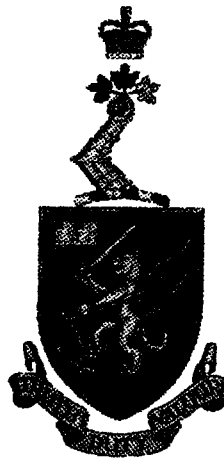


An Environmental Study of the Aishihik Airstrip Yukon Territory

**Prepared by the
Environmental Sciences Group**



**Royal Roads Military College
Victoria, British Columbia**

© Indian and Northern Affairs Canada, Whitehorse, February 1995

ACKNOWLEDGMENTS

This project was supported under the Action on Waste component of the Arctic Environmental Strategy. We would like to acknowledge the support and confidence of several individuals in the department of Indian and Northern Affairs: Mr. Bruce Chambers, Director, Renewable Resources, Whitehorse; Mr. Mark Palmer, Regional Manager, Mr. Paul Butra and Mr. Brett Hartshorne with the Action on Waste Program in Whitehorse. We would also like to thank Mr. John Trotter the resource officer at Haines Junction for support above and beyond the call.

This report, as with previous reports, is a product of the collective effort of the entire Environmental Sciences Group headed by Dr. Ken Reimer. Dr. Stephen Grundy was the coordinating author with extensive support from Dawn Pier (plants), Dave Pier (history), Marjorie Cahill (sample descriptions) and Dr. Bill Dushenko (QA/QC). The authors would particularly like to thank Doug Noonan and Wesa Gleave for purchasing and transporting our equipment. Pat Fortin and Sandra Englander deserve a medal for tracking and spread-sheeting the several thousand analytical results that are generated within the group. Olivia Whitwell is appreciated for spending hours battling with CorelDraw to produce the maps. Thanks are due to Deborah Reimer for program and financial administration. Proofing and editing was capably carried out by Marjorie Cahill, Bill Dushenko, Kathryn Johnston and Dr. John Poland. Final editorial responsibility is assumed by Ken Reimer.

The field work was conducted by Stephen Grundy, Dawn and Dave Pier, Kathryn Johnston and Wesa Gleave.

The analytical work was carried out by the Analytical Services Unit of Queen's University and by Axy's Analytical Services. As in the past, the high standards of these organizations made the preparation of this report much easier.

EXECUTIVE SUMMARY

Background

The Aishihik Airstrip was built in the early 1940s as part of the Northwest Staging Route (NWSR), in order to improve air transportation to the north in support of the war effort. Previous to this construction the area was home to the Aishihik people; a seasonal fishing camp was established at the head of the lake by the band and has been in use for almost 3,000 years. The airstrip was handed from U.S. to Canadian control in 1955 and continued to be operated by the Department of Transport until 1966 when it was transferred to the Territorial Government. At the time of writing, the Champagne-Aishihik band, who have a land claim in the area, have renovated the site for use as a cultural camp and for meetings.

A limited environmental survey carried out by Environment Canada and reported in March 1994 showed that PCBs were present on the floor of the powerhouse. The study described in this report was funded by the Action on Waste component of the Arctic Environmental Strategy, part of the Green Plan announced by the Canadian Government in 1991. The goals of this study were to collect soil, water and plant samples and to analyze them for a wide variety of contaminants of environmental concern - particularly PCBs and inorganic elements. The approach taken was to concentrate on the potential for impact; that is, to assess the potential for contaminant migration and uptake into the food chain.

Approach

The Aishihik Airstrip was visited on two occasions, 11 June 1994 and 7 - 10 July 1994. A total of 79 soil, 22 plant, 7 fuel/oil, 2 water and 3 plant samples were collected during the two visits. Care was taken to sample both stained and unstained areas, drainage courses from potentially contaminated areas, and unimpacted pristine background areas.

Selected samples were analyzed for a broad range of contaminants including inorganic elements, polychlorinated biphenyls, pesticides, the acid/base/neutral extractable analytical suite, as well as polychlorinated dibenzodioxins and furans. Following this initial round of analyses, a wider range of samples were analyzed for PCBs and inorganic elements.

Results and Observations

The main observations made by the field team were:

- most of the original facilities had been demolished, leaving only the powerhouse, garage, and airways building. Small cabins had been constructed to house summer camps and the airways building had been extended;
- physical debris around the building was limited to small pieces of pipe, wood and three transformer cases;
- barrels were cached in one area of the site and some contained fluid; and,
- the landfills were not engineered and contained exposed debris.

Chemical contamination at the site was assessed in terms of the DEW Line Cleanup Criteria (DCC), the interim Residential/Parkland criteria adopted by the Canadian Council of Ministers of the Environment (CCME) and the Canadian Environmental Protection Act.

A review of the analytical results indicated that contamination was limited to the powerhouse, and stains around the garage and at a dump site. The samples in excess of the applicable environmental criteria were as follows:

- three samples (one soil, two paint) taken from the interior of the powerhouse contained PCBs at levels in excess of 50 ppm. The contaminated substrate must be removed and then dealt with according to legislation arising from the Canadian Environmental Protection Act. The soil samples also contained levels of copper, lead and mercury in excess of DCC-II and CCME R/P criteria;
- two samples (one paint, one soil), taken from inside the powerhouse and on the south side of the powerhouse, contained PCBs in excess of the CCME R/P and DCC-II criteria;
- three soil samples taken around the powerhouse contained PCBs in excess of DCC-I; and,

- a soil sample taken in a stain near the garage contained lead in excess of DCC-II and CCME R/P criteria and a soil sample taken in one of the dumps also contained lead in excess of DCC-I.

Levels of all other contaminants were generally quite low and the results from analysis of plant tissues indicated that uptake was only a concern next to the powerhouse and adjacent to some lead-containing batteries in one of the dumps.

Recommendations

The powerhouse is clearly contaminated with PCBs and should be thoroughly cleaned before any further decision is made on the future use of the building. The extent of PCB contamination in the areas around the powerhouse should be delineated with PCB test kits and the soil disposed of in an appropriate fashion. The potable water well adjacent to the powerhouse should be tested for contamination and, if present, a groundwater investigation should be initiated. Other soils containing contaminants at concentrations in excess of the criteria should be removed, and the three dumps should be consolidated into one location. The oil drums in the barrel cache should be removed, using the guidelines described in the DEW Line Cleanup protocol for barrels. Full details regarding these recommendations are given in Chapters II and V.

TABLE OF CONTENTS

ACKNOWLEDGMENTS.....	i
EXECUTIVE SUMMARY	ii
TABLE OF CONTENTS.....	v
LIST OF MAPS.....	viii
LIST OF FIGURES.....	viii
LIST OF TABLES.....	ix
LIST OF PHOTOGRAPHS	x
GLOSSARY AND LIST OF ABBREVIATIONS	xii
I. INTRODUCTION	I-1
A. BACKGROUND	I-1
1. <i>The Arctic Environmental Strategy</i>	I-1
2. <i>Aishihik Airstrip</i>	I-1
B. CURRENT INVESTIGATIONS/OBJECTIVES	I-2
C. STRUCTURE OF THE REPORT	I-4
II. OVERVIEW	II-1
A. HISTORY.....	II-1
B. SAMPLING PROGRAM.....	II-3
C. ANALYTICAL PROGRAM	II-4
D. ENVIRONMENTAL CRITERIA	II-5
E. RESULTS	II-6
1. <i>Background</i>	II-6
2. <i>Site</i>	II-6
F. RECOMMENDATIONS.....	II-9
III. HISTORICAL BACKGROUND.....	III-1
A. PRE WORLD WAR II.....	III-1
B. WORLD WAR II TO PRESENT	III-2
C. ENVIRONMENTAL ASPECTS	III-5

1. <i>Geology</i>	III-5
2. <i>Previous Environmental Studies</i>	III-6
IV. ASSESSMENT CRITERIA	IV-1
A. INTRODUCTION.....	IV-1
B. CANADIAN ENVIRONMENTAL QUALITY CRITERIA FOR SOIL AND WATER	IV-2
1. <i>The Canadian Council of Ministers of the Environment</i>	IV-2
2. <i>The DEW Line Clean Up Criteria</i>	IV-3
C. OTHER CANADIAN CRITERIA FOR SOILS	IV-3
D. BACKGROUND SAMPLES.....	IV-4
E. WATER SAMPLES	IV-4
F. SOILS	IV-6
G. PLANTS.....	IV-9
H. BARRELS	IV-10
I. BUILDING SWABS.....	IV-11
V. SITE ANALYSIS	V-1
A. GENERAL.....	V-1
B. SAMPLING PROGRAM.....	V-6
1. <i>General</i>	V-6
2. <i>Background</i>	V-7
3. <i>Powerhouse and Vicinity</i>	V-7
4. <i>Dumps and South Area</i>	V-8
5. <i>Other Buildings and Sites</i>	V-9
C. ANALYTICAL PROGRAM	V-26
1. <i>Polychlorinated Biphenyls (PCBs)</i>	V-26
2. <i>Inorganic Elements</i>	V-26
3. <i>Acid/Base/Neutral Extractables (ABNs)</i>	V-27
4. <i>Polycyclic Aromatic Hydrocarbons (PAHs)</i>	V-28
5. <i>Pesticides</i>	V-28
6. <i>Polychlorinated dibenzodioxins and furans (PCDDs and PCDFs)</i>	V-28
D. RESULTS.....	V-30
1. <i>Background Levels in Soils and Plants</i>	V-30
2. <i>Powerhouse and Vicinity</i>	V-31
3. <i>Dumps and South Area</i>	V-35
4. <i>Other Buildings and Sites</i>	V-36

