United States Navy

Alaska Department of Environmental Conservation

The NARL Cleanup Team

Decision Document
for the
Navy Arctic Research Laboratory

Bulk Fuel Tank Farm

Barrow, Alaska

Final

December 2002

COVER SHEET AND SIGNATURE PAGE

SITE: Bulk Fuel Tank Farm, Former Naval Arctic Research Facility, Barrow, Alaska

ADEC Data Base Record Key: 198831x129104

ADEC CS File Number: 310.38.016

REGULATORY AUTHORITY: ADEC Site Cleanup Rules (18 AAC 75 Article 3)

RESPONSIBLE PARTY: U.S. Navy Office of Naval Research

CONTAMINANTS OF CONCERN/MEDIA IMPACTED:

Contaminants of concern are based on the results of a site-specific risk assessment and risk re-evaluation studies. These chemicals will be monitored to evaluate the effectiveness of the proposed remedy:

Surface Soil: Lead, diesel-range organics(DRO)

Subsurface Soil: Gasoline-range organics(GRO), volatile organic compounds (1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene)

Active Zone Water: Lead, DRO, GRO, benzene, xylenes

Sediments/Surface Water: DRO

ON-SITE CONTAMINANT CONCENTRATIONS:

Maximum observed concentrations for constituents identified through site sampling programs that exceed site-specific risk-based criteria or ADEC standards:

Surface Soil (mg/kg): lead – 970; DRO-aliphatics – 24,000; DRO-aromatics – 690

Subsurface Soils (mg/kg): GRO-aliphatics – 280; GRO-aromatics – 75; 1,2,4-trimethylbenzene – 58; 1,3,5-trimethylbenzene – 19

Active Zone Water (µg/L): Benzene – 1400; Lead – 210; GRO-aliphatics – 30,000; DRO-aromatics – 3,400; xylenes – 29

Sediments/Surface Water(µg/L): DRO - 350

[a] Abbreviations and technical terms are defined in the Appendix 1 glossary.

CLEANUP CRITERIA:

Risk-Based Levels: Human health risk-based cleanup level for DRO was established to protect construction workers who may contact active zone water during soil excavation activities. Ecological risk-based levels were established to protect receptors in contact with soil.

Regulatory-Based Levels: For soil, maximum allowable concentrations for Arctic Zone soils, 18 AAC 75.341 Table B-2. For protection of North Salt Lagoon, ADEC Water Quality Standards (18 AAC 70.020).

CLEANUP REMEDY:

The proposed cleanup remedy consists of the following elements:

- Excavate soil with the highest contamination concentrations, located at the turnaround area and the south bank of the gravel pad. Transport this soil to the NARL Airstrip site for thermal treatment using hot-air vapor extraction (HAVE).
- Construct biological treatment cells at the south end of the NARL Airstrip and/or at the gravel pad itself. Contaminated soil from the gravel pad and surrounding tundra which is not HAVE treated will be placed in the biocells and treated by landfarming.
- If soil treatment endpoints from landfarming are not reached at the end of one treatment season, transport remaining contaminated soil to the NARL Airstrip for thermal treatment using HAVE.
- Conduct a 5-year program monitoring the natural attenuation of active zone water along the shorelines of the nearby melt water pond and North Salt Lagoon
- Conduct a 5-year monitoring program for natural attenuation of sediments in North Salt Lagoon to verify that contaminant transport has ceased following soil cleanup
- After 5 years of operation, evaluate the need for continued monitoring
- Evaluate the cumulative residual risk for the site after cleanup levels have been achieved at the former NARL facility

REVIEW OF CLEANUP ACTION AFTER SITE CLOSURE:

Under 18 AAC 75.380(d)(1), ADEC may require the Navy to perform additional cleanup if new information is discovered which leads ADEC to make a determination that the cleanup described in this Decision Document is not protective of human health, safety, and welfare or the environment, or if new information becomes available which indicates the presence of previously undiscovered contamination or exposure routes related to Navy activities.

ACCEPTANCE BY PARTIES:

The United States Navy, the State of Alaska, and the Ukpeaġvik Iñupiat Corporation have agreed to the decisions outlined in this document.

The Navy is authorized, and responsible, under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) to identify and clean up hazardous substances released to the environment at the Naval Arctic Research Laboratory (NARL) during Navy operations at NARL.

Acceptance by Navy:

James L. Cline
Corporate Logistics Department, Head
Office of Naval Research

7 March 2003
Date

Acceptance as lead regulatory agency under authority of Alaska Statutes 46, 18 AAC 75 Article 3, and 18 AAC 75.990:

John Halverson, for
Jennifer Roberts
Contaminated Site Program, Section Manager
Alaska Department of Environmental Conservation

12/11/02
Date

Acceptance as landowner:

Anthony Edwardsen
President
Ukpeaġvik Iñupiat Corporation

12/11/02
Date

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DECLARATION

INTRODUCTION

The selected cleanup actions and supporting rationale for cleanup of fuel releases on the Bulk Fuel Tank Farm (BFTF) Site at the former Naval Arctic Research Laboratory (NARL) Facility, Barrow, Alaska, are presented in this Decision Document (DD). In November 1999 the U.S. Navy, the Ukpeagvik Inupiat Corporation (UIC), and the Alaska Department of Environmental Conservation (ADEC) (together constituting the NARL Cleanup Team) began working together to prepare plans to clean up historically contaminated soil and active zone water at four sites located on the former NARL facility. These are referred to as the Airstrip, Powerhouse, Bulk Fuel Tank Farm (BFTF), and Dry Cleaning Facility sites. This DD addresses activities at the BFTF Site.

This DD was developed in accordance with State of Alaska regulations governing the protection of human health and the environment from hazardous substances (18 AAC, Part 75, Article 3) and is generally consistent with procedures set forth by the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended in 1986 (42 USC 9601 *et seq.*). This decision is based on the Administrative Record for the former NARL cleanup project, which is located in offices of the Alaska Department of Environmental Conservation (ADEC) in Fairbanks, Alaska, and in the US Navy Engineering Field Activity-Northwest (EFA-NW) office in Poulsbo, Washington. The State of Alaska, UIC, and the Navy have agreed to the decisions outlined in this document.

The Navy established the NARL in 1947 with the original mission being a supply center for petroleum exploration in the region. In 1986, the Navy transferred ownership of portions of the former NARL, including the BFTF Site, to UIC.

Environmental conditions at the BFTF Site were evaluated under the Naval Assessment and Control of Installation Pollutants (NACIP) Program. The intent of the NACIP program was to identify and evaluate environmental contamination from past use and disposal of hazardous substances at Navy and Marine Corps installations. The functions of the NACIP are now incorporated into the broader Department of Defense Installation Restoration Program (IRP), referred to as the Navy IRP.

The Navy IRP was implemented to address the Navy's responsibilities under CERCLA, and is consistent with the process in CERCLA regulations. The EPA became involved to evaluate whether the sites at the former NARL would become CERCLA sites. The State of Alaska's Contaminated Sites Remediation Program became involved through its regulations that direct the investigation and cleanup of environmental sites in the state of Alaska.

The former NARL was evaluated under the Navy IRP and ADEC regulations. This process involved an Initial Site Assessment Study conducted in the early 1980s, to identify potential environmental issues and problems at the sites. If no potential problems were identified, a closure agreement could be reached. If potential environmental issues were indicated, additional information was gathered as part of a site inspection.

None of the sites or issues identified through this process warranted further EPA involvement because non-petroleum chemicals did not pose a significant threat to human health or the environment. However, the Bulk Fuel Tank Farms, Dry Cleaning Facility, fuel spills area at the Airstrip Site, and fuel tank area at the Powerhouse Site contained chemical concentrations above ADEC criteria, requiring further investigation and/or remediation activities. The ADEC is the regulatory agency responsible for cleanup of sites at the former NARL facility.

The historical use of the BFTF Site has been industrial. The six bulk fuel tanks and piping have been removed; the gravel pads remain in place. Currently the site is unoccupied and used for recreational purposes. For this DD, the long-term use of the site is anticipated to remain recreational but could be redeveloped for commercial or residential use at some future date.

The NARL Cleanup Team, in consultation with the Native Village of Barrow (NVB) and the Inupiat Community of the Arctic Slope (ICAS), have reviewed alternatives and identified a preferred alternative for cleanup for the BFTF Site.

SITE BACKGROUND

Location: The NARL facility is located about 4 miles northeast of the village of Barrow and 6 miles southwest of Point Barrow (see Figure 1). The NARL facility was established in 1947 as a supply facility for petroleum exploration in the area. The BFTF site covers an area of about five acres. Prior to 1990, the BFTF consisted of six above-ground storage tanks (ASTs) (see Figure 2) that were used for bulk storage of gasoline, diesel, and jet fuel. In 1990, the ASTs and their associated piping were removed from the site. Currently, most of the site is covered with gravel to support vehicle traffic. A 5-foot-thick raised gravel pad was used to support the tanks. Surrounding the raised gravel pad is tundra. Permafrost is approximately 5 feet below ground surface under the gravel pad and between one and five feet below ground surface in the tundra areas. A 1.5-foot-thick layer of active zone water is found on top of the permafrost, except beneath the raised gravel pad which is dry. North Salt Lagoon is located along the southwest boundary of the former bulk fuel tank farm and is used for fishing and waterfowl hunting.

Site Conditions: The former NARL facility is located in a coastal plain characterized by low-lying beaches and tundra. The area is flat with a topographic relief of 6 to 8 feet. Because surface water cannot infiltrate through the permafrost and the flat terrain minimizes runoff, shallow lakes are present during the thaw season.

The underlying geology is composed of a series of formations including the Topogorak Formation consisting of a marine-clay shale sequence extending from about 450 to at least 1,400 feet below the surface; the Grandstand Formation consisting of claystone and sandstone extending from approximately 50 to 450 feet below the surface; and the Gubik Formation consisting of unconsolidated marine and non-marine gravel, sand, silt, and clay extending to 65 feet below the surface. Beach deposits of coarse sand and gravel dominate the near-surface soils at former NARL. Surface soils consist of organic and clay or loam deposits of the tundra meadow.

The area is underlain by permafrost with an active layer depth during the thaw season of one to six feet. The short annual thaw season and the near-surface permafrost control hydrogeologic conditions in the area. A shallow groundwater system known as the "active zone layer" exists during the thaw season. Due to its limited availability, area active zone water supplies are not considered potable. Imikpuk Lake is the main source of potable water for the former NARL complex.

Active zone water is estimated to have minimal impact on surface water supplies in the area contributing less than 0.1 percent of the total inflow from snowmelt and precipitation. The active zone water/surface water system appears to be in a state of quasi-equilibrium with minimal recharge and discharge occurring. Studies suggest that surface developments and geologic conditions act as a barrier to lateral flow from the active zone layer to Imikpuk Lake although localized pathways may be present. A detailed discussion of these conditions, as well as other site condition information, is presented in the *Final NARL Environmental Status Report* (URS 2000).

