Pollution and Cancer in Alaska

Atomic Energy Commission lowering 5-megaton Spartan Missile nuclear warhead into Cannikin mile-deep hole on Amchitka Island, Alaska, November 6, 1971 (LLNL, 1971).

Table of Contents

List of Tables

1.0 Pollution in Alaska

What are Alaska's environmental and health concerns? The U.S. Environmental Protection Agency (EPA) published what they consider the most pressing environmental issues in the Pacific Northwest, including Alaska (EPA, 2004):

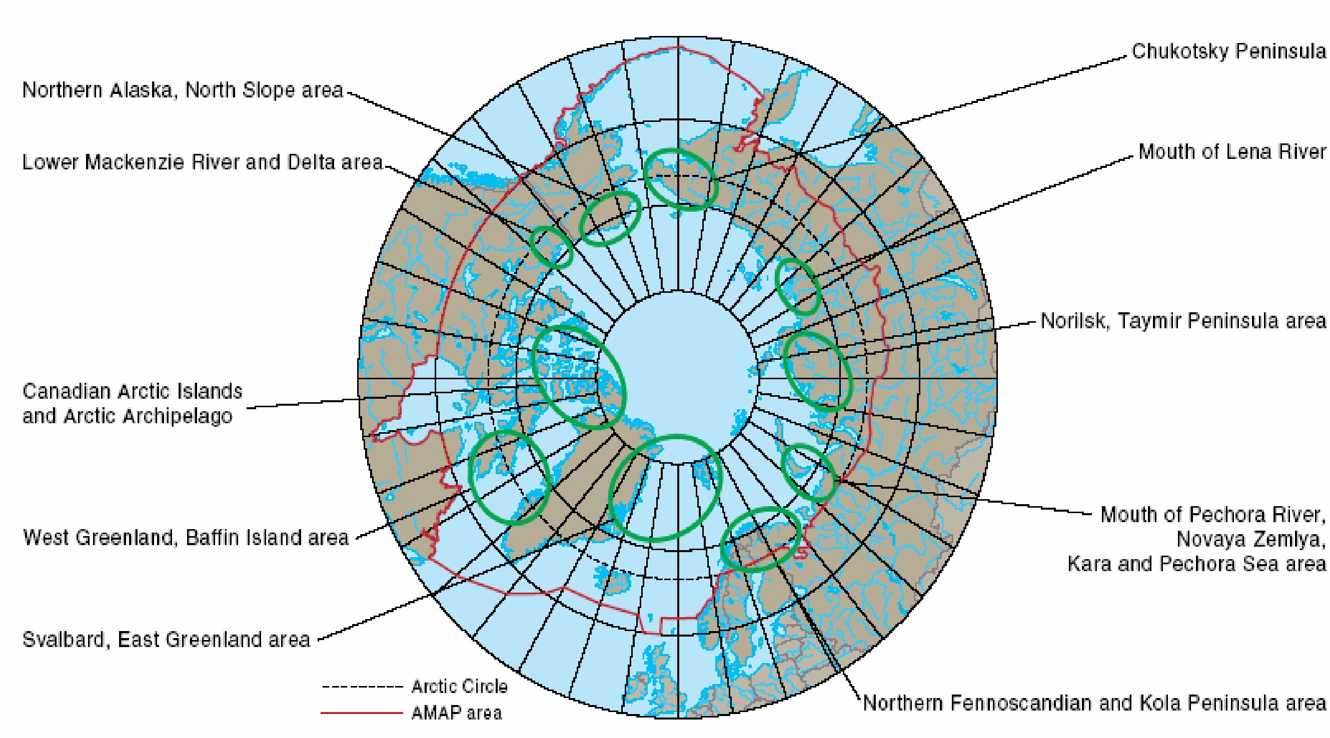
1) Tribal Environmental Health- "*alarmingly high rates of cancer* and influenza in Native communities" possibly related to poor drinking water quality, contamination of food sources and poor indoor air quality.

2) Clean-up of Contaminated Sites- human health and wildlife health impacts due to contaminated sites.

3) Oil & Gas Exploration- the expansion of the oil and gas industry into new areas of Alaska brings with it potential impacts due to large oil spills and low level hydrocarbons on tribal subsistence concerns and wildlife health.

EPA's concerns have been reverberated in several recent, comprehensive, environmental surveys conducted in Alaska and throughout the Artic environment. In 1991, ministers of several Artic countries adopted the Artic Environmental Protection Strategy (AEPS) and established the Artic Monitoring and Assessment Program (AMAP). Participating countries include Iceland, Russia, Canada, Denmark, Greenland, Finland, Norway, Sweden and the United States, among others. AMAP was requested to "examine levels of anthropogenic pollutants… from any sources… and to assess their affects in all relevant compartments of the Artic environment" (AMAP, 1997). The study area for AMAP is the land mass above the artic circle, including all of Alaska (see figure below).

AMAP has identified and focused on several environmental issues and contaminants affecting the health of the Arctic's indigenous peoples and its wildlife, including those found in Alaska. The primary objectives of AMAP are identifying trends and affects on human and wildlife health due to persistent organic pollutants (POP), polyaromatic hydrocarbons (PAH), heavy metals (HM) and radiation. All of these pollutants are toxic and both EPA and AMAP are concerned with the health affects of toxic pollutants on indigenous people and wildlife in Alaska and the Artic. Other concerns of AMAP include global climate change, ultra-violet radiation and acidification of arctic lakes. Indigenous people of the Artic, including Alaskan natives, also participate in AMAP on various levels. Scientists throughout the world and within AMAP collect and assess existing environmental information for the Artic and sub-artic environment with the purpose of producing integrated assessment reports on the status and trends of the conditions of the Artic ecosystems, including the health of its indigenous peoples (AMAP, 2004). There have been several excellent reports generated by AMAP which describe current environmental health issues facing the wildlife and indigenous peoples of the Artic, including Alaska (AMAP, 1997; AMAP, 2003; AMAP, 2004). The full reports can be viewed and downloaded at www.amap.no.



Artic Monitoring & Assessment Program Study Area (AMAP, 2004)**.**

Many parts of Alaska are pristine, untouched by pollution. However, Alaska also has thousands of hazardous waste sites including active and formerly used defense sites (FUDs), National Priority List (NPL) or Superfund Sites, active and abandoned mine sites, solid and industrial waste landfills, as will be described in this document. One purpose of this document is to identify local sources of contaminants (POP, PAH, HM, radiation) in Alaska. Chapter 2.0, Chapter 3.0, Chapter 4.0 and Chapter 5.0 discuss local sources of POP, PAH, HM and radiation in Alaska, respectively.

In addition, Alaska has a high incidence rate for many types of cancer when compared to the lower 48 states. A primary purpose of this document is to bring available cancer statistics to light for Alaska's residents as well as for epidemiologists and environmental scientists working in Alaska. Chapter 6.0 summarizes some of the available cancer statistics for Alaska. It is hoped that this information will be used by concerned residents, epidemiologists, scientists and others in an attempt to discover what relationship the high rate of cancer may have to local sources of contaminants in Alaska's environment.

2.0 Persistent Organic Pollutants in Alaska

2.1 Health Effects of Persistent Organic Pollutants

Persistent organic pollutants (POP) include the chlorinated pesticides-aldrin, chlordane, dieldrin, dichlorodiphenyltrichloroethane (DDT), endrin, heptachlor, hexachlorobenzene, mirex, and toxaphene, as well as polychlorinated biphenyls (PCB), polychlorinated dibenzo-p-dioxins & dibenzofurans (PCDD/F), and brominated flame retardants (AMAP, 2004). POP have common physical and chemical properties that allow them to remain in the Arctic environment including the ability to be transported long distances via air and water; the ability to persist in the environment; the ability to bioaccumulate or magnify up the food chain; the ability to cause disease in wildlife and humans. Other persistent organic pollutants include butylated tin, methylated mercury and polyaromatic hydrocarbons (PAH). New POP, such as chlorinated paraffins, brominated diphenyl ethers and other flame retardants are being characterized and studied in the environment, however their health affects and transportation mechanisms are not as well known.

The ability of POP to persist in Alaska's environment, bioaccumulate up the food chain, and to enable disease earns them the reputation of the most widespread and toxic group of pollutants. POP have been documented in Alaska on all trophic levels including, but not limited to, lichens and mosses of the Arctic tundra, marine invertebrates of the Chukchi and Beaufort Seas, resident and anadromous fish such as burbot (*Lota lota*), arctic char (*Salvelinus alpinus*), arctic grayling (*Thymallus arcticus*), arctic cod (*Boreogadis saida*), pink salmon (*Oncorhynchus gorbuscha*), top level predators such as the American peregrine falcon (*Falco peregrinus anatum*), sea otter (*Enhydra lutris*), northern fur seals (*Callorhinus ursinus*), ringed seals (*Phoca hispida*), bearded seals (*Erignathus barbatus*), resident and transient killer whales (*Orcinus orca*), beluga whales (*Delphinapterus leucas*), bowhead whales (*Balaena mysticetus*), Stellar sea lion (*Eumetopias jubatus*), Walrus (*Odobenus rosmarus divergens*), polar bears (*Ursus maritimus*), and man (*Homo sapien*) (AMAP, 2004).

In wildlife, mass mortality among sea mammals (seals, porpoises, dolphins and whales) has been linked to contamination with PCB which is thought to lead to a suppression of the immune system, making them more susceptible to the morbillivirus, a phocine distemper virus (AMAP, 2003). A higher incidence of infectious disease is also apparent in contaminated sea otters (*Enhydra lutris*) environmentally exposed to PCB (AMAP, 2004). Sea otters in Alaska's western Aleutian Islands were found to have PCB levels in their livers that were 38 times greater than otters living in southeast Alaska (AMAP, 2004). The U.S. Fish and Wildlife Service recently listed the southwest Alaska Distinct Population Segment of the northern sea otter (*Enhydra lutris kenyoni*) as threatened under the Endangered Species Act (ESA) (USFWS, 2006). Higher concentrations of PCB are also present in endangered Stellar sea lions (*Eumetopias jubatus*) living in the western Aleutian Islands compared to the Stellar sea lions living in the Gulf of Alaska and Southeast Alaska. Monitoring is required to determine if there is a relationship between the hundreds of formerly used defense sites and three atomic blasts that occurred in the Aleutian Islands and the decline of the marine mammals that inhabit these islands?

There are many potential human health affects related to exposure of POP including but not limited to: cancer, birth defects, immune system defects, altered sex hormone balance, neurological affects, behavioral abnormalities, altered metabolism and specific organ dysfunction, infertility, low birth weight, abnormal development of the fetus resulting in abnormal neurodevelopment, susceptibility to infection in infancy, elevated childhood blood pressure, asthma, chloracne, skin rashes and lesions (Carpenter et al., 1998; AMAP, 2004). Some POP are carcinogens while others act on the nervous, reproductive or immune systems of both humans and wildlife. Some POP mimic the estrogen and androgen hormones of the mammalian endocrine system, called endocrine disruptors, having multiple subtle affects which are just now being understood. Marine mammals and birds are generally susceptible to the same diseases that are associated with exposure to POP as seen in humans. The *exact* biochemical mechanisms by which toxic pollutants trigger their multiple affects remains unknown for some diseases like cancer. Multiple toxins can trigger multiple affects or suppress the effect of another toxic pollutant. Although we may never be able to establish an exact cause and effect relationship between toxic compounds in our environment and cancer, we do know enough not to ingest these compounds in our drinking water, the air we breathe, or the food we eat.

The primary, local sources of POP in Alaska are solid and industrial waste landfills, the open burning and incineration of solid waste, active and formerly used defense sites (FUDs), National Priority List (NPL) or Superfund sites, federal, state and privately owned contaminated sites. Most villages and boroughs in Alaska are spread out and not connected by roads. Transportation of solid and hazardous waste out of the local community is expensive and often not logistically possible. Therefore, solid and hazardous waste tend to remain where they are created. Disposal of waste in the local community remains a health concern. In Alaska, open burning of solid waste or garbage is routine, although not legal. Restrictions on open burning are generally not enforced in rural communities. Dioxins (PCDD/Fs) are some of the most toxic substances know to man and can enter the environment as by-products of incomplete combustion or low temperature incineration of chlorine containing compounds such as plastics prevalent in solid waste (AMAP, 2004). The primary route of exposure to people from this source of dioxins is from inhalation of airborne contaminants.

There are many un-monitored, Class III, municipal solid waste landfills in rural Alaska, in addition to industrial solid waste monofills, that may be sources of POP in Alaska. Monitoring is required to determine the extent and nature of potential contamination from these sources. Small drinking water systems and private drinking water wells are not regulated under the SDWA and may be act as a route of exposure to local residents. Monitoring of small system and private wells is needed to determine if residents are being exposed to POP and other contaminants in their drinking water. The following sections describe some of the local sources of POP in Alaska's environment including hazardous waste sites, Formerly Used Defense Sites (FUDs), solid and industrial waste landfills and drinking water.