E. RECOMMENDATIONS.....	V-41
1. Contaminant Summary	V-41
2. Suggested Actions.....	V-41
VI. REFERENCES.....	VI-1
VII. APPENDICES	VII-1
A. METHODS.....	A-1
1. Field Sampling.....	A-1
2. Chemical Analysis	A-4
3. Principal Components Analysis (PCA).....	A-13
B. QUALITY ASSURANCE/QUALITY CONTROL	B-1
1. QA/QC for Inorganic Analysis	B-1
2. QA/QC for PCB Analysis	B-2
3. QA/QC for Organochlorine Pesticides.....	B-5
4. QA/QC for Polycyclic Aromatic Hydrocarbons (PAHs)	B-5
5. QA/QC for Polychlorinated Dibenzo Dioxins and Dibenzo Furans	B-6
C. SITE DESCRIPTIONS AND SAMPLE LOCATIONS.....	C-1
1. Background.....	C-1
2. Powerhouse and Vicinity	C-2
3. Dumps and South Area.....	C-7
4. Other Buildings and Sites	C-11
D. VASCULAR PLANT CHECK LIST.....	D-1
E. INORGANIC ELEMENT RESULTS FOR SOIL AND WATER.....	E-1
F. INORGANIC ELEMENT RESULTS FOR VEGETATION	F-1
G. INORGANIC ELEMENT AND PCB RESULTS FOR PAINT SAMPLES.....	G-1
H. AROCLOR PCB RESULTS FOR SOIL AND WATER	H-1
I. AROCLOR PCB RESULTS FOR VEGETATION.....	I-1
J. PCB CONGENER RESULTS FOR SOILS	J-1
K. PCB CONGENER RESULTS FOR VEGETATION	K-1
L. AROCLOR PCB RESULTS FOR SWABS	L-1
M. PESTICIDE RESULTS FOR SOILS	M-1
N. POLYCYCLIC AROMATIC HYDROCARBON RESULTS FOR SOILS	N-1
O. ACID/BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUND RESULTS FOR SOILS	O-1
P. DIOXIN RESULTS FOR SOILS.....	P-1
Q. INORGANIC ELEMENT AND PCB RESULTS FOR BARREL SAMPLES	Q-1

LIST OF MAPS

MAP I-1: LOCATION OF AISHIHIK AIRSTRIP.....	I-3
MAP V-1: LOCATION OF AISHIHIK AIRSTRIP	V-3
MAP V-2: AISHIHIK AIRSTRIP GENERAL SITE LAYOUT	V-4
MAP V-3: AISHIHIK AIRSTRIP AS-BUILT.....	V-12
MAP V-4: AISHIHIK AIRSTRIP GENERAL SITE SAMPLE LOCATIONS	V-13
MAP V-5: AISHIHIK AIRSTRIP SITE BUILDINGS AND SAMPLE LOCATIONS	V-14

LIST OF FIGURES

FIGURE IV-1: FLOW CHART FOR DEW LINE CLEANUP OF BARRELS.....	IV-12
FIGURE V-1: SAMPLE LOCATIONS AND PCB CONCENTRATION AT FORMER SITE OF TRANSFORMERS ON SOUTH SIDE OF POWERHOUSE.....	V-32
FIGURE V-2: PRINCIPAL COMPONENT PLOT FOR PCBs IN SOILS AND PLANTS	V-39
FIGURE V-3: PRINCIPAL COMPONENT PLOT FOR DIOXIN AND FURAN SIGNATURES FROM VARIOUS SOURCES	V-40

LIST OF TABLES

TABLE II-1: SAMPLING PROGRAM SUMMARY	II-3
TABLE II-2: ANALYTICAL PROGRAM SUMMARY	II-4
TABLE II-3: BACKGROUND CONCENTRATIONS FOR INORGANIC ELEMENTS	II-6
TABLE II-4: SAMPLES EXCEEDING CRITERIA FOR PCBs.....	II-8
TABLE II-5: SAMPLES EXCEEDING CRITERIA FOR INORGANIC ELEMENTS	II-8
TABLE IV-1: ASSESSMENT CRITERIA FOR SOIL AND WATER ^A	IV-5
TABLE IV-2: CCME CRITERIA FOR RESIDENTIAL/PARKLAND AND THE DEW LINE CLEANUP CRITERIA (DCC) FOR SOIL	IV-6
TABLE IV-3: CRITERIA FOR ACID/BASE/NEUTRAL (ABNs) PRIORITY POLLUTANTS FOR SOILS	IV-7
TABLE IV-4: NATO INTERNATIONAL TOXICITY EQUIVALENCY FACTORS (I-TEFs) FOR CONGENERS AND ISOMERS OF PCDDs AND PCDFs	IV-9
TABLE IV-5: WASTE OIL INCINERATION CONTAMINANT LIMITS (µg/g).....	IV-10
TABLE V-1: SAMPLING PROGRAM SUMMARY	V-7
TABLE V-2: ANALYTICAL PROGRAM SUMMARY	V-29
TABLE V-3: BACKGROUND CONCENTRATIONS FOR INORGANIC ELEMENTS.....	V-30
TABLE V-4: SAMPLES EXCEEDING CRITERIA FOR PCBs	V-41
TABLE V-5: SAMPLES EXCEEDING CRITERIA FOR INORGANIC ELEMENTS.....	V-41

LIST OF PHOTOGRAPHS

PHOTOGRAPH V-1: AERIAL VIEW SHOWING AIRWAYS BUILDING, GARAGE AND POWERHOUSE.	V-5
PHOTOGRAPH V-2: BUFFALO GRAZING NEXT TO THE AIRWAYS BUILDING.	V-5
PHOTOGRAPH V-3: VIEW FROM THE NORTHWEST SIDE OF THE POWERHOUSE.	V-15
PHOTOGRAPH V-4: INSIDE THE POWERHOUSE IN THE ROOM THAT CONTAINED THE GENERATORS.....	V-15
PHOTOGRAPH V-5: A SAMPLE WAS OBTAINED FROM THE FLOOR OF THE POWERHOUSE (AA100).....	V-16
PHOTOGRAPH V-6: THE POLE STUMPS ARE ALL THAT REMAINS OF THE TRANSFORMER RACK THAT CONTAINED FOUR TRANSFORMERS.	V-16
PHOTOGRAPH V-7: UNDERGROUND FUEL TANK ON THE WEST SIDE OF THE POWERHOUSE.	V-17
PHOTOGRAPH V-8: GENERAL VIEW OF DUMP SITE 1, A TRANSFORMER CASE CAN BE SEEN HALF WAY UP THE HILL.	V-17
PHOTOGRAPH V-9: CLOSE UP VIEW OF THE TRANSFORMER IN DUMP SITE 1. THIS TRANSFORMER HAD AN OIL CAPACITY OF 12.5 GALLONS.	V-18
PHOTOGRAPH V-10: DUMP SITE 2 WAS THE LARGEST OF THE THREE DUMP SITES AND CONTAINED RECENT DOMESTIC GARBAGE AS WELL AS VERY OLD DEBRIS.	V-18
PHOTOGRAPH V-11: DUMP SITE 3 CONTAINED TWO LARGE PILES OF BROKEN BATTERIES (SAMPLE AA142).V-19	
PHOTOGRAPH V-12: REMAINS OF A BURNED BUILDING ON THE SOUTH SIDE OF THE SITE.	V-19
PHOTOGRAPH V-13: THE BARREL DUMP ON THE SOUTH SIDE OF THE SITE CONTAINED APPROXIMATELY 150 BARRELS, MOSTLY HIDDEN IN THE TREES.	V-20
PHOTOGRAPH V-14: THE GARAGE WAS USED BY LOCAL PEOPLE FOR VEHICLE REPAIR AND BOAT/GENERAL STORAGE.	V-20
PHOTOGRAPH V-15: A TRANSFORMER CASING FOUND APPROXIMATELY 70 M SOUTHWEST OF THE GARAGE (AA018/019).	V-21
PHOTOGRAPH V-16: THE SEPTIC FIELD WAS LOCATED IN A SHALLOW VALLEY APPROXIMATELY 200 M WEST OF THE GARAGE.....	V-21
PHOTOGRAPH V-17: THE FLAT AREA IN THE FOREGROUND WAS THE LOCATION OF SEVEN POL TANKS. THE POWERHOUSE CAN BE SEEN IN THE BACKGROUND.....	V-22
PHOTOGRAPH V-18: THE AIRCRAFT REFUELING POINTS WERE LOCATED NEXT TO THIS SMALL DEPRESSION. THE PIPES AND TANK RIBS CAN BE SEEN IN THIS AREA.	V-22
PHOTOGRAPH V-19: THE AIRWAYS BUILDING WAS IN GOOD CONDITION AND WAS USED TO HOUSE SUMMER FIELD CAMPS BY THE CHAMPAGNE-AISHIHIK BAND.....	V-23
PHOTOGRAPH V-20: SOIL SAMPLE AA026 WAS TAKEN NEXT TO THIS TRANSFORMER CASING TO THE SOUTH OF THE AIRWAYS BUILDING.	V-23
PHOTOGRAPH V-21: THESE GENERATORS AND ENGINES WERE FOUND IN A SHALLOW DEPRESSION OUTSIDE THE MAIN GATE TO THE AIRSTRIP.	V-24

