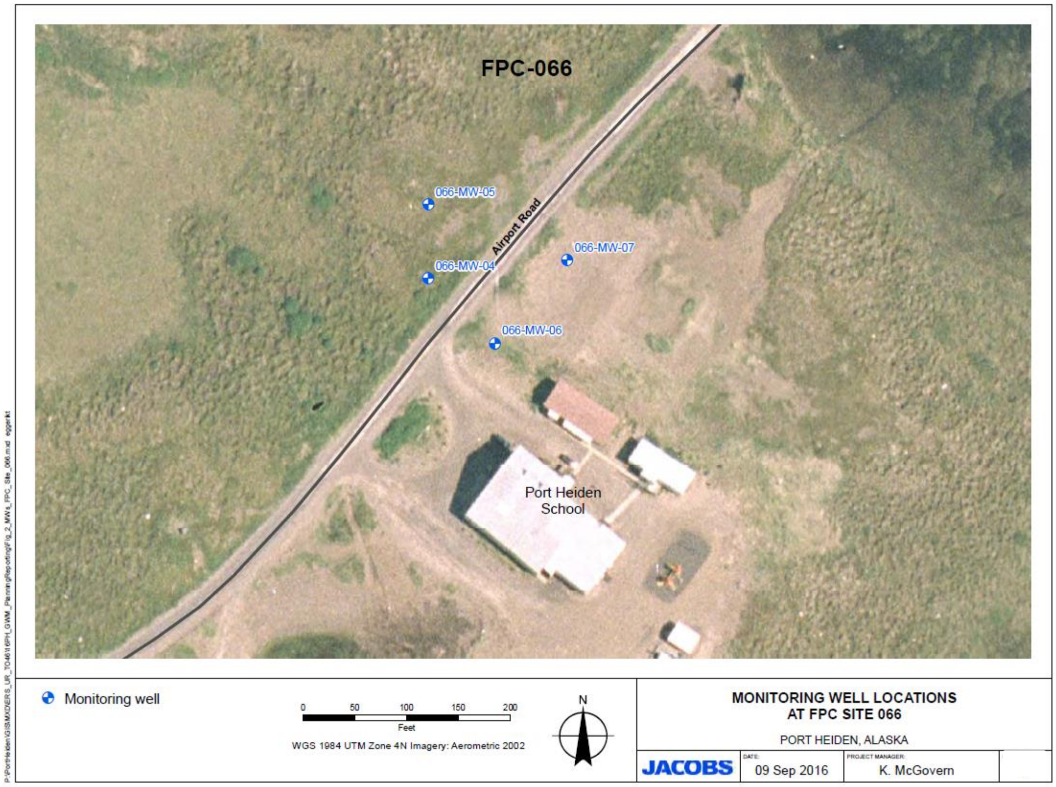


Figure A.9. Proximity to City Maintenance Shop to Meshik School, Port Heiden, Alaska. [Jacobs 2014, Google Earth]

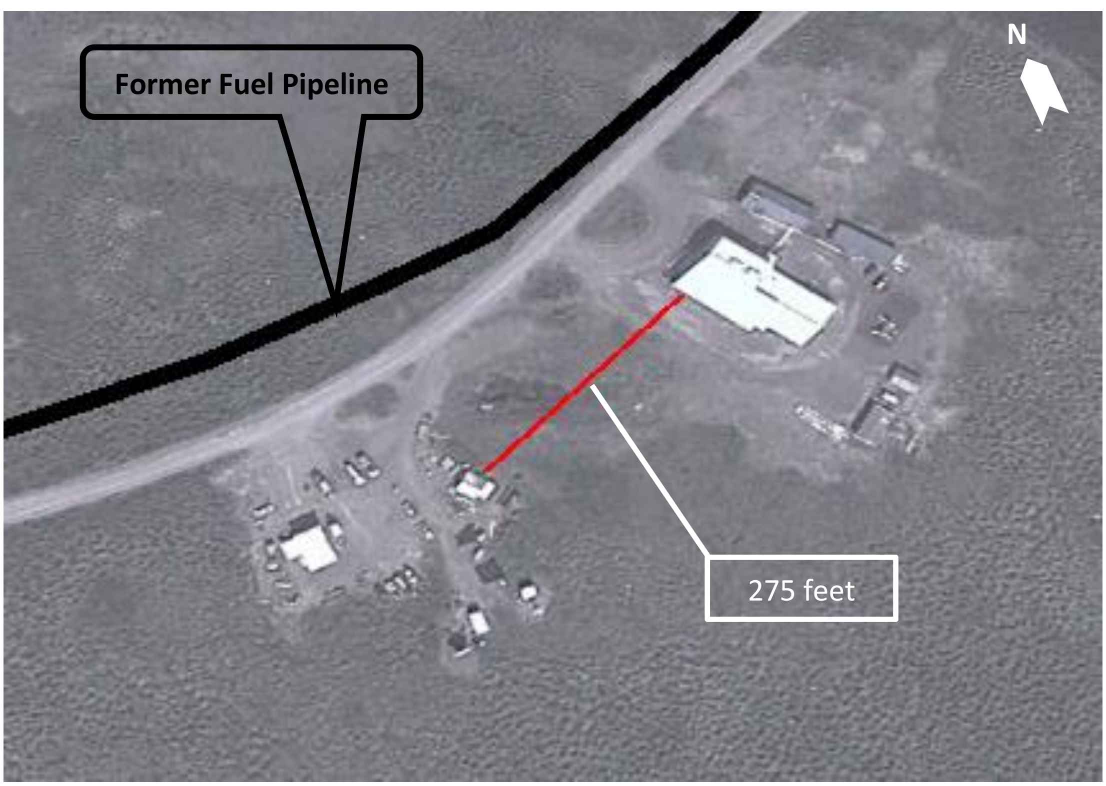


Figure A.10. Historical photo of city maintenance building with battery storage area near Meshik School, Port Heiden, Alaska. [ADEC 2012]

Appendix B: Description of Potentially Contaminated Areas and Related Exposure Pathways

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
1a. Port Heiden Landfill (Village Landfill West)	The Port Heiden Landfill, a Class III Municipal Solid Waste Landfill, operates under the solid waste permit number SW3A069-19. The landfill received and maintains contaminated soil from the RRS remediation in cells separate from municipal waste. Soil waste with concentrations greater than cleanup levels contain PCBs (less than 10 mg/kg), pesticides, and PAHs. Contaminated soil is covered with an impermeable liner to prevent leaching from rain and snow water. In 2012, ADEC's inspection letter indicated improvement in compliance for operations from 41 to 46% over the previous year. ADEC identified the following issues to be fixed: no access control, no operator on site, no separation of non-combustible waste, no recycling, no separating of hazardous waste, open and uncontrolled access to the active part of the landfill, no compaction, no seeding of inactive areas, no cover material, no storm water management, and no maintenance of operating records. **References**: ADEC 2013b, ADEC 2013c, USAF 2009	• Landfill cells with contaminated soils have institutional controls to prevent releases • Smoke from improper burning procedures may be releasing hazardous contaminants. • Eroding or wind-blown contaminants may be migrating off-site.	**Potential exposure pathway:** • No soil, groundwater, or surface water data are available for review. • Visitors to the landfill - community volunteers have access and clean up litter along the fence. Closest residence is about 1000 feet to the west
1b. Former Port Heiden Landfill (Village Landfill East)	The current landfill permit also refers to the no longer permitted "Old Port Heiden Class III Landfill" located east of the operating landfill. The former landfill closed in June of 2009. The most recent inspection found the closed portion of the landfill bare of vegetation with signs of uneven settling, sink holes and wildlife holes. ADEC recommended grading to fill uneven surfaces and seeding to promote drainage without erosion. Exposed weathered batteries were stored on pallets on the ground; ADEC recommended storing the batteries in an enclosed containment (Figure A.10). **References**: ADEC 2012, ADEC 2013b	• Fluid leaching from batteries may contain lead and cadmium. Acidic fluid may result in transport into groundwater. • Eroding or wind-blown contaminants may be migrating off-site.	**Potential exposure pathway:** • No soil, groundwater, or surface water data available for review. • Closest residence is more than 1000 feet) • Visitors to the landfill

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
2. USAF Marine Terminal Tank Farm	The tank farm at the former USAF Marine Terminal, located near Goldfish Lake on the coast, stored large quantities of fuel off-loaded by sea-bearing tankers (Figure A.4). It included two 250,000-gallon above ground fuel storage tanks, a pump house, and fuel distribution pipes. Environmental investigations in 1986 found evidence of fuel contaminated soil and groundwater. During the 1990s, the tanks were moved inland and approximately 10,000 tons of fuel-contaminated soil were removed. Remnants of former structures are eroding into the beach shoreline. During confirmation sampling of the excavation, fuel-contaminated soil and free product (free-floating fuel) on the water table were detected. The site investigation report stated that further subsurface investigation of free product was warranted. A large volume of debris was located around the periphery of the tank farm. Debris included vehicles and vehicle parts, boats, boat equipment, fishing equipment, household appliances, and building debris. Approximately 20 empty drums were present. The origin of the drums is not clear. One drum appeared to be of military origin with the word "Antifreeze" on the side. However, according to the remedial investigation, these were hard to identify and not likely of military origin. The Alaska Energy Authority began efforts in 2015 to move the tanks further inland to the Meshik school area because of continued erosion. **Soil samples** (n=13) were analyzed for fuels, metals and VOCs in 2004. Samples were collected from 0–4 feet and 4–11 feet deep. DRO was detected up to 68 mg/kg and RRO up to 140 mg/kg. The greatest lead level occurred in the same sample that had the highest fuel levels. **Groundwater samples** (n=13) were analyzed for fuels, metals, pesticides, VOCs and PAHs in 2004. DRO was detected up to 180 µg/L and RRO up to 210 µg/L. ATSDR identified arsenic, chromium, lead, iron and manganese were identified as contaminants of concern; however, there are no longer drinking wells at this location. **Cockle samples** were collected nearby next to the old Meshik landfill. **References:** USAF 1996, USAF 2006, Colton 2015	• Contaminated soil on the beach or bank eroded into the water and is now sediment. • Contaminated sediment near the former tank farm may lead to contamination of shellfish or fish	**Completed exposure pathway** • Physical hazard • Direct contact with contaminated soil (now sediment) including fuels and metals (Table D.5) **Potential exposure pathway** • Subsistence harvest of other clams, crabs and resident fish – no data available • Direct contact with current sediment (no data) **Eliminated exposure pathway** • No one is drinking contaminated water in the Old Meshik area – monitoring well data available for fuel and metals (Table D.4 and D.5)

