FINAL

Phase II Remedial Investigation
Remedial Action Alternatives
Technical Memorandum
Gambell, St. Lawrence Island, Alaska

Contract No.	Delivery Order No.
DACA85-93-D-0011	0013

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Prepared for:

Department of the Army
United States Army Engineer District, Alaska
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LIST OF ACRONYMS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ARARs	Applicable or Relevant and Appropriate Requirements
BD/DR	Building Demolition and Debris Removal
BTEX	Benzene, Tolune, Ethylbenzene, Xylenes
CA	Corrective Action
CDAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminants of Concern
COE	U.S. Army Corps of Engineers
CON/HTW	Containerized Hazardous or Toxic Waste
CWA	Clean Water Act
DERP	Defense Environmental Restoration Program
dioxins	Polychlorodibenzo-p-dioxins
DOD	Department of Defense
DRO	Diesel Range Organics
E&E	Ecology and Environment
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
FUDS	Formerly Used Defense Site
furans	polychlorodibenzofurans
GRO	Gasoline Range Organics
HTW	Hazardous or Toxic Waste
IEUBK	?see page A-3
IRA	Interim Removal Actions
PCBs	Polychlorinated Biphenyls
ppt	parts per trillion
QA	Quality Assurance
QC	Quality Control
RBCs	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
SOW	Scope of Work
SVOCs	Semi-Volatile Organic Compounds
TCDD	tetrachlorodibenzodioxin
TRPH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substance Control Act
TSDF	Treatment Storage and Disposal Facility
µg/kg	micrograms per kilogram
URS	URS Corporation
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Gambell is located on the northwest tip of St. Lawrence Island, in the western portion of the Bering Sea approximately 200 air miles southwest from Nome, Alaska, and 39 air miles from the Siberian Chukchi Peninsula. The village of Gambell is built on a gravel spit which projects northward and westward from the island. St. Lawrence Island, including the land which housed the former military sites, are currently owned jointly by Sivuqaq, Inc., Gambell, Alaska; and Savoonga Native Corporation, Savoonga, Alaska. Non-native land on St. Lawrence Island is limited to State lands used for airstrips and related facilities in Gambell.

A Remedial Investigation (RI) was conducted at Gambell by Montgomery Watson in July 1994. The RI was performed under contract to the U.S. Army Corps of Engineers (COE) in accordance with the requirements of the Scope of Work (SOW) for Contract No. DACA85-93-D-0011, Delivery Order No. 3. Eighteen sites were identified as part of this RI effort and were either sampled, or observed and photographed with a walk-through. This Remedial Action Alternatives Technical Memorandum is written in accordance with Tasks 1-3 of Delivery Order 13, which involves addressing areas where further collection of data is necessary at Gambell to resolve the extent of contamination, and identifying areas where presumptive technologies and interim removal actions will reduce the risk to human health or the environment. The eighteen sites evaluated at Gambell, including the Background Site, are listed below. Site 14, the Navy Plane Crash Site, was not visited during the 1994 RI investigation.

Site 1-North Beach
- Area 1A-Army Landing Area
- Area 1B-Air Force Landing Area

Site 2-Former Military Housing/Operations Site
Site 3-Former Communications Facility
Site 4-Sevuokuk Mountain
- Area 4A-Quonset Hut Area
- Area 4B-Former Radar Station
- Area 4C-Stream Drainage at South End of Mountain
- Area 4D-Transformers in Mountainside Drainage

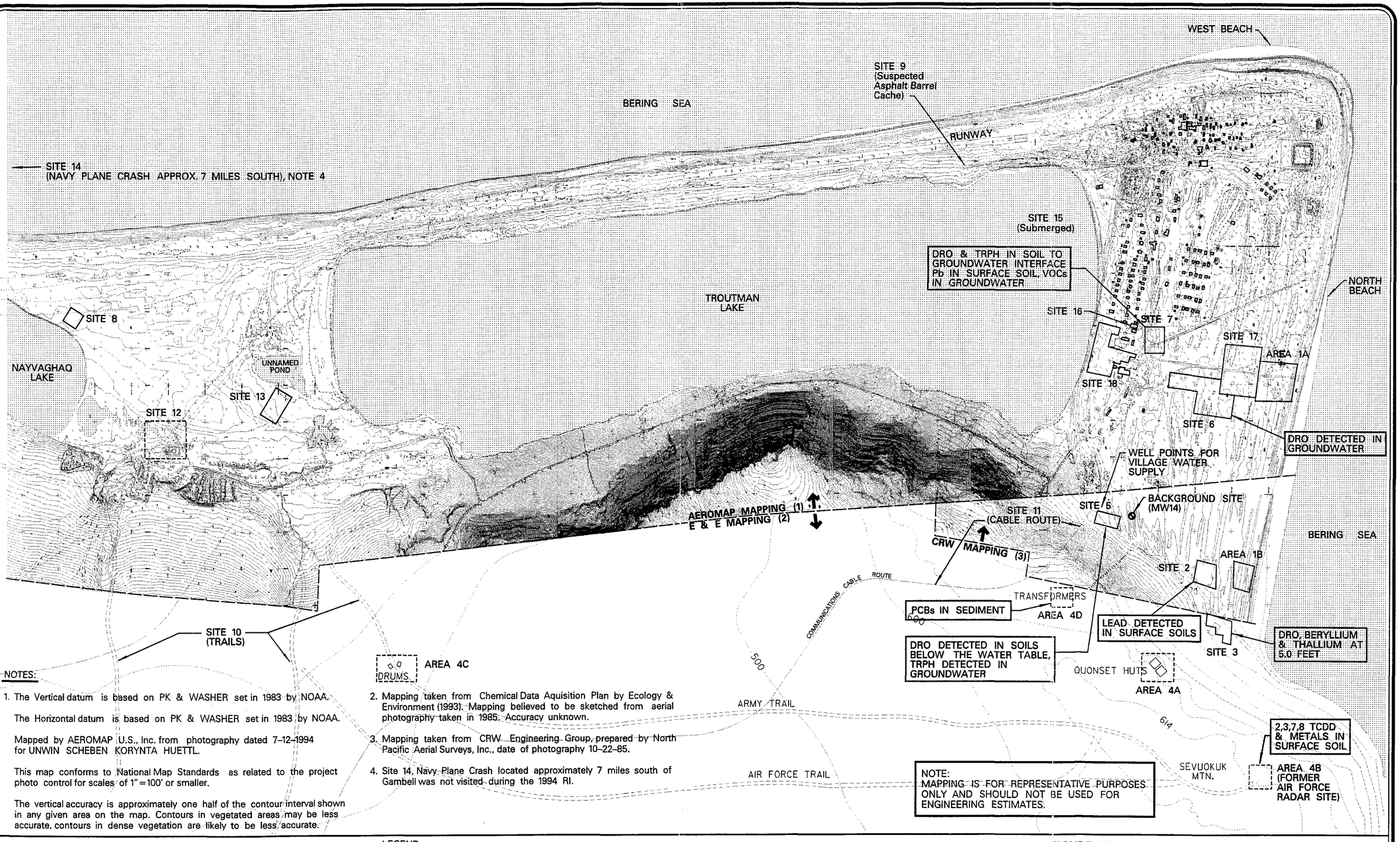
Site 5-Former Tramway Site
Site 6-Military Landfill
Site 7-Former Military Power Site/Former Motor Pool
Site 8-West Beacb/Army Landfill
Site 9-Asphalt Barrel Cache (evaluated with a site walk-through only)
Site 10-Sevuokuk Mountain Trail System (evaluated with a site walk-through only)
Site 11-Communications Cable Route (evaluated with a site walk-through only)
Site 12-Nayvaghaq Lake Disposal Site
Site 13-Former Radar Power Station
Site 14-Navy Plane Crash Site
Site 15-Troutman Lake Ordinance Site (evaluated with a site walk-through only)
Site 16-Gambell Municipal Building Site
Site 17-Army Landfills
Site 18-Former Main Camp
Background Site

Comparison of contamination levels found at the Gambell site to benchmark criteria and/or site specific factors has resulted in the retention of the following discrete areas that are identified for further investigation or remedial action. These areas are shown on Figure ES-1, and are listed below along with a brief summary of the reason for concern:

- Site 2 - elevated levels of lead and other metals were detected in surface soils;
- Site 3 - diesel range organics (DRO), beryllium, and thallium were found at a depth of 5 feet;
- Site 4/Area 4B - 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and several priority pollutant metals were detected in surface soil;
- Site 4/Area 4D - low levels of polychlorinated biphenyls (PCBs) were detected in sediments in a mountainside drainage;
- Site 5 - DRO and total recoverable petroleum hydrocarbons (TRPH) were detected in soils below the water table; and TRPH was detected in groundwater;
- Site 6 - DRO was detected in groundwater;
- Site 7 - DRO and TRPH were detected in soils in contact with groundwater; volatile organic compounds (VOCs) were found in groundwater at low concentrations; surface soils contained elevated levels of lead; and
- Debris qualified for removal as containerized hazardous or toxic waste (CON/HTW) were present at several locations at the Gambell site.

Site-specific recommendations at the areas of concern are as follows:

- Site 2 - Conduct additional surface soil sampling for priority pollutant metals in order to delineate the areal extent of elevated lead and other metals;
- Site 3 - Further surface soil sampling should be performed to confirm the presence of surface contamination, refine the delineation of the area of concern, and assess the risk to human health or the environment;
- Site 4/Area 4B - Perform a limited ecological and human health risk assessment to evaluate risks posed by low levels of dioxin and high levels of priority pollutant metals;
- Site 4/Area 4D - Limited amounts of sediment will be removed if staining is encountered upon removal of the three transormers;



NOTES:

1. The Vertical datum is based on PK & WASHER set in 1983 by NOAA.

   The Horizontal datum is based on PK & WASHER set in 1983 by NOAA.

   Mapped by AEROMAP U.S., Inc. from photography dated 7-12-1994 for UNWIN SCHEBEN KORYNTA HUETTL.

   This map conforms to National Map Standards as related to the project photo control for scales of 1"=100' or smaller.

   The vertical accuracy is approximately one half of the contour interval shown in any given area on the map. Contours in vegetated areas may be less accurate, contours in dense vegetation are likely to be less accurate.

2. Mapping taken from Chemical Data Aquisition Plan by Ecology & Environment (1993). Mapping believed to be sketched from aerial photography taken in 1985. Accuracy unknown.

3. Mapping taken from CRW Engineering Group, prepared by North Pacific Aerial Surveys, Inc., date of photography 10-22-85.

4. Site 14, Navy Plane Crash located approximately 7 miles south of Gambell was not visited during the 1994 RI.

LEGEND:

- Boundary of Site Geophysical Survey (1994 RI)
- Boundary of Site (no Geophysical Survey) (1994 RI)
- PCBs IN SEDIMENT — Area retained for further investigation in Phase II RI/FS or explanation is neccesary to implement no further action alternative

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MONTGOMERY WATSON
Anchorage, Alaska

FIGURE ES-1
ALASKA DISTRICT – CORPS OF ENGINEERS
GAMBELL, ST. LAWRENCE ISLAND, ALASKA
LOCATION OF INVESTIGATIVE SITES AND AREAS OF CONCERN

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- Site 5 - Conduct groundwater sampling of the village water supply using stringent criteria and keep a close watch on future results from Village Safe Water's biannual monitoring program;

- Site 6 - Frozen pore water and permafrost limits the mobility of low levels of non-volatile contaminants found in groundwater. The exposure risk through direct contact or the groundwater ingestion pathway appears low. No further action is recommended;

- Site 7 - Frozen pore water and permafrost limits the mobility of low levels of contaminants found in groundwater. Surface soil is found to be below risk-based concentrations. The exposure risk through groundwater ingestion pathway appears low. No further action is recommended;

- Remove surface debris which are categorized as CON/HTW, are eligible for interim removal actions, and poses a risk to human health.