PHOTOGRAPH V-22: THE UPPER BEACON SITE, LOCATED ABOUT 8 KM FROM THE AIRSTRIP. NOTE WOODEN

AND METALLIC DEBRIS IN UPPER LEFT CORNER. V-24

PHOTOGRAPH V-23: THE LOWER BEACON SITE WAS LOCATED BETWEEN THE AIRSTRIP AND THE BEACON SITE. V-25

GLOSSARY AND LIST OF ABBREVIATIONS

μg	=	10^{-6} grams
ABN	=	Acid/Base/Neutral Extractable
anthropogenic	=	derived directly or indirectly from human activity
Aroclor	=	Commercial PCB mixture
As	=	Arsenic
ASU	=	Analytical Services Unit (Queens University, Kingston, Ont.)
authogenic	=	derived from natural sources
BCE	=	Before Christian Era
CCME	=	Canadian Council of Ministers of the Environment
Cd	=	Cadmium
Co	=	Cobalt
Cr	=	Chromium
Cu	=	Copper
DCC	=	DEW Line Cleanup Criteria
DDT	=	Dichlorodiphenyltrichloroethane
DEW	=	Distant Early Warning
DND	=	Department of National Defence
ECD	=	Electron Capture Detector
EPA	=	Environmental Protection Agency (USA)
ESG	=	Environmental Sciences Group
forb	=	Wildflower or flowering herb
GC	=	Gas Chromatography
HCB	=	Hexachlorobenzene
HCH	=	Hexachlorocyclohexane
Hg	=	Mercury
leachate	=	substances (usually in solution) migrating from a source
MS	=	Mass Spectroscopy
na	=	not analyzed
NBS	=	National Bureau of Standards (USA)

NDR	=	Not reliably detected
ng	=	10 ⁻⁹ grams
Ni	=	Nickel
NIST	=	National Institute of Standards and Technology
NRC	=	National Research Council
PAH	=	Polycyclic Aromatic Hydrocarbons
Pb	=	Lead
PCB	=	Polychlorinated Biphenyl
PCDD	=	Polychlorinated Dibenzodioxin
PCDF	=	Polychlorinated Dibenzofuran
pg	=	10 ⁻¹² grams
POL	=	Petroleum, Oil, Lubricants
ppb	=	parts per billion, i.e., ng/g or µg/L
ppm	=	parts per million, i.e., µg/g
ppt	=	parts per trillion, i.e., pg/g or ng/L
RCAF	=	Royal Canadian Air Force
RRMC	=	Royal Roads Military College
TEF	=	toxic equivalent factor
TEQ	=	toxic equivalent
TPH	=	Total Petroleum Hydrocarbons
Zn	=	Zinc

I. INTRODUCTION

A. Background

1. *The Arctic Environmental Strategy*

The *Arctic Environmental Strategy* is a key component of the *Green Plan* which is a Canadian Government program initiated in 1991 to deal effectively with a broad spectrum of environmental issues. The goal of the *Arctic Environmental Strategy* is to preserve and enhance the integrity, health, biodiversity, and productivity of our Arctic ecosystems for the benefit of present and future generations (Indian and Northern Affairs Canada, 1991). Its main objectives encompass reducing, and wherever possible eliminating contaminants in country foods, eliminating unsafe, hazardous and unsightly waste, establishing an enhanced water resource regime, and resolving environmental and economic issues by using both scientific and traditional knowledge. Several projects have been carried out by the Environmental Sciences Group (ESG) at Royal Roads Military College (RRMC) in order to satisfy some of these objectives:

- the scientific investigation and environmental assessment of the former military installations at both Iqaluit and Resolution Island, NWT,
- the scientific investigation and environmental assessment of 21 abandoned DEW Line Sites, and;
- an environmental study of the Canol Trail from Norman Wells to the Yukon border.

These projects were funded under the Action on Waste component of the *Arctic Environmental Strategy*.

2. *Aishihik Airstrip*

The location of Aishihik Airstrip is shown on Map I-1. The airstrip was used for many years as a refueling stop for the Northwest Supply Route during World War II. It was handed over to the Department of Transport in 1955 and is now the subject of land claims negotiations between the Champagne-Aishihik

Band and the Government of Canada. An earlier, limited environmental assessment showed that PCB contamination may be present.

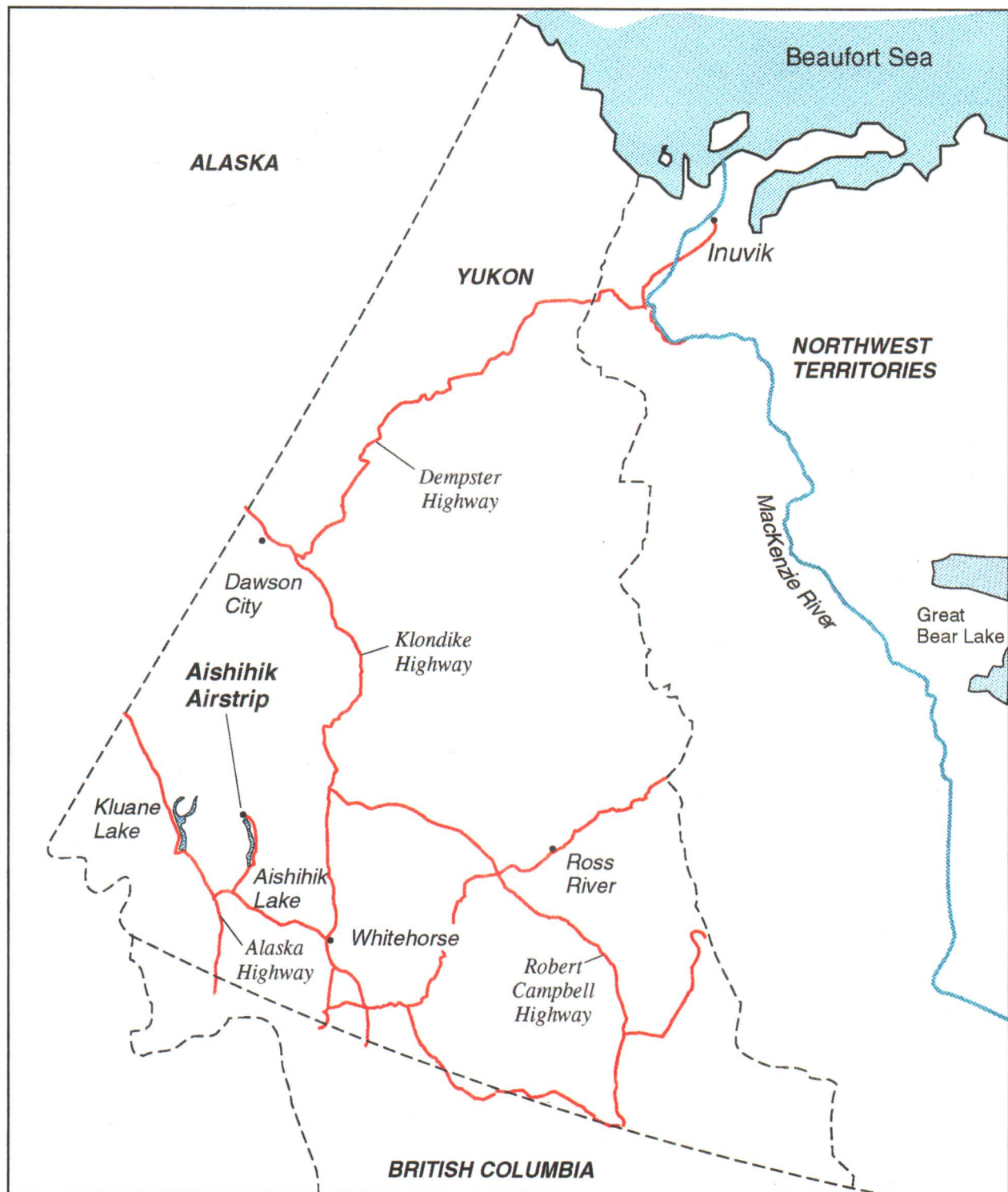
B. Current Investigations/Objectives

In June 1994, Indian and Northern Affairs Canada (INAC or colloquially DIAND) tasked the ESG to carry out an environmental study of the Aishihik Airstrip. The objective of this study was to assess the extent of environmental contamination and/or hazard at the site. Work included:

- the collection of soil, water, and plant samples and their analysis for inorganic elements and PCBs;
- the analysis of selected samples for other substances of environmental concern, including suspected sources of local contamination which may affect the terrestrial food chain or which may migrate into aquatic systems;
- cataloguing physical debris;
- performing a detailed asbestos analysis and inventory; and,
- the production of a report that would include a detailed assessment of surface contamination and hazards.