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
3. Army Drum Disposal Area	The Army disposed of drums on the coastline near the former Marine Terminal Tank Farm. The community also used this area as a dump site for household waste. In October 2007, NOAA found the drum disposal area to be the source of oil sheens in the Bering Sea. Some of the drums contained over 100 gallons of petroleum from a different military dump site. Items found included old fishing gear, batteries, old vehicles, and medical waste. Coast Guard responders noted that the shoreline had eroded from 10 to 40 feet over the prior month and the sheen had dissipated. The Army Corps of Engineers removed approximately 2,000 drums stored at this location. Numerous rusted and open drums remain in the intertidal zone. With no evidence of ongoing release, the Coast Guard instructed local residents to monitor the beach and dump site and remove remaining debris. Although the drums were removed, waste still remains in the disposal area. Sampling at the Marine Tank Farm covers the Drum Disposal Area (see above). Cockles sampled near the Old Village Landfill (see below). **References:** NOAA 2007	• Disposal area is entirely underwater • Contaminants in the drums previously on the beach may have leaked and contaminated the soil (now sediment) of the area. It may be impacting seafood	**Completed exposure pathway** • Physical hazard **Potential exposure pathway** • Subsistence harvest of clams, crabs and resident fish may be exposed to sediment with other contaminants such as PAHs (no data) • Direct contact with sediment (no data)
4. Meshik (Old Village)	Tribal residents abandoned Meshik because erosion began to destroy roads, homes, and community buildings. Building debris may have included asbestos-containing materials. The village had a seafood saltery/cannery, a WWII emergency seaplane landing, and army barge docks. The Tribal Environmental Office has anecdotal evidence of another landfill in the middle of the village that may include metal scraps and material from a medical clinic, including sharps. Many of the old military and village structures and debris have eroded to the point of being submerged or washed away. Remaining evaluation of physical and chemical hazards was part of a Phase I environmental assessment. During fall 2003 to spring 2004, USAF personnel noted a hydrocarbon odor in subsurface soil while relocating eroding graves approximately 40 feet north of the old church. No analytical samples were collected in the area at that time. **References:** Iliaska 2008; USAF 2006	• Debris is present on the shoreline, land and in the water • Location of second Meshik landfill is unknown • Building debris may contain asbestos • Contaminants from structures may now be present in soil and sediment	**Completed exposure pathway** • Physical hazards (debris) **Potential exposure pathway** • Direct contact with debris (no data) • Direct contact with sediment (no data) • Subsistence harvest of clams, crabs, and resident fish may be exposed to contaminated sediment

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
5. Former Meshik (Old Village) Landfill	The former Meshik Landfill, located near the Old Village, received municipal waste from the old village. Though this was not a permitted landfill of the USACE or USAF, some items recovered have military markings. These items are evidence of military landfill use or leftover or recovered military material that the villagers used or disposed of. The villagers believe the military deposited materials in the landfill. This landfill is near other sources of contamination including the marine terminal with associated pipelines, drum cache (Figure A.5), village buildings, military buildings, and a former seafood processing facility. Items of potential contamination in this landfill include drums, fuel storage tanks, fuel pipeline parts, munitions, graves, vehicles, boats, fishing equipment, household appliances, medical waste, lead-battery waste, domestic trash, building demolition wastes including asbestos-containing material. Villagers reclaimed some of the potentially hazardous debris and landfill materials to construct dwellings and other structures. Tides and storms continue to erode the old landfill material at rates exceeding 13 meters per year. Erosion has revealed buried electrical wires, open holes, and pipes. The landfill area has little remaining contamination that has not eroded away, though buried materials may still be uncovered. **Composite cockle samples** (n=2) were collected offshore from the old tank farm in 2004. Samples were analyzed for pesticides, metals, and phenanthrene but not petroleum, volatile or semi-volatile organic compounds, other PAHs or PCBs. **References**: USAF 2006, Kinsman 2014, USACE 2007a,b	• Debris is present on the shoreline, land, and in the water • Debris from the land fill may release chemicals into the bay and sediment • Debris may present physical hazards • Groundwater in coastal areas is not used for drinking water	**Completed exposure pathway** • Physical hazards with debris • Direct contact with sediment; beach soil in the past: tank farm/grave area beach soil (0–4 feet and 4–11 feet deep) analyzed for DRO, RRO, GRO, metals, and VOCs • Subsistence harvest of shellfish – cockle data from near former landfill available **Potential exposure pathway** • Subsistence harvest of other clams, crabs, and resident fish may be exposed to contaminated sediment **Eliminated exposure pathway** • No one is drinking contaminated water – monitoring well with fuel and metal data (fuel and metals) (Table d and D.5)
6. Munition Areas along the coast	During World War II, defense positions were dug along Port Heiden coast line (Figure A.6). Many of these locations have since eroded into the water. • Near the drum disposal area, military munitions were found where WWII supplies were unloaded to the beach. This item was reported as destroyed by the USAF. No unexploded ordnance or other military munition items were found during the 2007 drum removal action • An unexploded ordnance technician inspected several miles of coastline between Abbots and Reindeer Creeks in search of bunkers and ammunition. No ordnance was identified; however, dozens of spent 0.30 Caliber cartridges dated at 1940 to 1942 were located approximately one-half mile inland from the coast. Buried munition locations are not easy to identify without using geophysical methods. Many of the defense positions and bunker locations along the coast line are now under water. **References:** AGC 2010; USAF 2006	• Unexploded ordinance has not been found • Buried munition locations are still present • Defense positions previously on land may now be releasing contaminants in sediment or water	**Completed exposure pathway** • Physical hazards (debris or munitions) **Potential exposure pathway** • Direct contact with contaminated soil or munitions (area-wide soil data only) • Subsistence harvest of clams, crabs, and resident fish may be exposed to contaminated sediment (no data)

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
7. Army and Air Force Landfills (Landfill A and B)	At the conclusion of their respective missions in the 1980's the Army dismantled most of the remaining Army and Air Force military buildings and facilities, depositing the refuse into permitted landfills designated as Landfill A and B. Soil with petroleum concentrations less than 5,000 mg/kg of total petroleum hydrocarbons (TPHs) and PCBs less than 10 mg/kg were disposed of in these landfills in addition to asbestos and other materials described below. • **Landfill A**, first used in 1981, is located near the RRS. The USACE conducted cleanup activities throughout the Port Heiden site and disposed of materials in the landfill. The USAF removed and disposed of asbestos-containing pipe insulation, scrap metal, wood, paint, and empty petroleum/oil/lubricant (POL) barrels, former RRS composite building, and former Fort Morrow buildings. In 1987, USACE identified wastes including asbestos, polychlorinated biphenyls (PCBs), diesel, asphalt, and transformers. Landfill A lost vegetation but was recovered with clean fill and reseeded in 2012. In 2011, ADEC observed broken or no signs and vegetation missing, but new asbestos signs were placed in 2012. • **Landfill B**, used during the 1990s, is located approximately 1/2 mile south of the main runway at Port Heiden Airport. The Army disposed of Fort Morrow FUDS waste, mainly related to World War II debris, in the landfill. The debris included crushed barrels, abandoned vehicles, structural materials, and approximately 400 drums. Wooden structures and debris were stockpiled, burned, and ash residue was placed in the landfills. Approximately 525 cubic yards of petroleum-contaminated soil was placed over the landfill pit area before final cover and grading. In 2011 Landfill B conditions were better than Landfill A. In 2012 inspection found Landfill B in acceptable condition. **References:** USAF 1996; ADEC 2016b,c; USAF 2006; USACE 2005, 2012c	If improper maintenance and future building occurs, the landfills might • Produce gas that could impact future buildings, if constructed nearby. • Produce leachate that could get into surface or ground water (no leachate sampled). • Wind erosion may result in contaminated dusts that could land on berries or plants. Plants then eaten by animals. 2011 inspection of Landfill A: • Showed lost vegetation that may lead to surface water and increased wind erosion transporting chemicals offsite (was remediated in 2012)	**Past complete exposure pathway** • Physical hazard – there was a lack of adequate signage to inform visitors of potential asbestos and other hazards • Direct contact with soil on top of landfill by visitors **Potential exposure pathway** • Eating berries or plants that have contaminated dust originating from the landfill (no data) • Eating subsistence food animals may eat contaminated plants • Contact with surface water **Current incomplete exposure pathways** • No one is drinking water near the landfills (no groundwater data) • Physical hazard, direct contact with waste, and landfill gases are not a concern based on 2012 inspection. Annual inspections will advise to protect against future concerns.

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
8a. Radio Relay Station (RRS) Area	The RRS area is north of the Port Heiden Airport. Many potential sources of contamination were in the area: military buildings or facilities, equipment (including transformers), drum storage, waste piles or holes, storage tanks, POL disposal lagoons, debris, burial sites, septic systems, antenna pads, and chemical storage such as PCB containing coolants, chlorinated solvents for cleaning equipment, an above ground gasoline tank, flame retardants, herbicides, and pesticides. The USAF collected samples from the top two to three feet of soil in the main historical areas of RRS activities and analyzed the samples for petroleum, PAHs, organics, PCBs, and inorganics. The ADEC and USAF signed the ROD in 2009 requiring the removal and off-site disposal of PCB, PAH, and pesticide contaminated soil from the RRS area. Long-term groundwater monitoring and institutional controls were selected in the ROD. Ongoing remediation is removing some contamination. Many buried debris waste sites and miscellaneous dumping sites were present in the RRS area and are described in other reports. In addition, anecdotal evidence provided by a Port Heiden resident suggests that Port Heiden RRS workers may have dumped drums into a trench or pit within the former facility area pad. The location of these debris areas is mostly unknown. Three suspected debris burial sites were investigated during 2004. TCE found in soil was excavated, but TCE in groundwater was estimated at 670 µg/L near a drum storage area. **Composite crow berry samples** (n=4) from the RRS area prior to remediation were analyzed for pesticides, PCBs, PAHs, and metals [USAF 2006]. Trace levels of DDT and endosulfan sulfate may have been present in one of the samples. No other plants have been harvested for sampling. **References:** ADEC 2014, ATSDR 2014b, USAF 2006, USAF 2008, USAF 2009	• Fuels, PAHs, pesticides and metals were found in the top two to three feet of soil in some areas • Buried debris in miscellaneous dumping sites may have contaminated soil or leach contaminants into ground or surface water • TCE found in groundwater which may move across the site • Marshes are present downhill of the RRS. Small, shallow surface water ponds are east and southeast of the area. The ponds extend south toward Abbott Creek.	**Potential exposure pathways**: • Eating berries or plants that have contaminated dust originating from RRS area **Incomplete exposure pathway** • Direct contact with soil – soil samples were taken at depth and data quality was limited; fuels were present in some soil samples; some PAHs, pesticides, and metals were estimated (J qualified) or detected at concentrations greater than comparison values. (Table D.8). • Substance harvest of fish in creeks, or downstream estuary or bay that may be contaminated from contaminants leaving the RRS area and entering Reindeer Creek (North River) and Abbott Creek