Documented Releases: In 1970, an estimated 100,000 gallons of jet fuel (JP-5) was spilled onto the supporting pea-gravel pad between Tanks 2 and 3. In 1990, during tank removal it was found that Tank 3 had leaked, however there was no estimate of the quantity of fuel lost. Tank 3 had been previously used to store diesel grade DF-A fuel.

Cleanup activities: In 1994, two cubic yards of surface soil with highest contamination by petroleum compounds was removed from the site and treated at the former NARL complex by vapor extraction that reduced gasoline and diesel concentrations by 98 percent. Treated soil was returned to the BFTF Site two years later.

RESULTS OF INVESTIGATIONS

Numerous site investigations were conducted at the former BFTF starting in 1986. Initial investigations in 1986 and 1988 found petroleum compounds in soils and active zone water. After it was discovered that an aboveground storage tank had leaked, additional investigations in 1990 and 1991 confirmed petroleum contamination of soil and active zone water at the site.

Sampling results showed an area of petroleum contamination around the gravel pad that supported the tanks. Total petroleum hydrocarbon (TPH) concentrations ranged from 47 to 9,400 mg/kg and averaged 1,278 mg/kg. Lead, detected in all of the soil samples, had concentrations that ranged from 8.1 to 365 mg/kg (URS 1991b). Numerous classes of chemicals (*e.g.*, BTEX, halogenated aliphatic hydrocarbons and solvents, phenolics, PAHs, inorganic chemicals) were detected at least once in active zone water at the site (SAIC 1992). In 1994, further investigations were performed to determine the areas of soil with the highest petroleum contamination.

A site investigation was performed in 1997, followed by a risk assessment in 1999. The investigation identified types of contaminants that were present, and how far contamination had spread. About 9,000 cubic yards of soil were found to be contaminated with petroleum hydrocarbons and volatile organic compounds from the fuel leaks and spills. Petroleum hydrocarbons and volatile organic compounds were also found in active zone water at the site, and in surface water and sediments in the nearby melt water pond and North Salt Lagoon. In 2000, fish were sampled from North Salt Lagoon to determine whether contaminants found in surface water and sediment might also be in the fish that people eat.

Site Investigations

The following summarizes the initial site investigations and laboratory analyses conducted at the BFTF Site to identify and characterize potential contaminants:

1997 Site Investigation (EA 1999). During the summer of 1997, a site investigation was performed at the BFTF Site to generate data for use in assessing human health and ecological risks. Active zone water and soils around the former tank farm, and sediments and surface waters of the nearby melt water pond and North Salt Lagoon, were sampled and analyzed for organic chemicals, including petroleum-related compounds, TPH fractions, chlorinated solvents, and metals.

A total of 60 organic compounds (including TPH fractions) and 7 metals were detected in the 45 surface soil samples collected at the BFTF site. The diesel range aliphatic fraction of TPH, arsenic, and lead were the chemicals detected in surface soil samples at concentrations exceeding ADEC cleanup standards. A total of 55 organic compounds (including TPH fractions) and 6 metals were detected in the 40 subsurface soil samples collected at the BFTF site. The diesel-range aliphatic fraction of TPH was the chemical detected in subsurface soil samples at concentrations exceeding the ADEC cleanup level.

A total of 43 organic compounds (including TPH fractions) and 6 metals were detected in the 14 active zone groundwater samples collected at the BFTF site. Benzene, vinyl chloride, pentachlorophenol, and lead were the chemicals detected in active-zone groundwater samples at concentrations exceeding ADEC cleanup standards.

A total of 9 sediment and 14 surface water samples were collected from the North Salt Lagoon and the melt water pond adjacent to the BFTF site. Surface water samples did not contain any chemicals exceeding ADEC standards.

The results of the above sampling indicated that the main contaminants of concern at the BFTF Site are as follows:

Surface Soil: Lead, diesel-range organics (DRO)

Subsurface Soil: Gasoline-range organics (GRO), volatile organic compounds (1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene)

Active Zone Water: Lead, DRO, GRO, benzene, xylenes

Sediments/Surface Water: DRO

Free Product Investigations

Free phase petroleum was not encountered during the initial site investigations, during the 1994 soil removal, nor during the 1997 site investigation.

Cleanup Activities

In addition to investigations described above, the following cleanup activity was completed:

1994 Soil Removal and Treatability Study. Based upon the results of the 1990 field investigation, the Navy remediated the areas of highest GRO contamination during the summer of 1994. The surface soils in the area of highest GRO contamination were scraped away and approximately 2 cubic yards of soil were excavated and treated by vapor extraction. After 50 days, the concentration of GRO was reduced in the treatment cell with a removal efficiency of 98 percent. The cell was also effective in reducing DRO and TPH concentrations with removal efficiencies of 98 percent and 99 percent, respectively. The treated soil was then returned to the site (URS 1996).

Risk Assessments

Previous risk assessment activities and reports were performed for the sites at the former NARL complex, including the BFTF. Initial human health and ecological risk assessments were performed in the early 1990s (URS 1991, 1992). Subsequent to those reports, methodology was developed to address risks from Total Petroleum Hydrocarbon (TPH) fractions, such as GRO, DRO, and RRO. In 1996, the Navy presented a plan to the community of Barrow to reassess risks at the former NARL complex using the new methodology. The Navy solicited input from the community members at a RAB meeting on their health and ecological concerns for the former NARL area, and to receive comments on the plans and methodology for conducting human health and ecological risk assessments at the former NARL sites. A report was subsequently produced on the approach that was proposed for the risk assessments that encompassed community concerns and methodology for specific application to assessing risks at the former NARL sites (EA 1997a).

Following the development of a risk-based cleanup approach for the former NARL sites, a work plan was assembled for collecting additional site characterization data for use in the risk assessments at the Dry Cleaning Facility Site and the Bulk Fuel Tank Farm Site (EA 1997b). The approach and methodology for the risk assessments outlined in the work plan was used to prepare baseline risk assessments in 1999.

The ADEC-approved baseline Risk Assessment (RA) report for the BFTF Site was completed in 1999 (EA 1999) with supplemental risk calculations completed in 2000 for consumption of fish from North Salt Lagoon, and for inhalation of volatiles from soil and groundwater both outdoors and inside buildings (EA 2000a). The purpose of the baseline RA was to determine the potential for adverse health effects for people using the site (residents, industrial workers, construction workers, and recreational/ subsistence users) and to wildlife that may use the site or be exposed to chemicals in North Salt Lagoon. In accordance with ADEC cleanup regulations, the residual risk (after completing site cleanup) from a contaminant should not exceed a cancer risk standard of 1 in 100,000. In addition, the residual risk should not exceed a non-cancer hazard index of 1.0.

Exposure scenarios for humans that were evaluated consisted of the following:

- Future residents of the site who may be exposed to contaminants throughout the site through soil ingestion, dermal contact with soil, inhalation of volatile chemicals from soil and active zone water, and inhalation of particulates and dust from soil.
- Current and future industrial workers who may be exposed to contaminants throughout the site through soil ingestion, dermal contact with soil, inhalation of volatile chemicals from soil and active zone water, inhalation of particulates and dust from soil, and dermal contact with ponded surface water.
- Future construction workers who may be exposed to contaminants throughout the site through soil ingestion, dermal contact with soil, inhalation of volatile chemicals from soil and active zone water, inhalation of particulates and dust from soil, dermal contact with ponded surface water, and dermal contact with active zone water during excavation activities.

- Recreational and subsistence users of the site who may be exposed to contaminants through soil ingestion, dermal contact with soil, inhalation of volatile chemicals from soil and active zone water, inhalation of particulates and dust from soil, dermal contact with surface water and sediment of North Salt Lagoon and a nearby melt water pond, ingestion of surface water from North Salt Lagoon and the melt water pond, ingestion of fish that may be exposed to site-related contaminants in North Salt Lagoon, and ingestion of waterfowl that may be exposed to contaminants in the melt water pond or North Salt Lagoon.

Results of the human health baseline RA identified the following exposure pathways that exceeded the ADEC cancer risk management threshold of 1×10^{-5}:

- Future construction workers – Inhalation of volatiles (benzene) in subsurface soil during excavation activities.

The exposure pathways for which the ADEC non-cancer risk management threshold hazard index (HI) of 1.0 was exceeded consisted of the following, with hazard quotients (HQ) in parentheses:

- Future construction workers – Inhalation of 1,2,4- and 1,3,5-trimethylbenzenes from soil (HQ = 28); dermal contact with DRO-aliphatics in active zone water (HQ = 10). However, the dermal contact with active zone water pathway was not deemed to present a significant risk because of the high uncertainty over the use of a surrogate log K_{ow} value for modeling uptake of DRO-aliphatics from water.

- Recreational Users, Child - Dermal contact with DRO-aliphatics and RRO-aromatics in melt water pond surface water (HQ = 1.9).

- Subsistence fishers, Adult/Child – Ingestion of GRO-aliphatics in fish caught from North Salt Lagoon (HQ = 5/10).

Exposure scenarios for ecological receptors that were evaluated consisted of the following:

- Terrestrial ecological receptors consisting of plants, invertebrates, mammals (tundra vole, Arctic shrew, Arctic fox), and birds (Lapland longspur, snowy owl, mallard duck, and Arctic loon) could come in contact with site contamination through their food and from direct exposure to site soil, active zone water, and surface water and sediments from the nearby melt water pond and North Salt Lagoon.

- Aquatic receptors consisting of lower food chain organisms (invertebrates and phytoplankton) in North Salt Lagoon could be exposed directly to active zone water discharge, surface water, and sediments.

The ecological RA was performed in two tiers. The BFTF Site is characterized as posing a moderate level of risk to ecological receptors:

- Risks to lower trophic level organisms in soil from exposure to DRO-aromatics were low (HQ = 2.3).
- Risks to the fox, vole, and shrew were low to moderate for exposures to DRO-aliphatics in surface soils (HQ = 18 for shrew, based on maximum concentration). Exceedances of risk-based screening levels for the DRO-aliphatics were concentrated in the area southeast of the gravel pad.
- Risks to lower trophic aquatic organisms from potential exposure to petroleum hydrocarbons in active zone water that may transport to North Salt Lagoon were moderate based on maximum concentrations (HQ = 187 for GRO-aliphatic, HQ = 14 for DRO-aromatic, HQ = 433 for RRO-aromatic, HQ = 16 for xylenes). No exceedances were observed for exposures of higher trophic organisms to active zone water.