The asbestos inventory was not undertaken, since the site had been subjected to an asbestos removal program.

Map I-1: Location of Aishihik Airstrip



C. Structure of the Report

The complete report is presented in seven chapters:

Chapter I: Introduction

This chapter discusses the federal program under which the scientific investigation of Aishihik Airstrip is being conducted, along with a brief summary of the history of the airstrip. The overall objectives for the Aishihik Airstrip investigation are presented.

Chapter II: Overview

The overview chapter gives a summary of work as a whole; environmental summaries and recommendations are also included in tabular form. **The reader is encouraged to examine this chapter prior to proceeding to other parts of the report.**

Chapter III: Historical Background

This chapter documents the history of the construction and operation of the Aishihik Airstrip with particular reference to the construction of the Alaska Highway and the Canol Project. Previous environmental investigations as they relate to this report are also presented.

Chapter IV: Assessment Criteria

Approaches to assessing environmental quality are briefly examined and the use of assessment and remediation criteria is reviewed. The criteria used to assess this site are presented in tabular form.

Chapter V: Site Analysis

The details of the sampling and analytical program are presented. This is followed by a detailed discussion of the site and comparison with relevant remediation criteria. Maps and photographs showing the location of the sampling in key areas are also presented. Finally, recommendations are given for the remediation of the site.

Chapter VI: References

The chapter provides a bibliographic listing of all literature cited in the report.

Chapter VII: Appendices

The methods used during the sampling and analytical programs are discussed, and the results of the QA/QC procedures applied to the data are presented. Sample locations/descriptions and tabulated analytical results are also provided for all areas at the site.

A glossary has been provided at the beginning of the report, immediately following the Table of Contents.

II. OVERVIEW

A. History

The Aishihik band, one of six small bands that constitute the Southern Tutchone, traditionally hunted from Aishihik Lake to the east shore of Kluane Lake, and north and east to the Nisling and Nordenskiold Rivers. Aishihik village, on the northeast shore of Aishihik Lake, has long been an important seasonal fishing camp for the Aishihik band (Workman, 1978, pp77). Archeological evidence points to significant village population c. 950 B.C.E. (Workman, 1978, pp172). Today, the village remains home to several members of the Aishihik band and is located about five kilometres from the Aishihik Airstrip.

Before 7 December 1941 joint American and Canadian defensive operations were concentrated on the east coast, but with the bombing of Pearl Harbour, there was a rapid reorientation of defence planning (Dziuban, 1954, pp425) resulting in the posting of large numbers of American troops to defensive garrisons in Alaska. Construction of the Alaska Highway and the CANOL pipeline, two of the largest projects ever undertaken in northern Canada, were initiated in conjunction with this development. With this sudden, intense concentration of activities in the North, there was an urgent need for improved air transportation to service the region.

Construction began in the winter of 1940-41, and in 1942 several new fields, including Snag and Aishihik were built, and a number of emergency strips were added to the corridor (Coates and Morrison, 1992, pp41), giving rise to the Northwest Staging Route (NWSR). The end of the war in Europe in May 1945 called for a major regrouping of military personnel. By October, Canada had officially notified American authorities that they would assume all responsibilities along the NWSR at any time the United States wished to relinquish them (Carr, 1949, pp228). It was not until 1955, when the importance and usefulness of the NWSR had begun to decline, that most of the airstrips, including Aishihik, were

handed over to the Canadian Department of Transport (French, 1957, pp4; Hans-Bastedo, 1986, pp20), which continued to operate radio communications from Aishihik until 1966, at which time the area was turned over to the territorial government (Hans-Bastedo, 1986, pp20- 24).

Today the buildings on the site are being renovated by the Champagne-Aishihik band, who have claimed the abandoned airstrip as part of their territorial rights. Some of the buildings have been destroyed, and others, such as the control tower building, have been expanded and improved. Plans are under way to use the facilities as a cultural camp, as well as an alcohol and drug detoxification center. The site has also been used for tribal meetings. Currently, the remaining buildings are being occupied intermittently during the entire year.

The Aishihik site was visited in 1989 by John Trotter, the Resource Officer for the area as part of work on the DIAND waste management site inventory. The resulting report recommended burying and rehabilitating the dump sites and dismantling and disposing of the buildings not utilized by the Champagne-Aishihik band (Paul Butra, pers comm). Soil samples collected by Environment Canada showed that the floor of the generator room of the powerhouse building was contaminated with PCBs.

B. Sampling Program

The sampling program implemented by the ESG was designed to target areas of the site based on their known uses. Particular attention was paid to the powerhouse and to areas that were known to contain transformers, where there was the possibility of PCB contamination. Areas around the POL facilities were also sampled along with the garage and airways building.

Seventy-nine (79) soil samples, including six field duplicates, were collected in order to investigate contaminant presence and migration. Plant samples were also obtained to determine whether contaminants had been introduced into the terrestrial food chain. These were obtained in the same location as soils wherever possible. Twenty-two (22) plant samples were obtained including two root and shoot sub-samples. Detailed descriptions of the individual sampling locations are provided in the appendices (Section C). Maps and photographs showing key sampling locations are given in Chapter V.

Samples of paint were also obtained and the buildings were swabbed to investigate the possibility of PCB contamination. Fuel and oil drums containing product were opened and small samples obtained for analysis. The sampling program is summarized in Table II-1.

Table II-1: Sampling Program Summary

Area	Soils	Plants	Oil/Fuel	Building Swabs	Water	Paint
<i>1. Background</i>	5	3			1	
<i>2. Powerhouse and Vicinity</i>	20	3	1	9		3
<i>3. Dumps and South Area</i>	14	5	5			
<i>4. Other Buildings and Sites</i>	40	11	1	3	1	
TOTALS	79	22	7	12	2	3

C. Analytical Program

Analyses were initially targeted for representative samples from the most severely stained areas; these samples were analyzed for a broad range of substances. It became apparent from this initial analytical screen that PCBs were the main contaminants of concern and, as a consequence, the majority of soil samples were analyzed for PCBs. Elevated levels of inorganic elements are often found in stained areas and therefore a large number of samples were analyzed for inorganic elements. A summary of the analytical program by site can be found in Table II-2.

Table II-2: Analytical Program Summary

	PCBs	Inorganic Elements	Pesticides	ABNs	PAHs	Dioxins and Furans	Total Chlorine
SOILS							
1. Background	5	4					
2. Powerhouse and vicinity	15	13	2	1		3	
3. Dumps and South area	12	10	1		2		
4. Other buildings and sites	25	21	1	1	2		
PLANTS							
1. Background	3	3					
2. Powerhouse and vicinity	3	3					
3. Dumps and South area	4	4					
4. Other buildings and sites	7	7					
MISCELLANEOUS							
Barrel Samples	4	7					4
Building Swabs	12						
Water	2						
Paints	3	3					

D. Environmental Criteria

The presence of a contaminant in the environment does not necessarily imply a deleterious effect. In order to evaluate the results of the chemical analyses, it is necessary to consider both concentration and effect. The former is achieved by selecting appropriate criteria and the latter can be achieved by considering site specific information. In this case we have used plant uptake data and site use to assess impact.

Water quality was evaluated using the Canadian Council of Ministers of the Environment (CCME) Remediation Criteria for drinking water. Soil results were assessed using the CCME interim soil criteria modified by the DEW Line Cleanup Criteria (DCC) which have been shown to be particularly applicable to northern climates. The DCC define two tiers for the remediation of contaminated soils:

- all soils containing substances in excess of DCC Tier II (numerically equivalent to CCME R/P criteria) will have to be removed from direct contact with the ecosystem; and,
- substrate containing contaminants between DCC Tier I and DCC Tier II also require removal from contact with the environment, but may be placed in an appropriately engineered landfill at the site.

Substances for which CCME or DCC criteria were not available were compared to criteria available in British Columbia or Quebec. A detailed discussion of environmental quality criteria and tabulated values is given in Chapter IV.

E. Results

1. Background

The background PCB concentration in soils was 0.68 ppb when expressed as total Aroclor, or 0.42 ppb as the sum of the analyzed congeners. The vegetation PCB background concentration was 0.07 ppb expressed as the sum of congeners and less than detection if expressed as Aroclors. The PCB signature was consistent with long-range transport mechanisms: it indicated atmospheric deposition of PCBs rather than direct input.

The average concentrations of inorganic elements in the background samples are shown in Table II-3. Values of half the limit of detection were used where necessary for averaging. These concentrations are taken as being indicative of prevailing geological conditions.

Table II-3: Background Concentrations for Inorganic Elements

	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg
	ppm								
Soil	15	9.6	8.1	<1.0	<10	61	29	6.9	<0.1
Plants	8	6.5	<5	2.1	<15	95	13	<0.2	-

2. Site

One soil sample (AA100) contained PCBs in excess of 50 ppm, and therefore requires action under regulations arising from the Canadian Environmental Protection Act (CEPA). This sample was taken from the floor of the powerhouse in the main generator room and contained 1100 parts per million (ppm) PCBs; a paint sample taken from the floor in the same location (AAPC03) contained 154 ppm PCBs. **These two samples indicate that the floor of the powerhouse is highly contaminated with PCBs.** Two other paint samples were obtained from the powerhouse, AAPC01 was taken off a concrete bench in the rear room and contained 21900 ppm PCBs, well over the limit regulated by CEPA. The remaining paint sample (AAPC02) was obtained from the wall in the small front room and contained 26 ppm PCBs. **Clearly, the paint in the powerhouse is also contaminated with PCBs.** Inorganic element concentration

were also elevated in AA100; lead (620 ppm), zinc (2020 ppm) and particularly copper (118 ppm) were all greater than CCME R/P (DCC Tier II) criteria.