The most cost-effective strategy would be to conduct all further sampling, risk assessments, and interim removal actions for all of the areas of concern at the Gambell site at one time. Once additional information from further sampling and risk assessments is collected, presumptive technologies or development of alternative cleanup levels can be implemented, as appropriate.

1.0 INTRODUCTION

1.1 BACKGROUND

Gambell is located on the northwest tip of St. Lawrence Island, in the western portion of the Bering Sea approximately 200 air miles southwest of Nome, Alaska, and 39 air miles from the Siberian Chukchi Peninsula (Figure 1). The village of Gambell is built on a gravel spit which projects northward and westward from the island. St. Lawrence Island, including the land which housed the former military sites, are currently owned jointly by Sivuqaq, Inc., Gambell, Alaska; and Savoonga Native Corporation, Savoonga, Alaska. Non-native land on St. Lawrence Island is limited to State lands used for airstrips and related facilities in Gambell

The area around the village of Gambell is classified as a Formerly Used Defense Site (FUDS) under the Defense Environmental Restoration Program (DERP) of the Department of Defense (DOD). A Remedial Investigation (RI) was performed by Montgomery Watson in July 1994 under contract to the COE as per the requirements of the Scope of Work (SOW) for Contract No. DACA85-93-D-0011, Delivery Order No. 3.

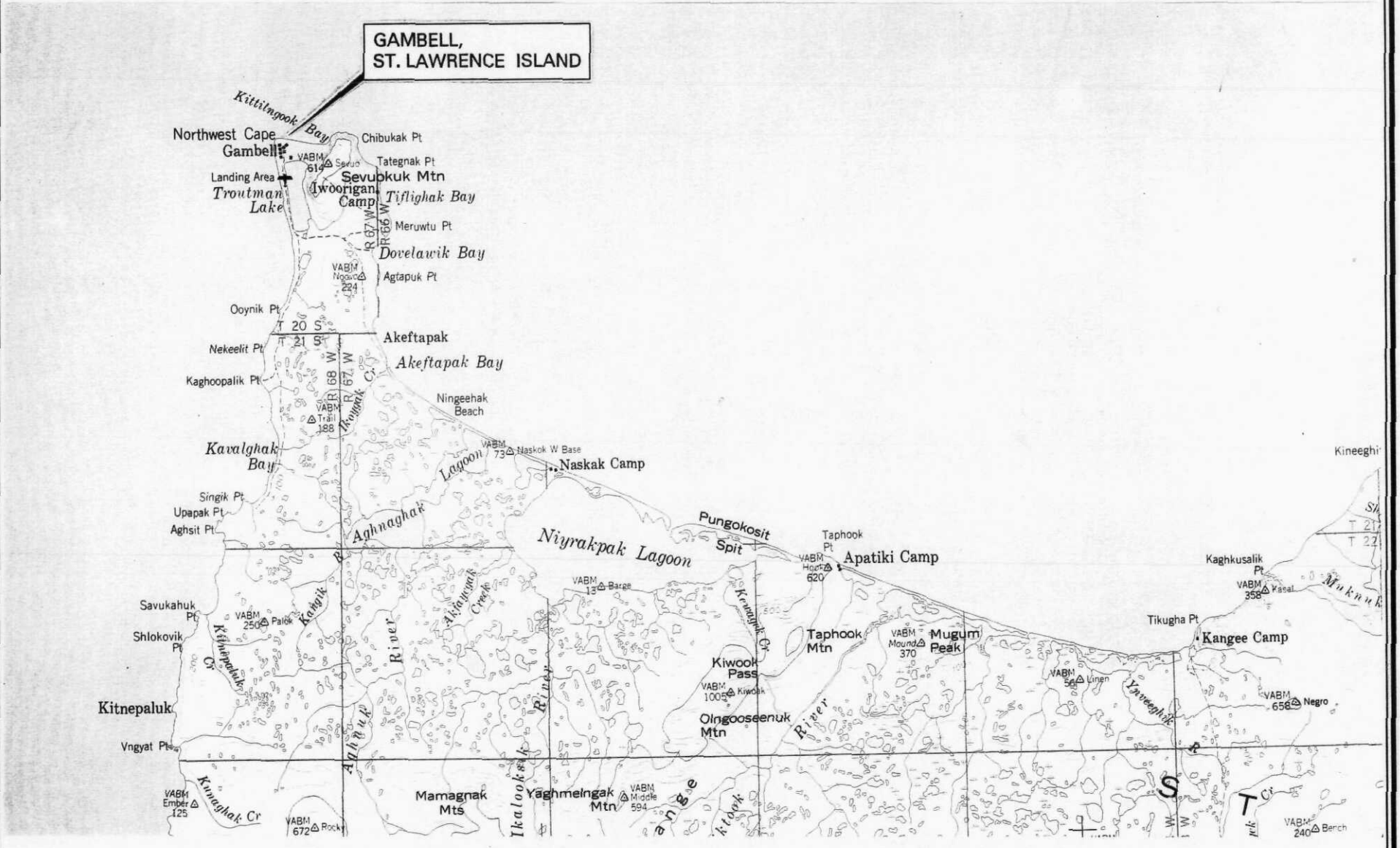
The village of Gambell is inhabited mainly by native Yupik people who lead a subsistence-based lifestyle. The Gambell area supports habitat for a variety of seabirds, waterfowl, and mammals that either breed in or visit the area. The area surrounding the top of Sevuokuk Mountain supports a large bird rookery. The birds and bird eggs serve as a subsistence food source to the local inhabitants. The ocean surrounding the Gambell area is used extensively for subsistence hunting of walrus, seal, sea birds, polar bear, and whale.

The objectives of the 1994 Remedial Investigation were to gather sufficient chemical, geophysical, and hydrogeological data to identify and characterize sites requiring remediation, and to develop remedial alternatives. The RI report presented the results of the field investigations, chemical sampling and analysis, and quality assurance (QA)/quality control (QC) activities performed during the investigation. Eighteen sites, including the Background Site, were identified as part of this RI effort and were either sampled, or observed and photographed with a walk-through. These investigative sites are shown on Figure 2, and include:

Site 1-North Beach
- Area 1A-Army Landing Area
- Area 1B-Air Force Landing Area

***Site 2-Former Military Housing/Operations Site**
***Site 3-Former Communications Site**
***Site 4-Sevuokuk Mountain**
- Area 4A-Quonset Hut Area
- **Area 4B-Former Radar Station**
- Area 4C-Stream Drainage at South End of Mountain
- **Area 4D-Transformers in Mountainside Drainage**

***Site 5-Former Tramway Site**
Site 6-Military Landfill



MONTGOMERY WATSON

Anchorage, Alaska

SOURCE: U.S. Geological Survey
Reston, Virginia 22092, 1976
St. Lawrence, Alaska
N6265 – W16830 /60x210
Surveyed 1948, Compiled 1957
Minor Revisions 1974
Scale 1:250,000

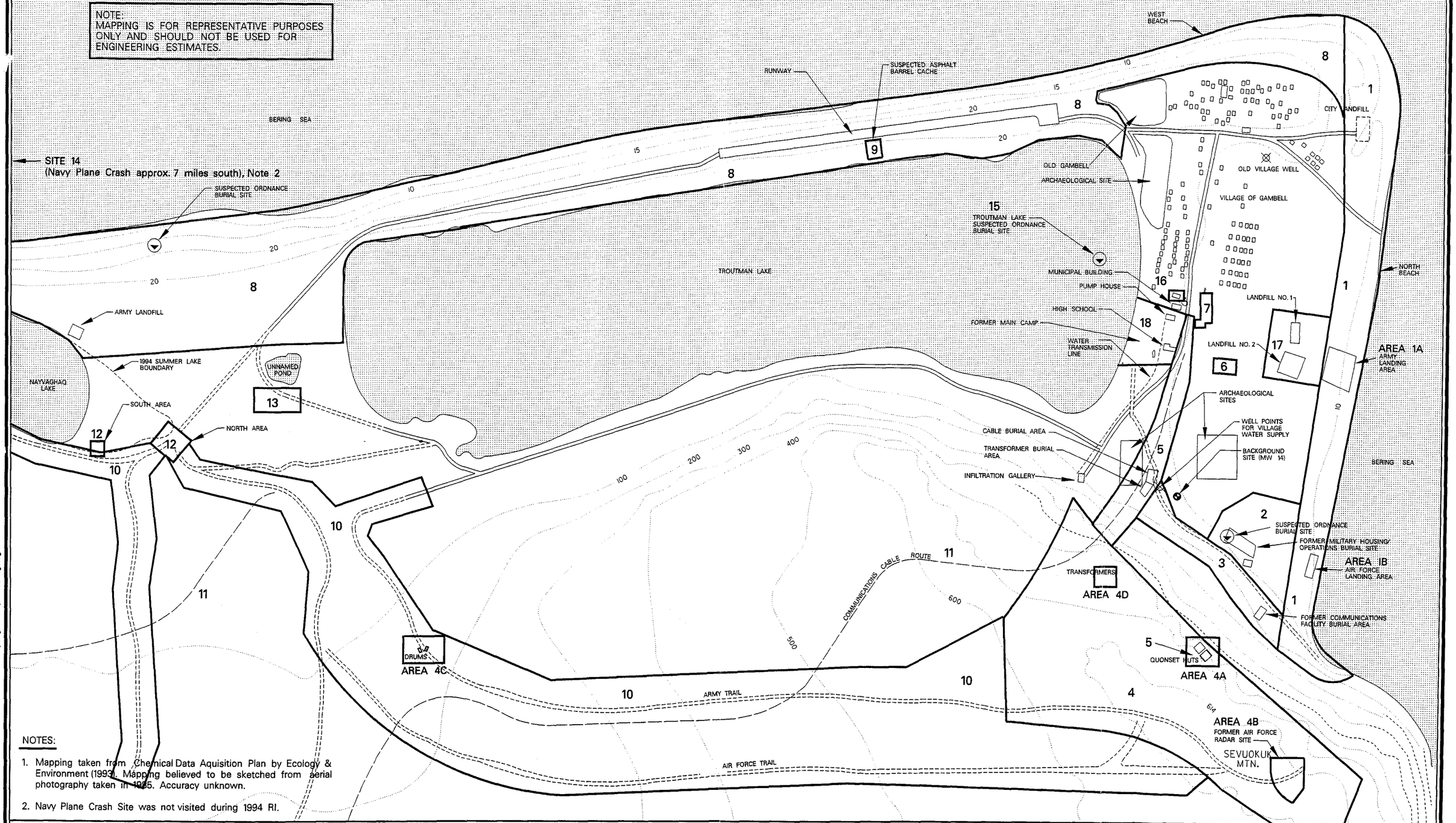
NORTH

FIGURE 1

ALASKA DISTRICT – CORPS OF ENGINEERS
ST. LAWRENCE ISLAND, ALASKA

LOCATION MAP
GAMBELL

NOTE:
MAPPING IS FOR REPRESENTATIVE PURPOSES ONLY AND SHOULD NOT BE USED FOR ENGINEERING ESTIMATES.



NOTES:

1. Mapping taken from Chemical Data Aquisition Plan by Ecology & Environment (1993). Mapping believed to be sketched from aerial photography taken in 1985. Accuracy unknown.
2. Navy Plane Crash Site was not visited during 1994 RI.

LEGEND:

Boundary of Site

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MONTGOMERY WATSON
Anchorage, Alaska

FIGURE 2
ALASKA DISTRICT – CORPS OF ENGINEERS
GAMBELL, ST. LAWRENCE ISLAND, ALASKA
GAMBELL INVESTIGATIVE SITES

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Site 7-Former Military Power Site/Former Motor Pool
Site 8-Army Landfill
Site 9-Asphalt Barrel Cache
Site 10-Sevuokuk Mountain Trail System
Site 11-Communications Cable Route
Site 12-Nayvaghaq Lake Disposal Site
Site 13-Former Radar Power Station
Site 15-Troutman Lake Ordinance Burial Site
Site 16-Gambell Municipal Building Site
Site 17-Army Landfills
Site 18-Former Main Camp
Background Site (all samples associated with MW-14)

* - indicates sites in which sample results indicate further evaluation is recommended or an explanation is necessary for implementation of the no further action alternative.