Given the high uncertainties about the toxicities of the GRO, DRO, and RRO petroleum fractions to aquatic organisms and wildlife, the risks to ecological receptors from these compounds were determined to be substantially lower than calculated in the baseline risk assessment (EA 1999, 2000a). The surrogate compounds that were used to estimate the toxicities of the fractions were not present in soils or surface waters, or were present in far fewer samples and at much lower concentrations than the respective petroleum fraction.

Figure 3 shows surface sample locations in soil where concentrations from the site investigation of 1997 exceeded ecological risk-based screening levels. Figure 4 shows sample locations in active zone water where concentrations from the site investigation of 1997 exceeded risk-based and regulatory criteria for the protection of human health and aquatic receptors.

Following the baseline RA, additional investigations and a removal action were performed that impacted the estimation of risk to human health and ecological receptors and subsequent development of cleanup objectives for the site, as described in the following section.

Risk Re-Evaluation Studies

The following studies were performed subsequent to the baseline RA, which resulted in reevaluation of human health and ecological risks:

Technical Response Letter (EA 2000a). Risks from inhalation of compounds that may volatilize from soil, subsurface soil, and groundwater were evaluated in a Technical Response Letter after completion of the baseline RA (EA 2000a). This assessment added the inhalation of gases from soil and active zone groundwater to the model. Risks were modeled for residential, commercial/industrial, and construction worker exposures and shown to be below ADEC risk management thresholds for cancer and noncancer risks

Risks associated with ingestion of fish from North Salt Lagoon were re-evaluated in the Technical Response Letter using different assumptions for fish ingestion rates (EA 2000a). Re-evaluated risks were estimated to be above ADEC risk management thresholds (HI = 12), resulting primarily from the DRO-aliphatic fraction detected in surface water and sediment of North Salt Lagoon.

Fish Sample Collection and Risk Re-Evaluation (EA 2000b, 2001c). In 2000, fish were sampled from North Salt Lagoon to determine whether contaminants found in surface water and sediment are actually in the fish that people eat. The sampling and analysis of fish from North Salt Lagoon demonstrated that TPH compounds, such as DRO-aliphatics, were not detectable in tissue fillets. The use of the detection limits to recalculate health risks resulted in a hazard index below the ADEC risk management threshold (i.e., HI < 1) (EA 2001).

SUMMARY OF RISK POSED BY THE SITE

The ADEC-approved risk assessment report for the BFTF Site was completed in 1999 with an additional Technical Response Letter in 2000. The purpose of the baseline RA was to determine the potential for adverse health effects for people using the site (residents, industrial workers, construction workers, and recreational/ subsistence users) and to wildlife. The baseline RA and risk reevaluation identified several exposure pathways posing non-cancer related risks. The exposure pathways for which the ADEC cancer risk management thresholds were exceeded consisted of inhalation of vapor from soil by construction workers, and dermal contact with surface water in the melt pond.

Potential Risks to Human Health

The results of Risk Assessments at the site indicated the two following unacceptable risks for site users:

- Noncancer risks for future construction workers from inhalation of volatile chemicals from soil.
- Noncancer risk to children that use the site for recreation exceeded the hazard index threshold due to contact with diesel range hydrocarbons in the melt water pond surface water.

Lifetime cancer risks estimates for future residents, recreational users, and subsistence fishers and hunters were all below the ADEC regulatory limit of 1×10^{-5}.

Potential Risks to the Environment

The BFTF site is characterized as posing a moderate level of risk to ecological receptors.

- Small mammals that live in the tundra adjacent to the raised gravel pad could be exposed to harmful contaminants in the soils. These areas have high concentrations of DRO petroleum hydrocarbons in surface soils.
- Risks were considered to be very low for fish and wildlife that use North Salt Lagoon or the nearby melt water pond.

PROPOSED CLEANUP LEVELS

Site cleanup levels were established to address conditions evaluated in the Risk Assessment. Risk-based cleanup levels have been proposed for the site.

Soil Cleanup Levels

On the basis of the RA results, soil cleanup levels shown in Table 1 were established to protect both people and wildlife at the site. Cleanup of the subsurface soils will prevent harm to construction workers and cleanup of surface soils will prevent risks to wildlife.

Table 1 soil cleanup levels will apply to soil left in place. Cleanup levels for treated soil will be based on 18 AAC 75.341, Method 1 for GRO (100 mg/kg) and DRO (500 mg/kg with benzene less than 0.5 mg/kg and BTEX less than 15 mg/kg). Cleanup levels for the treated soil trimethylbenzenes will be the risk-based levels shown in Table 1.

Table 1
Proposed Cleanup Levels for Soil at the Bulk Fuel Tank Farm Site

Cleanup Objective	Chemical of Concern	Proposed Cleanup Level (mg/kg) Surface Soil	Subsurface Soil
Prevent exposures of wildlife to lead and diesel-range hydrocarbons in surface soil	*Metals*		
	Lead	40.5	--
	Total Petroleum Hydrocarbon Fractions		
	Diesel-Range Aliphatic	1,328	--
	Diesel-Range Aromatic	300	--
Prevent exposures of construction workers to volatile organic compounds in subsurface soil	*Total Petroleum Hydrocarbon Fractions*		
	Gasoline-Range Aliphatic	--	5.8
	Gasoline-Range Aromatic	--	79
	Volatile Organic Compounds		
	1,2,4-trimethylbenzene	--	1.9
	1,3,5-trimethylbenzene	--	0.61

mg/kg = milligram of chemical per kilogram of soil.

"--" = Cleanup level not proposed because no risks were observed.

Active Zone Water Cleanup Levels to Protect Melt Water Pond and North Salt Lagoon.

The active zone water cleanup levels are based on risk-based levels to protect aquatic receptors and water quality standards. Active zone water cleanup levels are shown in Table 2. Active zone water cleanup levels were developed to protect future construction workers and wildlife at the site that may be exposed to active zone water. The ADEC groundwater cleanup level is used for benzene.

Table 2
Proposed Cleanup Levels for Active Zone Water
Bulk Fuel Tank Farm Site

Cleanup Objective	Chemical of Concern	Proposed Cleanup Level (µg/L)	Comments
Prevent exposures of aquatic organisms that may contact groundwater discharges to surface waters, as well as to protect construction workers	Lead	3.2	Cleanup levels meet: • risk-based standards for aquatic organisms, • groundwater cleanup level to protect construction workers, and • water quality standards
	GRO Aliphatic Hydrocarbons	160	
	DRO Aromatic Hydrocarbons	240	
	Benzene	5	
	Xylenes	18	

µg/L = microgram of chemical per liter of water

Free Product Cleanup Requirements

State regulations (18 AAC 75.325(f)(1)(B)) require that free product, if encountered, must be recovered to the maximum extent practicable. Free product has not been observed at the site.

Stained Soil Cleanup Requirements

State regulations (18AAC 75.325(f)(1)(E)) require that surface staining attributable to a hazardous substance be evaluated and cleaned up to the maximum extent practicable. Stained soil at the BFTF site will be addressed during soil excavation and remediation.

Cumulative Residual Risk Evaluation

Beyond demonstrating acceptable residual risk for the BFTF Site per 18 AAC 75, the Navy has agreed to evaluate cumulative residual risks for the entire NARL facility after cleanup goals have been achieved for the Powerhouse Site, Airstrip Site, Dry Cleaning Facility, and Bulk Fuel Tank Farm. The overriding cleanup objective is to achieve an acceptable cumulative risk for the former NARL facility as a whole, as estimated from the cumulative risk evaluation.

SUMMARY OF CLEANUP ALTERNATIVES

The following alternatives were evaluated for their application to the soil and active zone water at the Bulk Fuel Tank Farm Site, and to surface waters and sediments of nearby water bodies.

Estimated costs for cleanup alternatives were taken from the *Management Plan for the Dry Cleaning Facility and Bulk Fuel Tank Farm Sites* (EA 2001a), the *Proposed Plan for Cleanup of the Bulk Fuel Tank Farm Site* (EA 2001b), and calculated based on unit rates for similar projects.

Alternative #1 – No Action Alternative

Under this alternative, no control or active treatment of the soil or active zone water would be performed. This alternative does not satisfy government regulations and is not protective of human health or the environment. This alternative does not remove sources of contamination to the nearby water bodies.

Alternative #2 – Vapor Extraction System

Soils/Subsurface Soils: A Vapor Extraction System would be used to treat the surface and subsurface soils. Vapor Extraction is a process in which air is forced through the soil, and then collected by a vacuum system. Contamination evaporates off the soil particles into the air as it is drawn through the soil. The vapors are treated to remove the contaminants.

The advantage of Vapor Extraction System alternative is that it is very effective for gravel soils. The disadvantage is that it could take a long time for the contaminants to evaporate from the soil particles by the forced air because of the low-temperature arctic environment and high volume of soil. In addition, reduction in contaminant concentrations can be expected to be around 90 percent, which is not enough to reach cleanup goals for all contaminants.

Active Zone Water: Potential risks posed by site active zone water contamination would be addressed through a combination of actions. Active zone water would be cleaned up primarily by removing the source of contamination in the soil, and secondarily, by using natural attenuation. Natural attenuation uses natural processes to reduce contaminant concentrations in the active zone water. Monitoring of active zone water would be performed at three locations along the shoreline of the melt water pond and at three locations along the shoreline of North Salt Lagoon. After five years, the Navy, ADEC, and UIC would review the monitoring data to evaluate the success of natural attenuation in active zone water, and determine whether additional actions and/or monitoring for active zone water are needed. The source of active zone water contamination would be removed by the treatment of contaminants in the soil. The removal of sources of contamination to the active zone water would help to ensure that chemicals do not contaminate nearby water bodies in the future.

The low risks to recreational users, fish, and wildlife that may contact surface waters and sediments of the nearby melt water pond and North Salt Lagoon would be addressed through the following combination of actions:

- Surface water and sediment of the water bodies will undergo natural attenuation. Risks associated with sediments and surface waters of both the melt water pond and North Salt Lagoon were evaluated as low to negligible, and natural attenuation is an effective and feasible alternative. The long term process of natural attenuation is considered more beneficial to the environment than the disturbance associated with active remediation. Active remediation of the water bodies would be extremely costly, and would result in substantial disturbance of the aquatic habitats with relatively minor benefits in terms of risk reduction. For example, sediment dredging would result in damage to the shoreline tundra from the heavy equipment. Sediment dredging would also disturb the habitat along the shore for small aquatic organisms that live in the sediment and for wading birds that feed in the sediment.

- Active remediation of soils at the site is designed to control sources of contaminants to the nearby water bodies. To ensure that the transport of petroleum compounds from the former tank farm soil to North Salt Lagoon has ceased following soil remediation, sediment in North Salt Lagoon will be sampled after soil cleanup. Costs for sampling sediment in North Salt Lagoon are included in the total costs for each alternative.

The estimated cost for Alternative 2 is $880,540.