2.2 Contaminated Sites in Alaska

The mission of the Alaska Department of Environmental Conservation's (ADEC) Contaminated Sites Program is to protect public safety, public health and the environment by identifying, overseeing and conducting the cleanup and management at contaminated sites in Alaska and by preventing releases from underground storage tank systems and unregulated aboveground storage tanks (www.state.ak.us/dec/spar/csp/index.htm.). ADEC administers the Contaminated Sites Program through regulations found at 18 AAC 75. ADEC manages or co-manages the investigation and remediation of all federal, state, native and privately owned contaminated properties within Alaska, including those with leaking undergrounds storage tanks (LUSTs).

ADEC's in-house Contaminated Sites Program database was queried to quantify the number of contaminated sites and LUST sites in Alaska (Table 1). There are an estimated 3,513 open and 885 closed hazardous waste sites in Alaska, not including 2,297 open and closed LUST sites (ADEC, 2004a). There are currently an estimated 1,200 Department of Defense (DOD) contaminated sites in Alaska (ADEC, 2004a). The DOD is responsible for six of the twelve NPL sites in Alaska and approximately one-third of all active contaminated sites in Alaska. In addition, to active military base sites, there are inactive military or formerly used defense sites (FUDs). Hazardous waste sites in Alaska include Superfund or National Priority List (NPL) Sites; active military base sites; formerly used defense sites (FUDS); and those owned or controlled by the State of Alaska. Active contaminated sites, including LUST sites, are presented by City and order of cleanup priority (high, medium, low) in **Appendix A**- Contaminated Sites in Alaska by City (ADEC, 2004a).

Table 1. Contaminated Sites and LUST Summary for Alaska (ADEC, 2004a).

Site Description	Total Number of Sites in Alaska	Status
Total Number of Contaminated Sites	3,513	Active, Inactive, No Further Remedial Action Planned, Closed
Total Number of LUST Sites	2,297	Open & Closed
Total Number of FUD Sites	409 = ADEC Estimate 625= ACOE Estimate	Active, Inactive, No Further Remedial Action Planned, Closed
Total Number of DOD Contaminated Sites	944	Active or Inactive (not including FUDs)
Total Number of DOD LUST Sites	70	Active or Inactive (not including FUDs)
Total Number of Superfund Sites (CERCLA)	94	Active or Inactive
Total Number of Contaminated Sites Owned by or PRP is State of Alaska	556	Active, Inactive, No Further Remedial Action Planned, Closed

The location of all National Priority List sites, FUDs, active Department of Defense (DOD) contaminated sites, and state owned or controlled contaminated sites in Alaska (not including LUST sites) are displayed in **Appendix B**- Figure 1. Aleutian Region Contaminated Sites; Figure 2. Bristol Bay Region Contaminated Sites; Figure 3. Copper River Region Contaminated Sites; Figure 4. Interior Region Contaminated Sites; Figure 5. Kenai Region Contaminated Sites; Figure 6. Northern Region Contaminated Sites; Figure 7. Southcentral Region Contaminated Sites; Figure 8. Southeast Region Contaminated Sites; Figure 9. Western Region Contaminated Sites; Figure 10. Kodiak Region Contaminated Sites (ADEC, 2004a).

As shown in Figures 1 through 10, there are hundreds of contaminated sites located along Alaska's coast and adjacent to Alaska's freshwater resources (rivers, lakes, streams, wetlands). Additional monitoring and assessment are required in these areas to determine the spatial extent of contamination, impacts on estuarine sediments, deltas, lakes, rivers and streams wetlands, and to ascertain impacts on fish, wildlife and human health. The number of contaminated sites, including LUST sites, within select Cities or geographical areas can be very high. For example, there are approximately 427 contaminated sites in the Anchorage area; 377 contaminated sites in the Fairbanks area; 317 contaminated sites on the Kenai Peninsula; 98 contaminated sites in the Matanuska-Susitna Borough; and 93 contaminated sites on Kodiak Island (population 13,811). There are hundreds of hazardous waste sites on Alaska's Aleutian Islands including 374 contaminated sites on Adak Island, 57 near Unalaska, 56 on Amchitka Island, 19 near Dutch Harbor and 18 near Cold Bay to mention some (**Appendix A**).

The volume of waste disposed of at each contaminated site may be unknown. Contaminants may have been once contained in thousands of drums or multiple underground storage tanks. For example, at the King Salmon Air Force Station it is estimated that over 500,000 drums with unknown contents have been buried adjacent to King Salmon and Eskimo Creeks. Many contaminated sites have not been investigated or remediated and the nature and spatial extent of contamination as well the potential threat to human and ecological health is not known for many contaminated sites throughout Alaska. Contaminated sites can include all categories of toxic pollutants: PCB, dioxins, PAH, petroleum product, heavy metals, pesticides and radionuclides. The monitoring, assessment and restoration of contaminated sites is one of Alaska's environmental priorities due to the toxicity of contaminants present, their ability to persist in the environment, proximity to towns and villages, the unknown volume and unknown spatial contamination, the toxicological threat posed to human and wildlife health.

2.2.1 Cleanup Levels

ADEC's Contaminated Sites Program cleanup levels for soil and groundwater are found at 18 AAC 75 .340 and 18 AAC 75.345, respectively. Cleanup levels for contaminants in soil vary based on whether a site is located in the artic zone or not and proximity to the water table, among other factors (18 AAC 75.340 Tables A1 and A2). Site specific alternative soil cleanup levels can be developed by the PRP using site specific inhalation or ingestion levels and/or soil characteristics (18 AAC 75.340 Tables B1 and B2). ADEC's cleanup levels for groundwater are found in Table C (18 AAC 75.345). Groundwater contaminant cleanup levels may equal a concentration ten (10) times the cleanup levels in Table C, if groundwater is not a current source of drinking water. The PRP may also perform a site-specific Risk Assessment that, depending upon routes of exposure and types of contaminants present, can ultimately result in alternative cleanup levels and methods (18 AAC75.340). ADEC's Contaminated Sites Program has also developed sediment quality guidelines for contaminated sites (ADEC, 2001a).

2.2.2 Institutional Controls

ADEC's Contaminated Sites Program may, in its discretion, approve a cleanup level that allows contamination to remain on-site above what is considered to be safe for residential use or does not allow groundwater to be used as a drinking water source (ADEC, 2002). Institutional controls are legal or administrative tools designed to prevent or reduce human and/or ecological exposure to any contamination remaining at a site and to prevent activities which may result in increased exposure to or the spread of contamination. Institutional controls may provide the requirement for and maintenance of physical measures, such as fences and signs, to limit an activity that might result in exposure to a hazardous substance at the site. Institutional controls may include the requirement for and maintenance of engineering measures, such as liners and caps, to limit exposure to a hazardous substance. Institutional controls can also include restrictive covenants, easements, deed restrictions, or other measures that would be examined during a routine title search. Institutional controls can limit site use or site conditions over time or provide notice of any residual contamination and a zoning restriction or land use plan by a local government with land use authority. Institutional controls, such as capping of contaminants, can leave large volumes of contaminants in place. When contaminants are left in place or site closure is approved with soil and groundwater contamination present, additional written institutional controls, such as deed restrictions or easements may be needed to address the potential for public exposure and future off-site movement of contaminated soil and groundwater.

In addition to the 3,513 open, contaminated sites, there are 885 closed contaminated sites in Alaska. Closed contaminated sites are designated “No Further Remedial Action Planned”. This does not signify that contamination is not present but that contamination may be allowed to remain at these sites because it is not possible, practical or cost effective to remove. Sites deemed “No Further Remedial Action Planned” usually require the use of an institutional control and/or the requirement to monitor soil or groundwater until such time that ADEC determines it is no longer required. For example, at the King Salmon Air Force Station an estimated 500,000 barrels (contents unknown) were disposed of from the 1950s through the 1970s (ADEC, 2004a). Approximately 200 drums were removed in 1984, and 26,000 drums were removed in 1991. In 1997 and 1998, limited removal actions, re-contouring, and capping activities were conducted at North Barrel Bluffs. The Final Record of Decision states that based on current site conditions and the successful implementation of interim remedial actions, USAF, ADEC, and EPA have selected a plan of institutional controls (site-access and land-use restrictions), bluff inspection and maintenance, continued operation of the water-treatment system, and continued monitoring, with “no further remedial action planned”, as the final action for the North and South Bluff (ADEC, 2004a).

Remediation of the North and South Bluff areas has left approximately over 400,000 barrels (contents unknown) of potentially toxic waste in place. Buried drums and dumped items in the North and South Bluff sites have already impacted King Salmon Creek, Eskimo Creek and have the potential to impact the wetlands adjacent to the Naknek River and Bristol Bay. Both King Salmon Creek and Eskimo Creek have recently been removed from Category 4 (Impaired Water) on ADEC’s 303(d) list and placed in Category 2 “ attaining some uses but insufficient or no data are available to determine if remaining uses are being attained”. The institutional controls being implemented at King Salmon and Eskimo Creeks are thought to be sufficient to allow for attainment of water quality standards (WQS). A contaminated site that is removed from the 303(d) list but has large volumes of hazardous waste still in-place may still pose a significant threat to human and wildlife health. The King Salmon Air Force is just one example of the potential for lingering contamination to be present at contaminated sites that are deemed “No Further Remedial Action Planned”. Institutional controls are being implemented on many sites throughout Alaska, leaving large volumes of toxic compounds in place, potentially threatening fish, wildlife and human health.

2.2.3 Water Quality Standards at Contaminated Sites

ADEC’s water quality standards (WQS) apply to all surface waters of the State including surface waters at hazardous waste sites. Typically, ADEC’s Contaminated Sites Program staff are the lead at contaminated sites and ADEC’s Water Division staff monitor the response action to insure that the WQS are achieved (ADEC, 2001b). The Contaminated Sites Program staff utilize risk assessments to develop groundwater, sediment and soil cleanup levels. Risk assessments cannot be used to develop surface water cleanup levels less stringent than the WQS because the WQS are the regulatory action level for surface water and cannot be waived by the cleanup project manager. The WQS standards apply to wetlands and subsurface zones within wetlands affected by cleanup actions and at the soil/water interface of any surface water river, stream, spring, lake or pond. The Contaminated Sites Program staff make risk assessment decisions, which may allow for natural attenuation of contaminants in wetlands, determine how to achieve WQS at contaminated sites and in what time frame, with the goal of achieving WQS in the receiving water.

A cursory review of the contaminated sites database revealed that there are many current locations in Alaska where contaminated sites are affecting surface waters and/or wetlands (Table 2). For example, on Amchitka Island, it is known that all drainages within the nuclear test boring area are contaminated with chromium and diesel range organics and that the extent of radionuclide contamination is still unknown (ADEC, 2004a). Also on Amchitka Island, the Kiriloff Point Seeps are a 15 acre area that includes wetlands and a small stream where petroleum product is leaching into Constantine Harbor along a beach bluff. Again, on Amchitka Island, the St. Makarius Bay Landfill is leaching hazardous constituents into marine surface waters along an intertidal beach. On Kodiak Island, 3,000 55-gallon drums containing hazardous waste are buried adjacent to Buskin Lakes, the main drinking water source for the U.S. Coast Guard. On Kodiak Island, along both Buskin Beach and Womens Bay, hazardous waste is leaching onto the beach and into intertidal State waters. Both Lake Iliamna (a drinking water source) and an adjacent creek have been contaminated with benzene from an adjacent LUST site. The local school obtains its drinking water from a groundwater well located 100 feet from the contaminated LUST property. Table 2 lists just twenty examples of potentially hundreds of contaminated sites throughout Alaska that are impacting surface and drinking water, and have the potential to impact human and wildlife health. These are some of Alaska's most seriously impaired waters since associated toxicity has the potential to impact all trophic levels, from benthic invertebrates to man.

2.2.4 Future Contaminated Site Studies

Follow-up monitoring and assessment are required to identify impacts on drinking water quality, sediment quality, and biota in areas adjacent to contaminated sites that have been declared closed, inactive or designated "No Further Remedial Action Planned". Monitoring and assessment are needed for drinking water wells, sediments, rivers, lakes and wetlands, fish and wildlife, as well as for human health in areas adjacent to or impacted by contaminated sites. Sediments within estuaries and deltas, and sediment dwelling organisms such as mollusks, as well as resident fish should especially be targeted for follow-up monitoring because this is where contaminants tend to accumulate. Follow-up monitoring and health assessments are required where institutional controls have left large volumes of contaminants in place and where contamination has spread into surface waters of the State. A comprehensive review of the Contaminated Sites Database is recommended to identify those drinking and surface waters of the State being impacted by contaminated sites. These are some of Alaska's most seriously impaired waterbodies and should be targeted for drinking water, surface water, sediment, fish, shellfish, wildlife and human health monitoring.

Why are there so many contaminated military sites and how well is the Army Corp of Engineers and other military remediation processes working? DOD and DOE are reluctant to perform remediation and cleanup due to high costs. They (Navy, Army, Air Force, and Coast Guard) all say they are the lead agency. EPA's recently formulated "1 Cleanup Rule" is supposed to provide a solution to the infighting and provide cleanup levels/methods acceptable to all. However, it appears more investigation and oversight may be required to determine why there are so many military contaminated sites, to improve and expedite the cleanup process, and evidently more oversight may be needed to monitor military disposal practices.