A soil sample taken outside the front (east) door to the powerhouse also contained high levels of PCBs (10 ppm). The concentration of PCBs in this soil sample was in excess of the CCME R/P criteria and DCC Tier II. A transformer rack was originally present on the south side of the powerhouse. All that remained were several pole stumps that would have been the support for the rack. Eleven soil samples were obtained from this area, seven from the region directly around the poles and four in drainage from this area. The PCB concentration ranged from 15 - 3400 ppb and was greatest towards the northern end of the stained area.

Three soil samples including one analytical duplicate, taken from Dump Site 3, were analyzed for PCBs and inorganic elements; PCBs were not detected in any of the samples. Levels of inorganic elements were comparable to levels in background samples with the exception of lead in sample AA142. This sample was collected next to some broken lead batteries and not surprisingly contained 513 ppm lead, exceeding both the CCME R/P criteria and DCC Tier II. A root and shoot sample of *Salix richardsonii* was also taken at this location. Levels of lead were significantly elevated from background levels, both in the shoots and the roots. The lead concentration in the shoots was 234 ppm whilst in the roots it was 67 ppm. The levels of lead in the soil and the plants indicate that some source control is necessary.

Three soil samples, taken in stained areas around the garage, were analyzed for inorganic elements and two soil samples were analyzed for PCBs. Levels of lead were elevated in all three samples and in one case (AA116) were comparable (200 ppm) with the CCME R/P or DCC II criteria.

PCB and inorganic element contamination in excess of the criteria are summarized in Tables II-4 and II-5, respectively.

Table II-4: Samples Exceeding Criteria for PCBs

Sample	Concentration (ppm)	Applicable Criteria
AA100	1100	CEPA
AAPC01	21915	CEPA
AAPC03	126	CEPA
AAPC02	26	CCME R/P, DCC-II
AA101	10	CCME R/P, DCC-II
AA109	1.4	DCC-I
AA110	1.6	DCC-I
AA111	3.4	DCC-I

Table II-5: Samples Exceeding Criteria for Inorganic Elements

Sample	Element:Concentration (ppm)	Applicable Criteria
AA100	Cu:118, Pb:620, Zn 2020	CCME R/P, DCC-II
AA142	Pb:513	CCME R/P, DCC-II
AA116	Pb:200	DCC-I

F. Recommendations

The floor and walls of the powerhouse are highly contaminated with PCBs and inorganic elements. Soil on the east and south sides of the powerhouse are also contaminated with PCBs. On the west side of the powerhouse, there is an underground storage tank containing diesel fuel. Next to the tank is a potable water well. The following actions are recommended regardless of the future use of the building:

- Remove all loose paint on the walls;
- sweep and vacuum the floor and place all material in a suitable container for PCB waste;
- coat the floor with a PCB decontamination agent (Sanisolv) and allow to stand for at least 30 minutes;
- sweep the floor again and place residue in a suitable container for PCB waste;
- wipe all surfaces with an oil absorbant material and again place this in a container suitable for PCB waste; and,
- repeat the solvent wash three times.

If the building is not required, it can then be demolished and buried. If the building is required, holes and cracks in the floor should be filled and the floor sealed with epoxy paint; also the walls should be painted.

The extent of PCB contamination in the soils on the east and south sides of the powerhouse should be delineated using PCB field test kits before and during cleanup. Soils with PCB concentrations greater than 50 ppm should be placed in the same containers as the decontamination residue from the interior of the powerhouse. Soils with PCB concentrations greater than 5 ppm but less than 50 ppm should be excavated and disposed of in a manner which precludes contact with the ecosystem. Soils with PCB concentrations between 1 and 5 ppm should be excavated but may be buried on site in a suitable landfill.

The underground storage tank on the west side of the powerhouse should be removed. The soil underneath the tank should be tested for contamination according to the Alberta guidelines for underground storage tanks (Alberta MUST, 1991).

The potable water well must not be used until tested for compliance with the Canadian Drinking Water Standards. Particular attention should be paid to the analysis of Volatile Organic Compounds (VOCs), phenols, PCBs and inorganic elements.

The stained soil at the garage marked by AA116 should be removed and placed in the landfill on site. The same treatment should be applied to the soil underneath the broken battery at AA142.

The three dump sites should be consolidated at Dump Site 2, the dump farthest to the west. All material at the dumps should be sorted into hazardous and non-hazardous material. The hazardous material must be removed from the site, and the non-hazardous material should be buried in the base of the depression at Dump Site 2 and covered with 1 m of clean fill. The landfill should be engineered such that water infiltration is minimized. The oil drums in the barrel cache should be removed, using the guidelines in the DEW Line Cleanup protocol for barrels.

A groundwater investigation is probably not warranted at this time. The following observations support the view that groundwater contamination is minimal: there are no historical records of large spills at this site; there is no evidence for water-borne migration of petroleum contaminants in drainage paths, and the levels of PCBs in water samples were very low. However, it is suggested that either of the two following findings should trigger a groundwater investigation at this site:

- The potable water well is highly contaminated; or,

An excavation of the soil underlying the former POL facilities reveals extensive contamination.

III. HISTORICAL BACKGROUND

A. Pre World War II

Aishihik Airstrip is located at the head of Aishihik Lake, Yukon Territory (Map I-1), in the heart of a region that was for millennia the exclusive territory of the Southern Tutchone Indians (Workman, 1978, pp 74).

The Tutchone people followed a largely nomadic lifestyle, hunting and fishing over a broad-ranging area, their movements dictated by the seasons. They had extensive trading ties, although these were secondary to subsistence activities, and limited to trade in non-essential luxury items (Workman, 1978, pp115).

The Aishihik band, one of six small bands that constitute the Southern Tutchone, traditionally hunted from Aishihik Lake to the east shore of Kluane Lake, and north and east to the Nisling and Nordenskiold Rivers. Aishihik village, on the northeast shore of Aishihik Lake, has long been an important seasonal fishing camp for the Aishihik band (Workman, 1978, pp77). Archeological evidence points to significant village population c. 950 BCE (Workman, 1978, pp172). Today, the village remains home to several members of the Aishihik band and is located about five kilometres from the Aishihik Airstrip.

Historically, trading patterns and monopolies among various Indian nations had effectively isolated the natives of the southwest Yukon. The use of blockades, intended to restrict the trading practices of the Tutchones, also had the effect of delaying their contact with Europeans, and it was not until c. 1878, when small groups of prospectors began filtering into the area, that the first impact of white people was felt here. The discovery of gold in the Klondike in 1896 swamped the region with white settlers and irreversibly changed the lives of the Tutchone.

With the breakdown of the trade monopoly and the establishment of improved trails, the Aishihik band began trading in furs north to Fort Selkirk and Carmacks. By the early 1900s the Tutchones were building cabins rather than tents and brush shelters in Aishihik Village (Workman, 1978, pp148). The village continued to grow, and although the community continued to be involved in an aboriginal food and fur-trading economy, some residents were staying on a year-round basis.

B. World War II to Present

Before 7 December 1941 joint American and Canadian defensive operations were concentrated on the east coast, but with the bombing of Pearl Harbour, there was a rapid reorientation of Canadian defence planning (Dziuban, 1954, pp425) resulting in the posting of large numbers of American troops to defensive garrisons in Alaska. Construction of the Alaska Highway and the CANOL pipeline, two of the largest projects ever undertaken in northern Canada, were initiated in conjunction with this effort. With the sudden, intense concentration of activities in the North, there was an urgent need for improved air transportation to service the region.

There were two existing air routes: the Northwest Staging Route (NWSR), a series of airstrips forming a flight corridor from Edmonton to Fairbanks, and the Mackenzie River Staging Route, which followed the CANOL pipeline.

The necessity for an improved route for military traffic was graphically illustrated by early attempts to send aircraft to the defence of the Alaskan coast. In early January 1942 two squadrons were dispatched to Alaska. A month later, only 21 of the 38 aircraft had arrived; all the rest had crashed along the way (Dziuban, 1954, pp433). Official reports state that this was due to "the inexperience of the pilots, together with poor communications and inadequate landing fields along the routes" (Brebner, 1985, pp51).

It became one of the first priorities of the construction crews arriving in the Yukon and Alaska to strengthen and supplement the existing air routes, and the completion of the airway was deemed a matter of "extreme urgency" (Brebner, 1985, pp 51). Construction began in the winter of 1940-41, and in 1942 several new fields, including Snag and Aishihik, as well as a number of emergency strips, were added to the corridor (Coates and Morrison, 1992, pp41).