In the 1994 RI, sampling results from the investigated sites were compared to conservative benchmark criteria in order to identify sites in which further evaluation should be conducted. Many sites were removed for further consideration because contamination was not present, was present at concentrations below benchmark criteria, or site-specific criteria showed no risk to human health or the environment. This Technical Memorandum addresses only those sites which were retained for further evaluation based on the 1994 RI sampling results. Applicable federal, state and local regulations, along with a description of the benchmark screening criteria used in the 1994 RI is given in Appendix A.

1.2 OBJECTIVES

The purpose of this Remedial Action Alternatives Technical Memorandum is to:

- identify areas where collection of additional data is desired to refine the extent of contamination; and

- identify areas where presumptive remedies or interim removal actions will eliminate areas of concerns.

Based on this Technical Memorandum, a Work Plan, including a Sampling and Analysis Plan, Quality Assurance Project Plan, Investigative Derived Waste Plan, Site Health and Safety Plan, and Spill Release and Reporting Plan, will be designed for those areas requiring further sampling. An Engineering Evaluation/Cost Analysis (EE/CA) will be performed on sites where presumptive technologies and interim removal actions are recommended.

The objectives for this Technical Memorandum as stated in the Scope of Work are:

- integration of all previous data gathered at the site, along with additional data collected during the 1994 Montgomery Watson field investigations;

- identification of all areas and contaminants of concern (COC);
- comparison between site-specific contaminant concentrations, ARARS, and risk-based criteria;
- identification of media, concentration range, and estimated volume (area x depth), in site locations where COCs are identified for further investigation or remediation;
- identification of potential remedial action objectives and remedial alternatives for each site;
- identification of areas where presumptive remedies (Phase I remedial design) are recommended; and
- identification of source areas that can be removed during an interim removal action, and the volume of material involved.

This Technical Memorandum is designed to provide a means to distinguish between those areas where additional sampling will be required versus those eligible for presumptive remedies or interim removal actions.

1.3 RESULTS OF PREVIOUS INVESTIGATIONS

Prior to the 1994 RI, URS Corporation (URS) collected a limited number of soil and water samples at the Gambell Site (URS, 1986). In addition, they inventoried materials left by the military and any potential contamination. They sampled soil for PCBs; and water for oil and grease, arsenic, barium, cadmium, chromium, and lead. Sampling occurred at Site 2, 3, 4/Area 4B, 4/Area 4D, 6, 7, and 13. No PCBs were detected in either soil or water. No contamination was found at Site 4/Area 4B and Site 4/Area 4D. The URS sample locations were not clearly defined and the validity of the data is unknown (it is unclear whether or not the metals samples were filtered). In general, elevated concentrations of metals in groundwater found by URS were not substantiated by the results of the 1994 RI performed by Montgomery Watson.

In 1991 and 1992, Ecology and Environment (E&E) conducted site reconnaissance visits and interviewed individuals living at Gambell during the period of DOD occupation (E&E, 1992).

2.0 AREAS AND CONTAMINANTS OF CONCERN

This section contains information on all areas and contaminants of concern as noted in the 1994 RI Report. Comparison of contamination levels found at the Gambell site to regulatory benchmarks and/or site specific factors has resulted in the retention of the following discrete areas for further investigation or remedial action:

- Site 2 - elevated levels of lead and other metals were detected in surface soils;
- Site 3 - DRO, beryllium, thallium, cadmium, mercury, selenium and silver were found at a depth of 5 feet;
- Site 4/Area 4B - 2,3,7,8-TCDD, lead, antimony, arsenic, barium, cadmium, chromium, copper, nickel, selenium, silver, and zinc were detected in surface soil;
- Site 4/Area 4D - PCBs were detected at low levels in sediments in a mountainside drainage;
- Site 5 - DRO and TRPH were detected in soils below the water table; and TRPH was detected in groundwater;
- Site 6 - DRO was detected in groundwater;
- Site 7 - DRO and TRPH were detected in soils in contact with groundwater; VOCs were found in groundwater; and
- Site 1/Area 1A, Site 1/Area 1B, Site 2, Site 3, Site 4/Area A , Site 4/Area 4B, Site 4/Area 4D, Site 5, Site 6, Site 8, Site 10, Site 12, and Site 17 contain debris which are categorized as containerized hazardous or toxic waste (CON/HTW) and are eligible for interim removal actions (these are discussed further in Section 4).

All other sites are recommended for no further action. The sites not recommended for further action and its associated reason is shown below:

Site 4/Area 4C	sampling results below benchmark criteria; CON/HTW on-site is within the limits of Site 10
Site 9	no sampling performed; CON/HTW on-site is reportedly the responsibility of the FAA
Site 11	no sampling performed; no CON/HTW on-site
Site 13	sampling results below benchmark criteria; no CON/HTW on-site
Site 15	no sampling performed; no CON/HTW on-site
Site 16	sampling results below benchmark criteria; no CON/HTW on-site
Site 18	sampling results below benchmark criteria; no CON/HTW on-site
Background Site	sampling results below benchmark criteria; no CON/HTW on-site

The majority of the areas of concern involve elevated levels of petroleum hydrocarbons in soil and/or groundwater. The remaining areas involve surface soils with elevated levels of lead and other priority pollutant metals. A summary of the areas of concern at Gambell is listed on Table 1. A listing of site specific factors such as potential receptors, media, and potential pathways at each area of concern is described in Section 3, Tables 2 through 8.

2.1 DESCRIPTIONS OF AREAS OF CONCERN

Site 2

Site 2 (shown on Figure 3) is a former military housing/operations site which includes a power plant burial area and an ordnance burial area. All of the facilities associated with Site 2 were reportedly demolished and buried at the site. Activities conducted during the 1994 RI included a geophysical survey (EM-31 conductivity and GSM-19 magnetometry), installation of three monitoring wells, and subsurface and surface soil sampling. A detailed description of geophysical methods and results is available (Golder, 1994). Comparison of analytical results to benchmark criteria indicate that the primary contaminant of concern and media is elevated concentrations of lead and other metals in surface soils. Most notable was a lead concentration of 749 mg/kg from surface soil sample 27 (SS 27). Concentrations of metals from a second surface soil sample at the site were not elevated, and the areal extent of metal contamination is unknown.

Site 3

At Site 3, the Former Communications Facility (Figure 3), priority pollutant metals including beryllium, cadmium, mercury, selenium, silver, and thallium, were detected above regulatory benchmark criteria in soils collected at a depth of 2.5 feet. Beryllium and thallium are unlikely to occur naturally at these concentrations. Petroleum hydrocarbons were also detected at depths up to 5 feet at a maximum concentration of 522 mg/kg. The 1994 RI report indicated that the buried material located at Site 3 in the vicinity of the contaminated area is not likely to be the cause of the presence of DRO, beryllium, and thallium in shallow soils. As a result of the shallow depth of the contaminated soil, it is likely that a surface source, which is no longer present, was responsible for the contamination.

Site 4/Area 4B

At Site 4/Area 4B, the Former Air Force Radar Station located on Sevuokuk Mountain (Figure 3), 2,3,7,8-tetrachlorodibenzo-p-dioxin (51.22 ppt), lead, antimony, arsenic, cadmium, and copper were detected at levels above EPA Region III risk-based levels and normal background concentrations.

Site 4/Area 4D

At Site 4/Area 4D, the site containing three transformers in a mountainside drainage (Figure 3), PCBs were detected at a concentration of 194 µg/kg. The PCBs were found only in the QA split sample which was sent to the NPD laboratory for analysis. The NPD lab obtained a

AREA 1B

MW6 MW7 MW8 SS26

ELEVATED LEVEL OF LEAD IN SS27 (749 mg/kg)

SITE 2

Wood-lined Pit
Caterpillar Tracks
Tilt Dozer Blade
Pipe
Brick/Concrete Fireplace
Metal Debris
Concrete Pad
MW11 MW12 MW13 SS27 SS28

SITE 3

Small Mounds
MW9 MW10 PVC Pipe

ELEVATED LEVELS OF BERYLLIUM AND THALLIUM AT 2.5 FEET DEPTH

ELEVATED CONCENTRATIONS OF DRO (430–522 mg/kg) TO A DEPTH OF 5.0 FEET AND ELEVATED THALLIUM CONCENTRATIONS AT 5.0 FEET

Trail

AREA 4B

STEEL POLE
CHARRED WOOD
SS33 SS32 SS34 SS35 SS36

ELEVATED CONCENTRATIONS OF DIOXINS IN SURFACE SOILS

ELEVATED CONCENTRATIONS OF METALS IN SURFACE SOILS

SEVUOKUK MOUNTAIN (Auklet rookery located on mountain cliffs)

SITE 4

MI 64
MI 61,62,63
QUONSET HUTS
TRANSFORMERS
MI 65
SS29 SS31 SS30
DRUMS

Army Trail

AREA 4A

BACKGROUND SITE MW14

Steel Well Casing 4' high
MW15 SB1 SB2 MW16
Steel Freight Container
Spoil Mound

SITE 5

ELEVATED CONCENTRATIONS OF DRO IN SOIL (1,160–1,800 mg/kg) AT A DEPTH OF 5 FEET. TRPH IN GROUNDWATER AT CONCENTRATIONS OF 0.5 mg/l IN MW15 AND 0.4 mg/l IN MW16

CABLE

AEROMAP MAPPING
CRW MAPPING

E & E MAPPING

AREA 4D

SL262 SE159 SE162, SE163, SE164 (BACKGROUND) SE263 SE160 SE161 TRANSFORMERS

ELEVATED CONCENTRATIONS OF PCB'S IN SEDIMENT (0.194 mg/kg)

---1.0--- Groundwater Elevation Contour
Contour Interval = 0.5 Ft.

Direction of Groundwater Flow

Boundary of Site Geophysical Survey

- Soil Boring
- Monitoring Well
- Surface Soil Sample
- Hand Augered Sample
- Sediment Sample
- X Asbestos Sample
- Drum
- Metal Debris
- Transformer
- Landing Mat
- Geophysical Anomaly
- Area of Stained Soil
- Area of Concern

NOTE:
MAPPING IS FOR REPRESENTATIVE PURPOSES ONLY AND SHOULD NOT BE USED FOR ENGINEERING ESTIMATES.

NOTES:

1. The Vertical datum is based on PK & WASHER set in 1983 by NOAA.

   The Horizontal datum is based on PK & WASHER set in 1983 by NOAA.

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3. Mapping taken from CRW Engineering Group, prepared by North Pacific Aerial Surveys, Inc., date of photography 10–22–85.