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
8b. North RRS Landfill	Prior to the 1980's, the USAF deposited its debris in the North Landfill (also referred to as the RRS Landfill or LF007). The landfill surface covers approximately 900 square feet and is about 1,000 feet north of the main historical RRS area. Refuse included asbestos, PCBs, chlorinated solvents, and diesel and other petroleum products. During the 2004 RI, the USAF conducted geophysical investigations to determine the location of landfills and other RRS features. The USAF sampled cover soil, perimeter surface and subsurface soil and groundwater. Analysis included DRO, RRO GRO, metals, PCBs, PAHs, pesticides, and VOCs. No contaminants were detected above the USAF screening criteria in surface or subsurface soil around the perimeter of the landfill. PCBs, PAHs, and pesticides were detected above screening criteria in the soil cover material placed over the landfill. During the RI, an area with partially buried rusted drums was noted in the north central portion of the landfill. Institutional controls (signs) should be established after remediation indicating that buried contaminants may be present. Landfill cover should be maintained and excavation into or development over the landfill is restricted. An institutional control also restricts constant contact of low level pesticide contaminated soils with water. ADEC approval is required for any soil disturbance. **References**: USAF 2006, USAF 2009	• Building on or disturbing soil is prohibited in order to prevent exposure and release from the site • Landfill controls restrict water from entering into contaminated soils	**Completed exposure pathway** • Physical hazards to trespassers who may come into contact with debris **Potential exposure pathway** • Contaminants have been found on and around the landfill. Direct contact with landfill areas is possible. **Eliminated exposure pathway** • Contact with surface water – water does not flow through the landfill; institutional controls in place to prevent runoff, leaching and wind erosion (cap in place)
8c. RRS Black Lagoon Outfall	Groundwater near the "black lagoon," a pond where waste fluids were drained and piped from a garage at the RRS, is contaminated. Groundwater measurements at the outfall area found TCE up to 520 µg/L (around 60 feet deep) and DRO up to 15,600,000 µg/L and RRO up to 1,890,000 µg/L (around 50 feet deep). Benzene also exceeded the comparison values. The extent of this groundwater contamination has not been delineated but likely contains petroleum light no-aqueous phase liquid (LNAPL). Monitored natural attenuation was planned for the groundwater contamination until it reaches the selected cleanup goals. If groundwater contaminants increase in concentration or migrate, additional remediation may be required by ADEC. Preventing migration of groundwater containing fuels, TCE and benzene to Reindeer Creek was specified in the ROD. Monitoring is required until cleanup levels are met for two consecutive years. The organic contaminants are estimated to take approximately 26 years to naturally attenuate. Any new groundwater use must be approved by ADEC. **References**: Jacobs 2014; USAF 2009r	• The groundwater below the lagoon is contaminated with solvents and moving in the aquifer • Cleanup is allowing the contaminants to attenuate naturally; USAF does not expect it to migrate into surface water	**Incomplete exposure pathway** • No one is drinking the fuel and TCE-contaminated drinking water near the site **Potential exposure pathway** • Future use of groundwater could be a concern if the cleanup goals are not met before wells are installed.

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
9a. Former Fuel Pipeline (soil and surface water sampling)	The Army built a 2-inch fuel transmission pipeline to fuel aircraft/vehicles and heat Fort Morrow buildings. The pipeline passed through a 5.8-mile corridor from the marine terminal area to the RRS. The pipeline ran above ground except at where it intersected driveways and in part of the RRS area. The USAF operated the pipeline until the 1978 abandonment of the RRS. Reeve Aleutian Airways then used the pipeline to transport fuel from the marine terminal to the airport. The USAF demolished and removed the pipeline from the airport to the RRS in 1992. Reeve Airlines ceased pipeline operations around 2000. The USAF removed the pipeline from the Marine Terminal to the airport in 2008. **Soil and surface water sampling** • The USAF sampled soil for petroleum and organic compounds, but not inorganic compounds, along the pipeline corridor (Table D.8). The site's greatest concentrations of GRO were estimated to occur along the pipeline corridor. DRO, naphthalene, and arsenic are also chemicals of interest identified by the soil sampling. Soil samples were deeper than the surface (greater than three inches). • In some locations a small hole was dug in the vegetation root mass and the excavation was agitated as the hole was allowed to fill with surficial water. The seeped surface water was sampled in these locations along the pipeline corridor in place of soil (Table D.6). Analysis of the seeped surface water samples detected DRO up to 170,000 µg/L and petroleum related contaminants greater than comparison values for drinking water. Several inorganic contaminants were also detected or had reporting limits greater than drinking water comparison values, including for arsenic, cadmium, chromium, and lead. While the water is not expected to be used for drinking, the drinking water criteria are used as general indicators of the water quality. **References:** USAF 2006, ADEC 2016c, Jacobs 2014	• Fuel contamination of the soil has occurred along the former pipeline. Some areas have been cleaned up. • Fuel contamination may be taken up by plants that are harvested near the pipeline. • Metal contamination has not characterized. • Do not know what surface soil concentrations	**Potential exposure pathway** • Subsistence harvest of plants located near the pipeline (plant data along pipeline not available). • Direct contact with contaminated soil along the former pipeline (indicated by soil at depth in Table D.8) near the Meshik school, airport, old village, between Meshik estates and Meshik school, and near Landfill B.

9b. Former Fuel Pipeline (groundwater sampling)	**Groundwater monitoring wells** have been established along the pipeline. Since the RI/FS was released in 2006, monitoring wells have been established and routinely sampled for fuels and SVOCs at two known spill sites along the pipeline. ATSDR had access to fuel (DRO) measurements from seven groundwater monitoring wells at these two locations. Benzene, DRO, GRO, RRO, antimony, arsenic, lead, selenium, and vanadium were chemicals of interest in groundwater monitoring wells along the pipeline corridor (Table D.11). • Near Meshik School (see description below) • Near Port Heiden Airport (see description below) **Residential well investigation** (n=41) near the pipeline and other waste sites were sampled in 2003 under the Native American Lands Environmental Mitigation Program. Wells were screened from 40-100 feet deep and draw from the primary aquifer in the area. Contaminants, including arsenic, cadmium, copper and iron, were present (Table D.2). DRO was detected at 438 µg/L in a single sample in one of the older HUD buildings. Measurements along the pipeline found DRO up to 14,000 µg/L at 14 feet deep (site FPC, exact location unknown). **Soil boring groundwater samples** from 4–8 feet were analyzed for petroleum and organic compounds but not inorganic chemicals. DRO, GRO and RRO were less than ADEC removal levels but above provisional screening values for aliphatic and aromatic fractions common in DRO, GRO, and RRO (Table D.4). • **Near Old Meshik Village,** a snow plow hit the pipeline in 1985. DRO was detected up to 1,300 µg/L (FPC-029). • **Between Meshik Estates and Meshik School**, a small area of stressed vegetation and sheen on surface water was identified and contamination was confirmed (FPC-066). • **About half way between the airport and residents,** a small area of surface soil contamination and groundwater borings have identified fuel contamination (FPC-173). ATSDR cannot assess the applicability of EPA's levels without analysis of those fractions. The pipeline crosses areas within the former Fort Morrow. Both Army and USAF evaluations are ongoing to determine the nature and extent of fuel contamination within and or outside of the pipeline corridor. The extent of contamination in the groundwater is not well defined. **References:** USAF 2006, ADEC 2016c, Jacobs 2014	• Spills and leaks of fuel from the pipeline resulted in soil and groundwater contamination. • Meshik School well likely pulls from the same aquifer that is contaminated. • Airport well is contaminated • Soil boring groundwater data (above) supports hypothesis that other locations with fuel leaks have contamination that may be in groundwater • Contaminated groundwater may migrate into surface water (especially volatile or semi-volatile organic contaminants in the uppermost aquifers or vadose zone near buildings.	**Completed exposure pathway** • In the past, people ingested fuel-contaminated water (specific to one well). **Potential exposure pathway** • Drinking water at the Meshik School may become contaminated in the future. Meshik school well water likely comes from the same aquifer (see pathway below under Meshik School). (Table D.7) • Drinking water from residential wells located near the pipeline (Table D.2) may be of concern (no recent data).

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
9c. Former Fuel Pipeline (Meshik School)	The Lake and Peninsula School Districts operates Port Heiden's Meshik School which offers preschool through high school instruction. The Meshik school is within the WWI refuse (waste/debris) area and near the fuel pipeline. The drinking water well is 200 feet below ground surface and draws water from a deeper aquifer than most homes. A city maintenance shop and used lead battery storage area (Figures A.9 and A.10) are also near the Meshik school. The batteries are collected for periodic back-haul and recycling and properly stored in a designated building. **In a groundwater investigation related to the pipeline**, the USAF sampled groundwater near the Meshik school and analyzed the samples for petroleum, organics, and inorganics. DRO and GRO were detected at 8,100 µg/L and 900 µg/L near the Meshik school. Iron (17,100 µg/L) and manganese (2,450 µg/L) were detected where analyzed. Between 2009 and 2013, the highest DRO groundwater concentration detected among the four monitoring wells near Meshik School was 4,500 µg/L. **The well water at the Meshik school is tested regularly** and ATSDR reviewed results (Appendix D). The tap water is treated using a combination of permanganate, greensand and cartridge filtration. Arsenic concentrations vary over time and go above the EPAs maximum contaminant level of 10 µg/L. The Meshik school recently added a new filter system to reduce arsenic levels. Copper and lead levels were within EPAs limits in recent years though some levels were greater in the past; other water quality standards were above levels that result in bad taste or smell, including color units and pH ranging outside of EPA recommendations. **Limited monitoring of shallow groundwater** from 4–8 feet deep soil borings less than 100 feet from the Meshik school found DRO up to 4,500 µg/L (site FPC 066). Neither volatile nor semi-volatile organic compounds have been measured in groundwater near the pipeline. (see description 9a above) **References:** Jacobs 2014	• Nearby monitoring wells have fuels and metals; Meshik School well may draw plumes toward the Meshik school. • If plumes in shallow groundwater migrate to the Meshik School, volatile chemicals may evaporate into the building. • Arsenic (likely naturally occurring in the aquifer) is present in the Meshik School's drinking water and is increasing over time. • The Meshik school had pH lower and higher than limits recommended by EPA. • Battery storage areas may release lead and acids which may mobilize metals in soil.	**Completed exposure pathway** • Workers and children drank arsenic, copper, and lead-contaminated water in the past (Table D.1). **Potential exposure pathway** • In the future, workers and children may be drinking fuel- and metal-contaminated water (Tables D.4 and D.7). Other organic compounds may be present in this aquifer as well. • In the future, workers and children may be exposed to volatile organic compounds moving up from the shallow groundwater (Tables D.4 and D.7).