Alternative #3 – Thermal Desorption Vapor Extraction System

Soils/Subsurface Soils: This alternative includes all the cleanup elements of Alternative 2, except that thermal desorption would be added to the vapor extraction system for treating soil. In-situ thermal desorption is similar to vapor extraction. The important difference is that it uses long metal probes that are inserted into the soil. These probes are heated electrically. This heats the soil and causes petroleum to evaporate faster and more completely than from unheated soil. This method can remove 95 percent of the contamination, which will meet the soil cleanup levels.

The advantage of the Thermal Desorption Vapor Extraction System is that cleanup time is shorter compared with Vapor Extraction System by itself or with hot air injection. The implementation of the Thermal Desorption Vapor Extraction System is technically feasible. (Note: the Thermal treatment process will be placed on an elevated gravel pad that has an artificially raised permafrost level.) A disadvantage of the alternative is that the Vapor Extraction System components have to be shipped to the site. Also, significant melting of the underlying permafrost could occur, resulting in thaw bulb lakes that could decrease the area's recreational usability. The cost of this alternative is lower than excavation and off-site treatment of the soil.

Active Zone Water: Same as for Alternative 2.

The estimated cost for Alternative 3 is $1,226,200.

Alternative #4 – Bioventing

Soils/Subsurface Soils: This alternative utilizes bioventing to treat the contaminated surface and subsurface soils. Bioventing provides air to stimulate microbes (bacteria) to biodegrade volatile contaminants from soil. Bioventing systems promote biodegradation of the contaminants and minimize their release from soil particles.

The advantage of bioventing is that the contaminants are broken down right on the soil particles. Because of this, they do not need to be removed from the soil and do not need to be treated, as with the vapor extraction systems. The implementation of the bioventing alternative is technically feasible.

The disadvantage of bioventing is that it may take a long time for contaminants to decrease below the cleanup levels because the cold temperature will slow down the activity of the microbes. Even though the bioventing components are commercially available, they have to be shipped to the site.

Active Zone Water: Same as for Alternative 2.

Because of the long duration expected for bioventing to achieve cleanup levels, it is not considered effective for the site cleanup and costs were not estimated.

Alternative #5 – Enhanced Biodegradation

Soils/Subsurface Soils: A type of enhanced biodegradation, landfarming, would be used to treat the contaminated surface and subsurface soils by adding nutrients to the soil, along with tilling it regularly to provide aeration and promote biodegradation. Microbes are commercially available for the contaminants found at the site and would be added if necessary to stimulate degradation of the petroleum contamination by microbial action. In addition, non-chlorinated water would be added when soil moisture levels indicate the need for it.

At the time the proposed plan was prepared, enhanced biodegradation was not advanced as a preferred alternative due to a lack of confidence that cleanup levels could be reached within a reasonable period of time. Recent field applications, however, have shown that adequate remediation can occur in one season of treatment at petroleum-contaminated gravel pads in the arctic. These examples use addition of water and nutrients, as well as active tilling, to achieve success. Using lessons learned from case studies with conditions similar to the BFTF, landfarming is now considered a potentially viable alternative.

The advantage of landfarming is that contaminants are biodegraded. As such, they do not have to be removed from the soil and treated. Implementation of the landfarming is technically feasible. A disadvantage is that it can take a long time for contaminants to decrease below the cleanup levels because of the cold temperature.

Active Zone Water: Same as for Alternative 2.

The estimated cost for Alternative 5 is $1,200,000.

Alternative #6 – Heat Injection with Vapor Extraction System

Soils/Subsurface Soils: This alternative includes all the cleanup elements of Alternative 2 except that heat injection with the Vapor Extraction System would be used to treat the contaminated surface and subsurface soils. Injection of hot air along with the Vapor Extraction System enhances the removal of contaminants from the soil particles to the air spaces around the particles. The contaminants in the air spaces would then be removed by vacuum and treated at the site.

The advantage of heat injection with Vapor Extraction is that it is appropriate for gravel soil. The implementation of this alternative is technically feasible. The disadvantage of the heat injection Vapor Extraction System is that the cold environment of subsurface soil will rapidly cool the hot air. The inclusion of heat injection will be more effective than the Vapor Extraction System alone, but less effective and slower than the inclusion of Thermal Desorption to the Vapor Extraction System with electric probe heat.

Active Zone Water: Same as for Alternative 2.

Because this alternative would be less efficient than the Thermal Desorption Vapor Extraction System with electric probe heat, it is not considered as effective for the site and costs were not estimated.

Alternative #7 – Landcap

Soils/Subsurface Soils: A cover would be placed over contaminated soils to contain them at the site. The landcap alternative uses an impermeable cover to isolate the contaminated soil from the rest of the site and to prevent exposures.

The advantage of the landcap alternative is that it can be easily implemented. Disadvantages are that the landcap alternative does not treat the contaminants at the site and restrictions may be required to prevent the public from removing or damaging the cover and thereby being exposed to contaminated soils. In addition, the sources of contamination to nearby surface waters will not be removed, although the cap will reduce the washing of contaminants from soil to active zone water and nearby surface waters. A cap would also prevent the raised pad from being used for future construction purposes.

Active Zone Water: Same as for Alternative 2.

Because of these disadvantages, the landcap alternative costs were not estimated.

EVALUATION OF CLEANUP ALTERNATIVES

ADEC uses five criteria to evaluate its preferred alternative for cleanup of a given site. The next section evaluates the seven alternatives for the site against these criteria.

Practicality: *Are the alternatives capable of being designed, constructed and implemented in a reliable and cost-effective manner? Which of the alternative(s) are the most cost-effective?*

Alternative 1, no action, is the most easily implemented, although it does not meet regulatory agency requirements for protection of human health or the environment. Alternatives 2, 3, 4, 5, and 6 are similar in the design, construction, and practicability since each alternative works by promoting air contact with subsurface soil to either enhance biodegradation or strip contaminants from the soil. Alternative 7 is practical but does not offer long-term protection of surface waters. Of the alternatives that use air contact with soil, Alternative 3, thermal desorption vapor extraction, is the fastest since it heats the soil to a higher temperature. Alternative 5, enhanced biodegradation, can also be effective due to the high rate of air contact. The other alternatives likely will not achieve the removal efficiency because of low temperatures or low air contact rates and could take years to remediate the soil.

Regulations: *Will the alternative comply with all state and federal regulations?*

Alternative 1 does not comply with protection of human health or the environment. Alternative 7 does not comply with protection of surface waters. The remaining alternatives will comply with applicable state and federal regulations.

Short- and Long-Term Effectiveness: *Are there potential adverse impacts to human health, safety, and welfare or the environment during construction or implementation of the alternative? How fast does the alternative reach cleanup goals? How well does the alternative protect human health, safety, and welfare or the environment after completion of the cleanup?*

Alternative 1 does not offer long-term protection of health or the environment. Because of the length of time to achieve treatment objectives, Alternatives 4, 6 and 7 were not considered effective in the short term. Alternatives 2 through 6 offer long-term effectiveness, although there are potential risks to construction workers during implementation of the alternatives due to the subsurface contamination. The remediation of subsurface soils is designed to prevent future construction worker risks. Alternative 7 does not provide long-term protection of nearby surface waters. Because the risks from contamination of active zone water, the melt water pond, and North Salt Lagoon were low, Alternatives 2 through 6 will also provide long-term effectiveness to eliminate those risks.

Public Input: *Have significant comments received from the community been considered?*

All comments received during the public comment period were reviewed and considered before making a final cleanup decision. A Responsiveness Summary is included herein.

THE SELECTED CLEANUP ALTERNATIVE

Based on the information generated from the site investigation, risk assessment, analysis of alternatives, and site cleanup actions completed to date, the selected alternative for the Bulk Fuel Tank Farm Site is a combination of Hot Air Vapor Extraction (HAVE) and Alternative 5, landfarming. During the Proposed Planning phase for this project, Alternative 3 was selected because it has potential to be the fastest way to meet target clean-up levels. However, it is also the most expensive and one of the most disruptive. Significant melting of the underlying permafrost could occur under Alternative 3, resulting in thaw bulb lakes that would either temporarily or permanently decrease the area's recreational usability. The decision in 2002 to modify the remedy was based on a desire to eliminate the negative consequences of Alternative 3, and to utilize information gained from recent successes achieved while landfarming other petroleum-contaminated gravel pads in the arctic.

The selected cleanup alternative includes the following tasks:

- Excavate soil with the highest contamination concentrations, located at the turnaround area and the south bank of the gravel pad. Transport this soil to the airstrip site for thermal treatment using HAVE. Return the soil to the BFTF site after treatment cleanup endpoints have been reached.
- Construct biological treatment cells (biocells) at the south end of the NARL Airstrip and/or at the BFTF gravel pad itself. It is anticipated that three cells would be constructed, each capable of treating up to 2,000 cubic yards of soil. Contaminated soil from the gravel pad and surrounding tundra which is not HAVE treated would be placed in the biocells.
- Excavate contaminated soil and place it into the biocells.
- Inoculate each biocell with an application of nutrients. If deemed necessary or advantageous, hydrocarbon degrading microorganisms may be added to supplement activity by indigenous microorganisms. Each treatment cell will be tilled regularly, one to four times per week, throughout the field season. In addition to tilling, each cell will receive an application of non-chlorinated water when soil moisture levels indicate the need for it, in order to provide optimum soil moisture content for maximum productivity of the microorganisms. If treatment endpoints are not reached at the end of one treatment season, remaining contaminated soil will be transported to the NARL Airstrip for thermal treatment using HAVE.
- Monitor for five years natural attenuation of active zone water along the shorelines of both

the melt water pond and North Salt Lagoon.

- Monitor for five years natural attenuation of sediments in North Salt Lagoon to verify that contaminant transport has ceased following soil cleanup.
- Conduct a review of site conditions after 5 years to assess the need for additional monitoring.
- Evaluate the cumulative residual risk for the site after cleanup levels have been achieved at the former NARL facility.

The selected alternative uses a demonstrated soil treatment method that has been effective in similar petroleum-contaminated gravel pads in the arctic environment, protects construction workers by cleaning up soil sources of contaminants that could be inhaled, and provides for monitoring natural attenuation of contaminants in the active zone water and North Salt Lagoon sediment, which will verify whether recreational users and wildlife are protected from contaminant transport after soil cleanup. Excavating and treating contaminated soil will reduce risks to future construction workers. Treating the contaminated tundra soil adjacent to the raised pad will reduce risks to wildlife that use the tundra.

The cleanup components under the combination of Alternative 5 and HAVE achieve protection of human health and the environment, comply with ADEC cleanup regulations, achieve overall protection for all site media in the long term, and are relatively cost-effective. For these reasons, a combination of Alternative 5 and HAVE is the selected cleanup method for the Bulk Fuel Tank Farm Site.