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MONTGOMERY WATSON
Anchorage, Alaska

FIGURE 3
ALASKA DISTRICT – CORPS OF ENGINEERS
GAMBELL, ST. LAWRENCE ISLAND, ALASKA
AREAS OF CONCERN SITES 2, 3, 4, & 5 GAMBELL

TABLE 1
Summary of Areas of Concern
Gambell
St. Lawrence Island, Alaska

Site		Contaminant of Concern	Sampling Location/ Depth in feet	Units	Concentration	Applicable Regulatory Benchmark Criteria	Risk Based Criteria (1)	Estimated Volume (Cubic Yards)(10)	Comments (10)
Site 2									
Soil	**Metals:**	Lead	SS 27	mg/kg	749	500-1,000 (1); 9.6 (6); 12 (5)	400 (8)	?	Areal extent of lead contamination unknown
Site 3									
Soil		DRO	MW10 (2.5) (Ju), MW 10 (5.0)	mg/kg	430 to 522	100 (4)	8,760	5.2	ADEC Matrix Score=35; ADEC Level B
	Metals:	Thallium	MW9 (2.5), MW10 (2.5)	mg/kg	9 to 15	6.3-7.0 (1); <1 (6)	6.3-7.0	?	Low levels but not naturally occurring
		Beryllium	MW9 (2.5)	mg/kg	6	0.15 (1); <1 (6); 1.5 (5)	0.15	?	Low levels but not naturally occurring
Site 4/Area 4B									
Soil	**Metals:**	Antimony	SS33 (0.5)	mg/kg	130	31 (1); <10 (6)	31	?	
		Arsenic	SS32 (Ju), SS33 (Ju), SS34 (Ju), SS270 (J)	mg/kg	1.3 to 38	0.36-23 (1); 18 (6); 6.7 (5)	0.36-23	186	
		Cadmium	SS32	mg/kg	52	39 (1); <1 (6)	39	?	
		Copper	SS32, SS33	mg/kg	21,200 to 26,600	2,900 (1); 24 (5); 2.3 (6)	2,900	?	
		Lead	SS32, SS33	mg/kg	1,056 to 3,249	500-1,000 (1); 9.6 (6); 12 (5)	400 (8)	?	
		2,3,7,8-TCDD	SS32, SS33, SS34	µg/kg (ppt)	0.22 to 51.22	4.1 (1)	4.1	186	
Site 4/Area 4D									
Sediment		PCBs	SE162	mg/kg	0.194	1 (7)	1.6 (soil)	1	soils
Site 5									
Soil		DRO	MW16 (5.0), QA (Jo), QC	mg/kg	1,160 to 1,800	100 (4)	8,760	5.2	ADEC Matrix Score=38; Level B; adjacent to Gambell's drinking water supply
Site 6									
Water		DRO	SB6, SB8	mg/l	0.627 to 0.75	sheen (4)	none	NA	No soil sample taken as per CDAP
Site 7									
Soil		DRO	SS40, SS41, MW24 (2.5-10.0), MW25 (2.5, 5.0), MW26 (2.5,5.0)(Ju)	mg/kg	101-2,090	100 (4)	8,760	10,606	ADEC Matrix Score=43; ADEC Level A
		TRPH	SS40, SS41, MW24 (5.0-13.0), MW25 (2.5-10.0), MW26 (2.5-10.0), MW27 (2.0-10.0), SB17 (2.5-10.0)	mg/kg	11-13,000	2,000 (4)	none	?	Above 2,000 mg/kg in BH26 (2.5, 5.0), SS41 (0.5)
Water		DRO	MW24 (Ju), MW25, MW27 (Ju)	mg/l	1.18 to 19.4	sheen (4)	none	NA	
		GRO	MW24	mg/l	0.103 to 0.844	sheen (4)	none	NA	
		TRPH	MW24, MW27	mg/l	1.1 to 4.2	sheen (4)	none	NA	
	VOCs:	Benzene	MW24	mg/l	0.019	0.005 (2)(3)	0.00036	NA	

KEY:

CDAP - Chemical Data Acquisition Plan (E&E, 1993)
DRO - Diesel Range Organics
GRO - Gasoline Range Organics
GW - Groundwater
J - Data qualifier; estimated values, bias unknown
Jo - Data qualifier; estimated value, data biased high
Ju - Data qualifier; estimated value, data biased low
mg/kg - Milligrams per kilogram
mg/l - Milligrams per liter
MW - Monitoring well
NA - Not Applicable
PCB - Polychlorinated biphenyls
ppt - Parts per trillion
SB - Soil boring
SD - Sediment
SS - Surface soil
TCDD - Tetrachlorodibenzo-p-dioxin
TRPH - Total recoverable petroleum hydrocarbons
ug/kg - Micrograms per kilogram
VOC - Volatile organic compounds

1. Risk-based concentrations for residential soils and tapwater, "Risk-based Concentration Table," November 8, 1994, EPA Region III
2. Federal Drinking Water Maximum Contaminant Levels, 40 CFR 141, Subpart F
3. Alaska State Drinking Water Maximum Contaminant Levels, 18 AAC 70
4. Numerical Soil Cleanup Targets for Petroleum, "Interim Guidance for Non-UST Contaminated Soil Cleanup Levels (Revision 1), "July 17, 1991, ADEC
5. "Elemental Concentrations in Soils and Other Surficial Material of Alaska," 1988 U.S. Geological Survey
6. Background levels found at the Gambell Site, shown on Table 4-1 of the RI report (MW, 1995)
7. PCB action Level for residential soil and 1% organic carbon sediments, identified in the EPA Publication 9355.4-01 FS, "A Guide on Remedial Actions at Superfund Sites with PCB Contamination," August 1990.
8. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, OSWER Directive # 9355.4-12, IEUBK model.
9. Toxic Substances Control Act, 40 CFR 761.125
10. Assumptions for volume calculations and ADEC matrices are shown in Appendix E of the RI report (MW, 1995)

detection limit of 50 µg/kg, while the primary lab obtained a detection limit of 200 µg/kg. These values are below regulatory levels for PCBs in soil.

Site 5

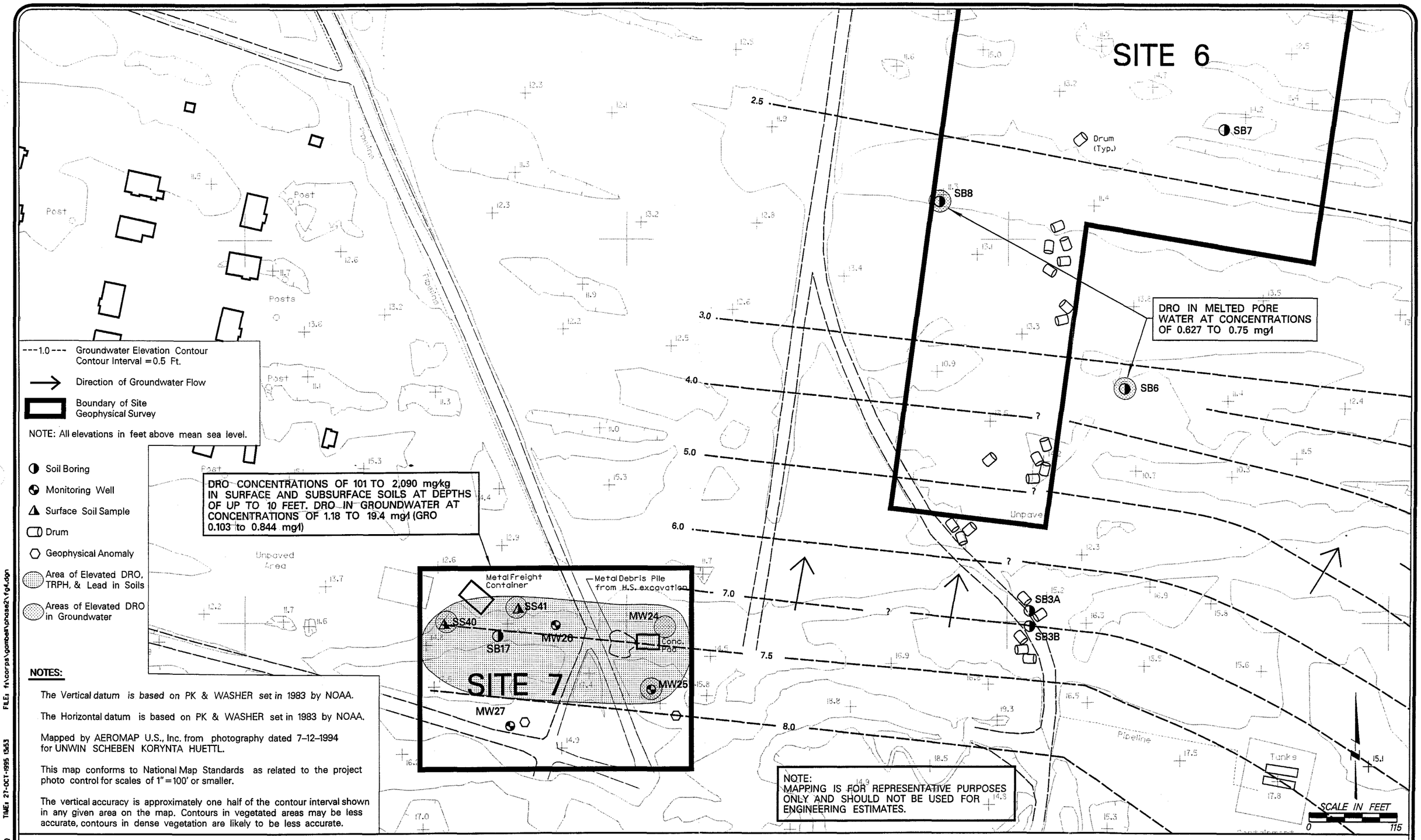
Site 5 (shown on Figure 3) is located immediately adjacent to a shipping container housing five well points which tap a shallow aquifer. The water is stored in tanks, and subsequently used as Gambell's potable water supply. DRO and TRPH were detected in soils at a maximum concentration of 1,800 mg/kg and 1,430 mg/kg, respectively, at a depth of 5 feet. Groundwater was present at a depth of 5 feet, indicating that the petroleum contamination is in contact with the groundwater. Groundwater generally flows in a direction slightly east of north, however, groundwater flow is influenced by the tide, storm events, and pumping from the adjacent Gambell water supply well points. Groundwater from monitoring wells placed at Site 5 showed detectable, but low levels of TRPH and DRO (0.5 mg/l and 0.105 mg/l, respectively, in MW-16), suggesting that groundwater may be impacted. Gasoline range organics (GRO) were not detected in any of the samples taken. As per the Chemical Data Acquisition Plan (CDAP), Benzene, Tolune, Ethylbenzene, Xylenes (BTEX) was not sampled during the 1994 RI (MW, 1995). Recent water quality samples on water taken from these well points, indicate that the water meets the existing drinking water quality criteria at the time it was sampled (June, 1994). ADEC's Village Safe Water Section performs a biannual water quality sampling program at Gambell's water supply wells.

Sites 6 and 7

Site 6 and Site 7 are adjacent to each other as shown on Figure 4. At Site 6, dissolved hydrocarbon constituents in groundwater are limited to DRO and TRPH, with maximum detected concentrations of 0.75 mg/l and 0.3 mg/l, respectively. Semi-volatile organic compounds (SVOCs) and VOCs were not detected. At Site 7, DRO, and TRPH were detected in groundwater at maximum concentrations of 19.4 mg/l and 4.2 mg/l, respectively. GRO was detected in groundwater at a concentration of 0.844 mg/l, and benzene was detected at a concentration of 0.019 mg/l. Low concentrations SVOCs were also detected at Site 7. In soils, DRO and TRPH were detected at maximum concentrations of 6,040 mg/kg and 13,000 mg/kg, respectively.

Interim Removal Actions at all Sites

In addition to the recommended soil and groundwater remediation alternatives, there are quantities of debris at the Gambell site that are eligible for removal under the DERP-FUDS program. The debris falls under specific categories for removal action including building demolition and debris removal (BD/DR), hazardous or toxic waste (HTW), and CON/HTW. Items such as drum remnants, empty fuel tanks, generators, engine blocks, and batteries are categorized as CON/HTW according to DERP-FUDS classifications for removal action. These items will be removed as interim removal actions (IRA) during Phase II of the Remedial Investigation and Feasibility Study (RI/FS). IRAs will be discussed further in Section 4 of this memorandum.



NOTES:

The Vertical datum is based on PK & WASHER set in 1983 by NOAA.

The Horizontal datum is based on PK & WASHER set in 1983 by NOAA.

Mapped by AEROMAP U.S., Inc. from photography dated 7-12-1994 for UNWIN SCHEBEN KORYNTA HUETTL.

This map conforms to National Map Standards as related to the project photo control for scales of 1" = 100' or smaller.

The vertical accuracy is approximately one half of the contour interval shown in any given area on the map. Contours in vegetated areas may be less accurate, contours in dense vegetation are likely to be less accurate.