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
10a. Port Heiden Airport	The Army built the two gravel runways during WWII. The airstrip construction involved substantial surface leveling and vegetation removal. No erosion controls appear to have been installed. The runways were lengthened and shortened over time and the length and width of the runways are big as they were in the past. Today, the former military airfield is owned by the Alaska Department of Transportation. The gravel runways are 5,000 feet and 4,000 feet long and 100 feet wide. The USAF, Army, Civil Aeronautics Authority, Federal Aviation Authority, Reeves Aleutian Airways, and State of Alaska have maintained, to some degree, runways and navigation equipment. The main airport building, a larger airport facility building, and several smaller buildings are currently present at the Port Heiden Airport. Many buildings were constructed, moved, or demolished during the airport's existence. In 1944, 22 aircraft berms used for maintenance of fighter and bomber planes may have released fuel, solvents, hydraulic fluids, and other hazardous materials. ATSDR did not find any data related to a WWII Army Air Force Landfill ("AL"). **Groundwater contamination** at Port Heiden Airport has been partially evaluated. Samples were collected near the airport an analyzed for fuels, metals, volatiles, PAHs, and PCBs. In 2004, petroleum was detected at 12,000 µg/L at a monitoring well near the airport. Between 2009 and 2013 the highest DRO groundwater concentration detected among the three monitoring wells near the airport was 14,000 µg/L. Chlorinated volatile contaminants were not included in the analyte list for groundwater samples at the airport. Such contamination has commonly been found at other airports in ATSDR health assessments. Metals were not measured either; lead is commonly associated with aviation gasoline. The two domestic wells sampled at the airport were 40 to 80 feet deep and found non-detect levels of volatiles, PAHs, PCBs, pesticides, DRO, and GRO. Arsenic and iron were slightly greater than comparison values. However, arsenic (3.6 µg/L) was less than EPA's MCL and iron (3,180 µg/L) was only subject to EPA's secondary standards. **References:** USACE 1987, Bush 1944, ATSDR 2010a, Keres 2003, LPSD 2017 personal communication.	• Surface soil may travel with runoff or migrate by windblown erosion. • Contaminated groundwater may migrate into surface water (especially volatile or semi-volatile organic contaminants in the uppermost aquifers or vadose zone near buildings.	**Eliminated exposure pathway:** • No one is drinking the contaminated water at the airport (Table D.2).

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
10b. Port Heiden Airport Tank Farm	• Potential contamination in the airport area has not been fully characterized as a result of disputes in liability. • Groundwater contamination with fuels may migrate toward surface water bodies. • If solvents are in the groundwater, they may evaporate into buildings, more information is needed.	**Potential exposure pathway** • Surface soil or subsurface soil exposed by earth-moving or erosion could present exposures **Incomplete exposure pathway** • People are not using the contaminated aquifer for drinking water. The well at the airport is not used as a source of drinking water.	**Potential exposure pathway** • People foraging, recreating, or working in the area without taking proper precautions could be exposed to soil contamination
10c. Port Heiden Beacon Facility area (near runways)	• Spills and leakage into soil from former drums and above- or underground storage tanks • Contaminated soil releases into groundwater are not migrating offsite • ADEC has institutional controls to prevent digging or well installation **References**: FAA 1999	**Potential exposure pathway** • Potential for vapor intrusion of solvents for buildings that lie over the groundwater plume. **Eliminated exposure pathway** • Cleanup and institutional controls prevent workers from excavating soil without oversight • Visitors and workers at commercial facilities aren't likely to come in contact with contaminated soil • People are not using the contaminated aquifer for drinking water	**Potential exposure pathway** • Visitors and workers may be exposed to contaminants other than fuel **Eliminated exposure pathway** • Workers at the Beacon Facility receive education and training regarding asbestos present in the buildings; FAA has installed controls (and monitoring) to protect workers if asbestos is disturbed

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
11. Wastes Site Areas of Concern (AOC)	Approximately 900+ historical site features are interspersed throughout the 30-square mile Port Heiden area (See Figure 2). The features are inland and along the coastline. Many of these features are military-related, including WWII munition storage and defensive positions, but some are of unknown origin. Sites are in remote areas; however, a number remain accessible and in areas used by Port Heiden residents. USACE defined 13 Areas of Concern (AOCs A-M) to sample. Sizes ranged from 0.38 to 4.43 acres. USACE focused on identifying sites with fuels present. Soil samples were analyzed for POL using ultraviolent fluorescence (UVOST) and metals using X-ray fluorescence (XRF) or laboratory techniques. Based on military use and feature type, potentially associated contaminants were identified during the planning phase of the project. Feature types that were potentially associated with VOCs, SVOCs, pesticides, PCBs or dioxins were sampled for these contaminants during the remedial investigations. A minimum of one soil sample was collected from each feature that might have had these contaminants, and analyzed for select chemicals based on potential military use.". Early USACE meeting minutes reported analytical results of soil (depth unknown) by area and not by specific location. The USACE remedial investigation reports, which ATSDR received in July 2018 and has only summarily reviewed, have more specific information. ATSDR will consider providing a full review of the new data upon request. The USAF 2004 and USACE 2012 and 2016 remedial investigations of areas of concern provide results that help describe the general potential for exposures and releases of site-wide contaminants. Remediation of select locations has occurred and continues as contaminated areas are discovered. **Soil investigations** identified DRO up to 170,000 mg/kg, arsenic up to 28 mg/kg, cadmium up to 10.3 mg/kg and chromium up to 250 mg/kg in soil **Groundwater investigations** found DRO up to 150,000 µg/L, arsenic up to 370 µg/L in groundwater, cadmium up to 12 µg/L, chromium up 550 µg/L in groundwater, and lead up to 50 µg/L. **Surface water investigations** did not trigger criteria for lake or other wetland sampling within 50 feet of a known source. Surface water sources exceed EPA MCLs for some metals that may or may not be naturally occurring. **References:** USACE 2012b, 2013a,b, 2014, 2016 USAF 2006	• Surface soils and subsurface soils exposed by erosion or earth-moving may migrate by runoff and wind erosion • Several streams transect Port Heiden and contaminated soils, surface water, and sediments can migrate according to the watershed runoff areas (Figure A.3)	**Potential Exposure Pathway:** • Direct contact or accidental ingestion of soil at any of the potentially contaminated 900+ features (extent of exposure unable to identify) (metals and petroleum; Limited contamination survey, soil samples were not tested for VOCs, SVOCs, PCBs or dioxins. Data presented as area information not specific information • Drinking contaminated groundwater (location unconfirmed) • Some areas of concern (AOC B, C, D, F) have residences nearby with people more likely to come in contact with contaminated soil or water

Area of Concern	Where contaminants may come from	How contaminants move in the environment	How people may be exposed (exposure pathway evaluation)
Other miscellaneous sites	The village bone yard (miscellaneous site). The bone yard (Figure 4) is an area of scrap metal and debris south of the air strip and north of New Meshik residences (Figure A.2). A community member expressed concern about potential military disposal of vehicles and equipment in a lake west of the New Village, but investigators did not note any visual evidence of such contamination. Dumpsite between the former pipeline and Meshik estates (miscellaneous site). ADEC's Brownfields program is evaluating an old dump by Jacks New Meshik Mall and is in a Phase I investigation. **References:** USAF 2006, ADEC 2016d	• Contamination might reach wetlands, tundra, grasslands and subsistence vegetation. • No vehicles or equipment found in the lake.	**Potential exposure pathway** • Direct contact with contaminated soil or drinking contaminated groundwater may be occurring (ongoing investigation). • Ingestion of berries or plants that are in areas affected by contamination (unknown) **Eliminated exposure pathway:** • Recreational use of the lake may lead to accidental ingestion of contamination if equipment found in lake.

Appendix C . Port Heiden Map User's Guide

What is the purpose of the Port Heiden Maps?

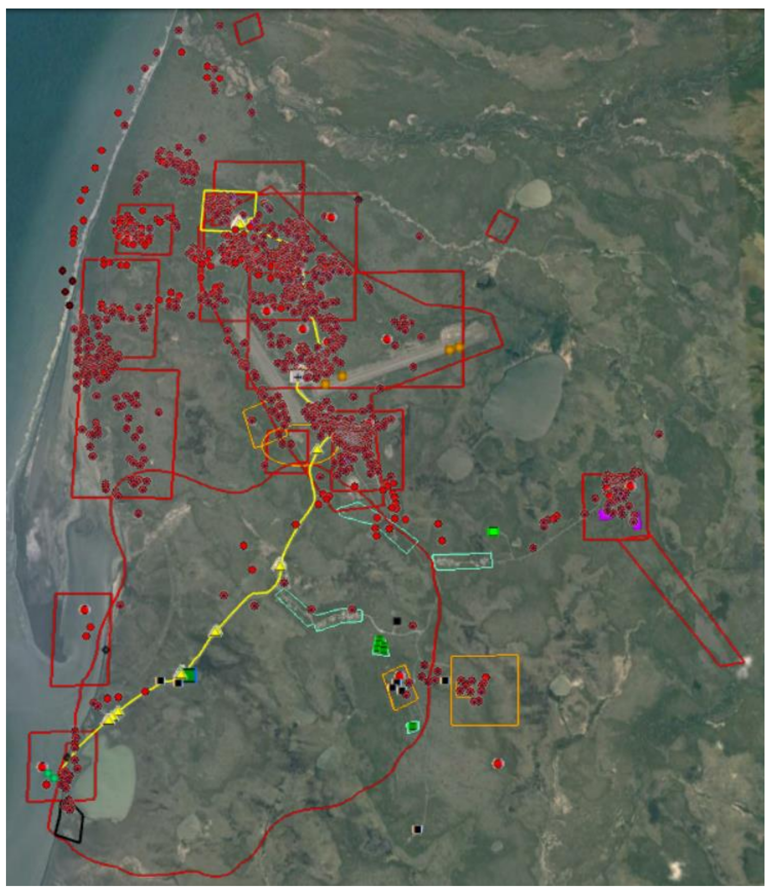
The Port Heiden Tribal Council asked the Agency for Toxic Substances and Disease Registry (ATSDR) to investigate pollution and hazardous materials at the former military sites and landfills at Port Heiden. ATSDR compiled information on historical use areas into two map files. The purpose of these maps is to give community members easy access to information about historical use areas that may be potentially hazardous or contaminated in the Port Heiden area.