The cleanup of soils through landfarming and HAVE is designed to lower the concentrations of petroleum hydrocarbons to below cleanup levels for unrestricted use of the land. This technology is capable of meeting ADEC requirements for cumulative residual risks after site cleanup.

The 5-year monitoring program for the active zone water will track trends in the active zone water near the interface with surface waters at the melt water pond and North Salt Lagoon. Monitoring will be performed to determine whether the remediation of soils has prevented further contamination of the surface water bodies, and to demonstrate the natural attenuation of active zone water. Three sentinel wells will be installed along the road to the east of the raised gravel pad to monitor for possible migration of the impacted active-zone water toward the melt water pond. Similarly, three sentinel wells will be installed along the southwest shoreline to monitor for possible migration of the impacted active-zone water toward the North Salt Lagoon. One sample will be collected from active-zone water from each of the sentinel wells in July and September of each year for five years. These groundwater samples will be analyzed for benzene, xylenes, GRO, DRO, and RRO using methods SW8260, AK101, AK102, and/or AK103 as appropriate.

The 5-year monitoring program for sediments will monitor trends in sediment concentrations in

North Salt Lagoon to determine whether contaminants of concern in the sediments are naturally attenuating. Three samples will be collected from the same stations sampled in 1997 from North Salt Lagoon in September of each year for five years. These sediment samples will be analyzed for GRO and DRO using ADEC methods AK101 and AK102, respectively.

PUBLIC INVOLVEMENT ACTIVITIES

Community Relations. The Navy has been involved in the Barrow Restoration Advisory Board (RAB) since it's inception in 1995, and has a representative assigned who is the Navy Co-Chair. The Barrow RAB has been very active in all restoration projects at the NARL facility. Primary documents are placed in the Barrow Library for review by the community.

In addition, the NARL Cleanup Team Partnership was formalized in 1999. The partnership team consists of one representative from the Navy as responsible party, one from ADEC as regulatory agency, and one from UIC as landowner. The partnership meets at least 3 times per year and more frequently as necessary to review primary documents and planning of activities.

Public meetings were held while preparing the risk assessment to provide information to, and obtain comments from, residents on potential risk scenarios and the approach to the analysis.

Government to Government Consultation. The Navy consulted with representatives of the Native Village of Barrow and the Inupiat Community of the Arctic Slope regarding the Risk Assessment, Management Plan, and Proposed Plan developed for the former BFTF site. The Representatives of the Native Village of Barrow and the Inupiat Community of the Arctic Slope have participated in quarterly meetings along with UIC, the Navy, and the State of Alaska to develop Management Plans and review of primary documents.

Primary Documents. Primary documents are made available to the public through the repository in the Tuzzy Consortium Library in Barrow.

Proposed Plan. A meeting with the Navy, UIC, State, and tribal leaders was held to present the proposed cleanup levels and plans. On July 12, 2001 a Community information session was held to discuss the cleanup alternatives for the BFTF Site.

Public Comment #1. A proposed cleanup action plan was sent out for a 30-day public comment period July 9, to August 10, 2001. Written comments were received from Barrow residents. These comments and the Navy's responses to them are summarized in the Responsiveness Summary section.

Public Comment #2. The Navy modified proposed remedies in 2002, and subsequently prepared a Fact Sheet that included a brief summary of the NARL site and details of landfarming as it could be applied at the Bulk Fuel Tank Farm. These Fact Sheets were made available at the

Tuzzy Consortium Library. Advertisements were aired on the radio and published in the Arctic Sounder for a public meeting held on September 18, 2002. Public comments were solicited for a comment period from September 18 to October 18, 2002. No public comments, either for or against the proposed change in remedy, were received during this second comment period.

FUTURE CONTACTS

Throughout the process, Barrow Community members have been encouraged to contact the Navy and ADEC site managers with questions and comments. Community members are still encouraged to do so. These representatives are:

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19917 - 7th Avenue NE
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RESPONSIVENESS SUMMARY

The following is a summary of the comments received during the 30-day public comment period #1 and the Navy's responses on the proposed cleanup plans for the four sites at the former NARL facility.

Comment: UIC Real Estate will not approve of any plans unless Navy uses local contractors.

Response: The Navy has worked with the Alaska Small Business Administration to obtain the services of Local 8A Contractors. Contractors are also encouraged to use Contractors and Equipment from the Local Community to the maximum extent practicable.

Comment: At the Airstrip Site there need to be sampling done by the old terminal north side at least 5 feet from the building there is an old gas line under the building the line broke during the winter of between 1960 and 1964. At the time the terminal was shut down till the fuel some it was picked up. The verbal reports are from former employees of NARL.

Response: During the course of performing site characterization there has been comprehensive sampling of soil and active zone water across the Airstrip Site completed to date. Figures 4, 5, and 6 in the Airstrip Management Plan (date February 16, 2001) shows soil data locations. We appreciate the comment, and we believe adequate site data was collected to make decisions regarding site cleanup. The Navy looked for a suspected free-product plume and determined that a contiguous free-product plume did not exist and that no more practicably recoverable free-product remains.

Comment: Recommend an archeologist be onsite during any excavations to protect any possible artifacts, suggest using UIC science division staff.

Response: The Navy appreciates this comment and respects the value of local cultural resources throughout the NARL area. The Navy's standard construction specifications have specific requirements in Section 1355A, part 3.9, addressing the protection of Historical, Archaeological, and Cultural Resources. The majority of the planned remedial actions involve shallow excavations within the limits of existing construction fill material where such resources are not anticipated. For excavations in the undisturbed native soil, the Navy will make provisions for consultation and excavation observations using archaeological services with the local experience.

Comment: *Excavation of top soil being one-foot off the top of proposed contaminated area around Power Plant, recommend excavation should be at least four feet deep. Prior to final approval, recommend UIC Real Estate, contractors and UIC consultants submit photos and video tapes to ADEC and BLM for review.*

Response: The one-foot excavation in the Management Plan refers to those areas where surface soil staining exists. It is important to understand that this action was conducted solely for reasons of aesthetics (visual) in the area we have assumed a reuser may want unrestricted (residential) use, east of the UICC yard. It is not done based on human health risk, and is not needed to make the area acceptable for unrestricted use based on human health risk. This action is being done only to make the area look nicer, the area would be acceptable for unrestricted use, in terms of health risks, without completing the stained surface soil removal. ADEC regulations require addressing stained surface soils to the extent practicable, and the proposed removal in this area has been discussed in project meetings with ADEC and UIC, we believe there has been agreement to use a 1-foot depth for planning purposes in the Management Plan. Regarding the September 2000 hot spot removal at the former ASTs, the excavation extended to active zone water at a depth of 2.5 feet (refer to page 18 and Photo 1 of Arctic Slope's January 2001 report). Contamination below the water table is addressed as part of the cleanup remedy for active zone water, not soil.

REFERENCES

Detailed information on investigation and cleanup activities at the former BFTF Site at the former NARL Facility, Barrow, Alaska, can be found in the following documents.

DOCUMENTS REFERENCED IN DECISION DOCUMENT

EA, 1997a. Development of a Risk-Based Cleanup Approach for Petroleum-Contaminated Sites, Naval Arctic Research Laboratory, Barrow. Prepared for US Navy Engineering Field Command, Engineering Field Activity, NW, Poulsbo WA. January 1997.

EA, 1997b. Human Health and Ecological Risk Assessment Work Plan for the Dry Cleaning Facility and the Bulk Fuel Tank Farm at NARL, Point Barrow, Alaska. Prepared for US Navy Engineering Field Command, Engineering Field Activity, NW, Poulsbo WA. August 1997.

EA, 1999. Site Investigation and Risk Assessment Report for the Dry Cleaning Facility and Bulk Fuel Tank Farm at NARL, Point Barrow, Alaska. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science and Technology, Inc. Bellevue, WA. July 1999

EA, 2000a. Technical Response Letter. Site Investigation and Risk Assessment Report for the Dry Cleaning Facility and Bulk Fuel Tank Farm at NARL, Point Barrow, Alaska. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science and Technology, Inc. Bellevue, WA. June 15, 2000.

EA, 2000b. Work Plan for Sampling and Analysis of Fish from North Salt Lagoon, Point Barrow, Alaska. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science and Technology, Inc. Bellevue, WA. August 18, 2000.

EA, 2001a. Management Plan for the Dry Cleaning Facility and Bulk Fuel Tank Farm Sites at the former NARL, Point Barrow, AK. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science, and Technology, Bellevue, WA. April 2001

EA, 2001b. Proposed Plan for the Bulk Fuel Tank Farm Site at the former Naval Arctic Research Laboratory, Barrow, AK. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science, and Technology, Bellevue, WA.

EA, 2001c. Results of Sampling and Analysis of Fish from North Salt Lagoon, Pt Barrow, AK. Prepared for Engineering Field Activity, Northwest, US Navy, Poulsbo, WA. EA Engineering, Science, and Technology, Bellevue, WA. August 18, 2001.

Hart Crowser, 2001c. Monitoring Well Installation and Field Activities Report, Powerhouse, Airstrip, Dry Cleaning Facility, and Bulk Fuel Tank Farm Sites, Former NARL, Point Barrow, Alaska. September 7, 2001. Prepared for Department of the Navy, Engineering Field Activity, NW, Naval Facilities Engineering Command under Contract No. N44255-98-D-4408.

Hart Crowser, 2001d. Final Groundwater, Surface Water, and Sediment Data Management and Evaluation Plan, Powerhouse, Airstrip, Dry Cleaning Facility, and Bulk Fuel Tank Farm Sites, Former NARL, Point Barrow, Alaska. November 26, 2001. Prepared for Department of the Navy, Engineering Field Activity, NW, Naval Facilities Engineering Command under Contract No. N44255-98-D-4408. Delivery Order No. 31.

Hart Crowser, 2002. Draft 2001 Annual Report for Groundwater and Surface Water Monitoring Powerhouse, Airstrip, Dry Cleaning Facility, and Bulk Fuel Tank Farm Sites, Former NARL, Point Barrow, Alaska. January 9, 2002. Prepared for Department of the Navy, Engineering Field Activity, NW, Naval Facilities Engineering Command under Contract No. N44255-98-D-4408. Delivery Order No. 31.

SAIC, 1992. Draft Human Health and Ecological Risk Assessments. The Naval Arctic Research Laboratory. Point Barrow, Alaska. Prepared for URS Consultants, Inc. Contract Task Order No. 0067. Science Applications International Corporation, Seattle, Washington.

URS, 1991a. Baseline Human Health and Ecological Risk Assessment, Naval Arctic Research Laboratory, Point Barrow, Alaska. CTO 0009. Prepared for U.S. Navy, Engineering Field Activity, NW, Naval Facilities Engineering Command, Poulsbo, WA, under CLEAN Contract No. N62474-89-D-9295. April 8, 1991.