Aishihik Airstrip was built during a period of extreme tension between Canadian and American authorities over the development of the NWSR. The Americans, speculating that there would be a large increase in air traffic along the corridor, were pushing for major additions and improvements to the existing facilities, which they felt were not progressing quickly enough. The Canadian government was concerned that new facilities would be of lasting benefit and would remain under Canadian authority. Also there was pressure from Canadian construction work crew unions that jobs not be lost to the (arguably) more efficient American Army Corps of Engineers.

As a result, American troops took over the completion of improvements to major airstrips along the route, while Canadian construction crews serving under the direction of the Canadian Department of Transportation and the RCAF, performed the initial work on the new and emergency facilities (Coates and Morrison, 1992, pp42).

One notable effect of the work was that suddenly some of the most isolated aboriginal populations in Canada were placed in direct contact with American and Canadian construction work forces. In places like Fort Nelson, Ross River, Burwash, Snag and Aishihik, the native communities now had sizable non-native populations (Coates and Morrison, 1992, pp74).

Construction of the Aishihik Airstrip began with bulldozers pulling supply sleds along a makeshift road following the Aishihik river. At Jamieson's Village, an Indian encampment beside Otter Lake, a barge was built on the spot to take the

men and equipment the rest of the way by water up Aishihik Lake. The water trail ended at the present site of Aishihik Village, approximately eighty kilometres north (French, 1957, pp7). From there a construction camp was set up and a gravel runway laid out. Initially, two log cabins were built along the shore of the lake; later the British Yukon Navigation Co. put up the control tower, barracks, and "a few other buildings"- all of log construction. The two original log cabins were moved up to the plain where they served as married quarters, supplementing the two existing Private Married Quarters (French, 1957, pp7).

An incident that gives some insight into conditions during the construction of the airstrip involved a *Dakota* that was attempting to land on the runway, but ended up "pancaking" after violently removing its undercarriage on the top of a bulldozer. The entire load of the plane was nails, and nails can be found scattered on the runway to the present day (French, 1957, pp11).

Control of the NWSR had been nominally handed over to the RCAF in September of 1942 (French, 1957, pp13). Most of the aircraft that flew the route were American, primarily destined for lend/lease to the Soviet Union (Dziuban, 1954, pp455). The route was also used by the many American personnel providing vital services at bases along the route. In June of 1944 American expenditures associated with the NWSR and the CANOL MacKenzie flight strips totaled some \$53,345,580. On assuming control, the Canadian government paid \$45,180,241. A more accurate assessment of Canadian investment in the air routes includes an additional \$23,520,953 for Canadian financed development work undertaken during the construction at the request of the United States (Carr, 1949, pp232).

The end of the war in Europe in May 1945 called for a major regrouping of military personnel. By October Canada had officially notified American authorities that they would assume all responsibilities along the NWSR at any time the United States wished to relinquish them (Carr, 1949, pp228). It was not until 1955, when the importance and usefulness of the NWSR had begun to

decline, that most of the airstrips, including Aishihik, were handed over to the Canadian Department of Transport (French, 1957, pp4; Hans-Bastedo, 1986, pp20), which continued to operate radio communications from Aishihik until 1966, when it was turned over to the territorial government (Hans-Bastedo, 1986, pp20- 24).

With the closing of the airstrip, families remaining at Aishihik Village were encouraged to move into government housing built for them in Haines Junction. However, a few families remained at the village on a seasonal basis (Hans-Bastedo, 1986, pp20).

Improved access to the Aishihik Lake region, brought about as a result of the road constructed to the airstrip, had some long-term impacts on the vicinity. Copper, gold, and molybdenite mining, as well as outfitting and an increased access to traplines, have all benefited from the presence of the Aishihik road (Hans-Bastedo, 1986, pp 22).

Today the buildings on the site are being renovated by the Champagne-Aishihik band, who have claimed the abandoned airstrip as part of their territorial rights. Some of the buildings have been destroyed, and others, such as the control tower building, have been expanded and improved. Plans are under way to use the facilities as a cultural camp, as well as an alcohol and drug detoxification center. The site has also been used for tribal meetings. Currently, the remaining buildings are being occupied intermittently during the entire year.

C. Environmental Aspects

1. *Geology*

The surface characteristics of this area are heavily influenced by recent glaciation events. In fact, glacial deposition at the north end of Aishihik lake and erosion at the south end reversed the former northward drainage of Aishihik Lake. Glacial deposits in the region of Aishihik Airstrip are gravel and sand up to 30 m deep. These deposits are mostly thaw-stable and are the preferred source for

building aggregates and for building location. Permafrost is not common in this area and the presence of well drained stable deposits allows the use of septic sewage disposal systems.

2. Previous Environmental Studies

There have been several environmental studies carried out in the vicinity of the Aishihik Airstrip or in similar areas. The Aishihik Lake area was the subject of a resource survey by the Faculty of Environmental Studies at the University of Waterloo. This survey was initiated following research by the Canadian Arctic Resources Committee (Theberge, Nelson and Fenge, 1980) that recommended that the Aishihik Lake area be identified as an environmentally sensitive area (ESA). These reports are separated into abiotic (Sauchyn, 1986), biotic (Bastedo and Theberge, 1986), cultural (Bastedo, 1986) and institutional (Nelson and Theberge, 1986) aspects, and include a review of the significant grasslands in the area (Sauchyn, 1987).

The Aishihik site was visited in 1989 by John Trotter, the Resource Officer for the area as part of work on the DIAND waste management site inventory. The resulting report recommended burying and rehabilitating the dump sites and dismantling and disposing of the buildings not utilized by the Champagne-Aishihik band (Paul Butra, pers comm). Soil samples collected by Environment Canada showed that the floor of the generator building was contaminated with PCBs, so the Champagne-Aishihik band was instructed "not to do any work on those buildings or use them for anything".¹ Champagne-Aishihik Enterprises under the foremanship of Harold Kane undertook an asbestos removal project in early 1994 and Atmospheric and Environment Services, Environment Canada, were satisfied with the results of this project.²

In a related study, soil, vegetation and fish were collected in the vicinity of the Champagne-Aishihik village of Klukshu. The soil samples were collected near the pipeline right-of-way, which has a history of treatment with Tordon-101, a

¹ Fax message from Brian Laird (A & ES Technical Services) to Harold Kane (Champagne-Aishihik Enterprises) dated 11 March 1994. DIAND file 2.4.22.1.

² Letter from Brian Laird (A & ES Technical Services, Environment Canada) to Paul Butra (Project Manager, Action on Waste) dated 29 March 1994. DIAND file 2.4.22.1.

herbicide based on 2,4-dichlorophenoxy acetic acid (2,4-D) and 4-amino-3,5,6-trichloropyridine-2-carboxylic acid (picloram). Herbicide formulations containing 2,4-D (and 2,4,5-T) are well documented as containing dioxin and furan contamination (Wenning et al, 1992). The soil samples at Kluksu were analyzed for PCDDs and PCDFs (Fowler, 1993). Very low concentrations were found, consistent with historic use of a phenoxy acid herbicide. The use of dioxin signatures is discussed in more detail in Chapter V, along with a comparison of analytical results of the samples taken from the Kluksu and Aishihik Airstrips.

IV. ASSESSMENT CRITERIA

A. Introduction

The desire for a clean and safe environment is currently a national and international issue. Regulatory agencies are continually being asked to define protocols for the proper handling, storage and disposal of toxic substances. The potential threat of contaminants at sites that have had inadequate disposal practices is of particular concern. While it is generally acknowledged that these potential threats must be reduced to an acceptable level, defining such a level is not easy. It should be noted that there is a clear difference between a *contaminant* and a *pollutant*. A contaminant is a substance whose presence causes a deviation from the normal composition of the environment. A pollutant, on the other hand, is a substance that fits the above definition and also has a detrimental effect on the environment. This detrimental effect must be considered if one is to discuss the need for remediation of contaminated sites.

Methods for the evaluation of environmental quality can be divided into two main groups: absolute and relative. Cleanup strategies arising from environmental assessments are often a combination of these approaches. Absolute, or criteria-based methods define numerical levels or limits that can be compared with measured environmental ones. This method establishes baseline concentration for various substances below which the impact of the environment is assumed to be negligible. Environmental samples containing concentrations of substances above these limits may require further investigation and/or remediation, depending on the extent to which the level is exceeded. This approach has the advantage that it can be applied easily. There is no requirement for the assessment of the level of pollution. It is assumed that the concentration limits specified in the criteria apply in all circumstances regardless of geographical, geological and ecological differences.

Relative strategies of environmental monitoring also begin with the identification of the concentration of substances in field samples. The focus, however, is on the potential for movement of a contaminant from the substrate in which it is found to humans or the environment. It is therefore necessary to examine the pathways for movement in the context of the specific location of that

sample and the effects that this movement might produce. This site-specific approach allows for the fact that the same contaminants in different locations can produce very different effects. In some cases, this form of *risk assessment* can be attempted using computer models. Often, such a level of complexity is not necessary or cannot be applied due to lack of data.

In Canada, there is a tendency to modify absolute, or criteria based, assessments by taking into account relative, or site-specific factors. This is the approach used in this report. The analytical results are reviewed and discussed with reference to the criteria described in the following two sections. The CCME criteria apply to both soil and water whereas the DCC refer to soil only.