How do I access the Port Heiden Maps?

The Port Heiden maps can be opened using the Google Earth app on a smart phone or using the Google Earth program on a computer. You can install the Google Earth app or program on your device at http://google.com/earth. Afterward, just click the Port Heiden map files, and they should open in Google Earth by default. For more resources on using Google Earth, please visit http://google.com/earth/learn/.

How do I understand the information on the Port Heiden Map?

- When you open the Port Heiden maps in Google Earth, you will see the two "layers" or sets of information (data) on top of a satellite photo of the Port Heiden area. One of the layers shows points and the other shows outlines of areas. The screenshot below shows how the maps look when opened in Google Earth.



- In the map window, you can zoom in and out to see features and their surrounding areas more closely or in context. You can move the map around as well.
- Click on individual features within the map window, and a pop-up table will appear with information about the feature. Some features have descriptions and notes in their tables, while others do not.
- Users that are familiar with using Google Earth on the computer will have other capabilities to manipulate the data.

What do the symbols on the map mean?

World War II (WWII) Army areas (1944-2016)*
- Historical munitions locations
- Locations with indications of use
- Main WWII area boundaries

Federal Aviation Administration (FAA) / Civil Aeronautics Administration (CAA) areas (1993-1999)*
- FAA sites (visual approach slope indicator (VASI) system of lights)
- FAA / CAA area boundaries

Air Force areas (1944-2016)*
- Air Force areas of interest
- PH USAF former pipeline investigation
- Removed Air Force tanks

Landfill areas
- Landfill areas (2013-2018)*

Brownfield investigation areas
- Brownfield areas (2002-2018)*

Subsistence food source sampling
- Shellfish sample areas (2006)*

Port Heiden buildings (2003-2018)*
- Airport
- Meshik School
- Current residential areas (approximate)
- Other Port Heiden buildings
- Old Meshik Village area

Subwatersheds (1998-2018)*
- Subwatershed division lines

For information about the data sources and additional site description, please see:

Health Consultation: Evaluation of Potential Exposure to Releases from Historical Military Use Areas, Port Heiden, Alaska. January 31, 2019. Available at: https://www.atsdr.cdc.gov/HAC/PHA/index.asp.

To get the map files: Email Joe Sarcone at jsarcone@cdc.gov.

* These are the dates of the data sources. See Appendix C of the health consultation for the list of sources.

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Appendix D. Environmental Media Data Tables

Table D.1. 1993–2017 Drinking Water Sampling Results for Meshik School, Lake and Peninsula School District, Port Heiden, Alaska*

Chemical	Number of Samples Greater than Comparison Value / Number of Samples with Detections¶	Range of Detected Concentrations (µg/L)	Comparison Value (µg/L)	Type of Comparison Value †	Chemical of Interest?‡
Aluminum (µg/L)	0 / 1	29.1	7,000	EMEG	No
Arsenic (µg/L)	18 / 19	1.4 – 13	0.016	CREG§	Yes
Barium (µg/L)	0 / 3	1.91 – 2.48	1,400	EMEG	No
Chloride (µg/L)	0 / 1	12,400	250,000	secondary MCL	No
Color (color units)	1 / 1	90	15	secondary MCL	Yes
Copper (µg/L)	5 / 28	9 – 2,524	70	EMEG	Yes
Fluoride (µg/L)	0 / 4	0.77 – 874	2,000	secondary MCL	No
Gross alpha (pCi/L)	0 / 1	5	15	MCL	No
Lead (µg/L)	2 / 15	1.28 – 398	15	EPA action level	Yes
Manganese (µg/L)	0 / 1	25.8	350	RMEG	No
Nickel (µg/L)	0 / 3	0.626	140	RMEG	No
pH (unitless)	2 / 2	6.3 – 9.1	6.5 – 8.5	secondary MCL	Yes
Sulfate (µg/L)	0 / 1	3,950	250,000	secondary MCL	No
Total dissolved solids (µg/L)	0 / 1	275,000	500,000	secondary MCL	No
Trichlorofluoromethane (µg/L)	0 / 2	0.6	2,100	RMEG	No

Source: ADEC 2017a

Notes: Table reviews data for all chemicals detected in at least one sample that is documented on ADEC's "Drinking Water Watch" website.

¶ On the Alaska website only samples with analytical detections are reported: http://dec.alaska.gov/DWW/JSP/AnalyteList.jsp?tinwsys_is_number=156&tinwsys_st_code=AK.

* Highlighted values were greater than ATSDR's comparison value.

† Key to health-based comparison values:

- CREG = ATSDR Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- EMEG = ATSDR Environmental Media Evaluation Guide (comparison value for non-cancer health effects)
- RMEG = ATSDR Reference Dose Media Evaluation Guide (comparison value for non-cancer health effects)
- MCL = EPA Maximum Contaminant Level in drinking water (secondary values are based on water aesthetics and not on health effects)
- EPA action level = Concentration used by EPA for evaluating lead levels in drinking water supplies

‡ Chemicals were selected for further evaluation if any measured concentrations exceeded corresponding comparison values, whether based on health effects or water aesthetics (e.g., taste, color, and odor).

§ Background levels may be greater than ATSDR's cancer comparison value.

Table D.2. 2003 Drinking Water Sampling Results from Private Wells, Port Heiden, Alaska

Chemical	Residential and Other Concentrations (µg/L) (41 results)	Airport Concentrations (µg/L) (2 results)	Ray's Place Concentrations (µg/L) (1 results)	Meshik School Concentrations (µg/L) (3 results)[†]	Selected Comparison Value (µg/L)	Type of Comparison Value[§]	Chemical of Interest?[¶]
Inorganic compounds:							
Arsenic	ND* - 8.7	2.1 – 3.6	4.2	ND – 8.2	10	MCL	No
Barium	ND – 4.2	2.7 – 3.8	1.0	2.1 – 6.8	1,400	EMEG	No
Beryllium	ND – 1.5	ND	ND	ND	4	MCL	No
Cadmium	ND – 1.2	ND	ND	ND	0.7	EMEG	Yes
Chromium	ND – 2.1	ND – 1.3	ND	ND – 3.6	6.3	EMEG	No
Copper	ND – 124	ND – 10.9	14.1	3.0 – 23.8	70	EMEG	Yes
Iron	10 – 7,220	538 – 3,180	179	495 – 16,400	300	Secondary MCL	Yes
Lead	ND – 6	ND – 2.1	ND	ND – 2.2	15	Action level	No
Nickel	ND – 4.0	ND – 1.1	7.2	ND – 1.1	140	RMEG	No
Selenium	ND – 2.1	ND – 1.5	ND	ND – 1.7	35	EMEG	No
Organic compounds:							
1,2-Dichloroethane	ND	ND	ND	ND- 0.7	0.27	CREG	Yes
Chloromethane	ND – 1.0	ND	ND	ND	190	RSL	No
DRO	ND – 438	ND	ND	ND	200	TPH	Yes
Methylene chloride	ND	ND	ND	ND – 1.8	6.1	CREG	No
Naphthalene	ND – 28.8	ND	ND	ND	140	RMEG	No
Styrene	ND – 0.6	ND	ND	ND	100	MCL	No

Source of range of concentrations: Keres 2003

[*] ND = non-detect. Highlighted values were greater than ATSDR's comparison value.

[†] The three "school" samples include locations described as "Building 14: Meshik High School," "West of School," and "North of School."

[§] Key to health-based comparison values:

- CREG = ATSDR Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- EMEG = ATSDR Environmental Media Evaluation Guide (comparison value for non-cancer health effects)
- RMEG = ATSDR Reference Dose Media Evaluation Guide (comparison value for non-cancer health effects)
- MCL = EPA Maximum Contaminant Level in drinking water (secondary values are based on water aesthetics and not on health effects)
- Action level = Concentration used by EPA for evaluating lead levels in drinking water supplies
- RSL = EPA Regional Comparison value for residential tap water use
- TPH = Minnesota Department of Health, ATSDR total petroleum hydrocarbon [ATSDR 2010b, MDH 2016, EPA 2016]. Note: ADEC Cleanup Level = 1500 µg/L.

[¶] Chemicals were selected for further evaluation if a measured concentration exceeded a health-based comparison value

Table D.3. USAF Radio Relay Station Cleanup Levels

Contaminant of Concern	Soil Cleanup Levels (mg/kg)
Tetrachloroethene (PCE)	0.03
Dieldrin	0.015
Heptaclor epoxide	0.2
Benzo(a)pyrene (PAH)	1
Benzo(a)anthracene	6
Dibenzo(a,h)anthracene	1
PCBs (Aroclor 1260)	1
Contaminant of Concern	**Groundwater Cleanup Levels (µg/L)**
Benzene	5
Trichloroethylene	5

Source: USAF 2009

mg/kg = milligrams per kilogram; µg/L = micrograms per liter; PAH = polycyclic aromatic hydrocarbons; PCB = polychlorinated biphenyls

*Table D.4. 2004 Water Collected at Soil Borings near the Former Fuel Pipeline Corridor at the Old Meshik Village, between Meshik Estates and the Meshik School, and near Landfill B, * Port Heiden, Alaska*

Chemical	Concentration (µg/L) from Area I: Boring FPC-029†‡	Concentration (µg/L) from Area II: Boring FPC-066†‡	Concentration (µg/L) from Area III: Boring FPC-173†‡	Comparison Value (µg/L)	Type of Comparison Value §
Fuel indicators:					
Diesel range organics (DRO)	460 - 1,300	< 23 - 79	120	200	TPH value ¶
Gasoline range organics (GRO)	44 – 140	< 4.9	ND	200	TPH value ¶
Residual range organics (RRO)	< 39	< 39	360	200	TPH value ¶
Organic compounds:					
1,2,4-Trimethylbenzene	ND	<0.46	ND	56	EPA RSL-nc
4-Isopropyltoluene	<0.37	ND	ND	None available	None available
Acetone	<4.2	ND	ND	6,300	ATSDR RMEG
Benzene	<0.1	<0.15	ND	0.44	ATSDR CREG
Fluorene	<0.25	ND	ND	280	ATSDR RMEG
Phenanthrene	<0.047	ND	ND	170	ADEC
sec-Butylbenzene	<0.56	ND	ND	2,000	EPA RSL-nc