Table 2. Examples of Contaminated Sites Impacting Surface Waters in Alaska (ADEC, 2004a).

Site Name & Location	Problem	Surface Water Impacted
A-J Mine, Juneau	PCB, metals, petroleum product	Contaminants discharging to Gold Creek above Capitol City's municipal drinking water well field.
DOE Base Camp, Amchitka Island	Diesel Range Organics, Chromium and Radionuclides	All drainages within the nuclear bore hole drilling areas impacted.
Kiriloff Point Seeps, Amchitka Island	Above Ground Storage tanks, petroleum product.	15 acre wetlands and stream flowing into Constantine Harbor.
St. Makarius Bay Landfill, Amchitka	Heavy Metals, miscellaneous compounds	Leachate seeping onto beach, contaminated sediments present.
Wastewater Lagoon, Amchitka	PCB	PCB present in sediments within lagoon and down gradient drainages.
Buskin Lake, Kodiak	3,000 55-gallon drums, & petroleum product	Adjacent to Buskin Lake, main drinking water source for U.S. Coast Guard.
Long Island, Near Kodiak	100s of drums with unknown contents disposed of in ravine between Dolgoi Lake and Cook Bay, PCB	Site located between Dolgoi Lake and Cook Bay
USCG, Building A-711, Kodiak	LUSTs	LUST site adjacent to Buskin River
Cannery Loop Drilling Mud Pit, Kenai	1.5 million gallons of drilling muds & associated hazardous waste	Mud pit located in wetland below water table, extent of contamination unknown
Pedro Bay School, Lake Ilimana,	500 drums leaked, Gasoline (Benzene) & Diesel	Lake Ilimana and adjacent creek impacted, school drinking water impacted.
Kotzebue Air Force Station, Kotzebue	Former Air Force Landfill, Unknown quantities of POP from landfill operation	PCB & Pesticides seeping into Kotzebue Sound and former drinking water supply lake for AFS.
Cape Romanzof Landfill, Scammon Bay	Former Air Force Landfill, PCB, metals, POP	Landfill in Yukon Flats National Wildlife Refuge, surface water pathways present.
Old Matanuska Townsite, Palmer	PCB, Petroleum Product, solvents	Wetlands and surrounding area impacted.
Valdez Creek Mine, Cantwell	Waste Motor Oil dumped into well, mine tailings.	Leaching into Susitna River and Valdez Creek Floodplain.
Cordova Electric Corp., Cordova	Waste oil, quantity and spatial extent of contamination unknown	Waste oil seeping into Eyak Lake- Class A PWS.
Chenega Bay Saltry, Near Seward	Solvent, PCB, Petroleum Product	Surface water runoff transporting contaminants into Crab Bay.
ADOT Maintenance Shop, Valdez	Petroleum Product	Seepage into Copper River.
Trident Seafoods Fuel, Sand Point	Diesel spill	Spill impacted 4.5 miles of ocean shoreline.
Toksook Bay School, Toksook Bay	4,550 Gallon Diesel Spill	Toksook Bay & Toksook Bay Elementary School PWS Contaminated
Nome Area Site #16, Nome	600 Drums with POP	Moonlight Springs, PWS for City of Nome is on-site.

2.3 Formerly Used Defense Sites

One of the most numerous and greatest sources of POP in Alaska are Formerly Used Defense Sites (FUDs). FUDs are lands that were used for former radar communications, naval defense, airfields and coastal defense sites during World War II, and are not currently be owned by the DOD. Since 1986, all FUDs have been transferred out of DOD's ownership or control and are now owned or operated by other federal, state, local or tribal governments or private parties (ADEC, 2004a). The Army Corp of Engineers (ACOE) currently administers funds to private contractors and oversees the remediation of FUDs. All site history records for FUD sites reside with the ACOE FUDs Program located on Elmendorff Air Force Base.

FUDs are located throughout Alaska including State and National Wildlife Refuges, National Marine Sanctuaries, National Parks and Monuments. These lands are primarily managed by the State of Alaska, U.S. Fish & Wildlife Service (USFWS), National Park Service (NPS) and the Bureau of Land Management (BLM). The USFWS, BLM, ACOE and other military branches continue to assess and mitigate hazardous waste on FUD lands under their care. Monitoring is required to determine the extent of contamination on National and State lands at un-remediated sites where contamination may have already seeped off-site into nearby estuaries, wetlands and freshwaters possibly impacting fish and wildlife health. This is one of Alaska's monitoring priorities. Precise identification and mapping of known FUD sites, sampling of estuaries, rivers, lakes and wetlands and their biota, as well as remediation, are necessary where contamination may have spread off-site into waters of the State.

FUD site, Adak Island, Alaska, USFWS.

FUD site, Attu Island, Alaska, USFWS.

Estimates for the number of FUDs in Alaska range from 625 to **about ten thousand** (ADEC, 2004a; pers. comm. Roberts, 2004). FUDs range in complexity from isolated unexploded munitions sites to large scale disposal of toxic waste. The volume of waste disposed may have been contained in a single 55-gallon drum or hundreds of drums. Spilled contaminants may include PCB, dioxins, DDT and other pesticides, metals, PAH, petroleum fuels, asbestos, solvents, tars, resins, lead and nickel-cadmium batteries, explosive ordinances, chemical warfare agents (nerve agents, mustard gas, hydrogen cyanide, lewisite, phosgene), among other unknown components.

The spatial extent of contamination at many sites has not been documented and remediation has not been completed at a majority of FUD sites, leaving estuaries, freshwaters, wildlife and people exposed. When and where remediation does occur, it generally does not extend beyond the DOD land ownership boundary, again possibly allowing off-site contamination. Remediation of FUDs and other contaminated sites are based on human health and ecological risk assessments. FUD sites can be removed from the ACOE remediation process if the military determines that they are not responsible for the contamination. Many sites have been listed by the military as requiring “No further action”. This does not mean that contamination is not present, it just means the military assumes no responsibility, and contamination remains un-mitigated. This may be why there is such a high discrepancy between the number of FUDs reported by the military as requiring cleanup (625) and the total number of FUDs in Alaska (~10,000). Remediation and institutional controls can leave high levels of contaminants behind with the assumption that off-site contamination will not occur. Many FUD sites have unrestricted access, are not fenced, and are not posted as being hazardous (pers. comm. Pikul, 2004). Dermal contact and ingestion of contaminants can occur at FUD sites used by subsistence hunters who employ FUD sites for camping or lodging. The extent of exposure to wildlife and people remains unknown for many FUD sites.

Concerned residents, epidemiologists and environmental scientists should obtain all available records on FUDs in Alaska. These records may currently reside with the Army Corp of Engineer’s FUD Program in a trailer at Elmendorff Air Force Base and may be the only historic information available which would be very useful in identifying toxic hotspots in Alaska’s landscape.

2.4 Solid Waste in Alaska

2.4.1 Municipal Solid Waste Landfills

ADEC has primacy of the solid waste program in Alaska and implements the program through Alaska Administrative Code found at 18 AAC 60. There are three types of municipal solid waste landfills (MSWLF) in Alaska; Class I, II and III. Only Alaska has Class III landfills (pers. comm. Roberts, 2004). A Class I MSWLF is a landfill that accepts, for incineration or disposal, 20 tons or more of municipal solid waste daily based on an annual average (18 AAC 60.300(1)).

A Class II MSWLF is a landfill that accepts, for incineration or disposal, less than 20 tons daily of municipal solid waste or other solid wastes based on an annual average; is located on a site where there is no evidence of groundwater pollution caused or contributed to by the landfill; is not connected by road to a Class I MSWLF or, if connected by road, is located more than 50 miles from a Class I MSWLF; or serves a community that experiences for at least three months each year, an interruption in access to surface transportation, preventing access to a Class I MSWLF; or, with no practicable waste management alternative, serves a community with a landfill located in an area that annually receives 25 inches or less of precipitation (18 AAC 60.300(2)).

A Class III MSWLF is a landfill that is not connected by road to a Class I MSWLF or, if connected by road, is located more than 50 miles from a Class I MSWLF; accepts, for disposal, ash from incinerated municipal waste in quantities less than one ton daily on an annual average, or receives less than five tons daily of municipal solid waste, based on an annual average; and is not located in a place where public access is restricted (18 AAC 60.300(3)).

ADEC issues permits for all three classes of MSWLFs in Alaska as well as for non-municipal landfills also known as solid waste monofills (Table 3). The majority of solid waste landfill permits currently issued by ADEC are for non-municipal landfills (97) and for Class III MSWLF camps and villages (81) (ADEC, 2004b). There are an estimated 152 un-permitted Class III MSWLF and 83 expired Class III MSWLF permits in Alaska. There are 181 un-permitted non-municipal landfills and 130 expired non-municipal landfill permits in Alaska. The surface and groundwater monitoring requirements vary depending on MSWLF class. There are no surface water or groundwater monitoring requirements for Class II or Class III landfills in Alaska, unless ADEC has reason to suspect a potential water quality or human health impact due to the landfill.

Table 3. Permit Status of MSWLF in Alaska (ADEC, 2004b).

Category	Current	Denied	Expired	In Progress	Un-permitted	Withdrawn	Total	Percent
Class I	10		1		1	1	13	1.5%
Class II	13		11	2	6	3	35	4%
Class III (camp)	28	3	41	2	14	2	90	39.5%
Class III (village)	53	4	42	10	138	7	254	
Non-Municipal	97	5	130	6	181	14	433	50%
Other	1		3		43		47	5%

2.4.2 Industrial Waste Monofills

In addition to MSWLF, there are numerous industrial waste monofills in Alaska which accept specific types of waste such as oil and gas drilling waste, mining waste, asbestos, sewage solids, wood waste, inert waste, or other industrial solid waste (18 AAC 60.400). Monofills, as well as MSWLF, can be located in floodplains and wetlands and each newly permitted monofill is required to have a liner. Those monofills used for the storage of drilling waste for more than one year require a permit from ADEC.

There are also numerous inactive reserve pits in Alaska. Inactive reserve pits are monofills that received drilling waste prior to January 28, 1996. The locations of all inactive reserve pits and small (Class III) MSWLF in Alaska are not known, although some historical monofills created during the 1960's and 1970's have been mapped by ADEC (pers. comm. Roberts, 2004). Some inactive reserve pits were formerly used for the disposal of millions of gallons of drilling waste, are now considered hazardous waste sites by ADEC.

Today, there are surface water and groundwater monitoring requirements for drilling waste monofills, sewage sludge monofills and for the closure of inactive reserve pits. The monitoring parameters for these types of monofills depend on their proximity to a surface water body, the groundwater table, permafrost, drinking water sources and human habitation. Monofills can be closed with contaminants left in place that exceed the contemporary cleanup standards for contaminated sites. Post-closure monitoring is required for drilling waste monofills, inactive reserve pits and for other types of monofills as required by ADEC on a case-by-case basis.

Landfills and monofills can leach hazardous constituents which can impact aquatic biota, drinking water quality and human health. There are no monitoring requirements for Class II and Class III MSWLF in Alaska. This is a monitoring gap because the majority of MSWLF in Alaska are Class III (Table 3). There are an estimated 152 un-permitted and 83 expired Class III MSWLF in Alaska. There are an estimated 181 un-permitted non-municipal landfills in Alaska, and 130 expired non-municipal landfill permits in Alaska. There are also an unknown number of inactive reserve pits in Alaska, although some of these have been inventoried and mapped (pers. comm. Roberts, 2004). There are also an unknown number of small landfills in Alaska that have no permits or records. A targeted monitoring strategy could be developed to assess drinking water quality, surface and groundwater quality, sediment and aquatic resources at un-permitted and expired Class III MSWLF, inactive reserve pits and select industrial waste monofills. Those Class III landfills that have the potential to impact surface waters of the State and/or drinking water quality should be targeted along with those inactive reserve pits for which there are records. Mapping of monofills and MSWLF for each locality is also required.

2.5 Drinking Water in Alaska

ADEC has primacy of the drinking water program and implements the Safe Drinking Water Act (SDWA) through Alaska Administrative Code found at 18 AAC 80. The primary purpose of the SDWA is to ensure that public water supplies do not adversely affect the health of the general public. A Public Water System (PWS) is defined as a system that provides water via piping or other constructed conveyances for human consumption to at least 15 service connections or serves an average of at least 25 people for at least 60 days each year. Currently, PWS are classified somewhat differently by the EPA and ADEC in Alaska. There are three types of federally regulated PWS in Alaska: community water systems (CWS), non-transient non-community water systems (NTNCWS), and transient non-community water systems (TNCWS).