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MONTGOMERY WATSON

Anchorage, Alaska

FIGURE 4

ALASKA DISTRICT – CORPS OF ENGINEERS
GAMBELL, ST. LAWRENCE ISLAND, ALASKA

AREAS OF CONCERN SITES 6 AND 7 GAMBELL

3.0 RECOMMENDED ACTIONS

A comparison potential remedial alternatives that were investigated and subsequently considered for implementation at specific areas of concern are given in Appendix B.

The decision process that has been used as an aid to distinguish between those areas where additional sampling and development of alternative cleanup levels will be required versus those eligible for presumptive technological applications or interim removal actions is depicted in Figure 5. Recommended actions for locations in Gambell are presented below. For all areas of concern at Gambell, the first recommended action includes:

- risk assessment to evaluate potential risks to human health and the environment; and/or
- further sampling for accurate delineation of contamination and potential source determination.

Risk assessment in support of potential alternative cleanup levels has been selected in many cases because the risk posed by contamination appears low, while the costs to remediate are high due to site-specific conditions at Gambell. In general, low-cost, rapid technologies for soil and groundwater remediation are not considered feasible.

In the event that excavation or removal of materials is deemed necessary or appropriate at any of the sites, safeguards will be put in place to ensure that any potential archeological findings encountered are not detrimentally affected by the removal action. Coordination with the State of Alaska Department of Natural Resources, State Historic Preservation Office will be sought to ensure that all appropriate protocols are put into effect.

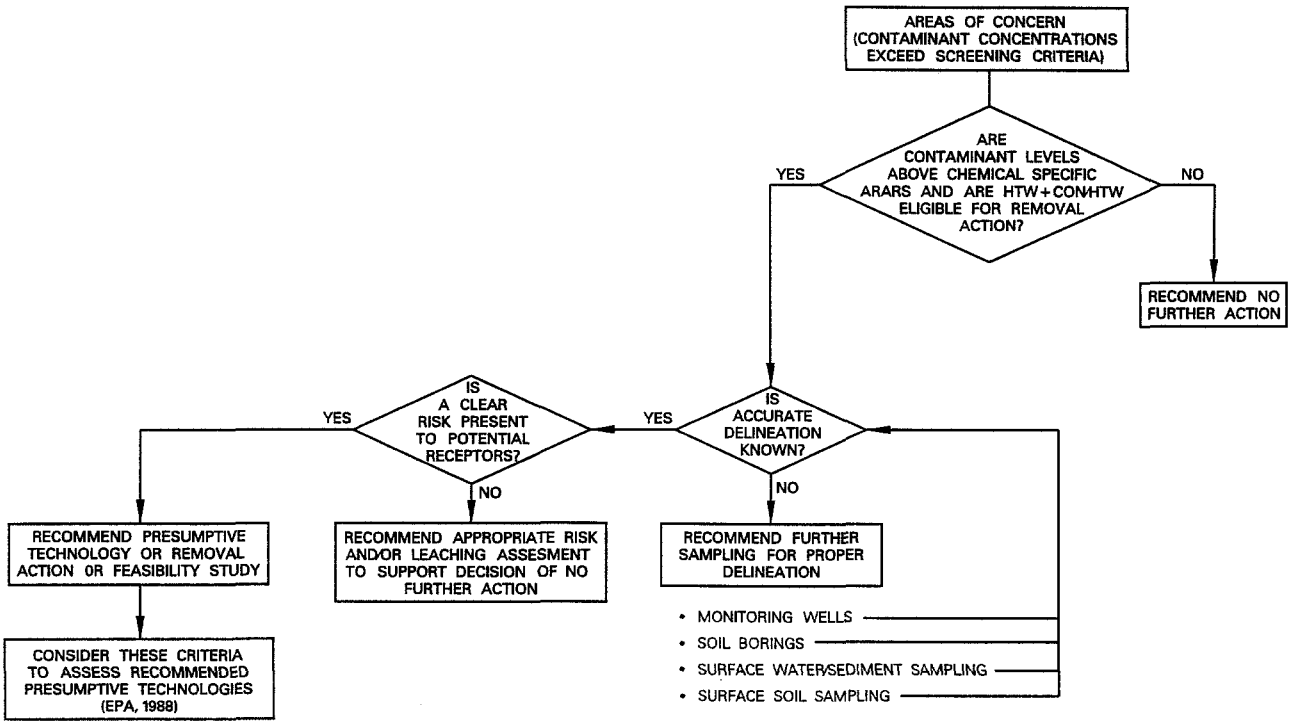
Tables 2 through 8 summarize the considerations for remedial action at Sites 2, 3, 4B, 4D, 5, 6, and 7. These sites are described in more detail below.

Site 2

Of primary concern at Site 2 is the human health risk associated with elevated levels of lead and other metals in surface soils. The maximum concentration of lead detected in one of two surface soil samples was 749 mg/kg. This concentration is not very high relative to the benchmark criteria (500 to 1,000 mg/kg), however, the areal extent and maximum concentration are not known. For this reason, further delineation sampling of surface soils at Site 2 for metals is proposed.

Site 3

The 1994 RI report indicated that the buried material located at Site 3 in the vicinity of the contaminated area is not likely to be the cause of the presence of DRO, beryllium, and thallium in shallow soils. Therefore, no excavation or remediation of the buried anomaly appears warranted. As a result of the shallow depth of the contaminated soil, it is likely that a surface



- OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
  - HOW ALTERNATIVE PROVIDES HUMAN HEALTH AND ENVIRONMENT PROTECTION
- COMPLIANCE WARARs
  - COMPLIANCE W/CHEMICAL-SPECIFIC ARARs
  - COMPLIANCE W/ACTION-SPECIFIC ARARs
  - COMPLIANCE W/LOCATION-SPECIFIC ARARs
  - COMPLIANCE W/OTHER CRITERIA, ADVISORIES, AND GUIDANCE
- LONG-TERM EFFECTIVENESS AND PERMANENCE
  - MAGNITUDE OF RESIDUAL RISK
  - ADEQUACY AND RELIABILITY OF CONTROLS
- REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT
  - TREATMENT PROCESS USED AND MATERIALS TREATED
  - AMOUNT OF HAZARDOUS MATERIALS DESTROYED OR TREATED
  - DEGREE OF EXPECTED REDUCTION OF TOXICITY, MOBILITY, AND VOLUME
  - DEGREE TO WHICH TREATMENT IS IRREVERSIBLE
  - TYPE AND QUANTITY OF RESIDUALS REMAINING AFTER TREATMENT
- SHORT-TERM EFFECTIVENESS
  - PROTECTION OF COMMUNITY DURING REMEDIAL ACTIONS
  - PROTECTION OF WORKERS DURING REMEDIAL ACTIONS
  - ENVIRONMENTAL IMPACTS
  - TIME UNTIL REMEDIAL ACTION OBJECTIVES ARE ACHIEVED
- IMPLEMENTABILITY
  - ABILITY TO CONSTRUCT AND OPERATE THE TECHNOLOGY
  - RELIABILITY OF THE TECHNOLOGY
  - EASE OF UNDERTAKING ADDITIONAL REMEDIAL ACTIONS IF NECESSARY
  - ABILITY TO MONITOR EFFECTIVENESS OF REMEDY
  - ABILITY TO OBTAIN APPROVALS FROM OTHER AGENCIES
  - COORDINATION WITH OTHER AGENCIES
  - AVAILABILITY OF OFFSITE TREATMENT, STORAGE, AND DISPOSAL SERVICES AND CAPACITY
  - AVAILABILITY OF NECESSARY EQUIPMENT AND SPECIALISTS
  - AVAILABILITY OF PROSPECTIVE TECHNOLOGIES
- COST (PRESENT WORTH)
  - CAPITAL COSTS
  - OPERATING AND MAINTENANCE COSTS
  - PRESENT WORTH COST
- COMMUNITY ACCEPTANCE
- REGULATORY ACCEPTANCE

Adapted from the Environmental Protection Agency, 1988, Guidance for Conduction Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.3-01, October.

MONTGOMERY WATSON

Anchorage, Alaska

FIGURE 5

ALASKA DISTRICT – CORPS OF ENGINEERS
GAMBELL, ST. LAWRENCE ISLAND, ALASKA

RECOMMENDED ACTION DECISION TREE

source, which is no longer present, was responsible for the contamination. In order to design an appropriate remediation strategy, additional surface soil sampling and risk assessment is recommended in order to determine the extent and associated risks of the contamination.

If a risk assessment shows that there is a low risk of dermal contact, it is recommended that alternative clean-up levels be developed. Alternatively, if there is a high risk of dermal contact at Site 3 and it is confirmed that the contaminated soil is primarily at shallow depths, then excavation and disposal of the accurately delineated contaminated soil would be implemented.

Site 4/Area 4B

At Site 4/Area 4B, low levels of dioxins and high concentrations of priority pollutant metals (including lead) are present surface soil. It is recommended that a strategy involving development of cleanup levels through site specific risk assessment be implemented as a result of several contributing factors as noted in the RI report. These include:

- the specific wildlife environment;
- the heavy dependence of local inhabitants on subsistence food sources that may or may not be effected by the contamination;
- dissension in the scientific community about the levels of dioxins and furans that adversely impact human health and the environment, and
- high level of public awareness and concern over dioxins and furans and the adverse public perception of these compounds.

A primary goal of a risk assessment would be to assess whether concentrations of contaminants would be likely to adversely impact the local wildlife. If impacted, significant additional pathways for impact on human health given the subsistence lifestyle of the local inhabitants will be determined.

If risk appears high, removing the top foot of soil and cover with clean soil would be a suitable remediation strategy at this site. Bedrock at the site is present at a depth of approximately 1 foot. Covering would involve the placement of clean fill over contaminated soils in order to prevent dermal contact.

Site 4/Area 4D

At Site 4/Area 4D, low concentrations of PCBs were detected in sediments at a remote location on Sevuokuk Mountain. The concentration detected (0.194 mg/kg) is below benchmark criteria for soils (1 mg/kg), although a criteria has not been established for sediments. As a result of the low risks of exposure and the concentrations being below soil benchmark criteria which appears to be applicable for this type of environment, no further sampling or presumptive technologies are recommended at Site 4/Area 4D. However , it is recommended that the transformers be

removed, as described in the following section. In addition, limited sediment should be removed if staining is encountered upon removal of the transformers.

Site 5

A potential concern at Site 5 is the human health risk posed by petroleum-contaminated soils in contact with groundwater used for local water supply. However, soluble components of hydrocarbons were not detected in soil and groundwater, and recent testing of the water supply indicates contaminants are not present. The risk to Troutman Lake is minimal due to the predominant groundwater gradient, and the brackish conditions of Troutman Lake which results in minimal lake use by the natives of Gambell.

It is recommended that the village water supply wells and the two existing monitoring wells be resampled. Also, close observations of ADEC's biannual sampling results of the water supply wells should be performed.

If the contamination is detected in the drinking water, a well-head treatment system could be designed to treat the water as it is extracted, eliminating the potential exposure pathway.

Site 6

At Site 6, DRO was detected in groundwater samples at concentrations of 0.63 to 0.75 mg/l. However, the more soluble and mobile components of petroleum hydrocarbons such as GRO and benzene were not detected. In accordance with the RI CDAP, no soil samples were collected at Site 6.

The RI analytical data and field observations indicate that soil contamination (petroleum hydrocarbons) is present in soils at Site 6, and that the heavier and less mobile components of hydrocarbons are present at low concentrations in groundwater. However, in the vicinity of Site 6, the mobility of groundwater is limited by frozen soils and permafrost. Groundwater was found in only two of the five soil borings at Site 6, and all of the borings met refusal due to frozen soils. This data suggests that the hydrocarbons in soils and groundwater at Site 6 pose little exposure risk. The primary migration pathway of concern would be groundwater migration to the drinking water supply near Site 5, located approximately 2,000 feet east of Site 6.