URS, 1991b. Supplemental Remedial Investigation (Powerhouse Fuel Spill Site, Airstrip Fuel Spill Site, Bulk Fuel Tank farm, Imikpuk Lake), Naval Arctic Research Laboratory, Barrow, Alaska. Final Report. Contract Task Order No. 0020. Prepared for the U.S. Navy under the Contract No. N62474-89-D-9295. URS Consultants, Seattle, Washington.

URS, 1992. Draft Human Health and Ecological Risk Assessments, Naval Arctic Research Laboratory, Point Barrow, Alaska. CTO 0067. Prepared for U.S. Navy, Engineering Field Activity, NW, Naval Facilities Engineering Command, Poulsbo, WA, under CLEAN Contract No. N62474-89-D-9295. April 23, 1992.

URS, 1994. Final Supplemental Site Characterization. Airstrip Fuel Spill Area, Imikpuk lake, North Salt Lagoon, and Selected Meltwater Ponds, Naval Arctic Research Laboratory, Point Barrow, Alaska. Contract Task Order No. 0067. Prepared for the U.S. Navy Engineering Field Activity Northwest, Southwest Division, Naval Facilities Engineering Command. Silverdale, Washington. March.

URS, 1996. Technical Memorandum. Results of the Treatability Study, The Naval Arctic Research Laboratory, Point Barrow, Alaska. URS Consultants, Seattle, Washington.

URS, 2000. Final NARL Environmental Site Status Report, Former Naval Arctic Research Laboratory, Point Barrow, Alaska, CTO 0236. Contract Task Order No. 0148. Prepared for U.S. Navy under Contract No. N62474-89-D-9295.

USGS, 1994. Assessment of the Hydrologic Interaction between Imikpuk Lake and Adjacent Airstrip Site near Barrow, Alaska. USGS Open File Report 94-362. U.S. Geological Survey, Anchorage, Alaska.

USGS, 1995. Assessment of the Subsurface Hydrology of the UIC-NARL Main Camp Near Barrow, Alaska, 1993-1994. USGS Open File Report 95-737. U.S. Geological Survey, Anchorage, Alaska.

OTHER SITE REFERENCE DOCUMENTS

ADEC, 1996. Petroleum Cleanup Guidance, Public Review Draft. December 1996.

ADEC, 1998a. Guidance on Cleanup Standards, Equations, and Input Parameters. September 16, 1998.

ADEC, 1998b. Risk Assessment Procedures Manual. Contaminated Sites Remediation Program. November 24, 1998.

ADEC, 1999b. Policy for Establishing Cleanup Levels for Sites in the Arctic Zone in Accordance with 18 AAC 75, Article 3. ADEC Guidance No. SPAR 99-3. December 22, 1999.

ADEC, 1999c. 18 AAC 75, Articles 3 and 9. Oil and Hazardous Substances Pollution Control Regulations. Discharge Reporting, Cleanup and Disposal of Oil and Other Hazardous Substances, and General Provisions. Department of Environmental Conservation, Juneau, AK. October.

ADEC, 2001. Application of Water Quality Standards to Contamination Cleanup Projects. ADEC Division of Spill Prevention and Response Contaminated Sites Remediation and Storage Tanks Programs. Technical Memorandum 01-005. January 30, 2001.

Arctic Slope, 2001. Final Remedial Action Report for Hot Spot Removal, Former Naval Arctic Research Laboratory, Barrow, Alaska. January 2001.

Biggar, K.W., S. Haidar, M. Nahir, and P.M. Jarrett, 1998. Site Investigations of Fuel Spill migration Into Permafrost. Journal of Cold Regions Engineering. V. 12, No. 2. June 1998. pp. 84-104.

Blake, S.B., and R.A. Hall, 1984. Monitoring Petroleum Spills with Wells: Some Problems and Solutions. Presented at the Fourth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, NWWA, Columbus, Ohio.

Braddock, J.F., and K.A. McCarthy, 1996. Hydrologic and Microbiological Factors Affecting the Persistence and Migration of Petroleum Hydrocarbons Spilled in a Continuous-Permafrost Region. Environmental Science and Technology, v. 30, no. 8, pp. 2626-2633.

Braddock, J.F., J.L. Walworth, and K.A. McCarthy, 1997. Enhancement and Inhibition of Microbial Activity in Hydrocarbon-Contaminated Arctic Soils: Implications for Nutrient-Amended Bioremediation. Environmental Science and Technology, v. 31, no. 7, pp. 2078-2084.

Braddock, J.F., J.L. Walworth, and K.A. McCarthy, 1999. Bioremediation of Aliphatic vs. Aromatic Hydrocarbons in Fertilized Arctic Soils. Bioremediation Journal, v. 3, no. 2, pp. 105-116.

Ebasco, 1995. Technical Memorandum: Preconstruction Investigation, Construction of a Containment Berm, Naval Arctic Research Laboratory, Point Barrow, Alaska. October 2, 1995.

EPA, 1992. Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B. Interim Report. January 1992.

EPA, 1993. Bioaccumulation Factor Portions of the Proposed Water Quality Guidance for the Great Lakes System. EPA/822/R-93/-008. August 1993.

EPA, 1996. Eco Update. EcoTox Thresholds. Office of Emergency and Remedial Response Intermittent Bulletin, v. 3, no. 2. EPA 540/F-95/038. January 1996.

EPA, 1998. Human Health Risk Assessment Protocol at Hazardous Waste Combustion Facilities. EPA/530/D-98/001. Office of Solid Waste. July 1998.

EPA, 1999. Region IX Preliminary Remediation Goals (PRGs). October 1, 1999.

Farr, A.M., R.J. Houghtoten, and D.B. McWhorter, 1990. Volume Estimation of Light Nonaqueous Phase Liquids in Porous Media. Ground Water 28-1.

Foster Wheeler, 1998. Close Out Report: Technical Summary for a Containment Berm and Recovery Trench Project. Naval Arctic Research Laboratory, Point Barrow, Alaska. Revision 0. March 12, 1998.

Foster Wheeler, 2000. Free Product Recovery Report, Environmental Remediation for the Containment Berm and Recovery Trench, Modification 1, Naval Arctic Research Laboratory, Barrow, Alaska. August 15, 2000.

Himmelbauer, L., 1997. Email communication from Linda Himmelbauer to ADEC Contaminated Sites Project Managers regarding How to Evaluate Sediment Contamination: Risk-Based Screening. August 4, 1997.

ICF Kaiser, 1996. Final Risk Assessment, Point Barrow, Radar Installation, Alaska. United States Air Force 611th Air Support Group/Civil Engineering Squadron, Elmendorf AFB, Alaska. February 19, 1996.

Johnson, P.C., and R.A. Ettinger, 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environ. Sci. Technology, 25:1445-1452.

Lenhard, R.J., and J.C. Parker, 1990. Estimation of Free Hydrocarbon Volume from Fluid Levels in Monitoring Wells. Ground Water 28-1.

Liddell, B.V., D.R. Smallbeck, and P.C. Ramert, 1991. Arctic Bioremediation: A Case Study. Paper presented at the International Arctic Technology Conference, Anchorage, Alaska, May 1991. Society of Petroleum Engineers.

Linder, 1997a. Remedial Action Report, Petroleum-Contaminated Soil (PCS) Remediation, Naval Arctic Research Laboratory (NARL), Barrow, Alaska. November 3, 1997.

Linder, 1997b. Remedial Action Report. Pipeline Removal and Sample Investigation, Naval Arctic Research Laboratory (NARL), Point Barrow, Alaska. November 7, 1997.

Naval Energy and Environmental Support Agency (NEESA), 1983. Initial Assessment Study of Naval Arctic Research Laboratory, Point Barrow, Alaska. NEESA 13-026. May 1983.

Reidel, 1988. Naval Arctic Research Laboratory (NARL). Point Barrow, Alaska. Final Report.

Reynolds, C.M., W.A. Braley, M.D. Travis, L.B. Perry, and I.K. Iskandar, 1998. Bioremediation of Hydrocarbon-Contaminated Soils and Groundwater in Northern Climates. Army Corps of Engineers Cold Regions Research and Engineering Laboratory Special Report 98-5. March 1998.

Reynolds, C.M., L.B. Perry, B.A. Koenen, and K.L. Foley, 2000. Status of Phytoremediation Demonstrations at Remote Locations, Alaska and Korea. Invited paper at "Phytoremediation: State of Science Conference", Boston, MA, May 2000.

SAIC, 1987. Evaluation of Hazardous Materials and Potential Environmental Contamination at the Naval Arctic Research Laboratory, Point Barrow, Alaska. Final Report. Prepared for the U.S. Department of Energy under Contract No. DE-AC05-840R21400. Science Applications International Corporation, Seattle, Washington.

SAIC, 1988. Evaluation of Hazardous Materials and Potential Environmental Contamination at the Naval Arctic Research Laboratory, Point Barrow, Alaska. Final Report. Prepared for the U.S. Department of Energy under Contract No. DE-AC05-840R21400. Science Applications International Corporation, Seattle, Washington.

SAIC, 1989a. Final Evaluation of Site Options at the Naval Arctic Research Laboratory, Point Barrow, Alaska. Prepared for the U.S. Department of Energy under Contract No. DE-AC05-840R21400. Science Application International Corporation, Seattle, Washington.

SAIC, 1989b. Investigation of Environmental Concerns at the Naval Arctic Research Laboratory, Point Barrow, Alaska. Study performed for the Martin Marietta Energy Systems. Prepared for the U.S. Department of Energy. Science Applications International Corporation, Seattle, Washington.

SAIC, 1990. Evaluation of Potential Environmental Contamination at the Naval Arctic Research Laboratory, Point Barrow, Alaska. April 1990.

TPHCWG, 1997. Selection of Representative TPH Fractions Based on Fate and Transport Considerations. Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3. July 1997.

Tryck, Nyman and Hayes, 1987. Naval Arctic Research Laboratory Fuel Spill Investigation. Prepared for the U.S. Navy Western Division Naval Facilities Engineering Command. Anchorage, Alaska.

URS, 1991. Field Investigation, Naval Arctic Research Laboratory, Barrow, Alaska. Contract Task Order No. 0050. Prepared for the U.S. Navy under the Contract No. N62474-89-D-9295.

URS, 1993. Supplemental Site Characterization for the Comprehensive Long-Term Environmental Action Navy Contract Northwest Area, Naval Arctic Research Laboratory, Barrow, Alaska. Contract Task Order No. 0067. Prepared for the U.S. Navy under the Contract No. N62474-89-D-9295.

USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies, under CERCLA. EPA/540/G-89/004. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

USGS, 1992. Letter from Gordon Nelson (Assistant District Chief, USGS Anchorage, Alaska) to Richard Stoll (Engineering Field Activity, Northwest). November 16, 1992.