ADEC's Drinking Water Program defines PWS based on the number of people served and duration of annual service. Both CWS and NTNCWS are classified by ADEC as "Class A" PWS in Alaska. The "Class A" PWS is a public water system that is expected to serve, year-round, at least 25 individuals; is expected to serve, year-round, at least 15 residential service connections; or regularly serves the same 25 or more individuals for at least six months of the year. The "Class B" PWS is a PWS that is not a Class A public water system, and that regularly serves at least 25 individuals each day for at least 60 days of the year. TNCWS are also classified as "Class B" PWS in Alaska. The "Class C" PWS is a PWS that is not a Class A PWS, a Class B PWS, or a private water system (18 AAC 80.1990(12)(13)(14)).

In 2003, there were 1,614 federally regulated PWS in Alaska serving a total population of approximately 605,887 persons (ADEC, 2004c). In 2003, there were 434 CWS and 221 NTNCWS or "Class A" PWS in Alaska. "Class A" PWS represent approximately 21% of the total number of PWS in Alaska. In 2003, there were 949 "Class B" PWS or TNCWS in Alaska. This represents about 31% of the total number of PWS in Alaska. In 2003, there were an estimated 1,798 "Class C" PWS (non-federally regulated) in Alaska, however, the exact number of "Class C" water systems in Alaska is currently unknown (pers. com. Trask, 2004). "Class C" PWS are being considered for de-regulation by the State of Alaska. "Class C" PWS represent approximately 48% of the total number of PWS in Alaska.

Of the 1,614 federally regulated PWS in the State of Alaska, 1,485 (92%) are very small systems serving 500 persons or less. There were 103 PWS (6.4%) categorized as small (serving 501 to 3,300 persons), 20 PWS (1.2%) categorized as medium-sized (serving 3,301 to 10,000 persons), 5 PWS (<1%) categorized as large (serving 10,001 to 100,000 persons), and 1 PWS categorized as very large (serving more than 100,000 persons). Of the 1,614 federally regulated PWS, 1,359 PWS (84.2%) obtain their water from a ground water source; 234 PWS (14.5%) provide drinking water from a surface water source; and 21 PWS (1.3%) use ground water that has been determined to be directly under the influence of surface water (ADEC, 2004c).

2.5.1 Drinking Water Monitoring Requirements

The PWS monitoring and reporting requirements vary depending on Class (Table 4). In Alaska, **only** "Class A" PWS are required to monitor for toxic compounds including metals, volatile organic compounds, pesticides, disinfection byproducts, radioactive contaminants, secondary contaminants and other organic compounds**,** as listed at 18 AAC 80.300-335.

Table 4. Minimum Raw Water Testing Requirements (18 AAC 80.205(c)(2)).

Monitoring Parameters	Class A PWS		Class B PWS		Class C PWS	
	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water	Surface Water
Total Coliform Bacteria	Yes	Yes	Yes	Yes	Yes	Yes
Nitrate	Yes	Yes	Yes	Yes	Yes	Yes
Inorganic Chemicals	Yes	Yes	No	No	No	No
Volatile Organic Chemicals	Yes	Yes	No	No	No	No
Secondary Contaminants	Yes	Yes	No	No	No	No

2.5.2 Drinking Water Maximum Contaminant Levels

Under the SDWA, EPA sets national limits on regulated contaminant levels in drinking water to ensure that the water is safe for human consumption. These limits are known as Maximum Contaminant Levels (MCLs). A PWS is required to monitor and verify that the levels of regulated contaminants present in the water do not exceed the MCL. If a PWS exceeds the MCLs for a given parameter, fails to have its water tested as required or fails to report test results correctly to ADEC, a monitoring violation occurs. Significant monitoring violations are generally defined as any major monitoring violation that occurred during the calendar year. A major monitoring violation, with rare exceptions, occurs when no samples were taken or no results were reported during a compliance period.

ADEC’s Drinking Water Compliance & Enforcement Section tracks and enforces violations of MCLs. Violations of MCLs are stored in ADEC’s Drinking Water Program database and uploaded to SDWIS every 45 days (pers. comm. Trask, 2004). In 2003, a total of 4,393 individual violations occurred at 686 PWS (ADEC, 2004c). Of the 4,393 noted individual violations, 66% were for failure to monitor for either a Chemical Rule or the Surface Water Treatment Rule (SWTR). In CY 2003, fifty-eight percent (58%) of the federally regulated PWSs were in full compliance for all federal drinking water regulations. This figure represents a slight increase from the 56% of Alaska PWS in full compliance for all federal drinking water regulations during the CY 2002.

In 2003, a total of 54 health-based MCL violations were opened or issued. Seven violations were issued to seven systems for exceeding the fecal coliform MCL, 44 violations were issued to 35 systems for exceeding the total coliform MCL, two violations were issued to two PWS for a thallium MCL exceedance, and one violation was issued to a PWS for a cadmium MCL exceedance. Sixty-seven PWSs were in violation of the Surface Water Treatment Rule (SWTR) treatment technique requirements resulting in 214 violations. Of the 1,614 total federally regulated PWSs, 28% were in violation of the Total Coliform Rule (a slight increase over 26% in CY 2002) and 12% in violation of the Surface Water Treatment Rule (a slight increase from 10% in CY 2002).

In 2003, a total of 286 PWS (18%) serving 81,161 people were in violation of the Chemical or Radiological Rules (compared with 14% in CY 2002).

2.5.3 Future Drinking Water Studies

Currently, only "Class A" PWS are required to test for toxic compounds: metals, volatile organic compounds, radionuclides and inorganic chemicals (Table 4). Currently, of those "Class A" systems, 286 (18%) had violations of the chemical and/or radiological rule (ADEC, 2004c). "Class A" PWS represent approximately 21% of the total number of PWS in Alaska. There are an estimated 1,798 "Class C" PWS in Alaska, however the exact number of "Class C" PWS in Alaska is currently unknown. The number of "Class C" PWS in Alaska represents about 50% of the total number of PWS in Alaska. In addition, it is estimated that there are over 50,000 private wells in Alaska (pers. com. Ireland, 2004). Monitoring requirements for "Class B" and "Class C" PWS includes testing for bacteria and nitrates, only (Table 4). ADEC may be phasing out all support of "Class C" PWS in Alaska. "Class B" and "Class C" PWS represent approximately 79% of the total number of PWS in Alaska. In addition, there are no monitoring requirements for private wells. There is a monitoring gap because drinking water quality data for toxic (chemical and radiological) substances are not available for "Class B" PWS, "Class C" PWS, and for over 50,000 private wells in Alaska.

What percent of "Class B" PWS, "Class C" PWS and private wells exceed the MCL for toxic contaminants and what impact is this having on public health? It is recommended that a monitoring strategy be developed to include targeted monitoring for toxics (volatile organic compounds, radionuclides, pesticides and inorganics) in "Class B" and "Class C" PWS and private wells in Alaska. The Drinking Water Protection Area maps developed by the ADEC Drinking Water Program could be used to develop an area-wide monitoring survey of tap water from villages and towns with known or suspected contamination sources and with known MCL violations. The drinking water "Needs Assessment" recently completed by ADEC's Drinking Water Program could also be used to guide monitoring and assessment activities. This is one of Alaska's monitoring priorities because drinking water is a primary route of exposure to carcinogenic substances and many (approximately 79% of PWS) rural Alaskans obtain their drinking water from small drinking water systems or private wells which are not currently monitored for toxic substances. Targeted monitoring should occur in towns and villages with suspected contamination due to FUDs, NPL and LUST sites. This should be one of ADEC's highest monitoring priorities because of the link between cancer and the consumption contaminated drinking water.

3.0 Polyaromatic Hydrocarbons in Alaska

3.1 Oil Exploration & Extraction

Alaska's petroleum reserves are vast and extraction occurs both on land and off-shore in the marine environment. Petroleum hydrocarbons can enter Alaska's marine, surface water and groundwater environment during the exploration, extraction and transportation of Alaska's crude oil, natural gas, coal and coal bed methane resources. In addition to the potential for large spills to occur during transportation, oil is discharged during accidental blowouts and when it is discovered. Low volumes of oil are continually discharged during the drilling process along with heavy metals and lubricants as process water containing drill cuttings and muds are disposed directly into estuaries, on land or in deep injection wells. During offshore exploration and extraction of offshore oil resources, as in Cook Inlet, produce water containing drill cuttings and muds are disposed of directly in the marine environment. Drill cuttings and muds may contain low levels of cadmium and mercury as well as petroleum hydrocarbons and synthetic oils.

Studies conducted around offshore Norwegian oil fields have shown that benthic infauna can be impacted within 15 square kilometers of an oil rig due to disposal of water-based muds (AMAP, 1997). Drill cuttings and muds discharged from land based oil wells are disposed of in monofills located on Alaska's North Slope tundra. As the earth's climate warms, there are concerns that industrial waste monofills, once thought continually frozen in the permafrost of Alaska's tundra, may no longer be able to hold their spoils. Wastewater obtained from land based oil wells is discharged to deep, underground injection wells. Groundwater monitoring is required to assess the potential impacts on future drinking water resources.

Alaska's existing oil fields at Prudhoe Bay and Kuparuk River account for nearly one quarter of the nation's annual domestic crude oil production (MMS, 2003). Known oil and gas provinces are the North Slope, Beaufort Sea and Cook Inlet (ADNR, 2003a). Alaska's existing and oil, natural gas, coal, and coal bed-methane exploration and extraction leases are shown in **Appendix B-** Figure 11. Existing Oil, Gas, Coal and Coal Bed Methane Leases in Alaska.

The State of Alaska and Federal government are currently expanding their oil and gas leasing program in other areas of Alaska and offshore to allow for the exploration and extraction of oil and gas in an effort to meet the nation's energy needs. State issued exploratory licenses allow for the exploration of areas between 10,000 and 500,000 acres within remote areas of Alaska outside of known oil and gas provinces. Exploratory licenses have been issued for Norton Sound, the Chukchi Sea and Hope Basins along Alaska's north western shoreline, as well as the Copper River and Nenana Basins. Exploratory licenses and leases are currently being considered for the northern portion of the Bristol Bay basin in an area totaling about 875,000 acres, as well as the Bristol Bay coastline extending from Dillingham to Cold Bay (ADNR, 2003b). Exploratory licenses and leases are currently being considered for the Susitna Basin as well.

Alaska's five-year oil and gas leasing program includes planned State lease sales for the North Slope Foothills region, Beaufort Sea, and Cook Inlet region. At least a total of 20 lease sales are scheduled over the next five years; 10 on the North Slope, 5 in Cook Inlet and 5 in the Beaufort Sea. In addition, the entire 425 mile Beaufort Sea coastline, from the Canadian border to Barrow, within three miles offshore, is currently being considered for leasing and exploration, a total of about 2 million acres (ADNR, 2003b). This exploration area will also include upland acreages located along the Beaufort Sea between the Staines and Colville Rivers. The five areawide leases in the North Slope Foothills area contain about 7 million acres of land located between ANWR and the National Petroleum Reserve (NPR) of Alaska. The five areawide lease sales in the Cook Inlet region will include a total of about 4.2 million acres and include uplands located in the Matanuska-Susitna Valleys, the Anchorage Bowl, the western and southern Kenai Peninsula as well as the western shore of Cook Inlet from the Beluga River to Harriet Point. Tidal and submerged lands in upper Cook Inlet, from Kink and Turnagain Arms south to Anchor Point and Tuxedni Bay will also be included in Cook Inlet sales. Proposed oil and gas leased land sales are displayed in **Appendix B**- Figure 12. Proposed Oil & Gas Leases.

Oil and gas extraction are also expanding on federally administered lands in Alaska both on and offshore. Interior Secretary Gale Norton announced recently that 8.8 million acres of Alaska's National Petroleum Reserve (NPR) would be opened for exploration (ADN, 2004a). Oil and gas exploration also occur in Federally leased waters which extend from 3 to 200 nautical miles offshore. Federal leases in Alaska's Cook Inlet are currently being issued for a two million acre area extending from 3 to 30 miles offshore in depths ranging from 30 to 650 feet (MMS, 2003). Offshore leases are also being considered fro Norton Sound, the Chukchi Sea and Hope Basin.

America's desire to become more energy self-sufficient and rely on Alaska's oil reserves poses some hard questions and great challenges when considering a statewide monitoring strategy. As Alaska expands its oil and gas program to other regions of the State, monitoring is required to understand the cumulative impact of multiple oil platforms on migration routes, reproductive patterns and populations of threatened and endangered marine mammal species. It is essential that monitoring protocols be conducted to establish baseline biological conditions, and used to prevent impacts on marine mammal and bird diversity and abundance. There is a 58% to 99% chance that between one and eight spills of 1000 barrels of oil will occur in the Beaufort and Chukchi Seas (AMAP, 1997). Monitoring is required to document baseline sediment and water quality conditions and understand the impact of low level hydrocarbons on water and sediment quality, on fish and shellfish health, on subsistence hunting and fishing and on human health. Alaska has come along way in its prevention and response capabilities, however, as Alaska expands its oil and gas program to other regions of the State, it will be imperative that adequate oil spill monitoring, response and cleanup provisions are in place. This will continue to be one of Alaska's major environmental challenges in the 21^{st} century.