B. Canadian Environmental Quality Criteria for Soil and Water

1. The Canadian Council of Ministers of the Environment

In September 1991, the Canadian Council of Ministers of the Environment (CCME) Interim Environmental Quality Criteria for Contaminated Sites were published. The CCME criteria are largely based on numerical values that have been used in other jurisdictions, but are considered to be interim until those that lack the complete set of supporting rationale have been validated.

Two classes of criteria are described - assessment criteria and remediation criteria. The CCME Interim Assessment Criteria indicate the background concentrations or analytical detection limits for contaminants in soil and water (Table IV-1). Soil and water with concentrations that do not exceed these limits are considered to be clean, that is, free of any contamination. Higher concentrations may not be indicative of contamination or pollution but require further investigation. Results of such investigations are evaluated in terms of the CCME Interim Remediation Criteria which are divided into three categories - agricultural (AG), residential/parkland (R/P), and commercial/industrial (C/I). For the Aishihik Airstrip, the residential/parkland criteria are clearly the most appropriate.

2. The DEW Line Clean Up Criteria

The DEW Line was a radar system stretching across the Canadian Arctic, Alaska and Greenland at about 70° latitude. In 1963 half the radar stations were abandoned. Between 1989 and 1993, the remaining system was modernized and, as a result, considerably downsized physically. During this time, the radar sites were transferred from US to Canadian control and an environmental assessment was carried out (Reimer et al., 1992, 1993a, 1993b). The DEW Line Cleanup Criteria (DCC), which are similar to the CCME criteria, were developed in concert with all relevant government regulatory agencies and are based on site-specific investigations and ecosystem impact studies (Table IV-2). The criteria define remediation levels for contaminants in soil and are determined to be generally protective of the Arctic ecosystem (Reimer et al., 1993a). The DCC define two tiers for the remediation of contaminated soils:

- all soils containing substances in excess of DCC Tier II (numerically equivalent to CCME R/P criteria) will have to be removed from direct contact with the Arctic ecosystem; and,
- substrate containing contaminants between DCC Tier I and DCC Tier II also require removal from contact with the environment, but may be placed in an appropriately engineered landfill at the site.

The DEW Line Cleanup Protocol provides a comprehensive method for the assessment of former DEW Line facilities, and the establishment of practical environmental objectives and corresponding cleanup plans. No other such strategies have been developed for the North. The objective of the general protocol is to prevent the migration of contaminants from sources to other parts of the Arctic ecosystem.

C. Other Canadian Criteria for Soils

The CCME criteria do not address levels of certain chemicals, particularly PAHs and ABNs. Criteria equivalent to CCME R/P can be found for many of the PAHs and ABNs in the Quebec and British Columbia guidelines. For PAHs the Quebec and BC guidelines are numerically equivalent. The CCME R/P criteria

and the BC environmental quality criteria have been amalgamated and are displayed in Table IV-3.

D. Background Samples

In this study, efforts were made to obtain background samples that were removed from any disturbance or activity associated with the construction and use of the Aishihik Airstrip. Soil samples were obtained that would be representative of soil types at the site. Data from these samples were compared to the CCME assessment criteria (Table IV-1). These results were then used as a starting point for the interpretation of soil contamination at the site. Plant samples were also collected at these background locations.

E. Water Samples

Two water samples were collected in the vicinity of the site. Data from these samples were compared to the CCME remediation criteria for drinking water (Table IV-1).

Table IV-1: CCME Criteria for Soil and Water^a

	Assessment Criteria		Remediation Criteria
	Soil µg/g (ppm) dry weight	Water µg/L (ppb)	Drinking Water ^{b,c} µg/L (ppb)
<i>Inorganic Elements</i>			
Arsenic (As)	5	5	25
Cadmium (Cd)	0.5	1	5
Chromium (Cr)	20	15	50
Cobalt (Co)	10	10	--
Copper (Cu)	30	25	≤1000
Lead (Pb)	25	10	10
Mercury (Hg)	0.1	0.1	1
Nickel (Ni)	20	10	--
Zinc (Zn)	60	50	≤5000
<i>Organic Compounds</i>			
Polychlorinated Biphenyls	0.1	0.1	--
Benzene	0.05	0.5	5
Toluene	0.1	0.5	≤24
Xylene	0.1	0.5	≤300
Benzo(a)anthracene	0.1	0.01	---
Benzo(a)pyrene	0.1	0.01	0.01
Hexachlorocyclohexane	0.01	---	---
Hexachlorobenzene	0.1	0.1	---
Naphthalene	0.1	0.2	---
Pyrene	0.1	0.2	---

- This is only a partial list; a complete list may be found in Canadian Council of Ministers of the Environment (CCME) "Interim Canadian Environmental Quality Criteria for Contaminated Sites" Report CCME EPC-CS34, September 1991 (also see Table IV-3).
- Drinking water guidelines are expressed as maximum acceptable concentrations (MAC), and are for unfiltered samples at the point of consumption. Heavy metals are expressed as total concentration (particulate and dissolved) unless otherwise indicated.
- Several parameters also have aesthetic objectives; these are indicated by a "≤" symbol.

F. Soils

Soil samples were initially assessed using a broad analytical screen, including ABNs (acid-base-neutral extractables), PCBs, inorganic elements and PAHs (polycyclic aromatic hydrocarbons) and dioxins and furans. This type of analytical screen is very expensive and was therefore applied to a representative sub-set of all the samples collected. The results from this broad screen are discussed in detail in Chapter V. A combination of criteria taken from CCME and British Columbia was used to assess ABN contamination (see Table IV-3). Dioxin levels were evaluated using the CCME criteria. The CCME criteria for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are expressed as a 2,3,7,8-tetrachlorodibenzodioxin toxic equivalent (TEQ). This TEQ is obtained by multiplying the concentrations of the toxic compounds by a toxic equivalent factor (TEF) set by NATO (see Table IV-4). The individual TEQs are then summed and must be under 1 ppb to satisfy the CCME R/P criteria. The levels of inorganic elements and PCBs were assessed relative to the CCME criteria for residential/parkland and the DCC. A comparison of these criteria is given in Table IV-2.

Table IV-2: CCME Remediation Criteria for Residential/Parkland and the DEW Line Cleanup Criteria (DCC) for Soil

	DCC µg/g (ppm) dry weight		CCME (R/P) µg/g (ppm) dry weight
	Tier I	Tier II	
<i>Organic Compounds</i>			
PCBs	1	5	5
<i>Inorganic Elements</i>			
Arsenic (As)	---	30	30
Cadmium (Cd)	---	5	5
Chromium (Cr)	---	250	250
Cobalt (Co)	---	50	50
Copper (Cu)	---	100	100
Lead (Pb)	200	500	500
Mercury (Hg)	---	2	2
Nickel (Ni)	---	100	100
Zinc (Zn)	---	500	500

Table IV-3: Criteria for Acid/Base/Neutral (ABNs) Priority Pollutants for Soils

Substance	Assessment Criteria	Remediation Criteria		
		Agricultural	Residential/ Parkland	Commercial/ Industrial
		ng/g (ppb) dry weight		
<i>Monocyclic Aromatic Hydrocarbons</i>				
1,3-Dichlorobenzene	100	100	1000	10000
1,4-Dichlorobenzene	100	100	1000	10000
1,2-Dichlorobenzene	100	100	1000	10000
<i>Polycyclic Aromatic Hydrocarbons (PAHs)</i>				
Naphthalene	100	100	5000	50000
Acenaphthylene	100	10000	10000	100000
Acenaphthene	100	10000	10000	100000
Fluorene	100	10000	10000	100000
Phenanthrene	100	100	5000	50000
Anthracene	100	10000	10000	100000
Fluoranthene	100	10000	10000	100000
Pyrene	100	100	10000	100000
Benz(a)anthracene	100	1000	1000	10000
Chrysene	100	1000	1000	10000
Benzo(a)fluoranthene	100	1000	1000	10000
Benzo(a)pyrene	100	100	1000	10000
Dibenz(a,h)anthracene	100	100	1000	10000
Indeno(1,2,3-c,d)pyrene	100	100	1000	10000
Benzo(ghi)perylene	--	--	--	--
<i>Phenolic Compounds</i>				
2,4-Dimethylphenol	100	100	1000	10000
4,6-Dinitro-o-cresol	100	100	1000	10000
2,4-Dinitrophenol	100	100	1000	10000
2-Nitrophenol	100	100	1000	10000
4-Nitrophenol	100	100	1000	10000
Phenol	100	100	1000	10000
2-Chlorophenol	50	50	500	5000
4-Chloro-3-methylphenol	50	50	500	5000
2,4-Dichlorophenol	50	50	500	5000
2,4,6-Trichlorophenol	50	50	500	5000
2,4,5-Trichlorophenol	50	50	500	5000
Pentachlorophenol	50	50	500	5000