Wood, L.W., P. O'Keefe, and B. Bush, 1997. Similarity Analysis of PAH and PCB Bioaccumulation Patterns in Sediment-Exposed *Chironomus Tentans* Larvae. Environmental Toxicology and Chemistry, v. 1, no. 2, pp 283-292.

Appendix 1 - Glossary of Abbreviations and Technical Terms

ADEC. State of Alaska Department of Environmental Conservation

BFTF. Bulk Fuel Tank Farm

Carcinogenic. Having the potential to cause cancer.

CERCLA. Comprehensive Environmental Response Compensation and Liability Act

Downgradient. In the direction of active zone water flow.

DD. Decision Document

DRO. Diesel Range Organics (petroleum hydrocarbons in the diesel range)

EPA. United States Environmental Protection Agency

GRO. Gasoline Range Organics (petroleum hydrocarbons in the gasoline range)

In Situ Bioventing. A method of treating soils in-place (i.e., no excavation required).

IRP. Department of Defense Installation Restoration Program

Leachate. Water that has come into contact with contaminated soils.

Method Two Petroleum Hydrocarbon Soil Cleanup Levels in Arctic Zones. Soil cleanup levels for Arctic Zones specified in Table B2 of ADEC's Oil and Hazardous Substances Pollution Control Regulations (18 AAC 75.3).

mg/kg. Milligrams of analyte per kilogram of soil (equivalent to parts per million)

NARL. Naval Arctic Research Laboratory

RAB. Restoration Advisory Board

Risk Assessment (RA). A process that uses regulatory guidelines to determine whether the level of human health or ecological risks are high enough to be unacceptable.

RRO. Residual Range Organics (petroleum hydrocarbons in the motor oil range)

Subsistence Consumer. A person who depends on the food source in question for a large portion of his or her diet.