4.0 Heavy Metals in Alaska

Major anthropogenic sources of heavy metals in Alaska include combustion of fossil fuels, solid waste landfills, underground injection control wells, contaminated sites, waste incineration and mining. Coal burning is the major source of mercury, arsenic, chromium and selenium while combustion of oil is the most important source of nickel and vanadium (AMAP, 1997). The industrial complexes of China and Russia are thought to account for more than half of the air pollution measured over the Arctic. Emissions from the select smelters in the Urals and Norlisk area of Russia are thought to account for 3,000 tonnes of copper and 2,700 tonnes of nickel in the atmosphere, annually (AMAP, 1997). The prevailing winds send these pollutants to Alaska via the Siberian high and Aleutian low pressure systems. High levels of lead and copper have been measured in moss samples collected near the Prudhoe Bay oil fields in Alaska, although the source was not identified. Local oil refineries may be a source of heavy metals in the tundra. Biological monitoring is needed to fit the pieces together to determine where these metals originate from and what effect they may have on caribou and reindeer of Alaska's tundra where reports of bone marrow and liver abnormalities are being reported (ANSC, 2004). Currently, the National Park Service is conducting some monitoring for toxics in air over Alaska's National Parks. Alaska needs a statewide air toxics monitoring program.

4.1 Hardrock Mining in Alaska

Alaska has some of the most extensive deposits of precious metals (gold, silver, copper and zinc) in the world. Currently, there are six large hard rock mines permitted in Alaska; Fort Knox, Red Dog, Illinois, Greens Creek, and True North mines. There are currently (2004) three large mine permits currently under review; Pogo, Donlin Creek and Kensington Projects. State and federal mining claims are presented in **Appendix B-** Figure 13. State & Federal Mining Claims. Hardrock mines process millions of tons of ore a year and use cyanide and other chemicals to leach the gold from the ore. Wet tailings are left over after the ore has been processed. This process water requires a National Pollutant Discharge Elimination System (NPDES) and/or ADEC wastewater discharge permit if it is discharged to surface or ground waters. For example, the Greens Creek mine on Admiralty Island in Southeast Alaska discharges to ground water, fresh water (Greens Creek and Zinc Creek) and an estuary (Hawk Inlet). Groundwater, surface water and biological monitoring are required by ADEC to insure compliance with acute and chronic, aquatic life-based water quality standards.

> "For hardrock mines located inland, a common practice for permanent tailings storage is to construct a dam across the mouth of stream, divert the stream, and deposit the tailings in the drainage. At the Ft. Knox gold mine, outside of Fairbanks, over 1,000 acres of the upper Fish Creek drainage will eventually be consumed by tailings. Through the construction of a dam, the stream is converted to a waste treatment facility, and thus is no longer subjected to NPDES regulations, unless there is discharge from the facility. Mines that employ this type of treatment don't apply for discharge permits because the facility is designed for 'zero discharge'. In theory this means the dam is high enough and the

impoundment large enough to hold all tailings, entrained water, normal precipitation and major storm events so that no fluid escapes from the impoundment" (NAEC, 2004).

Fort Knox Gold Mine (Golder & Assoc., 2004).

Ft. Knox tailings impoundment (NAEC, 2004).

"Although the dams are lined, the drainage impoundments are not. Bedrock has fractures and cracks which can become conduits for contaminated leachate to seep into ground water. Roughly two years after mining began, the Ft. Knox tailings impoundment started leaking. Currently, pumps below the dam keep contamination from reaching groundwater and lower Fish Creek, mechanically maintaining the operation's compliance as a zero discharge facility. However, pumpback containment systems can fail resulting in the discharge of contaminated groundwater to the environment" (NAEC, 2004).

Monitoring is required to determine if groundwater, streams, wetlands and aquatic life are being impaired by cyanide and heavy metals leaching from the impoundments. In Alaska, monitoring and regulation of hardrock mines is extensive. However, additional monitoring and assessment of the environment surrounding these facilities may be appropriate to measure impacts on water and wildlife resources.

4.2 Placer Mining

Placer mining and panning for gold are popular in Alaska. Placer mining methods include both dredging systems and open-cut mining (EPA, 2001). Dredging methods include small sized suction dredging (< 4inch diameter nozzle); medium sized suction dredges (4-8 inches nozzle diameter); and mechanical or bucket dredging. Suction dredge mining employs dredging systems using either hydraulic, floating, suction systems or mechanical buckets. Suction dredges work the stream from within the stream bed removing large amounts of overburden to extract gold from alluvial sediments. Small, medium and mechanical dredging operations are covered by one of three separate, EPA, General, NPDES permits. The greatest number (1,278) of NPDES authorizations issued for any water discharge category in Alaska are for small sized suction dredges

(ADEC, 2004d). Currently, there are *no Federal monitoring requirements for small sized suction dredges* required under the EPA's General, NPDES permit.

The affects of placer mining on water quality, invertebrates and fish have been well documented (Madison, 1981). During dredging operations, sediment-rich effluent is discharged in-stream resulting in high turbidity and sediment loads which can extend far downstream. Sedimentation can result in loss of salmonid spawning habitat, loss of juvenile rearing areas and direct mortality due to clogged or damaged gillrakers. Sedimentation of stream beds can also cause a reduction in macroinvertebrate abundance and diversity impacting available food sources for juvenile salmonids. Increases in organic loading may result in decreased dissolved oxygen concentration, increases and biological and chemical oxygen demand, and result in in-stream anaerobic conditions. In-stream mining activities mobilize trace metals making them more available for uptake by fish. Concentrations of arsenic and mercury in streams with active placer mines in Alaska have been shown to be close to the estimated maximum no-effect concentration for juvenile Arctic grayling (Mueller and Matz, 2002). Monitoring and inspections are needed to determine the potential impacts of placer suction dredge mining on water quality, biota and habitat.

4.3 Abandoned Mines

There are hundreds of abandoned mines in Alaska. Monitoring is required to determine if acid mine drainage is impacting water quality and biota. Abandoned mines include both coal and non-coal related mines. In Alaska, the Commissioner of the Alaska Department of Natural Resources (ADNR) was granted jurisdiction over surface coal mining and reclamation operations under the Alaska Surface Coal Mining Control and Reclamation Act of 1983. "In addition to regulating the coal industry, state and federal law created the Abandoned Mine Lands (AML) Program for the purpose of reclaiming abandoned historic mines. Coal and non-coal abandoned historic mines in Alaska have been inventoried. Coal mining in Alaska has been well documented and every mine of significance has been identified. The coal inventory was completed in 1983, and 340 sites were identified. A literature search of known non-coal mines was compiled in 1991, and 432 sites were identified. The non-coal inventory is incomplete for state, private and native lands" (ADNR, 2004). However, a fully, mapped inventory of abandoned mines in Alaska is not currently available. Monitoring and assessment of off-site impacts are required for Alaska's abandoned mines.

5.0 Radiation in Alaska

5.1 Amchitka Island Nuclear Tests

Major sources of radionuclides in Alaska's marine environment include releases from underground nuclear test explosions, European reprocessing plants, nuclear submarine accidents, dumped and spilled radioactive waste, spent nuclear fuel and old nuclear reactors. The U.S. Department of Defense and U.S. Atomic Energy Commission detonated three nuclear test blasts (1965, 1969 and 1971) underground on Amchitka Island, located in Alaska's eastern Aleutian Island chain (DOE, 2002; EPA, 1998). Each bomb blast was more powerful than the preceding blast. In 1971, Project Cannikin detonated a 5-megaton blast one mile underground which resulted in a crater more than a mile wide and 40 feet deep. The large underground cavities caused by the blasts are now filled with groundwater, and it is suspected that radioactive elements are seeping into the local marine environment.

Atomic Energy Commission lowering 5-megaton Spartan Missile nuclear warhead into Cannikin mile-deep hole on Amchitka Island, Alaska, November 6, 1971 (LLNL, 1971).

Based on the rate at which radioactive material decays, or half-life, tritium is one of the primary radioactive elements expected to be prevalent in the fissures underlying Amchitka Island at the present time (pers. com. Dasher, 2004). Monitoring of the marine and terrestrial environment occurred at Amchitka Island during the summers of 1997, 1999 and 2001 by ADEC and the Consortium for Risk Evaluation with Stakeholder Participation (CRESP). The results indicate that the tritium concentration is slightly elevated in marine waters around Amchitka Island (pers. comm. Dasher, 2004). This may be indicative of radioactive leakage from the underground test blasts or may reflect other ocean sources. More monitoring is planned for the summer of 2004, sponsored by the Department of Energy (DOE). However, tritium is not on the list of parameters for sampling and analysis. In effect, by not sampling for tritium, conclusions may not be forthcoming about potential radioactive leakage from the Amchitka blasts sites into the marine environment.

5.2 Nuclear Reactor at Fort Greely

Another radiation source in Alaska's environment is the nuclear reactor and its waste material located on the 1,200 square mile Fort Greely military base, near Delta Junction, Alaska. The Army operated a nuclear reactor from about 1962 until 1972, which was thought to produce small scale nuclear weapons for the battlefield. Suspected sources of radionuclides include liquid radioactive wastes released into the ground water; radioactive steam used in the laundry and to heat the military base; a control rod accident and subsequent cleanup process; fallout near reactor from accident that caused permanent closing; improper methods of disposal of solid radioactive wastes; radiation remaining in containment structure of decommissioned reactor (Buske *et al*., 2000).   Some residents of Delta Junction suspect that there is a relationship between the reactor and high cancer rates in the community. The area that lies just north of Delta Junction has been dubbed "*cancer row*" by residents of the area (Buske *et al*., 2000). A school is located on the military reserve, and people are worried about the health of their children. Monitoring is needed to determine if radioactive elements are present in the groundwater, surface waters, air and to discern if there is a relationship between cancer in the community and local radiation sources .

5.3 Future Radiation Studies

Recent monitoring at Amchitka will have cost about 3 million dollars but may not provide information concerning leakage from the test sites and the type of radiation leaking from Amchitka Island. Additional monitoring may be required to discern if radiation is leaking from the Amchitka test sites. Monitoring is required to discern if radiation leakage is having health impacts on resident marine mammals, birds, fish and invertebrates. The Stellar sea lion (*Eumetopias jubatus*) and the southwestern Alaskan sea otter (*Enhydra lutris kenyonii*) in the western Aleutian Islands are listed as endangered and threatened species, respectively. In addition, the human lung cancer rate for the western Aleutian Islands was documented at 154.7 per 100,000 people, almost three times the rate for Alaska (67.5) and U.S. (56.1) for the period 1996-98 (ACR 2002). The western Aleutian Islands received the bulk of the radioactive fallout from the three nuclear test explosions at Amchitka Island. Monitoring of people and wildlife, as well as monitoring sediment and water quality monitoring, are required to determine if there are any health impacts resulting from exposure to the nuclear radiation potentially seeping out of Amchitka Island and from the numerous FUDs located along the western Aleutian Island chain. Additional biomonitoring may also be warranted to determine if there are any public health impacts on people living near the Fort Greely Nuclear Reactor.

6.0 Cancer in Alaska

6.1 Cancer Statistics for Alaska

The incidence and death rate due to all forms of disease in Alaska is tract and recorded by the Alaska Department of Health and Social Services, Division of Public Health's Alaska Cancer Registry and the Bureau of Vital Statistics. This report utilizes cancer statistics obtained from the Bureau of Vital Statistics (ADHSS, 2006). This report also summarizes data published in 2002 by the Alaska Cancer Registry (ACR) which contained data for the period 1996-1998 (ACR, 2002), and data obtained from the ACR for the period 1997-2001 (ACR, 2004).

According to the Alaska Department of Health and Social Service (ADHSS), Public Health Division's Bureau of Vital Statistics the cancer incidence rate in Alaska per 100,000 people, for colorectal, pancreatic, lung, breast, bladder, kidney, renal gland, thyroid, non-Hodgkin's lymphoma and leukemia were all reported to be above the national average for the time period 1996-1998 (ACR, 2002). ADHSS also reported that the leading cause of death for 18 out of 27 Boroughs/Census Areas in Alaska was malignant neoplasms for the period 1994-2004 (ADHSS, 2006). Cancer rates in particular boroughs and census areas vary based on geographic location and the type of cancer. For example, the incidence rate of breast cancer per 100,000 people, for the period 1996-1998, on Kodiak Island (258.1) was twice that found elsewhere in Alaska (118.1) and twice the national average (114.3) (ACR, 2002). The incidence rate for all types of cancer in Yakutat (974 per 100,000 people) was documented to be over twice the rate for Alaska (409.7) and the U.S. (400.5) during this same time period (ACR, 2002). The Matanuska-Susitna Borough was found to have a statistically elevated rate of non-Hodgkin's Lymphoma (26.3 per 100,000 people) when compared to the U.S. rate (16.1) for the time period 1996-1998 (ACR, 2002). Non-Hodgkin's lymphoma is a proliferation of white blood cells, which may be related to exposure to Persistent Organic Pollutants (POP). The lung cancer rate for the western Aleutian Islands was documented at 154.7 per 100,000 people, almost three times the rate for Alaska (67.5) and U.S. (56.1) for the period 1996-98 (ACR 2002). The western Aleutian Islands received the bulk of the radioactive fallout from the three nuclear test explosions at Amchitka Island. Are these facts related?