Source: USAF 2006
ND = non-detect; µg/L = micrograms per liter
Notes: Table reviews data for all chemicals detected in at least one sample of water collected from soil borings along the former fuel pipeline corridor. The table does not consider the two areas (FPC-066 and FPC-215) where monitoring wells were present. The water sampling results in this table were not collected from drinking water wells.
* Highlighted values were greater than comparison value or serve as an indicator chemical. ATSDR notes that concentrations would not be relevant to actual exposures. The measured data do not represent exposure concentrations because the groundwater wells are not used for drinking water.
† Key to sampling areas (FPC locations shown in Figure A.7):

- Area I = Two samples at the spill near the old Meshik Village caused when a snow plow hit the pipeline in 1985
- Area II = Two samples at the area of stressed vegetation and sheen on surface water between Meshik Estates and Meshik School
- Area III = One sample in a small area of surface soil contamination near Landfill B

‡ Key to abbreviations and qualifiers used for the sampling data: ND = non-detect; < = measured concentrations below the reporting limit listed.
§ Key to health-based comparison values:

- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide (comparison value for non-cancer health effects)
- ATSDR RMEG = Reference Dose Media Evaluation Guide (comparison value for non-cancer health effects)
- EPA RSL-nc = Regional comparison value for residential drinking water based on non-cancer effects
- ADEC = Alaska Department of Environmental Conservation Cleanup Level

¶ Minnesota Department of Health and ATSDR value for total petroleum hydrocarbons [ATSDR 2010b, MDH 2016, EPA 2016]. Note: ADEC Cleanup Levels are 1,500 µg/L for DRO, 2,200 µg/L for GRO, and 1,100 µg/L for RRO.

Table D.5. 2004 Soil and Groundwater Data from the Marine Terminal Area for General Characterization Purposes (not direct exposure evaluation)[*], Port Heiden, Alaska

Chemical	Highest Soil Concentration (mg/kg)[†]	Comparison Value (mg/kg)	Type of Comparison Value[‡]
Fuel Indicators:			
Diesel range organics	68	10,300	Lowest ADEC Cleanup Value for Direct Exposure
Gasoline range organics	<4.9	3,600	Lowest ADEC Cleanup Value for Direct Exposure
Residual range organics	140	10,000	Lowest ADEC Cleanup Value for Direct Exposure
Inorganic compounds:			
Arsenic [§]	7.57	17	ATSDR EMEG
Cadmium [§]	<0.36	5.7	ATSDR EMEG
Chromium[§]	15.1	51	ATSDR EMEG
Iron	31,300 M		No soil value
Lead[¶]	6.74	400	EPA RSL[**]
Manganese	300	2,900	ATSDR RMEG
Chemical	**Highest Groundwater Concentration (µg/L)[†]**	**Comparison Value (µg/L)**	**Type of Comparison Value[‡]**
Fuel Indicators:			
Diesel range organics	180	1,500	ADEC Cleanup Value
Diesel range organics	180	200	TPH Value[††]
Gasoline range organics	<4.9	2,200	ADEC Cleanup Value
Gasoline range organics	<4.9	200	TPH Value[††]
Residual range organics	210	1,100	ADEC Cleanup Value
Residual range organics	210	200	TPH Value[††]
Inorganic compounds:			
Arsenic	<21	2.1	ATSDR EMEG[‡‡]
Cadmium	<2.1	0.7	ATSDR EMEG
Chromium	<1.2	100	EPA MCL
Iron	48,500	300	EPA secondary MCL
Lead[¶]	<5.4	15	EPA action level**
Manganese	2,800	350	ATSDR RMEG

Source: USAF 2006

ND = non-detect; mg/kg = milligrams per kilogram; µg/L = micrograms per liter;

Notes: Table reviews data for select chemicals in Marine Terminal Area soil and groundwater sampled during the RI/FS. Contamination in these waters was evaluated for its potential to affect other media.

[*] Highlighted values were greater than comparison value or serve as an indicator chemical. ATSDR notes that concentrations would not be relevant to actual exposures. The measured data do not represent exposure concentrations because soil was sampled from the subsurface and the groundwater wells are not used for drinking.

[†] Key to abbreviations and qualifiers used for the sampling data: M = measured value is uncertain due to a matrix effect; < = analyte was less than the method detection limit

[‡] Key to health-based comparison values, which are all based on drinking water exposure assumptions:

- ATSDR EMEG = Environmental Media Evaluation Guide (comparison value for non-cancer health effects)
- ATSDR RMEG = Reference Dose Media Evaluation Guide (comparison value for non-cancer health effects)

- EPA RSL = Regional comparison value
- MCL = EPA Maximum Contaminant Level in drinking water (secondary values are based on water aesthetics and not on health effects)

§ Range of background concentrations in the RI/FS for metals in soil – Arsenic 2.05 to 12.9 mg/kg, Cadmium non-detected to 0.82 mg/kg, Arsenic background levels are greater than ATSDR's cancer risk evaluation guide. Chromium comparison value is for hexavalent chromium.

¶ Lead has no known safe exposure level [CDC 2012]

** ATSDR has not identified a threshold or a safe level of lead exposure for children.

†† Minnesota Department of Health, ATSDR total petroleum hydrocarbon values [ATSDR 2010b, MDH 2016, EPA 2016].

‡‡ Background levels may be greater than ATSDR's cancer comparison value, so the non-cancer level is used.

Table D.6. 2004 Maximum Surface Water Results from Locations along the Former Fuel Pipeline Corridor with the Highest Concentrations of Detected Chemicals, Port Heiden, Alaska.*

Chemical	Highest Surface Water Concentration (µg/L)†	Location of Highest Concentration	Comparison Value (µg/L)	Type of Comparison Value‡
Organic compounds:				
2,4,5-TP (Silvex)	0.094 J	FPC-090	100	WQC
Benzene	0.98	FPC-086	0.58-2.1	WQC
Ethylbenzene	4.7	FPC-074	68	WQC
Fluoranthene	<0.12	FPC-074	20	WQC
Fluorene	<1.5	FPC-074	50	WQC
Pyrene	<0.16	FPC-074	20	WQC
Toluene	2.2	FPC-128	57	WQC
Trichloroethylene	<0.22	FPC-074	0.6	WQC
Inorganic compounds:				
Antimony	<43	FPC-080	5.6	WQC
Arsenic	53	FPC-080	0.018	WQC
Manganese	39,900	FPC-128	50	WQC
Nickel	44	FPC-080	610	WQC
Selenium	<180	FPC-080	170	WQC
Thallium	<9.1	FPC-086	0.24	WQC
Zinc	2,180	FPC-080	7,400	WQC

Source: USAF 2006

µg/L = micrograms per liter

Notes: Table reviews data for all chemicals detected in at least one surface water sample from areas sampled during the RI/FS along the former fuel pipeline corridor (Figure A.7). The "surface water" sampled was typically water that pooled within the root mass of saturated vegetation. Contamination in these waters was evaluated for its potential to affect other media.

* Highlighted values were greater than comparison value or serve as an indicator chemical. ATSDR notes that concentrations may be relevant to limited dermal or ingestion exposures and eating exposed plants and fish/wildlife. This screening method is conservative because the exposures are less than those used to develop these (drinking water) screening values.

† Key to abbreviations and qualifiers used for the sampling data: < = measured concentrations below the reporting limit listed; J = chemical was positively identified but the concentration reported is an estimated value.

‡ Key to health-based comparison values, which are all based on drinking water exposure assumptions:
WQC = EPA national recommended Water Quality Criteria for human health for the consumption of water + organism. Note: Other criteria, such as MCLs, may be more stringent for some of these chemicals [EPA 2017c].

Table D.7. 2004 Groundwater Sampling Results from Monitoring Wells near Meshik School and the Airport close to the Former Fuel Pipeline Corridor, Port Heiden, Alaska*

Chemical	Monitoring Well at Site "FPC-066" near Meshik School (µg/L) †	Monitoring Well at Site "FPC-215" near Airport (µg/L) †	Comparison Value (µg/L)	Type of Comparison Value‡
Fuel indicators:				
Diesel range organics	8,100	12,000	1,500	ADEC Cleanup Value
Diesel range organics	8,100	12,000	200	TPH value
Gasoline range organics	900	710	2,200	ADEC Cleanup Value
Gasoline range organics	900	710	200	TPH value
Residual range organics	ND	490	1,100	ADEC Cleanup Value
Residual range organics	ND	490	200	TPH value
Organic compounds:				
1,2,4-Trimethylbenzene	180	4	56	EPA RSL-nc
1,3,5-Trimethylbenzene	60	43	60	EPA RSL-nc
2-Butanone	<7	Rejected result	4,200	ATSDR RMEG
4-Isopropyltoluene	8.4	5.4	None	None available
Acenaphthene	0.89 J	ND	420	ATSDR RMEG
Acetone	18	Rejected result	6,300	ATSDR RMEG
Anthracene	ND	<0.16	2,100	ATSDR RMEG
Ethylbenzene	32	ND	700	ATSDR RMEG
Fluorene	0.96 J	<0.32	280	ATSDR RMEG
Isopropylbenzene	23 J	ND	700	ATSDR RMEG
m,p-Xylene	160	25	1,400	ATSDR RMEG
Methane	120	Not sampled	None	None available
Naphthalene	120	23	140	ATSDR RMEG
n-Butylbenzene	16	ND	1,000	EPA RSL-nc
n-Propylbenzene	23	ND	660	EPA RSL-nc
o-Xylene	79 J	70	1,400	ATSDR RMEG
Phenanthrene	0.26 J	ND	170	ADEC
sec-Butylbenzene	6.6	ND	2,000	EPA RSL-nc
tert-Butylbenzene	1.6	1.4	690	EPA RSL-nc
Toluene	35	ND	560	ATSDR RMEG
Inorganic compounds:				
Aluminum	<50	Not sampled	7,000	ATSDR EMEG
Arsenic	<7.8	Not sampled	2.1	ATSDR EMEG††
Barium	<15	Not sampled	1,400	ATSDR EMEG
Beryllium	<0.89	Not sampled	4	EPA MCL
Calcium	7,630	Not sampled	None	None available
Chromium**	<1.6	Not sampled	6.3	ATSDR EMEG
Cobalt	<4.7	Not sampled	70	ATSDR int EMEG
Copper	<2.3	Not sampled	70	ATSDR int EMEG
Iron	17,100	Not sampled	300	EPA secondary MCL
Lead	<2.2	Not sampled	15	EPA action level
Magnesium	4,670	Not sampled	None	None available
Manganese	2,450	Not sampled	350	ATSDR RMEG
Mercury	<0.052	Not sampled	2	EPA MCL
Molybdenum	<6.8	Not sampled	35	ATSDR RMEG
Nickel	<3.6	Not sampled	140	ATSDR RMEG
Potassium	2,760	Not sampled	None	None available
Selenium	<4.5	Not sampled	35	ATSDR EMEG
Sodium	15,000	Not sampled	None	None available
Vanadium	<6.4	Not sampled	70	ATSDR int EMEG

Source: USAF 2006

Notes: Table reviews data for all chemicals detected in at least one groundwater sample from monitoring wells sampled during the RI/FS along the former fuel pipeline corridor. All samples reviewed in this table are from monitoring wells, not drinking water wells.