UIC. Ukpeaġvik Iñupiat Corporation

µg/L. Micrograms per liter

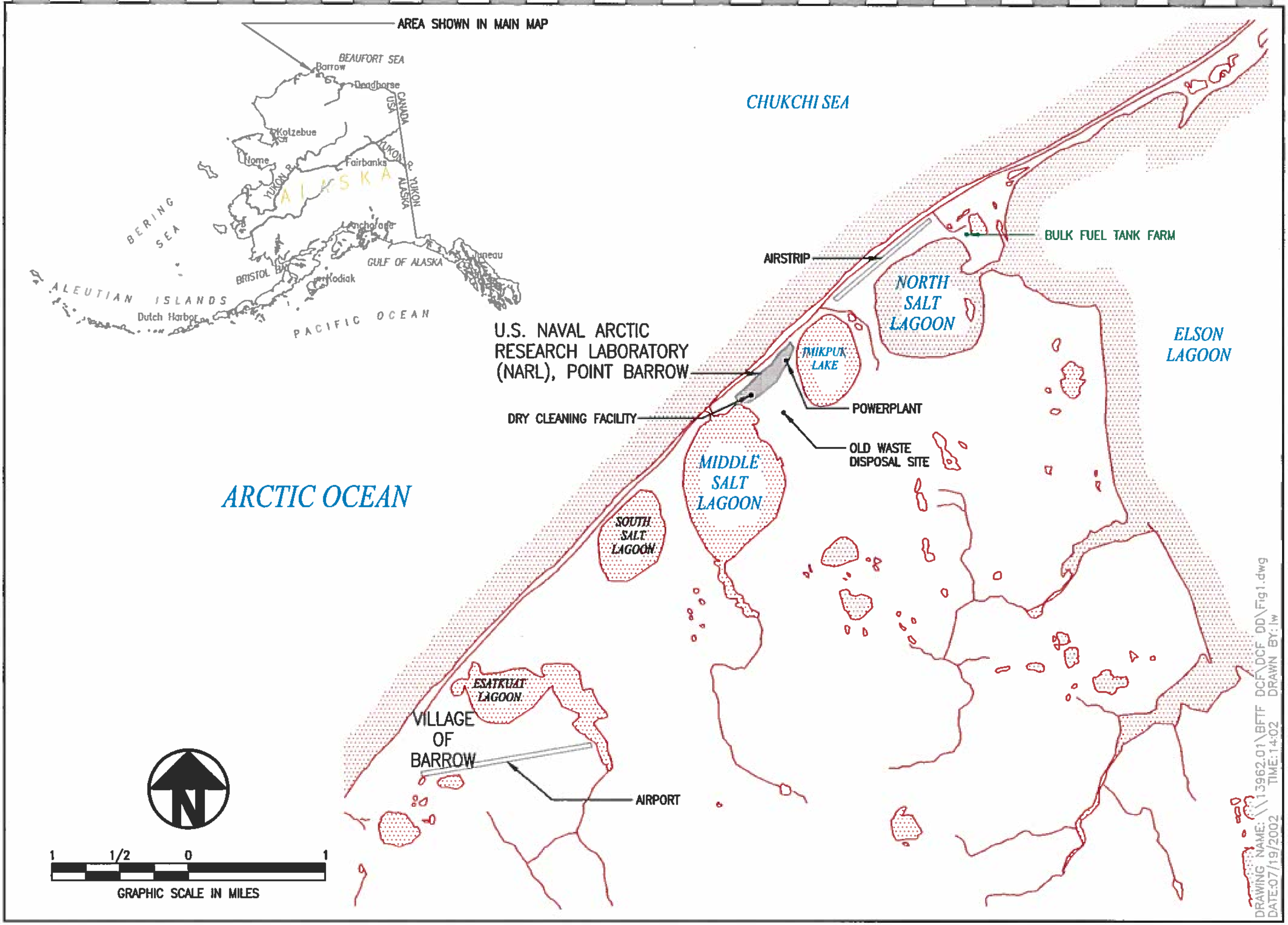

Figure 1. Regional Location Map for the Naval Arctic Research Laboratory

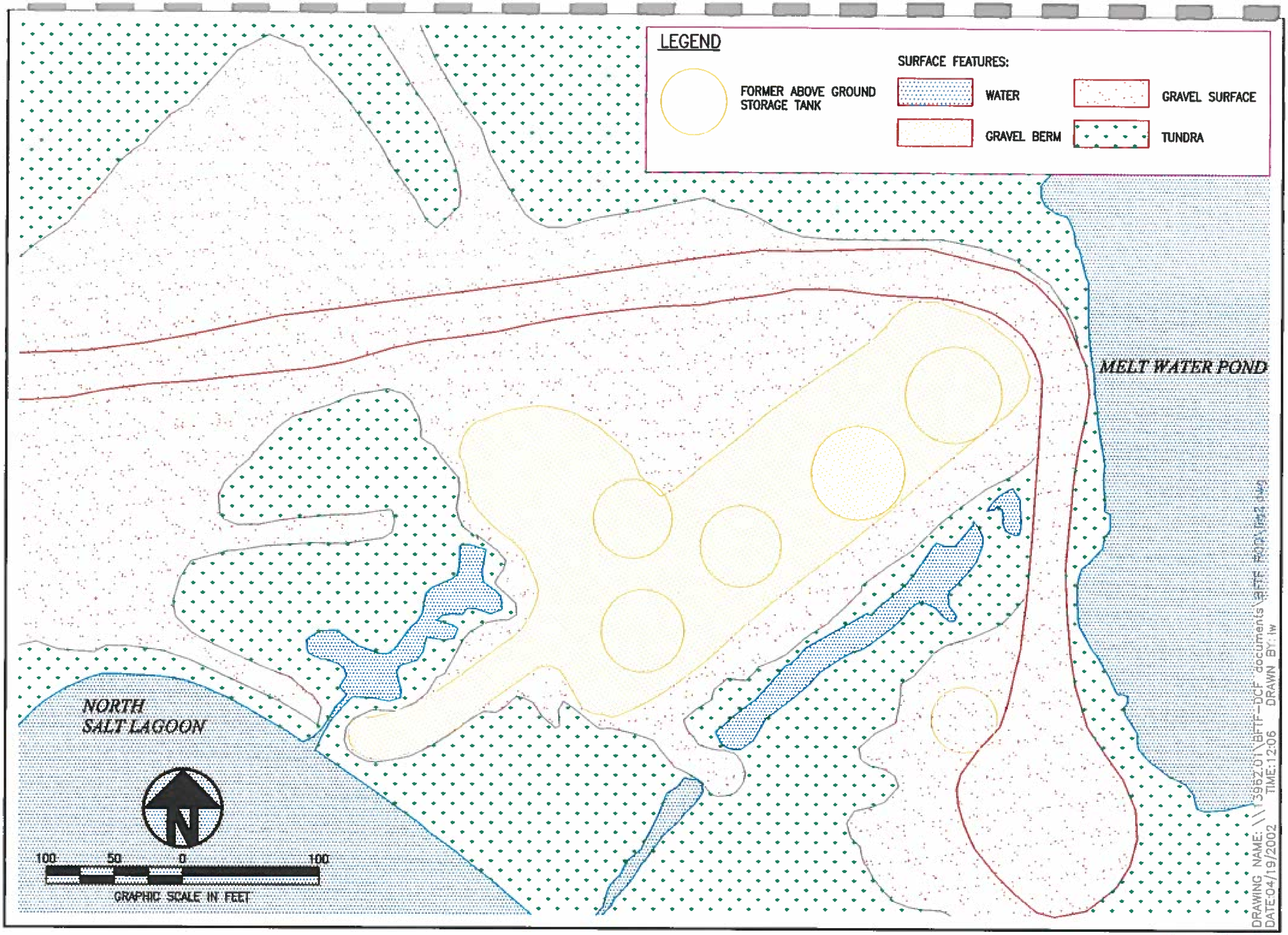

Figure 2. Surface Features at the Former Bulk Fuel Tank Farm Site

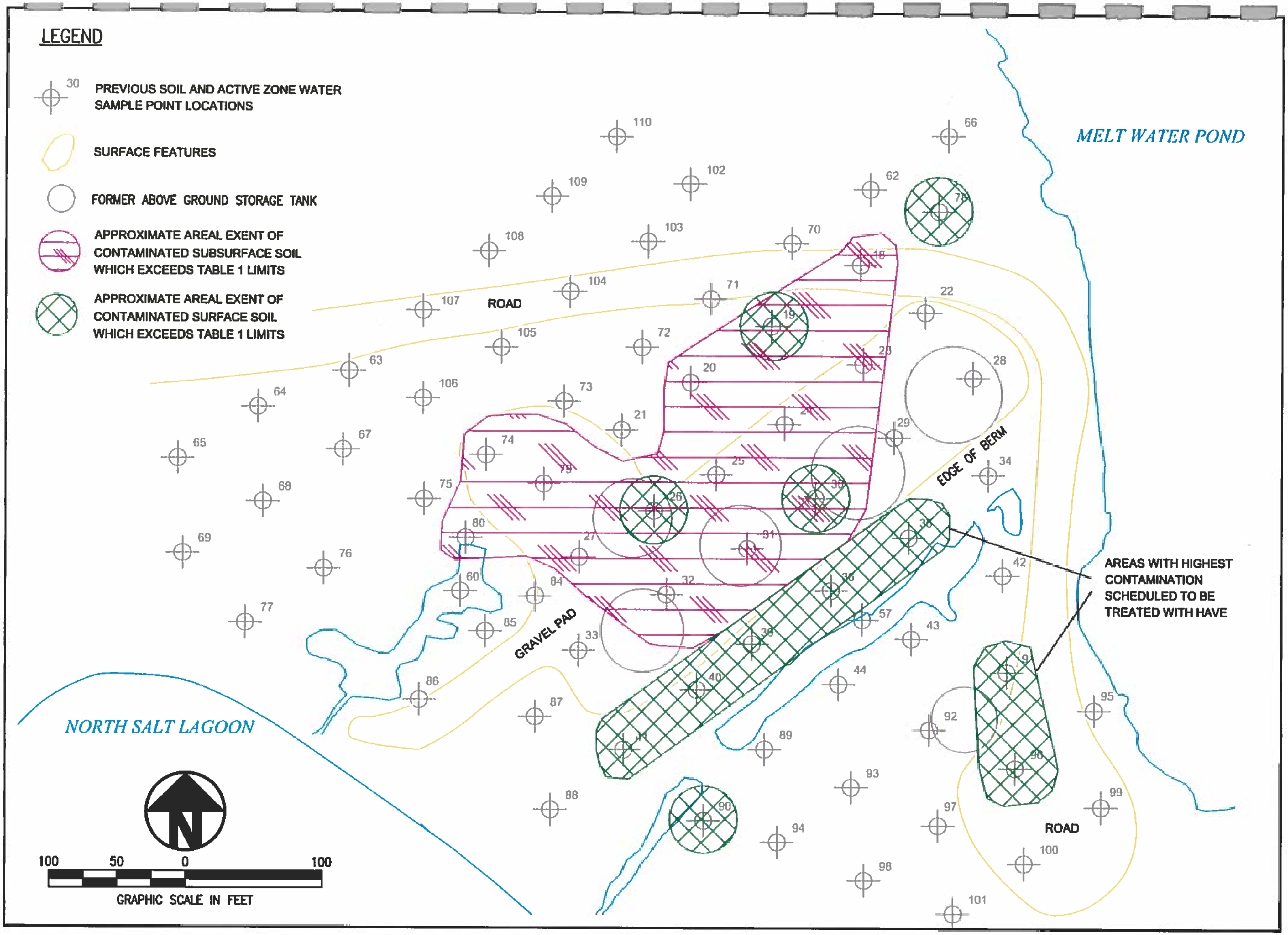

Figure 3. Approximate Areal Extent of Petroleum Contaminated Soil Which Exceeds Table 1 Cleanup Levels at the Former Bulk Fuel Tank Farm

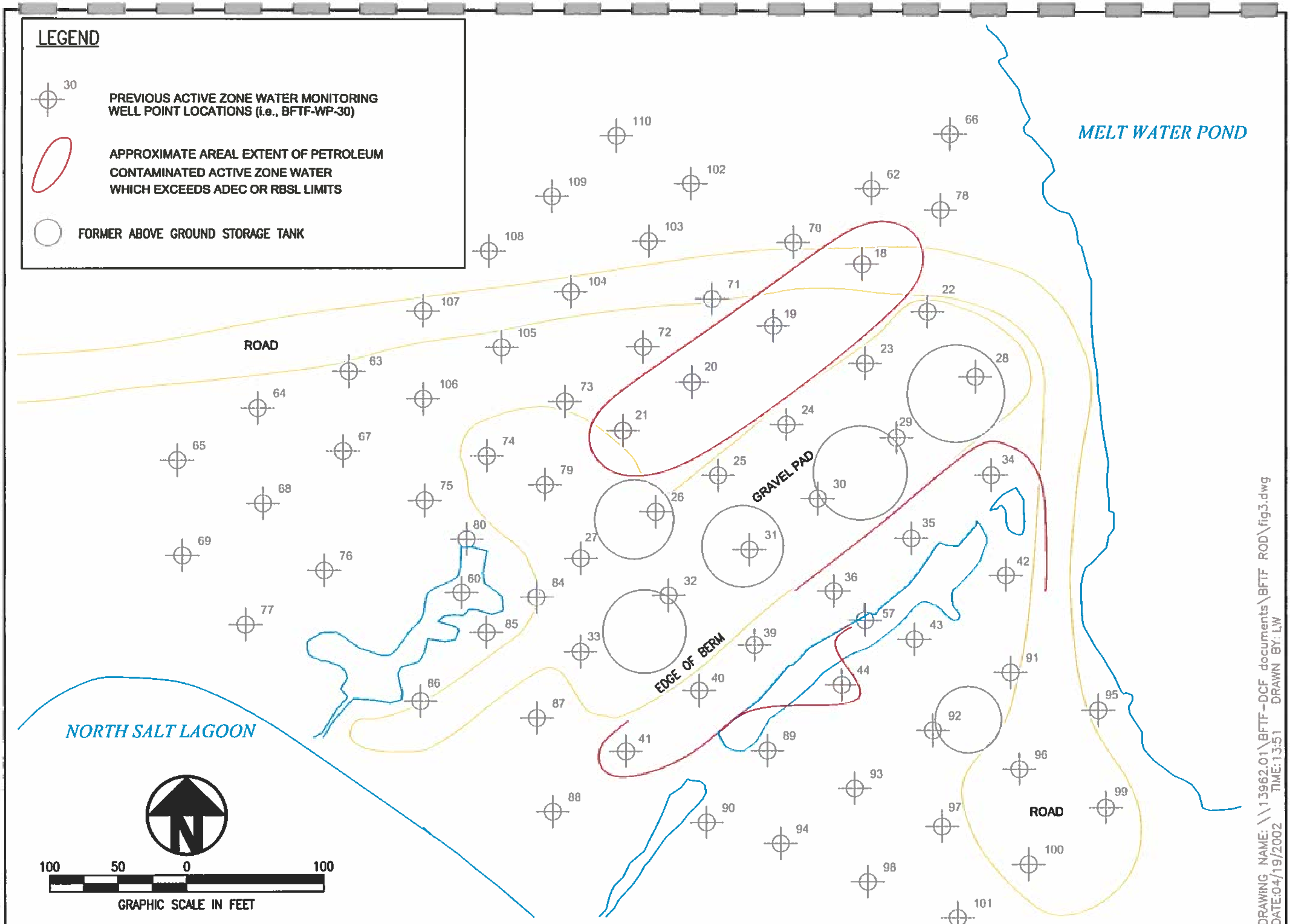

Figure 4. Approximate Areal Extent of Petroleum Contaminated Active Zone Water Which Exceeds ADEC or RBSL Limits at the Former Bulk Fuel Tank Farm

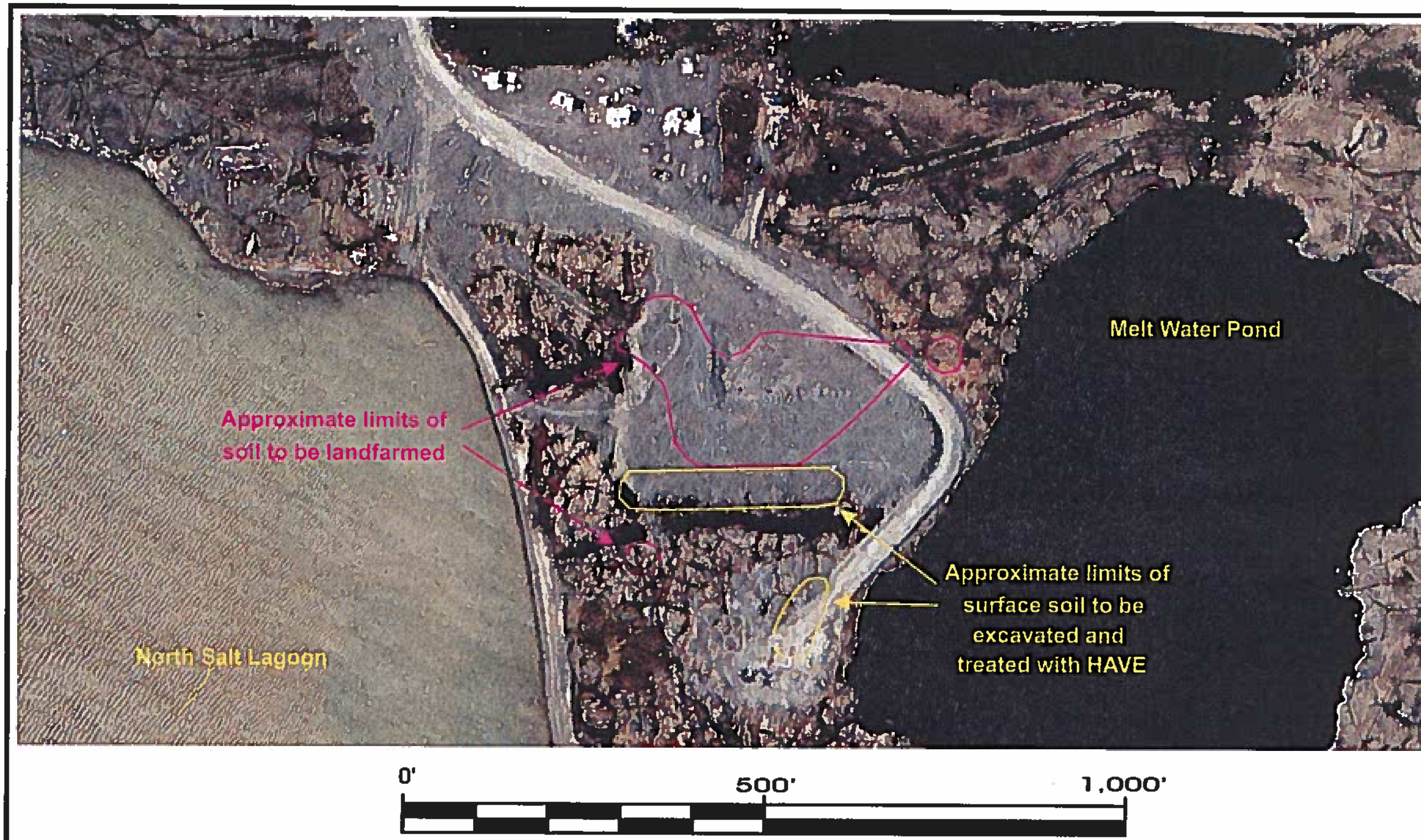

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Figure 5. Aerial Photo of Former Bulk Fuel Tank Farm

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