A review of the ACR's cancer statistics (ACR, 2004) for the period 1997-2001, by Borough/Census Area, reveals that the national, cancer incidence rate for all types of cancer (479.7 per 100,000 people) is exceeded in the Municipality of Anchorage (510.7), Denali Borough (572.9), Fairbanks North Star Borough (504.8), Haines Borough (503.1), Juneau Borough (518.4), Kenai Peninsula Borough (518.9), Ketchikan Gateway Borough (561.3), Kodiak Island Borough (507.7), Lake & Peninsula Borough (587.9), Matanuska-Susitna Borough (531.1), Nome Census Area (484.3), Prince of Wales-Outer Ketchikan (547.8), Southeast Fairbanks Census Area (515.7), Valdez-Cordova Census Area (488.5) and the Yakutat Borough (1339.6). Some of these rates may be inflated due to the small population size. A total of 15 out of the 27 Boroughs or Census Areas in

Alaska exceeded the national cancer incidence rate for all types of cancer (ACR, 2004). The Alaska, female cancer incidence rate for all types of cancer (450.9) was found to be higher and statistically significant when compared to the national, female cancer incidence rate for all types of cancer (421.6). However, the cancer incidence rate for Alaskan males (567.1) was found to be similar to the national incidence rate (566.6) for all types of cancer (ACR, 2004).

For this same time period (1997-2001), the national, cancer incidence rate for non-Hodgkin lymphoma (19.4 per 100,000 people) was exceeded in the Municipality of Anchorage (19.5), Fairbanks North Star Borough (19.7), Juneau Borough (27.2), Kenai Peninsula Borough (23.8), Ketchikan Gateway Borough (21.6), Matanuska-Susitna Borough (22.2), Nome Census Area (20.4), Prince of Wales-Outer Ketchikan (33.7), and the Valdez-Cordova Census Area (28.0) (ACR, 2004). The rates of non-Hodgkin lymphoma for Alaskan males (24.1) and females (17.2) were found to be above the national average for non-Hodgkin lymphoma in males (23.6) and females (16.0), respectively (ACR, 2004). Nine out of thirteen boroughs (69%) that reported non-Hodgkin lymphoma statistics were above the national average for the time period 1997-2001. Fourteen of the twenty-seven Boroughs or census areas had less than six cases and did not have non-Hodgkin lymphoma incidence rates calculated.

The national, leukemia incidence rate (12.4 per 100,000 people) was exceeded in the Municipality of Anchorage (13.0), Juneau Borough (15.0), Kenai Peninsula Borough (19.7), Ketchikan Gateway Borough (23.0), Kodiak Island Borough (21.9), Matanuska-Susitna Borough (17.4), and the Southeast Fairbanks Census Area (37.9) for the time period 1997-2001 (ACR, 2004). Seven out of the eight boroughs/census areas (88%) that reported leukemia statistics had incidence rates above the national average. Nineteen out of the 27 boroughs or census areas did not report leukemia statistics. Both non-Hodgkin lymphoma and leukemia are proliferation of white blood cells which may be related to exposure to POP.

A review of these same statistics (ACR, 2004) reveals that the national, breast cancer rate (137.5 per 100,000 people) is exceeded in the Municipality of Anchorage (155.1), Denali Borough (180.8),), Dillingham Census Area (180.1), Fairbanks North Star Borough (148.5), Juneau Borough (146.6), Kenai Peninsula Borough (149.3), Ketchikan Gateway Borough (153.7), Kodiak Island Borough (178.2) and the Matanuska-Susitna Borough (137.9) for the time period 1997-2001. Five boroughs had no breast cancer statistics reported due to the low number of cases reported.

The national, lung cancer rate (64.8 per 100,000 people) was exceeded by the lung cancer rate in **all** of Alaska's Boroughs except two (ACR, 2004). The lung cancer rate for both male and female Alaskans (77.0) was found to be higher and statistically significant when compared to the national, lung caner rate (64.8). The lung cancer rate for Alaskan males (92.0) and females (64.3) was also found to be higher and statistically significant when compared to the national, lung cancer rates for males (83.4) and females (51.4), respectively.

6.2 Quotes from Native Alaskan Regional Meetings

The Alaska Native Science Commission conducted state-wide, regional interviews of Native Alaskans to document their concerns about their health in relation to their environment. Many people had concerns about cancer and its relation to their subsistence food, drinking water and their living environment. The following are some excerpts from these interviews (ANSC, 2004).

> Hannah Miller noted: "Few people of my age are still living. So when all this cancer started, I wondered at night whether all this cancer is caused by something we are eating, breathing, or because we aren't cleaning up after ourselves? Would it be wonderful if we could just get a glimpse of what's happening to our food." Edith Morgan from Aniak noted, "When I was at the Norton Sound meeting, they asked the ANHB to have their epidemiology center come up here and check out the cancer concern - Anne Lanier has been looking at getting a register of cancers. The information is really limited, so she is asking to come to regions." Delano Barr from Shishmaref noted, "We just have go guess about the sources of contaminants. My sister died a couple of months ago of cancer. I often wonder what caused it. Could it have been her Native food, the air she breathed, or the non-Native food she ate? It makes you wonder why cancer is getting more frequent, especially among our older people" (ANSC, 2004).

More information about the Alaska Native Science Commission and these interviews can be found at www.nativeknowledge.org.

6.3 Future Epidemiological Studies

There were many reports of disease occurring in wildlife and people that were found in the literature and documented in personal communications during the preparation of this document. These reports ranged from whole families being lost to cancer around the State to lesions being documented in livers of marine mammals and in fish tissue. Prominent documented sources include former Lt. Governor Fran Ulmer who referred to cancer in Alaska as an epidemic in an article posted in the Kenai Peninsula Online Newspaper **"Why is cancer rate so high in Alaska?"** (KPO, 2001). One of Alaska's greatest challenges may be coming to terms with the high incidence of cancer in Alaska and determining what relationships, if any, there are to toxics in the environment. It seems the widespread reports of cancer in people and wildlife of Alaska warrant a detailed investigation of state and federal cancer statistics, registries and other data sources.

Full disclosure and analysis of all, available and current, local and statewide cancer statistics are warranted based on the available cancer incidence rates. These data should be analyzed to aid the people and wildlife in areas where cancer clusters, whether environmentally related or not, are occurring. Full disclosure and analysis of current, local and statewide cancer statistics are necessary to aid in protecting human health. These data could be analyzed to help answer the following questions: Where are the cancer clusters located? What is the relationship of particular types of cancer in various communities to contaminated sites, formerly used defense sites, landfills, and contaminated drinking water or food resources? When someone contracts cancer it is not always easy to obtain information from the patient or doctor. How do we utilize cancer statistics, infectious disease and other health data to provide public health assistance, monitoring and mitigation where it is needed? How do we track cancer statistics and other health information in order to mitigate potential human health impacts related to environmental exposures?

A detailed review and analysis of all available, current, local, state and federal cancer statistics are necessary to identify cancer clusters and determine if the incidence of cancer is related to environmental exposures. Independent epidemiological studies, outside of the ADHSS and Agency for Toxic Substances Disease Registry, should be conducted in suspected areas to preclude foregone conclusions of no state or federal liability. Concerned residents, epidemiologists and environmental scientists may want to analyze the last ten years of statewide cancer statistics available from the Alaska Department of Health and Social Services, Division of Public Health, Epidemiology Section**.** {Address: State of Alaska, Department of Health & Social Services, Division of Public Health, Section of Epidemiology, Cancer Registry, 3601 "C" Street, Suite 722, P.O.B.240249, Anchorage, Alaska, 99524-0249, telephone # 907-269-8000}.

7.0 Public Health & Wildlife Concerns

7.1 Public Health Concerns

1) How do we monitor the occurrence of cancer and track cancer statistics for Alaska? How do we obtain and analyze the latest cancer statistics for Alaska? ? How do we utilize cancer statistics, infectious disease and other health data to provide public health assistance, monitoring and mitigation where it is needed?

2) Why are malignant neoplasms the leading cause of death in Alaska for 18 out of 27 Boroughs or Census Areas (ADHSS, 2006)? Why do a total of 15 out of the 27 Boroughs or Census Areas in Alaska exceed the national cancer incidence rate for all types of cancer (ACR, 2004)? Why is the Alaska female cancer incidence rate for all types of cancer higher and statistically significant when compared to the national female cancer incidence rate for all types of cancer? Are these facts related to contaminated air, drinking water and/or food resources, or a combination of public health conditions?

3) Why is the national, lung cancer incidence rate exceeded by the lung cancer incidence rate in **all** of Alaska's Boroughs except two (ACR, 2004)? Why is the lung cancer rate for all Alaskans found to be higher and statistically significant when compared to the national, lung caner rate

(ACR, 2004)? Why is the lung cancer rate for Alaskan males and females also higher and statistically significant when compared to the national, lung cancer rates for males and females (ACR, 2004)? Why was the lung cancer rate in the western Aleutian Islands (154.7 per 100,000 people) found to be almost three times the incidence rate for Alaska (67.5) and the U.S. (56.1) (ACR, 2002)? Is the high incidence of lung cancer related to radiation exposure from Amchitka nuclear fallout and/or foreign radiation sources?

4) Why do seven out of the eight boroughs or census areas that reported leukemia statistics have leukemia incidence rates above the national average? Why are nine out of thirteen boroughs or census areas in Alaska that reported non-Hodgkin lymphoma statistics above the national incidence rate for this type of cancer (ACR, 2004)? Both Non-Hodgkin lymphoma and leukemia are proliferation of white blood cells which may be related to exposure to POP.

5) Why do the breast cancer incidence rates in the Municipality of Anchorage, Denali Borough, Dillingham Census Area, Fairbanks North Star Borough, Juneau Borough, Kenai Peninsula Borough, Ketchikan Gateway Borough, Kodiak Island Borough and the Matanuska-Susitna Borough all exceed the national breast cancer incidence rate? Why was the incidence rate of breast cancer on Kodiak Island (258.1 per 100,000 people) twice the rate found elsewhere in Alaska (118.1) and twice the national average (114.3) (ACR, 2002)? Is the high incidence of breast cancer related to contaminated air, drinking water and/or food resources?

6) What is the relationship of particular types of cancer in various communities to formerly used defense sites, hazardous waste sites, landfills and the contamination of air, drinking water and food resources? How do we mitigate these impacts? Is the high incidence of these cancers due in part to the effects of toxic environmental contaminants (POP, HM, PAH, radiation) which can cause a suppression of the immune system and make people more susceptible to disease?

7.2 Fish & Wildlife Concerns

1) The Cook Inlet Beluga Whale (*Delphinapterus leucas)* population is currently listed as depleted by the National Marine Fisheries Service, although evidence exists for listing it as a threatened or endangered species (ADN, 2004b). It is estimated that the Cook Inlet Beluga Whale populations is declining with an estimated 300 individuals remaining. The NMFS is currently considering listing this population under the ESA (JDN, 2006). What is the cause of their decline and why is this population not recovering? Is this population not recovering due global climate

change and changing sea conditions, pollution sources from oil rig discharges in Cook Inlet, untreated wastewater (primary treatment only for Anchorage's wastewater treatment plant), noise pollution, or a combination of factors resulting in immune suppression?

2) Why are the western Aleutian Island Stellar sea lion (*Eumetopias jubatus)* and southwestern Alaskan sea otter (*Enhydra lutris kenyonii*) populations (both inhabit the western Aleutian Islands) currently listed as endangered and threatened species, respectively? Is the decline of these species related to environmental contaminant sources in the western Aleutian Islands such as formerly used defense sites (FUDs), Amchitka nuclear radiation, or foreign environmental contaminant sources emanating from Russia and Asia or a combination of factors? Is their decline related to global climate change and changes in sea water temperature or a combination of these factors?

3) In the summer of 2004, residents of the village of False Pass in the eastern Aleutian Islands were trying to understand what is causing seabirds by the dozens to die there. Since the Fourth of July weekend, as many as 200 dead birds of several species were seen floating in the strait beyond the village or washed up on the beach (ADN, 2004c; ADN, 2004d). No cause for the die-off was evident. Is the cause of their decline related to environmental contamination, global climate change or a combination of factors?

4) Are these marine mammal and avian declines due in part to the effects of toxic environmental contaminants (POP, HM, PAH, radiation) which can cause a suppression of the immune system and make them more susceptible to disease? Is their decline due in part to global climate change, changing sea conditions or a combination of these factors?

5) What are the potential impacts of global climate change on fish and wildlife? How do we monitor and assess long term changes in water quality and associated environmental impacts? Can they be mitigated?

The recent listing of the southwestern Alaskan sea otter (*Enhydra lutris kenyonii*) distinct population as threatened, the steady decline of the Cook Inlet Beluga Whales (*Delphinapterus leucas)* and the seabirds dying in the eastern Aleutian Islands during the summer of 2003 may indicate that something is changing in Alaska's coastal environment.