Due to the apparently low risk posed by the petroleum hydrocarbons present in soils and groundwater at Site 6, the primary recommendation is the attainment of alternative clean levels, supported by documentation that the site poses little risk to humans or the environment.

Site 7

Petroleum hydrocarbons were found in surface and subsurface soils (maximum DRO concentration 2,090 mg/kg) at Site 7. Site 7 is centrally located and, thus, exposed to heavy pedestrian and ATV traffic. However, maximum concentrations of surface contamination are below RBCs for surface soils.

A primary consideration in evaluating the exposure risk posed by hydrocarbons is the potential effect on drinking water supplies. In contrast to Site 6, the more mobile "lighter end" fractions of fuels were detected at MW-24 at Site 7 (Table 1). GRO was detected at a concentration of 0.844 mg/l, and benzene was detected at a concentration of 0.019 mg/l. The benzene concentration exceeds the state and federal drinking water standard of 0.005 mg/l.

However, Site 7 is located over 2,000 feet west of the drinking water supply extraction location near Site 5. Existing information indicates that groundwater is migrating northward from Site 7, and frozen pore water and permafrost limits the mobility of subsurface contaminants.

As a result of the predominant gradient, frozen soils, and surface soil concentration being lower than soil RBC's, it is recommended that alternative clean-up levels be attained. These will be supported by documentation that the site poses little risk to humans or the environment.

TABLE 2
Summary of Remedial Considerations
Site 2 - Gambell

Original Sources: Unknown, probably a surface structure now removed.

Current Status of Original Sources: Only scattered debris remains.

COCs	Soil	Estimated Soil Volume (cubic yards)	Groundwater	Sediment	Surface Water
POL PCBs BNAs METALS VOCs	X	Unknown			

Potential Migration Pathways: Dermal exposure and ingestion.

Potential Receptors: Local population and incidental visitors.

Key Site Specific Considerations: Depth to groundwater at the site is approximately 9 feet. Soils consist of poorly graded gravel with sand (beach gravels). Permafrost is present at a typical depth of 15 feet. Groundwater flows north to the Bering Sea. Elevated lead (749 mg/kg) was detected in one surface soil sample (SS 27), but not in another (SS 28). Areal extent and maximum concentration of lead and other metals is unknown.

Program Objectives:

- Delineate the areal extent and maximum concentration of lead and other metals in surface soils.

Primary Recommended Action:

- Perform surface soil sampling.

Secondary Recommended Action:

- Limited surface soil removal (pending delineation of extent of contamination) or development of alternative cleanup levels.

TABLE 3
Summary of Remedial Considerations
Site 3 - Gambell

Original Sources: Suspected buried debris (based on EM-31 conductivity and GSM-19 magnetometry geophysical surveys), such as power plant remnants (e.g., generators, transformers, oils, fuels, batteries).

Current Status of Original Sources: Suspect metal debris is currently buried on-site. No information on whether an on-going source is present or not.

COCs	Soil	Estimated Soil Volume (cubic yards)[1]	Groundwater	Sediment	Surface Water
POL	X	5.2			
PCBs					
BNAs					
Beryllium & Thallium	X	Unknown			
VOCs					

Potential Migration Pathways: Direct contact. Based on groundwater sampling results, groundwater has not been significantly impacted.

Potential Receptors: Local population and incidental visitors.

Key Site Specific Considerations: Depth to groundwater at the site is approximately 10 feet. Soils typically consist of poorly graded sand and gravel (permeable). Permafrost may be present at a typical depth of 20 feet. Surface vegetation is minimal. Structures are not present. Groundwater flow is estimated at 0.0035 ft/ft in a flow direction slightly east of north. Suspect that flow direction and velocity is impacted by well point pumping and surface water runoff.

Program Objectives:

- Document concentration of metals and POLs in surface soils.
- Delineate extent of metals contamination.

Primary Recommended Action:

- Collect surface soil samples at Site 3.

Secondary Recommended Action:

- Excavation and disposal of surface soils if surface soil concentrations exceed risk-based concentrations.

1 - Assumptions for volume calculations are shown in App. E of the 1995 RI report (MW, 1995)

TABLE 4
Summary of Remedial Considerations
Site 4/Area 4B - Gambell

Original Sources: Burning of Air Force Radar Station accompanied by explosion of ordnance causing scattering of debris.

Current Status of Original Sources: Burned debris still present.

COCs	Soil	Estimated Soil Volume (cubic yards)[1]	Groundwater	Sediment	Surface Water
POL					
PCBs					
BNAs					
METALS	X	186			
VOCs					
2,3,7,8-TCDD	X	186			

Potential Migration Pathways: Direct contact.

Potential Receptors: Area is on remote hillside, local population and incidental visitors, probably minimal. Site is located near an auklet rookery with roosting and nesting birds, birds may contact contamination. Humans may ingest birds and bird eggs, and depend on the quantity of birds and eggs for maintenance of subsistence lifestyle.

Key Site Specific Considerations: Groundwater is not present at the site. Soils typically consist of a thin mantle of weathered debris on granitic bedrock. Surface vegetation is minimal. Debris present consists of burned remains and rusted metal.

Program Objectives:

- Identify ecological and human health risk posed by metals and low levels of dioxin.

Primary Recommended Action:

- Ecological and human health risk assessment.

Secondary Recommended Action:

- Capping of surface debris if risk assessment indicates significant human or ecological risk.

1 - Assumptions for volume calculations are shown in App. E of the 1995 RI report (MW, 1995)

TABLE 5
Summary of Remedial Considerations
Site 4/Area 4D - Gambell

Original Sources: Three transformers currently in the mountainside drainage.

Current Status of Original Sources: Still present

COCs	Soil	Estimated Soil Volume (cubic yards)	Groundwater	Sediment	Surface Water
POL PCBs BNAs METALS VOCs				X	

Potential Migration Pathways: Transport of PCB-contaminated sediments.

Potential Receptors: Local population and incidental visitors.

Key Site Specific Considerations: Site is isolated on Sevuokuk Mt. drainage. Low concentration (194 ppb) of PCBs detected in one sediment sample. Concentration found is below regulatory criteria for PCBs in soil. Investigation area is tundra-covered bog.

Program Objectives:

- Wipe sample inside each transformer for PCBs; removal of the three transformers as part of an interim removal action.
- Limited sediment removal if staining is encountered upon removal of the transformers.

Primary Recommended Action:

- Removal of transformers.
- Limited provisional sediment removal.

Secondary Recommended Action:

TABLE 6
Summary of Remedial Considerations
Site 5 - Gambell

Original Sources: Unknown. Possibly related to buried material (suspected to be transformers) detected in EM-31 conductivity and GSM-19 magnetometry geophysical surveys. Two areas of potential subsurface sources include mounded ground and geophysical anomaly.

Current Status of Original Sources: Unknown.

COCs	Soil	Soil Volume (cubic yards)[1]	Groundwater	Sediment	Surface Water
POL PCBs BNAs METALS VOCs	X	5.2			

Potential Migration Pathways: Groundwater used as the village drinking water source.

Potential Receptors: Local population and incidental visitors.

Key Site Specific Considerations: Depth to groundwater at the site is approximately 5 feet. Soils typically consist of poorly graded gravel. Permafrost may be present at a typical depth of 10 to 15 feet. Surface vegetation is minimal. Local village water supply is located immediately (150 feet) west of Site 5. Groundwater flow is estimated at 0.0026 ft/ft with a gradient slightly east of north. Volatile hydrocarbon components were not detected in soils or groundwater. Low levels of DRO and TRPH were detected in groundwater monitoring wells. Sampling of well points by the State in June 1994 indicated no contamination of the village water supply.

Program Objectives:

- Document presence or absence of contamination through a resampling of the village well points and the existing monitoring wells.

Primary Recommended Action:

- Keep close observations of future biannual sampling results of the village well points.
- Resample village well points and MW-15 and MW-16.

Secondary Recommended Action:

- If contamination is noted in groundwater, install wellhead treatment at village well points.

1 - Assumptions for volume calculations are shown in App. E of the 1995 RI report (MW, 1995)

TABLE 7
Summary of Remedial Considerations
Site 6 - Gambell

Original Sources: Military landfill.

Current Status of Original Sources: Still present.

COCs	Soil	Soil Volume (cubic yards)	Groundwater	Sediment	Surface Water
POL			X		
PCBs					
BNAs					
METALS					
VOCs					

Potential Migration Pathways: Groundwater used for drinking water approximately 1,800 feet slightly south of east.

Potential Receptors: Local population and incidental visitors.

Key Site Specific Considerations: Depth to groundwater at the site is approximately 8 feet. Soils typically consist of poorly graded gravel with sand. Permafrost is present at a typical depth of 7 to 11 feet. Frozen pore water limits the mobility of subsurface contaminants. Volatile components (GRO, BTEX) of hydrocarbons were not detected.

Program Objectives:

- Attainment of alternative clean-up levels supported by documentation that the site poses little risk to humans or the environment.

Primary Recommended Action:

- No further action.

Secondary Recommended Action:

TABLE 8
Summary of Remedial Considerations
Site 7 - Gambell

Original Sources: Former military power site and motor pool, possible buried debris. Buried POL pipeline.

Current Status of Original Sources: Power site and motor pool not present. Buried debris in place.

COCs	Soil	Soil Volume (cubic yards)[1]	Groundwater	Sediment	Surface Water
POL	X	10,606	X		
PCBs					
BNAs					
METALS					
VOCs			X		

Potential Migration Pathways: Groundwater

Potential Receptors: Local population and incidental visitors (groundwater ingestion and subsistence food sources), Bering Sea ecosystem, Troutman Lake.

Key Site Specific Considerations: Depth to groundwater at the site is approximately 8 feet. Soils typically consist of poorly graded gravel with sand. Permafrost is present at a typical depth of 7 to 10 feet. Surface vegetation is minimal. Benzene and GRO were detected in groundwater samples from MW-24. Frozen pore water and permafrost limits mobility of subsurface contaminants. Surface concentrations of POL below RBCs.

Program Objectives:

- Attainment of alternative clean-up levels supported by documentation that the site poses little risk to humans or the environment.

Primary Recommended Action:

- No further action.

Secondary Recommended Action:

1 - Assumptions for volume calculations are shown in App. E of the 1995 RI report (MW, 1995)

4.0 INTERIM REMOVAL ACTIONS (IRAS)

4.1 RECOMMENDED INTERIM REMOVAL ACTIONS

There is a significant amount of debris at the Gambell site which can be classified as CON/HTW and must be disposed of at an approved off-site disposal facility in accordance with all applicable rules and regulations. As part of the Interim Removal Action it is recommended that all debris that can be positively identified as CON/HTW be containerized and removed from the site and disposed of accordingly. Those materials which cannot clearly be identified as CON/HTW nor meet the criteria for BD/DR shall be (by individual site) stockpiled and a composite sample collected to determine its CON/HTW status. If the materials are found to meet the criteria for CON/HTW then they should be containerized and sent to an approved off-site disposal facility.

Off-site transportation of CON/HTW is dependent upon the contaminants found as well as the volume. Transportation options are limited to either a chartered landing barge or "Hercules" C-5 cargo-aircraft. Regardless of the mode of transportation, the transporter must have all current applicable licenses and registrations required to transport these types of materials.

Much of the debris found among Gambell's investigative sites will most likely be categorized as BD/DR, and will, in turn, be addressed during the BD/DR Design Task. However, items such as empty fuel tanks, generators, engine blocks, and batteries would be categorized as CON/HTW and is considered a source area that can be removed as an interim removal action during Phase II of the RI/FS. Some surficial and partially exposed debris which are the highest risk to human health and/or the environment, and warrants immediate removal, are the three transformer casings at Site 4/Area 4D and the half buried drums at Site 6.