[*] Highlighted values were greater than comparison value or serve as an indicator chemical. ATSDR notes that concentrations would not be relevant to actual exposures. The measured data do not represent exposure concentrations because the groundwater wells are not used for drinking water.

[†] Key to abbreviations and qualifiers used for the sampling data: ND = non-detect; < = measured concentrations below the reporting limit listed; J = chemical was positively identified but the concentration reported is an estimated value; µg/L = micrograms per liter.

[‡] Key to health-based comparison values:

- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide (comparison value for non-cancer health effects), ATSDR int EMEG= intermediate EMEG.
- ATSDR RMEG = Reference Dose Media Evaluation Guide (comparison value for non-cancer health effects)
- EPA MCL = Maximum Contaminant Level in drinking water (secondary values are based on water aesthetics and not on health effects)
- EPA action level = Concentration used by EPA for evaluating lead levels in drinking water supplies
- EPA RSL-nc = Regional screening level for residential drinking water based on non-cancer effects
- ADEC = Alaska Department of Environmental Conservation Cleanup Level

[§] Minnesota Department of Health and ATSDR value for total petroleum hydrocarbons [ATSDR 2010b, MDH 2016, EPA 2016].

**Chromium comparison value is for hexavalent chromium.

[††] Background levels may be greater than ATSDR's cancer comparison value, so the non-cancer level is used.

Table D.8. Health-based comparison values and soil sampling results greater than the U.S. Air Force Remedial Investigation and Feasibility Study's screening criteria, Port Heiden, Alaska*

Chemical	Sites with Soil Concentration Greater than USAF Screening Criteria†	Highest Concentration (mg/kg)‡	Site Number / Depth (feet) of Sample with Highest Concentration†	Comparison Value (mg/kg)	
Diesel Range Organics	2, 3, 4, 5, 7, 8, 9, 11, 12, 13	150,000	2 / unknown (test pit)	10,300 / 250	ADEC
Gasoline Range Organics	9, 13	1,000 J	13 / 9-11	3,600 / 300	ADEC
Residual Range Organics	2	280,000 J	7 / unknown (test pit)	10,000 / 11,000	ADEC
Benzene	14	0.026 J	14 / 2.5-4.5	6.8	CREG
Benz(a)anthracene	3, 10	36 J	3 / 11	1.1	RSL-c
Benzo(a)pyrene	3, 8, 10	31 J	3 / 11	0.12	CREG
Benzo(b) fluoranthene	3	22 J	3 / 11	1.1	RSL-c
Dibenz(a,h) anthracene	3, 10	4.4 J	3 / 11	0.11	RSL-c
Dieldrin	4, 5, 6, 10	5 J	4 / 1-2	0.023	CREG
Heptachlor epoxide	4	1 J	4 / 1-2	0.041	CREG
Indeno(1,2,3-cd) pyrene	3	13 J	3 / 11	1.1	RSL-c
Naphthalene	13	22	13 / 9-11	3.8	RSL-c
Tetrachloroethylene	2	<0.077	2 / 2	180	CREG
Trichloroethylene	2, 4, 5, 6, 7, 8, 12	0.34 J	6 / 59-61	5.7	CREG
Arsenic¶	2-4 and 6-18	11.4	11 / 1	17	EMEG
Cadmium¶	10	10.3	10 / 2	5.7	EMEG
Selenium¶	2, 3, 4, 6, 7, 11, 12, 15, 17, 18	<6.26	11 / 1	290	EMEG

Source: USAF 2006

mg/kg = milligrams per kilogram

* Nearly all soil samples were collected from the subsurface. ATSDR evaluated these sampling data, even though residents do not frequently come into contact with subsurface soils. Chemicals listed included those with soil concentrations at any depth above the RI/FS screening criteria. The large amount of data was not available in spreadsheet format for ATSDR screening and manipulation of the raw data.

† Key to site numbers:

1 = Antenna Pads
2 = Black Lagoon Outfall
3 = Black Lagoon Pipeline/Septic Tank
4 = Cont. Soil Removal Areas
5 = Debris Burial Sites
6 = Drum Storage Area
7 = Focus Area Confirmation Sampling
8 = Former Composite Building Foundation
9 = Gray Lagoon Outfall and Cable
10 = Radio Relay Station Landfill
11 = Septic System Outfall
12 = Underground Storage Tanks
13 = Former Fuel Pipeline Corridor
14 = Marine Terminal Area
15 = Buried Water Tank
16 = Gray Lagoon Pipeline
17 = Septic System Pipeline
18 = Septic Tank

The sites are in the Former Fuel Pipeline Corridor (#13), Marine Terminal Areas (#14), and RRS Facility Source Areas (#1-12 and #15-18) (Figure A.4b).

‡ Highlighted values are greater than health-based comparison values or serve as an indicator chemical. A "J" qualifier means the chemical was positively identified but the concentration reported is an estimated value.

§ Key to health-based comparison values:

- ADEC = Lowest ADEC Cleanup Value for Direct Exposure / Migration to groundwater value [ADEC 2018]
- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide
- EPA RSL-c = Regional screening level for residential soil based on cancer effects

¶ Range of background concentrations in the RI/FS for metals in soil – Arsenic 2.05 to 12.9 mg/kg; Cadmium on-detected to 0.82 mg/kg; Selenium 4.89-32.9 mg/kg. Arsenic background levels are greater than ATSDR's cancer risk evaluation guide.

Table D.9. Health-based comparison values and groundwater sampling results greater than the U.S. Air Force Remedial Investigation and Feasibility Study's screening criteria, Port Heiden, Alaska*

Chemical	Sites with Groundwater Concentration Greater than Screening Criteria†	Highest Concentration (µg/L)‡	Site Number of Sample with Highest Concentration†	Comparison Value (µg/L)	Type of Comparison Value§
Diesel range organics	2, 12, 13	170,000	13	200	TPH¶
Gasoline range organics	13	3,250	13	200	TPH¶
Residual range organics	2, 9, 10, 13	84,000 J	2	200	TPH¶
Benzene	2, 13	9.4	13	0.44	CREG
Dieldrin	6	0.058 J	6	0.0015	CREG
Tetrachloroethylene	2	15	2	5	MCL
Trichloroethylene	2, 4, 6, 12	690 J	6	0.43	CREG
Antimony	2, 6, 7, 12, 13, 14	<43	13	2.8	RMEG
Arsenic	6, 10, 13	370	6	2.1	EMEG**
Barium	6, 10, 12	3,770	6	1,400	EMEG
Beryllium	4, 6, 10, 12	21	12	4	MCL
Cadmium	6, 10	12	10	0.7	EMEG
Chromium (total)	6, 10	550	6	100	MCL
Lead	6, 10, 13	150	6	15	EPA action level
Nickel	6, 10, 12	730	6	140	RMEG
Selenium	6, 13	180	13	35	EMEG
Vanadium	6, 10, 13	2,630	6	70	Int EMEG

Source: USAF 2006
µg/L = micrograms per liter
* Chemicals listed included those with groundwater concentrations above the RI/FS screening criteria.
(shaded) values are greater than comparison values or serve as an indicator chemical. The groundwater sampling data were not collected from drinking water wells. ATSDR evaluated these sampling data because the contamination might eventually migrate toward drinking water supplies.
† Key to site numbers:

1 = Antenna Pads
2 = Black Lagoon Outfall
3 = Black Lagoon Pipeline/Septic Tank
4 = Cont. Soil Removal Areas
5 = Debris Burial Sites
6 = Drum Storage Area
7 = Focus Area Confirmation Sampling
8 = Former Composite Building Foundation
9 = Gray Lagoon Outfall and Cable
10 = Radio Relay Station Landfill
11 = Septic System Outfall
12 = Underground Storage Tanks
13 = Former Fuel Pipeline Corridor
14 = Marine Terminal Area
15 = Buried Water Tank
16 = Gray Lagoon Pipeline
17 = Septic System Pipeline
18 = Septic Tank

‡ Key to qualifiers used for the sampling data: J = chemical was positively identified but the concentration reported is an estimated value
§ Key to health-based comparison values:

- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide for child exposures; Int = intermediate EMEG
- ATSDR RMEG = Reference Dose Media Evaluation Guide
- EPA Action Level = Concentration used by EPA for evaluating lead levels in drinking water supplies
- EPA MCL = Maximum Contaminant Level in drinking water

¶ Minnesota Department of Health and ATSDR value for total petroleum hydrocarbons [ATSDR 2010b, MDH 2016, EPA 2016]. Note: ADEC Cleanup Levels are 1,500 µg/L for DRO, 2,200 µg/L for GRO, and 1,100 µg/L for RRO.
** Background levels may be greater than ATSDR's cancer comparison value, so the non-cancer level is used.