8.0 Future Studies Summary

8.1 Epidemiological Studies

A detailed review and analysis of all available, current, local, state and federal cancer statistics are necessary to identify cancer clusters and determine if the incidence of cancer is related to environmental exposures. Concerned residents, epidemiologists and environmental scientists may want to analyze the last ten years of statewide cancer statistics available from the Alaska Department of Health and Social Services, Division of Public Health, Epidemiology Section**.** {Address: State of Alaska, Department of Health & Social Services, Division of Public Health, Section of Epidemiology, Cancer Registry, 3601 “C” Street, Suite 722, P.O.B.240249, Anchorage, Alaska, 99524-0249, telephone # 907-269-8000}.

Full disclosure and analysis of current, local and statewide cancer statistics may be warranted based on the available cancer statistics for Alaska. These data are necessary to aid in protecting human health. These data could be analyzed to help answer the following questions: Where are the cancer clusters located? What is the relationship of particular types of cancer in various communities to contaminated sites, formerly used defense sites, landfills, contaminated drinking water or food resources? Independent epidemiological studies, outside the State of Alaska and Agency for Toxic Substances Disease Registry, should be conducted in suspected areas to preclude foregone conclusions of no state or federal liability.

8.2 Identification, Monitoring & Assessment Summary

8.2.1 Contaminated Sites in Alaska

Follow-up monitoring and assessment are required to identify impacts on drinking water quality, sediment quality, and biota in areas adjacent to contaminated sites that have been declared closed, inactive or designated “No Further Remedial Action Planned”. Monitoring and assessment are needed for drinking water wells, sediments, rivers, lakes and wetlands, fish and wildlife, as well as for human health in areas adjacent to or impacted by contaminated sites. Sediments within estuaries and deltas, and sediment dwelling organisms such as mollusks, as well as resident fish should especially be targeted for follow-up monitoring because this is where contaminants tend to accumulate. Follow-up monitoring and health assessments are required where institutional controls have left large volumes of contaminants in place and where contamination has spread into surface waters of Alaska.

Why are there so many contaminated military sites and how well is the Army Corp of Engineers and other military remediation processes working? It appears more investigation and oversight may be required to determine why there are so many military contaminated sites, to improve and expedite the cleanup process, and evidently more oversight may be needed to monitor military disposal practices.

8.2.2 Formerly Used Defense Sites

Identify and map all FUD sites in Alaska. Concerned residents, epidemiologists and environmental scientists should obtain all available records on FUDs in Alaska. These records may currently reside with the Army Corp of Engineer's FUD Program in a trailer at Elmendorff Air Force Base and may be the only historic information available which would be very useful in identifying toxic hotspots in Alaska's landscape. Posting and fencing all FUD sites would limit environmental exposures. Complete identification and mapping for all FUD sites located within or adjacent to each community is needed.

8.2.3 Solid & Industrial Waste Landfills

Landfills and monofills can leach hazardous constituents which can impact aquatic biota, drinking water quality and human health. There are no monitoring requirements for Class II and Class III MSWLF in Alaska. This is a monitoring gap because the majority of MSWLF in Alaska are Class III (Table 3). There are an unknown number of inactive reserve pits in Alaska, although some of these have been inventoried and mapped (pers. comm. Roberts, 2004). There are also an unknown number of small landfills in Alaska that have no permits or records. A targeted monitoring strategy could be developed to assess drinking water quality, surface and groundwater quality, sediment and aquatic resources at un-permitted and expired Class III MSWLF, inactive reserve pits and select industrial waste monofills. Those Class III landfills that have the potential to impact surface waters of the State and/or drinking water quality should be targeted along with those inactive reserve pits for which there are records. Identification and mapping of all monofills and MSWLF for each locality is also required.

8.2.4 Drinking Water

What percent of "Class B" PWS, "Class C" PWS and private wells exceed the MCL for toxic contaminants and what impact is this having on public health? It is recommended that a monitoring strategy be developed to include targeted monitoring for toxics (volatile organic compounds, radionuclides, pesticides and heavy metals) in "Class B" and "Class C" PWS and private wells in Alaska. The Drinking Water Protection Area maps developed by the ADEC Drinking Water Program could be used to develop an area-wide monitoring survey of tap water from villages and towns with known or suspected contamination sources and with known MCL violations. The drinking water "Needs Assessment" recently completed by ADEC's Drinking Water Program could also be used to guide monitoring and assessment activities. Targeted monitoring should occur in towns and villages with suspected contamination due to FUDs, NPL and LUST sites. This should be one of the highest monitoring priorities because of the link between cancer and the consumption contaminated drinking water.

8.2.5 Polyaromatic Hydrocarbons

Monitoring is required to understand the cumulative impact of multiple oil platforms on migration routes, reproductive patterns and populations of threatened and endangered marine mammal species. It is essential that monitoring protocols be conducted to establish baseline biological conditions, and used to prevent impacts on marine mammal and avian diversity and abundance. Monitoring is required to document baseline sediment and water quality conditions and understand the impact of low level hydrocarbons on water and sediment quality, on fish and shellfish health, on subsistence hunting and fishing and on human health. Alaska has come along way in its prevention and response capabilities; however, as Alaska expands its oil and gas program to other regions of the State, it will be imperative that adequate oil spill monitoring, response and cleanup provisions are in place.

8.2.6 Heavy Metals

High levels of lead and copper have been measured in moss samples collected near the Prudhoe Bay oil fields in Alaska, although the source was not identified. Local oil refineries may be a source of heavy metals in the tundra. Biological monitoring is needed to fit the pieces together to determine where these metals originate from and what effect they may have on caribou and reindeer of Alaska's tundra where reports of bone marrow and liver abnormalities are being reported (ANSC, 2004). The State of Alaska currently does not monitor for heavy metals or other toxic compounds in air. Currently, the National Park Service is conducting some monitoring for toxics in air over Alaska's National Parks. A statewide air toxics monitoring program could be developed to benefit all Alaskans. Monitoring and assessment of Alaska's abandoned mines is needed as well as a complete, mapped inventory of abandoned mines in Alaska.

8.2.7 Radiation

Biomonitoring is required to discern if radiation leakage from the Amchitka test sites is having health impacts on people as well as resident marine mammals, birds, fish and invertebrates living in the western Aleutian Islands. Additional biomonitoring may be warranted to determine if there are any public health impacts on people living near the Fort Greely Nuclear Reactor.

8.3 Human Health and Ecological Restitution

There are several serious public health and ecological issues facing the peoples and wildlife of Alaska as outlined in this document. These issues range from cancer and disease in people and wildlife, to loss and depletion of marine mammal and avian species. The DOE Amchitka nuclear test site has still not been fully monitored or assessed. In addition, there are literally hundreds of DOD sites throughout Alaska requiring monitoring, assessment and mitigation, as described previously. An exact cause and effect relationship may never be established between the nature of environmental contamination emanating from these sites and the disease process due to the complexity of establishing this relationship.

Previous epidemiological studies conducted in Alaska, (designed to study the high incidence of cancer in select Alaskan communities) have been primarily conducted by the U.S. Center for Disease Control which is a federal agency with federal interests. These interests may conflict with those of the people and wildlife of Alaska because of the potential federal liability of acknowledging the damage caused by nuclear testing and military disposal practices. Independent epidemiological studies, outside the State of Alaska and Agency for Toxic Substances Disease Registry, should be conducted in suspected areas to preclude foregone conclusions of no state or federal liability.

Several people stated during the preparation of this document that a permanent source of funding or “cold war fund”, in the amount necessary to be a self-sustaining, should be made available from the U.S. Department of Energy and U.S. Department of Defense for public health assistance and ecological monitoring for damages done to the ecological and human resources of the State of Alaska.

9.0 Bibliography

ACR. 2002. 1998 Alaska Cancer Registry "Cancer in Alaska, Cancer Incidence and Mortality". Division of Public Health, , Epidemiological Section, Anchorage, Alaska, March, 2002. http://www.epi.hss.state.ak.us/pubs/cancer98.pdf .

ACR, 2004. Unpublished data for the period 1997-2001, from the Alaska Cancer Registry, Alaska Department of Health and Social Services, Division of Public Health, Epidemiological Section, Anchorage, Alaska, September 2004.

ADEC. 2001a. Sediment Quality Guideline Options for the State of Alaska. Prepared for the Contaminated Sites Program, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation, by OASIS and Bristol Joint Venture, May 2001.

ADEC. 2001b. Internal ADEC Technical Memorandum, dated January 30, 2001, prepared by the Contaminated Sites Program, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation, Juneau, Alaska.

ADEC. 2002. Internal Memorandum "What are institutional controls", dated August 27, 2002, published by the Contaminated Sites Program, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation, Juneau, Alaska.

ADEC. 2004a. Data obtained from Contaminated Sites Database, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation, Juneau, Alaska, March, 22, 2003, http://www.dec.state.ak.us/spar/csp/dod_sites.htm .

ADEC. 2004b. ADEC Internal Memorandum dated March 26, 2004 from Sandra Woods, Environmental Specialist, Solids Waste Program, Environmental Health Division, Alaska Department of Environmental Conservation, Juneau Alaska.

ADEC. 2004c. Alaska's Public Water System Annual Compliance Report for Calendar Year 2003, prepared by the Drinking Water Program, Alaska Department of Environmental Conservation, Anchorage, Alaska.

ADEC. 2004d. State of Alaska's Assumption of the National Pollutant Discharge Elimination System. A Report to the Alaska Legislature. Prepared by the Alaska Department of Environmental Conservation, Juneau, Alaska, January 2004.

ADHSS, 2006. Alaska Department of Health & Social Services, Public Health Division, Bureau of Vital Statistics, Leading Causes of Death by Census Area for the period 1994-2004. http://www.hss.state.ak.us/dph/bvs/death_statistics/Leading_Causes_Census/default.htm

ADN. 2004a. Anchorage Daily News article "NPR-A Lease Sales Get Okay" written by Wesley Loy, published January 23, 2004.

ADN. 2004b. Anchorage Daily News article "Explanation sought for beluga whale population puzzle" written by Doug O'Harra, published May 28, 2004.

ADN. 2004c. Anchorage Daily News article "Die-off of seabirds puzzles villagers", written by Peter Porco, published July 14, 2004.

ADN. 2004d. Anchorage Daily News article "Explanation unclear for bird die-off", written by Peter Porco, published September 17, 2004.

ADNR. 2003a. Five-Year Oil and Gas Leasing Program, with Reports on Exploration Licensing and Shallow Gas Leasing, January 2003. Prepared by the Division of Oil and Gas, Alaska Department of Natural Resources, Juneau, Alaska.

ADNR. 2003b. 2003 Oil and Gas Report for the period ending December 31, 2002. Prepared by the Division of Oil and Gas, Alaska Department of natural Resources.

ADNR, 2004, Alaska Department of Natural Resources, Division of Mining, Land and Water, Abandoned Mine Lands Program, Juneau, Alaska, www.dnr.state.ak.us/mlw/mining .

AMAP. 1997. Arctic Pollution Issues: A State of the Arctic Environment Report, Artic Monitoring and Assessment Program, Oslo, Norway.

AMAP. 2003. AMAP Assessment 2002: Human Health in the Arctic, Artic Monitoring and Assessment Program, Oslo, Norway.

AMAP. 2004. Arctic Monitoring and Assessment Program 2002 Assessment: Persistent Organic Pollutants in the Arctic. Published in 2004, Oslo, Norway.

ANSC, 2004. Alaska Native Science Commission, http://www.nativeknowledge.org/login.asp .

Buske, N., P. K. Miller, L. Eckstein. 2000. Investigative Report by Alaska Community Action on Toxics for Delta Junction, Alaska "The Nuclear Reactor at Fort Greeley", published May, 2000.

Carpenter, D.O., K.F. Arcaro, B. Bush, W.D. Niemi, S. Pang and D.D. Vakharia. 1998. Human health and chemical mixtures: an overview. Environmental Health Perspectives 106(6):1263-1270.

Dasher, D. 2004. Personal communication April 20, 2004 with Doug Dasher, Environmental Engineer, Alaska Department of Environmental Conservation, Fairbanks, Alaska.

DOE. 2002. Screening Risk Assessment for Possible Radionuclides in the Amchitka Marine Environment, prepared for the U.S. Department of Energy, National Nuclear Security Administration, Nevada Operations Office, Las Vegas, Nevada, DOE/NV-857, October 2002.

EPA. 1998. Long Term Hydrological Monitoring Program, Amchitka, Alaska, 1997, prepared by the Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, June 1998, EPA-402-R-98-002.

EPA. 2001. U.S. EPA Fact Sheet for Alaska Small Suction Dredge Miners for NPDES Permit #AKG-37-5000. Published by the U.S. Environmental Protection Agency, December 19, 2001.

EPA. 2004. 2004 Strategic Plan. U.S. Environmental Protection Agency, Region 10, Revised Draft, January 2004.

Ireland, R. 2004. Personal communication with Roy Ireland, June 9, 2004, Database Management Specialist, Water Resources Program, Division of Mining, Land and Water, Alaska Department of Natural Resources, Anchorage, Alaska.