Other CON/HTW or HTW materials eligible for DERP funded cleanup or investigation at the Gambell site are as listed below. The inventory of eligible debris and associated quantities have been compiled from field investigations completed by both E&E (E&E, 1992) and Montgomery Watson (MW, 1994). The areas are shown on Figure 2, and listed below:

Site 1/Area 1A - empty drums (16);
Site 2 - empty drum (1);
Site 3 - empty drums (19), empty fuel 275-gallon storage tank (1);
Site 4/Area 4A - empty drums (34), transformers (3), generators (1 at 1,000 lbs.);
Site 4/Area 4B - metal gas tank (1), empty drums (4), generators (7), engine blocks (2 at 200 lbs.);
Site 4/Area 4D - transformers (3);
Site 5 - empty drum (1);
Site 6 - empty drums associated with potential hazardous waste (30 lbs.);
Site 8 - empty drums (66), drums containing asphalt (8);
Site 10- drums (157);
Site 12 - empty drums (170), batteries (10); and
Site 17 - drum remnants associated with potential hazardous waste (15 lbs.).

The individual sites and debris located at each are described in more detail below.

Site 1/Area 1A-Army Landing Area

The 1994 RI did not find contamination at Site 1 above benchmark criteria. Most debris associated with the Army Landing Area are buried. This debris, as explained in E&E's Inventory Report (E&E, 1992), are based on reports by residents of Gambell. Buried debris includes large engines formerly used to run pulley systems attached to buried deadman anchors and drums with unknown contents.

Approximately 16 exposed empty drums that are found between Site1/Area 1A and West Beach qualify for removal as CON/HTW and will be crushed, stockpiled, and disposed of in a recyling and reclamation facility or at the project landfill. The project landfill will be an approved non-hazardous waste landfill.

Site 1/Area 1B-Air Force Landing Area

Potential CON/HTW at the Air Force Landing Area include a decaying drum that has released an unknown tar-like material onto the beach berm. The empty drum will be crushed, stockpiled, and disposed of in a recycling and reclamation facility or at the project landfill. The tar-stained soil was sampled during the 1994 RI and was found to contain low levels of lead (35 mg/kg). No further investigation or remediation is recommended for the stained soil.

Site 2-Former Military Housing/Operations Area

Potential CON/HTW at the Former Military Housing/Operations Area include a decaying drum and an area containing discolored gravel. The decaying drum will be crushed, stockpiled, and disposed of in a recycling and reclamation facility or at the project landfill. The tar-stained soil was sampled during the 1994 RI (SS 27) and was found to contain elevated levels of lead, chromium, copper, and zinc (MW, 1995). Further investigation of the tar-stained soil is recommended and is discussed further in Section 3 of this technical memorandum.

Site 3-Former Communications Facility

Potential CON/HTW at the Former Communications Facility include 19 empty drums and an empty 275-gallon fuel storage tank. The tank and drums will be dismantled into smaller more manageable pieces for stockpiling and future disposal. Debris will be disposed of in a recycling and reclamation facility or at the project landfill.

Site 4/Area 4A-Quonset Hut Area

Potential CON/HTW at the Quonset Hut Area include three empty transformers, 34 empty drums, and one 1,000 pound generator. Surface soil samples taken adjacent to the transformer during the 1994 RI showed no trace of PCBs. The transformers and generator will be dismantled, wipe-sampled for PCBs, and placed into an overpack drum until results determine

the disposition of the debris for disposal. The drums will be disposed of at a recycling and reclamation facility or at the project landfill.

Site 4/Area 4B-Air Force Radar Station

Potential CON/HTW at the Air Force Radar Station are one empty metal gas tank, four empty drums, seven Howelite generators and two 200-pound engine blocks. The tank, drums, and engine blocks will be dismantled into smaller more manageable pieces for stockpiling and future disposal. The generators will be dismantled, wipe-sampled for PCBs, and placed into overpack drums until results determine the disposition of the debris for disposal.

Site 4/Area 4D-Transformers in Mountainside Drainage

Potential CON/HTW at Site 4/Area 4D are three transformers in a mountainside drainage. The transformers will be dismantled, wipe-sampled for PCBs, and placed into an overpack drum until results determine the disposition of the debris for disposal.

Site 5-Former Tramway Site

Potential CON/HTW at the Former Tramway Site is one empty drum. The decaying drum will be crushed, stockpiled, and disposed of at the project landfill.

Site 6-Military Landfill

Potential CON/HTW at the Military Landfill consist of partially buried drums. Drums of human waste were reportedly buried at Site 6 during military activity at Gambell. The remnants of approximately 20 drums protruding from the surface will be uncovered, crushed, stockpiled, and disposed of at a recycling and reclamation facility or at the project landfill. A large portion of the military landfill was excavated during construction of the Gambell High School in July, 1994 (MW, 1995).

Site 8-West Beach

Potential CON/HTW at West Beach include approximately 66 empty drums and eight drums containing asphalt. The decaying drums will be crushed, stockpiled, and disposed of at a recycling and reclamation facility or at the project landfill. The drums filled with asphalt will be emptied and the asphalt sent to an approved non-hazardous waste landfill.

Site 10-Sevuokuk Mountain Trail System

Potential CON/HTW at the Sevuokuk Mountain Trail System are approximately 160 drums in various conditions located approximately 200 feet apart along the trail systems extending from the top of the mountain to the areas east and south of Nayvaghaq Lake. Several drums contain gravel, but most are empty. E&E observed one drum with a tar-like substance leaking from it during their 1992 investigation (E&E, 1992). No tar-like substance was seen leaking from any of the drums during MW's 1995 investigation. However, not every drum was examined, thus, other

drums may contain remaining product. The empty drums will be crushed, stockpiled, and disposed of at a recycling and reclamation facility or at the project landfill. The drums containing gravel or product will be emptied and the gravel or product sampled to determine its disposition for disposal.

Site 12-Nayvaghaq Lake Disposal Site

The Nayvaghaq Lake Disposal Site includes two drum disposal areas, the northern area located at the intersection of two ATV trails, and the southern area located approximately 470 feet south of the intersection. Potential CON/HTW include approximately 170 empty drums and ten batteries. Surface soil samples taken downslope of two batteries in the northern area, and in the southern area within a group of discarded drums, contained metals concentrations below background levels found at the Gambell Site (MW, 1995). The drums will be crushed, stockpiled, and disposed of at a recycling and reclamation facility or at the project landfill. The batteries will be contained in an overpack and disposed of off-site at an approved treatment storage and disposal facility (TSDF).

Site 17-Army Landfills

Potential CON/HTW at the Army Landfills are drum remnants associated with potential hazardous waste. The presence of drum remnants on the landfill surface suggests that drums may be buried within the landfills. These drums potentially contained hazardous or toxic waste. The drum remnants will be crushed, stockpiled, and disposed of at a recycling or reclamation facility or at the project landfill.

All debris at the Gambell Site which qualifies for removal as CON/HTW should be included in the EE/CA which is to be completed for Phase II of the Gambell RI/FS.

5.0 CONCLUSIONS

Table 9 summarizes the recommended actions, including the no-action alternative, at Gambell at the seven areas of concern identified in the 1994 RI. With the exception of potential CON/HTW removal identified in Section 4, most of the areas of concern are not amenable to low-cost or rapid presumptive technologies. In general, the environmental risk posed by the contamination appears low relative to the potential cost for application of typical remediation technologies. At Site 2 and Site 3, further delineation is recommended to document the extent of contamination and the ecological and/or human health risks associated with the contamination. At Site 4B, a risk assessment should reflect the necessity to develop alternative cleanup levels. At Site 4D, sediment will be removed only if staining is encountered upon removal of the transformers. The most significant potential human-health risk associated with soil and groundwater contamination at the Gambell Site is contamination of the local drinking water supply located near Site 5. Existing data indicates that this has not occurred. If future biannual sampling indicates that the drinking water supply is contaminated, wellhead treatment appears to be the most cost-effective way to eliminate this potential exposure pathway.

TABLE 9
Summary of Recommended Actions
Gambell
St. Lawrence Island, Alaska

Site	Media	Contaminant	Proposed Action	Rationale
Site 2	surface soil	Pb, Cr, Cu, Zn	Surface soil sampling for priority pollutant metals	Determine the extent and associated risks of the contamination, potential receptors, and possible development of alternative cleanup levels
Site 3	soil	DRO, Thallium, Beryllium	Surface soil sampling for DRO, beryllium, and thallium	Determine the extent and associated risks of the contamination, potential receptors, and possible development of alternative cleanup levels
Site 4/Area 4B	surface soil	Pb (other priority pollutant metals), 2,3,7,8-TCDD	Site specific risk assessment	Determine the extent and associated risks of the contamination, potential receptors, and possible development of alternative cleanup levels
Site 4/Area 4D	sediment	PCB	Remove limited sediment if evidence of staining is encountered upon removal of the three transformers	Further sampling or sediment removal is not necessary at this time because soil PCB regulatory levels are appropriate to use given this type of exposure
Site 5	subsurface soil	DRO, TRPH	Complete sampling of village water supply well points and existing wells using stringent criteria, and keep a close watch on results from ADEC's biannual sampling of the wells	Further sampling or soil removal is not necessary at this time because of the immobility of the contamination and the low risk of dermal contact
Site 7	soils, groundwater	DRO	Attain alternative clean-up levels supported by documentation that the site poses little risk to humans or the environment No further action is recommended at this time	Not a significant threat to drinking water because of predominant gradient and frozen soils or to Bering Sea because of frozen soils. Low risk of dermal contact because surface soil contaminant levels are below risk-based levels.
Site 6	soils, groundwater	DRO, TRPH	Attain alternative clean-up levels supported by documentation that the site poses little risk to humans or the environment No further action is recommended at this time	No significant pathways because of discontinuous nature of permafrost soils

Key:
DRO - Diesel Range Organics
Pb - Lead
PCBs - Polychlorinated biphenyls
TCDD -tetrachlorodibenzo-p-dioxin
TRPH - Total Recoverable Petroleum Hydrocarbons

6.0 REFERENCES

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APPENDIX A APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS, AND BENCHMARK SCREENING CRITERIA

Although the Gambell site is apparently not currently subject to the RCRA Corrective Action (CA) or Superfund, additional existing federal, state, and local regulations can be triggered by discoveries or activities resulting from investigation at the site. In Superfund, these requirements are referred to as applicable or relevant and appropriate requirements (ARARs). In general, the regulatory requirements address:

- reporting and cleanup of newly-discovered spills and contamination;
- storage, labeling, transportation, and disposal of excavated materials and debris;
- permitting of facilities and discharges;
- cleanup criteria and technologies;
- access restrictions; and
- monitoring and closure.

Regulatory requirements pertinent to this stage of the assessment are discussed in the following paragraphs. In the course of performing the environmental investigation, discovery of existing environmental conditions may trigger reporting and cleanup requirements under a number of environmental statutes and regulations targeted at specific constituents or situations. Relevant Federal regulations include:

- Resource Conservation and Recovery Act (RCRA) - Subtitle C and D, other than CA requirements
- Toxic Substance Control Act (TSCA)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Of the federal regulations listed above, TSCA may be relevant and appropriate, but is not directly applicable to remedial action at the site because it applies to releases that occurred after May 4, 1987. The CERCLA program includes guidance on remedial actions at PCB-contaminated sites (EPA, 1990). Both of these regulations are considered, but may not be directly applicable.

In addition to the Federal regulations, the state of Alaska requires that as additional information becomes available through on-going site assessments, any past releases to the environment (spills) which have not previously been reported to the ADEC, must be reported under the requirements of the Alaska Oil and Hazardous Substances Pollution Control Regulations (18 AAC 75).

Upon discovery and reporting, regulatory requirements and guidelines can be identified for ensuing activities such as: evaluating the nature and extent of contamination, identifying appropriate contaminant-specific action levels and cleanup criteria, and specifying remediation strategies.

ADEC has authority for specifying soil, surface water, and groundwater cleanup levels resulting from the discharge of an oil or a hazardous substance. The authority is granted under AS 46.03.070, AS 46.09.020, and AS 46.04.020 and codified in Oil and Hazardous Substances Pollution Control Regulations (18 AAC 75.327), which specifies that a "discharge must be cleaned up to the department's satisfaction."