*Table D.10. 2012 Site-wide soil detected sampling results from Army Investigations * compared with health-based screening values, Port Heiden, Alaska*

Chemical	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Type of Comparison Value†	Location	Depth (feet)
Diesel range organics (DRO)	25,000	10,300 / 250	ADEC	AOC B	12
Residual range organics (RRO)	14,000	10,000 / 11,000	ADEC	AOC J	0.5-1
Arsenic	28	0.25	CREG	AOC C	10-12
Chromium§	370	51	EMEG	AOC C	4-8
Lead	4,300‡	400	EPA Action Level	AOC J	0.5-1
Methyl-t-butyl ether (MTBE)	7.7	17,000	Intermediate EMEG	AOC H	2-3
Bromomethane	0.3	80	EMEG	AOC C	4-6
2-Methylnaphthalene	18	230	RMEG	AOC C	4-6

Source: USACE 2013a, 2016

Mg/kg = milligrams per kilogram

Notes: * Highlighted values are greater than comparison value or serve as an indicator chemical. It is unclear if many of these data represent exposure concentrations because the meeting notes that document these sampling results do not specify the depths or locations where the samples were collected. The Army performed removals of areas of contamination as part of more recent investigations [USACE 2016]. ATSDR has not fully reviewed the recently obtained reports of new site-wide data, but can do so upon request.

† Key to health-based comparison values:

- ADEC = Lowest ADEC Cleanup Value for Direct Exposure / Migration to groundwater value [ADEC 2018]
- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide
- ATSDR RMEG = Reference Dose Media Evaluation Guide
- EPA Action Level = Concentration used by EPA for evaluating surface soil contamination data for lead

‡ The meeting notes that document these sampling results do not specify the size fraction of the soils that were sampled. Lead contamination tends to be enriched in the finer (dust-sized) soil fraction to which people are most exposed.

§ Chromium comparison value is for hexavalent chromium

Table D.11. 2012 Site-wide groundwater sampling results compared with health-based screening values from U.S. Army Investigations , Port Heiden, Alaska*

Chemical	Concentration (µg/L)	Comparison Value (µg/L)	Type of Comparison Value†	Location
Diesel Range Organics (DRO)	28,000	200	TPH¶	AOC C
		1,500	ADEC	
Residual Range Organics (RRO)	2,800	1,100	ADEC	AOC B
Arsenic	11	2.1	ATSDR EMEG§	AOC J
Cobalt	12	70	ATSDR Intermediate EMEG	AOC J
Iron	46,000	300	EPA secondary MCL	AOC J
Lead	24	15	EPA Action Level	AOC J
Manganese	720	350	ATSDR RMEG	AOC C

Source: USACE 2013a, 2016
µg/L = micrograms per liter
Notes: * Highlighted values are greater than comparison value or serve as an indicator chemical. It is unclear if the many of these data represent exposure concentrations because the meeting notes that document these sampling results do not specify the depths or locations where the samples were collected. The Army performed removals of areas of contamination as part of investigations [USACE 2016]. ATSDR has not fully reviewed the recently obtained reports of new site-wide data with depths and locations, but can do so upon request.
† Key to health-based comparison values:

- ADEC = Alaska Department of Environmental Conservation groundwater cleanup level [ADEC 2018]
- ATSDR CREG = Cancer Risk Evaluation Guide (comparison value for cancer health effects)
- ATSDR EMEG = Environmental Media Evaluation Guide
- ATSDR RMEG = Reference Dose Media Evaluation Guide
- EPA secondary MCL = Maximum Contaminant Level in drinking water (secondary values are based on water aesthetics and not on health effects)

¶ Minnesota Department of Health and ATSDR value for total petroleum hydrocarbons [ATSDR 2010b, MDH 2016, EPA 2016].
§ Background levels may be greater than ATSDR's cancer comparison value, so the non-cancer level is used.

Appendix E. Cockles and Crowberry Data

Table E.1 2004 Shellfish (Cockle) Sampling Results from Offshore Waters Near the Marine Terminal Area, Port Heiden, Alaska*

Chemical	Composite Sample 1 (mg/kg)†	Composite Sample 2 (mg/kg)†	Average Background Concentration‡ (mg/kg)	Alaska Average Cockle / Composite Concentration (mg/kg, wet weight)	Health-Based Comparison Value and Type§ (mg/kg, wet weight)	Chemical of Interest? ¶
Aluminum	191 M	484 M	225	Not measured	326 (RSL-nc)	Yes
Antimony	<2.35	<0.58	1.04	Not measured	0.13 (RSL-nc)	Yes
Arsenic	<1.84	<1.43	1.58	1.172 (5 samples) / 1.9	0.00058 (RSL-c)	Yes
Barium	0.94 M	1.39 M	1.43	Not measured	65 (RSL-nc)	No
Cadmium	<0.46	0.55	0.38	0.068 (5 samples) / 0.089	0.33 (RSL-nc)	Yes
Calcium	876	978	573	Not measured	None available	Yes
Chromium	8.59 M	17 M	5.40	Not measured	0.00175 (RSL-c)	Yes
Cobalt	0.19 M	0.27 M	0.28	Not measured	0.098 (RSL-nc)	Yes
Copper	2.18 M	2.15 M	1.39	0.786 (5 samples) / 1.1	13 (RSL-nc)	No
Iron	332 M	598 M	350	Not measured	230 (RSL-nc)	Yes
Lead	<0.86	<0.65	0.66	0.129 (5 samples) / non detect	None available	No
Magnesium	706	759	798	Not measured	None available	No
Manganese	14 M	15.1 M	11.4	Not measured	46 (RSL-nc)	No
Mercury	0.0097	0.014	0.016	0.019 (5 samples) / non detect	None available	No
Nickel	4.12 M	9.15 M	4.47	Not measured	3.58 (RSL-nc)	Yes
Phenanthrene	0.0015 UM	0.011 M	13.3	Not measured	None available	No
Potassium	870	978	1,709	Not measured	None available	No
Selenium	<0.78	<0.76	0.71	1.2 (5 samples) / 1.4	1.63 (RSL-nc)	No
Sodium	3,110 M	3,400 M	4,510	Not measured	None available	No
Vanadium	1.44 M	2.14 M	0.98	Not measured	1.64 (RSL-nc)	Yes
Zinc	17 M	14.7 M	12.4	Not measured	98 (RSL-nc)	No

Source of measured concentrations during RI/FS: USAF 2006; **Source of Alaska Fish Monitoring Program average concentrations for 2001 - 2016:** ADEC 2017c

Notes: * Highlighted values were greater than ATSDR's comparison value. mg/kg = milligrams per kilogram

† Unknown basis of wet or dry weight; Data qualifiers: < = measured concentration below the reporting limit; M = measured values uncertain because of a matrix effect;

U = chemical was analyzed for but not detected; the concentration shown is either at or below the detection limit.

‡ Seven background cockle samples were collected during the RI/FS at locations approximately 1 to 1.5 miles north of the location where Marine Terminal Area samples were collected. These background sampling locations are not immediately adjacent to the Marine Terminal Area, but are within an area expected to be affected by contaminants in runoff from various other sources in Port Heiden.

§ Comparison values calculated by applying EPA's Regional Screening Level (RSL) calculator [EPA 2017b]. For screening purposes, ATSDR assumed all default values except for the cockle ingestion rate of 256 grams/day based on fish ingestion rates for adults reported for other Alaska villages [Seldovia 2013].

¶ Chemicals were selected for further evaluation as follows: For chemicals with a health-based comparison value, chemicals were selected if either composite sample had a concentration higher than the corresponding comparison value. For chemicals without a health-based comparison value, chemicals were selected if both composite samples had concentrations higher than the corresponding background value.

Table E.2 2004 Crowberry Sampling Results from the RRS and Background Sites

Chemical	Former Facility Area (mg/kg; 4 samples)*	Background Sites (8 samples)
4,4-DDT'	0.00037 U – 0.0015 J	Not detected
Aluminum	10.2 F – 14.1 F	6.52 – 18.6
Antimony	0.48 F – 0.94 F	0.44 – 7.7
Arsenic	0.36 U – 0.43 F	0.4 – 0.61
Barium	0.43 F – 0.55 F	0.26 – 0.92
Cadmium	0.076 U – 0.32 F	0.093 – 0.093
Calcium	61 F – 170	89.4 – 292
Chromium	0.81 F – 1.2	0.22 – 2.95
Copper	0.54 F – 2.97	0.75 – 2.95
Endosulfan sulfate	0.00028 U – 0.00094 J	Not detected
Fluorene	0.00048 U – 0.0006 F	0.6 – 1.2
Iron	8.62 B – 15.5 B	5.49 – 25.7
Lead	0.4 F – 0.57 F	0.39 – 0.62
Magnesium	34.5 F – 110	39.5 – 118
Manganese	1.05 – 4.44	2.26 – 7.11
Naphthalene	0.0016 F – 0.002 F	1.4 – 2
Nickel	0.42 F – 0.59 F	0.16 – 1.41
Phenanthrene	0.0048 F – 0.0068 M	4.4 – 8.6
Potassium	396 M – 1,700 M	312 – 2,010
Sodium	51 M – 120 M	46 – 123
Zinc	1.35 F – 3.5	1.94 – 7.19

Source of measured concentrations: USAF 2006

Notes: In some cases, the minimum and maximum concentrations in the background samples were equivalent.
mg/kg = milligrams per kilogram; unknown wet/dry weight

* Data qualifiers are:

U = Chemical was not detected. The value shown is the method detection limit.
F = Chemical was positively identified but the value is below the reporting limit.
B = Chemical was found both in the berry sample and in the associated blank sample.
J = Chemical was positively identified but the reported concentration is an estimated value.
M = Measured values are uncertain due to a matrix effect.

Appendix F. USAF and USACE Reports Unavailable at the Time of Development of this Health Consultation

[ADEC] Alaska Department of Environmental Conservation. Mar 26, 2013. Letter subject: Port Heiden Site A Cap Maintenance Report.

[USACE] U.S. Army Corps of Engineers. Nov 2011. Fort Morrow Systematic Planning Summary Document for a Remedial Investigation at Port Heiden, Alaska.

[USACE] U.S. Army Corps of Engineers. Jun 2012a. Port Heiden/Fort Morrow Remedial Investigation, Port Heiden, Alaska Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP).

[USACE] U.S. Army Corps of Engineers. Nov 2012c. Port Heiden/Fort Morrow, Landfill Site A Cap Maintenance Report.

[USACE] U.S. Army Corps of Engineers. Nov 2013. Remedial Investigation Report, Fort Morrow Remedial Investigation Port Heiden, Alaska.

[USACE] U.S. Army Corps of Engineers. Jun 2014. Port Heiden/Fort Morrow Remedial Investigation, Phase II Port Heiden, Alaska Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP).

[USACE] U.S. Army Corps of Engineers. Jan 2015. Preliminary Assessment Port Heiden / Fort Morrow Port Heiden.

[USACE] U.S. Army Corps of Engineers. Nov 2016. Fort Morrow Phase II Remedial Investigation Report Port Heiden, Alaska.