JDN. 2006. Juneau Empire Daily News article "Cook Inlet belugas fading away", dated February 28, 2006.

KPO. 2001. Kenai Peninsula Online Newspaper. "Legislators want to know why cancer rate so high in Alaska", by Senator Lyda Green, web-posted Tuesday May 8, 2001.

LLNM. 1971. Photo courtesy of Lawrence Livermore National Laboratory and the University of Alaska at Fairbanks, http://www.uaf.edu/news/featured/06/amchitka/gallery/historical/source/w71-cannikin.html .

Madison, R.J. 1981. Effects of Placer mining on Hydrologic Systems in Alaska- Status of Knowledge. U.S. Geological Survey Open-File Report 81-217.

MMS. 2003. Alaska Regional Update, 5-Year Plan issued December 2003, prepared by the Alaska Outer Continental Shelf Region, Minerals Management Service, U.S. Department of the Interior.

Mueller, K.A. and A.C. Matz. 2002. Water Quality, Metals and Metalloid Concentrations in Water, Sediment and Fish Tissues for Innoko National Wildlife Reserve, Alaska, 1995-1997. Published by the U.S. Fish and Wildlife Service, Fairbanks, Alaska, May 2, 2002.

NAEC. 2004. Northern Alaska Environmental Center, http://www.northern.org/artman/publish/mcurrent.shtml .

Pikul, G. 2004. Personal communication March 9, 2004 with Gretchen Pikul, Environmental Specialist, Division of Spill Prevention and Response, Alaska Department of Environmental Conservation, Anchorage, Alaska.

Roberts, J. 2004. Personal communication March 30, 2004 with Jennifer Roberts, Solid Waste and Contaminated Sites Program Manager, Alaska Department of Environmental Conservation, Anchorage, Alaska.

Trask, S. 2004. Personal communication July 1, and March 31, 2004, with Sherri Trask, Environmental Compliance and Enforcement Officer, Drinking Water Program, Alaska Department of Environmental Conservation, Anchorage, Alaska.

USFWS. 2006. U.S. Fish and Wildlife Service, Region 7- Alaska, http://alaska.fws.gov/fisheries/endangered/listing.htm, 1011 East Tudor Road, Anchorage, Alaska.

Appendix A- Contaminated Sites in Alaska by City

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Adak	192	21	38	110	361
Adak (near)	11	1		1	13
Akhiok (near)	1	1			2
Akiachak		2			2
Akiak		1		4	5
Akutan	1			1	2
Akutan (near)	1	2	1		4
Alakanuk		1		1	2
Aleknagik	1				1
Aleknagik (near	1				1
Allakaket	1		1		2
Ambler	1	1			2
Amchitka	11	2		1	14
Amchitka (near)	12	15	2	25	54
Anaktuvuk Pas	1	1			2
Anaktuvuk Pas (	1	3	3		7
Anchor Point	1	1	2		4
Anchorage	101	107	66	9	283
Anchorage (near				1	1
Angoon			1		1
Angoon (near)		2	1		3
Aniak	6	2	3		11
Aniak (near)		1	1		2
Anvik				7	7
Arctic Village	1	2			3
Atka	2	1			3
Atqasuk	1				1
Auke Bay	1	1			2
Auke Bay (near)		2	1		3
Barrow	11	3	3		17
Barrow (near)	3	1			4
Beaver	1		1		2
Bethel	8	9	6		23
Bethel (near)		1			1
Bettles Field	2	10	4		16
Big Lake	2	1	6	1	10
Big Lake (near)		1	1		2
Brevig Mission			1		1
Buckland			1		1
Cantwell	1	4		1	6
Cantwell (near)		4	4		8
Cape Yakataga	1	2			3
Cape Yakataga (		1			1
Central		1			1
Chalkyitsik		1			1
Chalkyitsik (ne	1				1
Chefornak	2			4	6
Chevak	1	1			2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Chickaloon (nea		1	1		2
Chicken			1		1
Chignik		1			1
Chignik Lagoon			1		1
Chignik Lake	1	2	2		5
Chiniak	2				2
Chitina	1	2			3
Chitina (near)			3		3
Chugiak	2	4	1		7
Circle (near)	1				1
Clam Gulch		1	1		2
Clear	4	2	11		17
Clear (near)			1		1
Coffman Cove	1	2			3
Cold Bay	9	6		1	16
Cold Bay (near)		2			2
Coldfoot	1		2		3
Coldfoot (near)	2	3	5		10
Cooper Landing	1	1	1		3
Copper Center			2		2
Copper Center (			2		2
Cordova	5	12	4	1	22
Cordova (near)	2	4	10		16
Craig		5	1		6
Craig (near)	1	1	3		5
Deadhorse	29	19	12	3	63
Deadhorse (near	3	7	7		17
Deering				1	1
Deering (near)	1				1
Delta Jct.	4	13	31	2	50
Delta Jct. (nea	3	2	9	3	17
Denali Park		3	6		9
Denali Park (ne	1	6	7		14
Dillingham	2	5	1	1	9
Dillingham (nea	2				2
Douglas	1	1	1		3
Dutch Harbor	1	3	12		16
Dutch Harbor (n	2	1			3
Eagle		1			1
Eagle River	2	2	5	1	10
Eek		1			1
Egegik	1	2			3
Eielson AFB	33	21	15	21	90
Eielson AFB (ne		1	3		4
Elfin Cove (nea			1		1
Elim		2			2
Elim (near)	2		3		5
Elmendorf AFB	19	21	20	1	61

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Emmonak	3	4	1		8
Ester		1	1		2
Fairbanks	70	44	38	5	157
Fairbanks (near	3	1	2		6
Fort Richardson	9	11	62	1	83
Fort Wainwright	27	16	19	15	77
Fort Yukon	8	1	1	4	14
Gakona	1	1	1		3
Gakona (near)		1	1		2
Galena	11	1			12
Galena (near)	1				1
Gambell	2	1			3
Girdwood		4	3		7
Girdwood (near)	2		1		3
Glennallen		3	6		9
Glennallen (nea		3			3
Golovin		1			1
Grayling				5	5
Gustavus	1	7	2		10
Haines	5	3	3		11
Haines (near)		1	1		2
Healy		3	5	1	9
Holy Cross	1	1	1		3
Homer	8	9	8	1	26
Homer (near)	1			1	2
Hoonah		5	1		6
Hoonah (near)		2	1		3
Hooper Bay	1			1	2
Hope	1				1
Houston	1	1			2
Hughes	1		1		2
Hughes (near)	9	1	2		12
Huslia		4	1		5
Hydaburg		3			3
Iliamna	5	3	2	2	12
Iliamna (near)	10	3			13
Indian	1		1		2
Indian (near)		1			1
Juneau	8	29	13		50
Juneau (near)		1	1		2
Kake	1	1	3	1	6
Kake (near)		1	1		2
Kaktovik	15	3	1	1	20
Kaktovik (near)		6	2	1	9
Kaltag	1	1			2
Karluk		1			1
Kasigluk	1				1
Kasilof	2	1	2		5

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Kenai	21	21	10	5	57
Kenai (near)	1	5	1		7
Ketchikan	3	9	11		23
Ketchikan (near	7	3	3		13
Kiana		1			1
King Cove	1		1		2
King Cove (near	1				1
King Salmon	23	13	9	8	53
King Salmon (ne	1	1	1		3
Kipnuk	1				1
Kivalina		1			1
Kivalina (near)	1				1
Klawock	4	6	1		11
Klawock (near)	1	3			4
Kodiak	27	40	18	6	91
Kodiak (near)	1	1			2
Koliganek				1	1
Kongiganak	1				1
Kotlik	1	2			3
Kotzebue	14	8	4		26
Kotzebue (near)	1				1
Koyuk		1		1	2
Koyuk (near)	13				13
Koyukuk		2			2
Kwethluk	1				1
Kwigillingok	1	3			4
Lake Minchumina	1	1	1		3
Little Diomede			1		1
Manley Hot Spgs	1	1	1		3
Manokotak	1				1
Marshall	2	2			4
McGrath	7	6	3		16
McGrath (near)	13		2		15
Mentasta Lake	1				1
Metlakatla (nea	1		1		2
Meyers Chuck		1			1
Minto	2	1	1		4
Minto (near	1	4	4		9
Moose Pass	1	3	1	1	6
Mountain Villag		2			2
Naknek	1	1			2
Nanwalek		1			1
Napakiak	1				1
Napaskiak	1	1			2
Nenana		2	1	1	4
Nenana (near)	1				1
Newtok		1			1
Nightmute		1			1

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Nikiski	15	11	9		35
Nikiski (near)		1			1
Nikolai			1		1
Nikolai (near)			1		1
Nikolski	4	2	5	2	13
Ninilchik	1	2			3
Ninilchik (near			1		1
Noatak		1			1
Nome	22	5	4		31
Nome (near)	2	2	1		5
Nondalton		1			1
Noorvik	1		1		2
North Pole	21	12	7	2	42
North Pole (nea	1				1
Northway	28	6	2	12	48
Northway (near)		1		1	2
Nuiqsut	1				1
Nuiqsut (near)	12	3	3		18
Nulato		4			4
Nunapitchuk	1				1
Old Harbor		2			2
Ouzinkie (near)	1				1
Palmer	4	8	12	5	29
Palmer (near)	1	1			2
Paxson		4	1		5
Paxson (near)	3	4	6		13
Pedro Bay	1				1
Pedro Bay (near			1		1
Pelican		1	1		2
Pelican (near)			1		1
Perryville	1				1
Petersburg	1	8			9
Petersburg (nea	1	1	2		4
Pilot Point	1	1			2
Pilot Station			1		1
Platinum		1			1
Platinum (near)	3	1	5		9
Point Hope	5	6	2		13
Point Hope (nea	1	2			3
Point Lay	4		1		5
Point Lay (near	1		1		2
Port Graham	1				1
Port Graham (ne			1		1
Port Heiden	2		5		7
Port Lions		1			1
Port Lions (nea		1		1	2
Prudhoe Bay	9	9	1	2	21
Prudhoe Bay (ne	16	18	7	1	42

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Quinhagak	1	1			2
Rampart		1	1		2
Rampart (near)			1		1
Red Devil	2				2
Ruby			1		1
Saint George	4	7	11	1	23
Saint Marys		3	2		5
Saint Michael		2			2
Saint Paul	10	9	10	1	30
Salcha		1	1		2
Salcha (near)			1		1
Sand Point	1	1			2
Sand Point (nea		1	1		2
Savoonga	1	1			2
Savoonga (near)	2				2
Scammon Bay	1				1
Scammon Bay (ne	3	5	3		11
Selawik	2	1	1		4
Seldovia		4	1		5
Seward	9	12	2	2	25
Seward (near)		2	1		3
Shageluk		1			1
Shaktoolik			1		1
Sheldon Point		2			2
Shungnak		1	2	1	4
Sitka	6	11	5	2	24
Sitka (near)	3	6	4		13
Skagway	4	3	5		12
Skagway (near)		1			1
Skwentna		1	2	1	4
Skwentna (near)		1	1		2
Slana		1			1
Slana (near)	1				1
Sleetmute		1			1
Soldotna	16	12	6	2	36
Stebbins		1		1	2
Sterling	2	4	7		13
Sterling (near)	11	3	2		16
Stevens Village	1	1	1		3
Stony River (ne	5	2	2		9
Sutton	1	1	4		6
Sutton (near)		1	1		2
Talkeetna	1	5	2		8
Talkeetna (near	1		2		3
Tanacross	1	1	1		3
Tanacross (near			1		1
Tanana	9		2		11
Tatitlek			1		1

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CONTAMINATED SITES DATABASE
DEC Inventory of Contaminated Sites
Ordered by City and Priority Classification

City	High	Medium	Low	Unranked	Total
Tatitlek (near)	1	1			2
Teller	1	2			3
Teller (near)				1	1
Tenakee Spr.		4	2		6
Tenakee Spr. (n		1			1
Tetlin			1	1	2
Thorne Bay	3	1	2	1	7
Thorne Bay (nea		3	2		5
Togiak	1		1		2
Tok	3	7	1		11
Tok (near)		1			1
Toksook Bay	1	1			2
Trapper Creek		1	4		5
Tuntutuliak		3			3
Tununak			1		1
Twin Hills	1				1
Tyonek	9	19	5	2	35
Tyonek (near)	7	12	2		21
Unalakleet	3	2	3		8
Unalaska	41	11	1	4	57
Valdez	6	23	26	3	58
Valdez (near)		2			2
Wainwright	10	1			11
Wainwright (nea	1				1
Wales		1			1
Wales (near)	7		1		8
Ward Cove	1		1		2
Ward Cove (near	1	1			2
Wasilla	6	21	16	2	45
Wasilla (near)		3			3
White Mountain	1	1			2
Whittier	3	5	2	1	11
Whittier (near)	2	1			3
Willow		1	2		3
Willow (near)		2			2
Wrangell	2	4	1		7
Wrangell (near)	2	3	3		8
Yakutat	12	4			16
Yakutat (near)	1				1
Totals	1279	1075	844	315	3513

Appendix B- Figures