Excavated materials that are designated as waste, such as contaminated soils and groundwater wastes, are subject to the requirements of RCRA. Wastes must be classified according to the prescribed procedures in RCRA, Section 261 to determine whether the waste is hazardous or non-hazardous, including characterization for the four RCRA hazardous waste characteristics, ignitability, corrosivity, reactivity, and toxicity (generally referred to as TC or TCLP) and application of the "contained in," "derived from" and "mixed with" stipulations of RCRA.

BENCHMARK SCREENING CRITERIA USED IN THE 1994 REMEDIAL INVESTIGATION

Absolute action levels and cleanup goals are rarely, if ever specified. This is because it is widely recognized by the regulatory agencies that specific-conditions have a significant impact on the specification of cleanup criteria. In order to eliminate levels of contamination from further consideration that are unlikely to adversely impact human health or the environment under any reasonable circumstances, benchmark criteria can be used to identify environmental situations that warrant no further consideration.

Benchmark criteria were identified in the 1994 RI for evaluating the significance of documented site conditions at Gambell and evaluating whether further action might be required in specific areas of the site. The criteria presented are not to be construed as cleanup goals or criteria. Cleanup goals or criteria are to be established between the ADEC and parties undertaking environmental restoration. These benchmark criteria are listed below.

Soil

- Level A Numerical Soil Cleanup Targets for Petroleum Constituents, "Interim Guidance for Non-UST Contaminated Soil Cleanup Levels (Revision 1)," July 17, 1991, ADEC
- "Elemental Concentrations in Soils and Other Surficial Materials of Alaska," 1988, U.S. Geological Survey
- Risk-based concentrations for residential soils, "Risk Based Concentration Table," October 15, 1993, EPA Region III
- Calculated risk-based concentration for diesel in residential soil using the reference dose (RfD) identified for JP-4 in the EPA Region 10 Memorandum entitled "Toxicity of Fuels," April 9, 1992 and the equations for risk-based calculations in the EPA Region III Memorandum entitled "Risk-based Concentration Table," October 15, 1993

- PCB action levels identified in "A Guide on Remedial Actions at Superfund Sites with PCB Contamination," EPA Publication No. 9355.4-1FS (August)

- IEUBK Model for Lead, Risk Assessment News. U.S. EPA, Region 10, May 1994.

Surface and Groundwater

- Federal and State Maximum Contaminant Levels referred to in "Interim Guidance for Surface and Groundwater Cleanup Levels," September 26, 1990, ADEC

- Federal Drinking Water Maximum Contaminant Levels, 40 CFR 141, Subpart F

- Alaska State Drinking Water Maximum Contaminant Levels, 18 AAC 70

- Risk-based concentration in tap water, "Risk-Based Concentration Table," October 15, 1993, EPA Region III

- Calculated risk-based concentration for diesel in tap water using the RfD identified for JP-4 in the EPA Region 10 Memorandum entitled "Toxicity of Fuels," April 9, 1992 and the equations for risk-based calculations in the EPA Region III Memorandum entitled "Risk based Concentration Table," October 15, 1993

Sediment

- "Elemental Concentrations in Soils and Other Surficial Materials of Alaska, "1988, U.S. Geological Survey

These criteria are intended as a very conservative screening device for identifying situations that appear to warrant no remedial action, based on the identity of the contaminants, contaminant concentration, and environmental conditions at the site. In all cases, with the exception of metals, the lowest benchmark was used. For metals, the higher of the two criteria, either USGS background for Alaska, or background found at the Gambell site, was used. In addition, the 400 mg/kg level for lead in soils provided by the EPA (IEUBK) was used as the baseline benchmark criteria from which data were screened. Tables 6-1 through 6-13 of the Gambell RI describe applicable ARARs and Benchmark Criteria used for data evaluation during the 1994 RI (MW, 1995).

Dioxin and Furans Benchmark Criteria

Polychlorodibenzo-p-dioxins (dioxins) and polychlorodibenzofurans (furans) are compounds consisting of two benzene rings bound together by either 1 or 2 oxygen molecules at the ortho and meta positions or only one oxygen molecule at the meta position, respectively. Dioxins are most often produced by waste incineration, metal recovery, wood preservation, chemical manufacturing, and paper pulp bleaching. These compounds vary in toxicity by the number of chlorine molecules and their respective points of attachment. The isomer 2,3,7,8-tetrachlorodibenzodioxin (TCDD) has been found to be highly toxic to all mammalian species,

with varying sensitivity. Dioxins have been found to bioaccumulate and are susceptible to bioaccumulation throughout the food chain.

The risk-based concentration of furans is 78 mg/kg in residential soil, or 78 ppm, according to the EPA Region 3 Risk Based Concentration Table (EPA, 1993). This concentration, which corresponds to fixed levels of risk, have been calculated by combining toxicity constants with "standard" exposure scenarios. This risked-based concentration was compared against the concentrations of furans detected on top of Sevuokuk Mountain, which was a maximum concentration of 5 ppm. Because furan levels at the site are below the conservative benchmark level for residential soils, it was determined that furans do not represent a significant risk in this isolated area in Gambell.

In order to determine the risk-based benchmark concentrations of dioxins, the dioxin concentrations are recalculated in terms of 2,3,7,8-TCDD equivalence, as described in Section 4.3.1.5 of the 1995 RI report (MW, 1995).

These criteria are intended as a very conservative screening device for identifying situations that appear to warrant no remedial action, based on the identity of the contaminants, contaminant concentration, and environmental conditions at the site.

APPENDIX B POTENTIAL REMEDIAL ALTERNATIVES

The contaminants of concern and environmental matrices at areas retained for further investigation at the Gambell site include:

- Petroleum Hydrocarbons in soils
- Lead in surface and subsurface soil

Potential remedial technologies vary according to the type of contaminant present and the environmental matrix, as described in the following sections.

PETROLEUM HYDROCARBONS IN SURFACE AND SUBSURFACE SOIL

There is a wide range of remedial alternatives which have historically been utilized at sites with petroleum hydrocarbons. The most promising technologies for application at Gambell, as indicated in the 1994 RI report, include the four recommended alternatives listed below. Selection was based on effectiveness, cost, and implementability. Each of the options identified for Gambell are briefly described below.

Development of Alternative Cleanup Levels: This includes risk assessment and/or leaching assessment.

Risk Assessment: Site-specific conditions dramatically effect the level of risk presented by fuel contaminated soils. Land and subsurface water usage patterns, the levels of highly mobile and toxic compounds, such as benzene and naphthalene, and the ability of the soil to inhibit migration of the contaminants are some of the significant site-specific factors that are evaluated and presented in the course of risk assessment studies. A risk assessment can demonstrate extenuating conditions that support no remedial action (natural attenuation) or the development of less stringent alternative cleanup criteria. The overriding factor will be to evaluate the potential receptors. If there are no receptors than alternative cleanup levels would be applicable. In some cases, collection of additional field data is necessary to complete a risk assessment. Comparison of petroleum hydrocarbon levels found in soils at the site to RBCs suggest that alternative cleanup levels for the site are appropriate.

Contaminant Leaching Assessment: Leaching assessments may be conducted at locations where risk appears to be low and alternate cleanup levels for petroleum contaminated soils will be required to be developed (ADEC, 1993). The goal is to determine if chemical constituents will leach out of soil contaminated with petroleum. Recommended standards for use in evaluating leaching assessment are:

- the leaching assessment must demonstrate that soil contamination left in place will not result in groundwater contamination which exceeds the standards established in 18 AAC 80 (Drinking Water Regulations), 18 AAC 70 (Water Quality Standards) or any Federal Drinking water MCL.

- a contaminant leachability analysis is required by ADEC Underground Storage Tank Regulations. Extraction testing is necessary to quantify the leachability of a particular soil type

- groundwater monitoring may be required at the discretion of the department

- after cleanup is complete contaminated soil must not be available for uptake by surface receptors.

When determining soil leachability, samples from each type of contaminated soil must be collected or prepared and evaluated. The total contamination levels present before extraction must be determined. The soil will be subjected to an extraction test and the extract will be analyzed for the contaminants of concern. In addition, quantity and horizontal and vertical location of contamination within the soil profile must be determined. Leachability must be assessed for each type of soil present on the site.

Bioventing: Bioventing consists of a blower connected to a series of screened wells drilled into vadose-zone soils. The system injects ambient air into the contaminated soils. In the environment, hydrocarbons will biodegrade, but at depth the oxygen in the soil becomes depleted and slows further natural biodegradation. The intent of the bioventing system is to increase the natural tendency of the indigenous microorganisms to biodegrade the petroleum constituents in the soil by replenishing the subsurface supply of oxygen. Proven to operate well in Alaska, bioventing systems are generally relatively low cost, easy to operate, and require little to no labor to maintain and operate. The system can be installed without excavating the soils and disturbing the vegetation significantly, but similar to any biological system, bioventing proceeds slowly over the course of several years. Public acceptance of bioventing is generally very good, because it is perceived as a "natural" technology. Contaminants are eliminated because it is a destructive technology.

Landfarming: Landfarming works on the same principal as bioventing and is often employed to remediate soils in many remote Alaskan locations. During landfarming, contaminated soils are fertilized and plowed periodically to increase the oxygen levels in the soil, and thereby, the rate of natural biodegradation. Contaminated soils are sometimes excavated and placed on an impervious surface such as plastic and are bermed and covered to prevent the leaching of contaminants into nearby soils. In areas where the depth of contamination is limited to about a foot, soils may be land farmed in-place. Land farming is generally a low-cost, effective remedial alternative. Periodic maintenance (plowing) is required until remediation is complete, often 6 months to 2 years. Land farming requires disturbance of the soil and overlaying vegetation and exposure of the contaminated soils to public access, unless measures are taken to limit access, such as a fence, or construction of the system inside a locked building.

Excavate and Dispose Off-site: Excavation and disposal off-site is generally a costly option in remote Alaskan locations, where transportation costs often exceed the cost of removal or treatment. Excavated soils could be containerized and shipped to a disposal facility in Alaska, such as a soil burner. The holes left by the excavated materials often require backfill. The

advantage is that complete remediation is accomplished quickly, often within a few days or weeks.

LEAD IN SOILS

The remedial alternatives for lead would be similar to the remediation methods proposed for some of the other primary pollutant metals which accompany lead in the areas of concern at Site 2 and Site 4B.

Remedial alternatives for lead in soils include:

- Development of Alternative Cleanup Levels
- Soil stabilization or fixation
- Excavation and off-site disposal
- Capping or covering

Development of Alternative Cleanup Levels through risk assessment is a potential alternative for lead contamination in soils. As with other contaminants, an evaluation of human health or ecological risk may provide documentation to support the development of alternative cleanup levels.

Soil Stabilization involves the addition of chemicals such as lime or cement to the soils to reduce the toxicity and minimize migration of lead to the environment. These techniques can be either in-situ (involving injection of grout-type material) or ex-situ (involving excavation and mixing). Given the limited volume of lead-contaminated soils at Gambell, stabilization or fixation may involve an inordinate unit cost for mobilization.

Excavation and Off-site Disposal is a rapid, relatively inexpensive method for remediation of low volumes of lead-contaminated soils, and may be done in conjunction with other soil removal actions associated with petroleum hydrocarbons or PCBs.

Capping or covering is also an alternative for soils with elevated lead concentrations. Capping would involve the placement of clean, relatively impermeable fill over lead-contaminated soils in order to prevent dermal contact and impair leaching potential. A disadvantage of capping is that is does not destroy or remove contamination from the site, and the potential for some future exposure to lead cannot be totally eliminated. Covering is differentiated from capping in that the material placed over the surface contamination is not necessarily impermeable. Covering effectively removes the dermal contact pathway, but does not prevent leaching of contaminants. Covering is appropriate in cases where surface contaminants have a low mobility in water.