Table IV-3: Continued

Substance	Assessment Criteria	Remediation Criteria		
		Agricultural	Residential/ Parkland	Commercial/ Industrial
		ng/g (ppb) dry weight		
<i>Phthalate Esters</i>				
Dimethyl phthalate	30000	30000	--	--
Diethyl phthalate	30000	30000	--	--
Dibutyl phthalate	30000	30000	--	--
Butyl-Benzyl phthalate	30000	30000	--	--
Bis(2-ethylhexyl)phthalate	30000	30000	--	--
Di-N-Octyl phthalate	30000	30000	--	--
<i>Chlorinated Hydrocarbons</i>				
Hexachlorobenzene	100000	50000	2000	10000
Hexachlorobutadiene	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--
Hexachloroethane	--	--	--	--
1,2,4-Trichlorobenzene	50000	50000	2000	10000
2-Chloronaphthalene	--	--	--	--
<i>Halogenated Ethers</i>				
Bis(2-chloroethoxy) methane	--	--	--	--
Bis(2-chloroethyl) ether	--	--	--	--
Bis(2-chloroisopropyl) ether	--	--	--	--
4-Bromophenyl phenyl ether	--	--	--	--
4-Chlorophenyl phenyl ether	--	--	--	--
<i>Nitroaromatics, Cyclic Ketones and Other Compounds</i>				
Nitrobenzene	--	--	--	--
2,4-Dinitrotoluene	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--
Isophorone	--	--	--	--
N-Nitrosodi-n-propylamine	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	--
3,3-Dichlorobenzidine	--	--	--	--

Notes:

- a. Figures in italics are equivalent values from "Criteria for Managing Contaminated Sites in British Columbia, (BC MOE); CCME criteria are yet to be established.
- b. No criteria are available for the substances with a "--" symbol.

Table IV-4: NATO International Toxicity Equivalency Factors (I-TEFs) for Congeners and Isomers of PCDDs and PCDFs

Congener	TEF
<i>Polychlorinated dibenzodioxins</i>	
2,3,7,8-TCDD	1.0
1,2,3,7,8-PCDD	0.5
1,2,3,4,5,8-HCDD	0.1
1,2,3,7,8,9-HCDD	0.1
1,2,3,6,7,8-HCDD	0.1
1,2,3,4,6,7,8-HCDD	0.01
OCDD	0.001
<i>Polychlorinated dibenzofurans</i>	
2,3,7,8-TCDF	0.1
2,3,4,7,8-PCDF	0.5
1,2,3,7,8-PCDF	0.05
1,2,3,4,7,8-HCDF	0.1
1,2,3,7,8,9-HCDF	0.1
1,2,3,6,7,8-HCDF	0.1
2,3,4,6,7,8-HCDF	0.1
1,2,3,4,6,7,8-HCDF	0.1
1,2,3,4,7,8,9-HCDF	0.01
OCDF	0.01

G. Plants

Plants vary greatly in their ability to accumulate contaminants; some naturally accumulate substances that, in excessive amounts, can be toxic. The specific concentrations in plants of substances (such as inorganic elements) at which environmental deterioration is expected in this environment is not known. The impact was therefore assessed by a comparison of the analytical results for samples collected from disturbed areas with those collected from undisturbed, or background areas.

Plant data were interpreted by assuming that the concentrations of substances in the plants should be greater than twice that of background concentrations before they were considered significant.

H. Barrels

There were some 45 gallon drums containing product present at the Aishihik Airstrip. Every attempt was made to take samples that were representative of the contents of the barrels. There are few criteria that would help in assessing the environmental risk associated with these barrels. Clearly, if barrels contain high levels of hazardous materials such as PCBs, and are leaking, there is little question that they should be removed. There are provincial criteria available to decide whether the contents of a barrel can be incinerated. Some of these are shown in Table IV-5. The Government of the Northwest Territories is in the process of developing similar regulations.

Table IV-5: Waste Oil Incineration Contaminant Limits (µg/g)

Province/ Parameter	Arsenic	Cadmium	Chromium	Lead	Total Halogens	Flash Point	PCB
BC - Kiln	20	3	10	1,000	3,000	-	500
BC - Other	5	2	10	50	1,500	-	3
Alta. - Permit	5	2	10	100	1,000	-	3
Sask.							
Manitoba	5	2	10	100	1,000	38° C min.	2
Ontario	5	2	10	50	1,500	-	2
Quebec	5	2	10	100	1,500	38° C min.	3
NB - Restricted	5	2	10	100	1,000	-	5
NS	5	2	10	100	1,000	38° C min.	5
PEI	5	2	10	100	1,000	38° C min.	5
NFLD. - Kiln	-	3	10	1,000	3,000	-	500
NFLD. - Other	-	2	10	100	1,000	-	5
US EPA	5	2	10	100	4,000	37.5° C min.	-

- all units in mg/L unless otherwise noted.
- conversion to ppm using a density of 0.80 kg/L.
- New Brunswick levels are draft and have an unrestricted category which are very low.

Cleanup criteria for barrels have been developed as part of the DEW Line Cleanup Protocol. Empty barrels can be crushed or shredded and buried in an engineered landfill or shipped south for recycling. The fate of barrels containing materials is dependent on the material present. The protocol, given in full as Annex A to this chapter, and summarized by the flow chart shown in Figure IV-1, also contains information regarding the types and methods of analysis.

The discussion of analytical data from barrel contents collected at Aishihik Airstrip is reviewed with respect to the Dew Line Cleanup Protocol.

I. Building Swabs

The options for disposition of site buildings is *partially* governed by whether their inner surfaces are highly contaminated with PCBs. There are, however, no federal or territorial regulations which direct the demolition and disposal of PCB-contaminated physical structures. Environment Canada, for example, has no regulations for such cleanup. Health Canada has provided advice to northern agencies on suitable criteria for occupied buildings. A surface cleanup standard for a residential area is $10 \mu\text{g}/100 \text{ cm}^2$ ($10,000 \text{ ng}/100 \text{ cm}^2$) of PCBs while that of an electrical substation area is $100 \mu\text{g}/100 \text{ cm}^2$ ($100,000 \text{ ng}/100 \text{ cm}^2$). These guidelines are based on a draft policy statement of the U.S. EPA (see Annex D in Dushenko et al., 1994). In the absence of any regulatory policy, these levels have been used to guide site-specific cleanup.

Buildings found to contain PCBs on inner surfaces at levels exceeding $10 \mu\text{g}/100 \text{ cm}^2$ should not be made available for future human habitation; they should be demolished. Infrequently used buildings such as storage areas need only be removed if PCB levels exceed $100 \mu\text{g}/100 \text{ cm}^2$. Other considerations would undoubtedly influence whether or not the buildings would be demolished, such as liability to the Crown. Only the environmental factors will be discussed in this report.



ANNEX A: DEW LINE CLEAN UP PROTOCOL FOR BARRELS

Initial proposals for the methodology for dealing with barrels and their contents at the DEW Line sites were put forward at a meeting in Victoria in March 1993. The general approaches were discussed by representatives of the government agencies present which included Indian and Northern Affairs, Department of National Defence, Environment Canada and the Government of the Northwest Territories. At a follow up meeting in April 1994, the group endorsed the protocol. The protocol was employed during the decommissioning of the Horton River site and in further field investigations at Resolution Island during the summer of 1994. The following outlines procedures for the cleanup of barrels on the DEW line.

A. Inspection:

- 1 The area around the barrels should be tested with a VOC meter to ensure safe working conditions. If the VOC levels exceed 20 % of the Lower Explosive Limit (LEL), then all work shall be conducted in accordance with appropriate sections of the NIOSH Guidelines, the National Fire Code of Canada and the TDGA for flammable and combustible materials.
- 2 All barrels are to be inspected to address the following items which shall be recorded and used as a guide when opening barrels (section B.3):
 - 2.1 Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.
 - 2.2 Symbols words, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.
 - 2.3 Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves.
 - 2.4 Spillage or discoloration on the top and sides of the barrel.
 - 2.5 Signs that the barrel is under pressure such as bulging and swelling.

B. Opening and Sampling:

- 1 Pressurized barrels are extremely hazardous and shall be opened with extreme caution. Only non-sparking equipment shall be used to open barrels. All personnel responsible for opening barrels shall be provided with appropriate safety equipment and clothing. Procedures outlined in NIOSH USEPA 1988 Safety and Health Compliance for Managers (165.8) USEPA-29-CFR, 1910-1920, shall be followed.
- 2 If the bungs can readily be moved, then the barrels shall be opened slowing allowing time for any pressure in the barrel to be released before the bung is fully removed.
- 3 If the bungs are not readily moved, or inspection suggests that opening of the barrel presents a special hazard, then the barrels shall be vented remotely to relieve any internal pressure that may be present prior to opening. Remote venting shall be conducted using a suitable device such as, a sharp spear weighted and dropped from an appropriate height or released from a tube housing a spring to penetrate the barrel. The remote venting operation shall be conducted from a safe distance from other site operations and from behind suitable walls or barricades. After sampling, the spear opening shall be plugged.
- 4 Samples of the contents of all barrels shall be extracted using a drum thief. All barrels shall be clearly numbered using spray paint or other suitable marker.
- 5 Barrels shall not be transported until it has been determined that they are not under pressure, do not leak, and are sufficiently sound for transport.
- 6 Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents which consist of black oil shall not be consolidated.
- 7 Consolidation of barrel contents shall take place in a secure barrel processing area. At many DEW Line sites several caches of barrels are present and, therefore, it may be desirable to establish several secure sorting areas; barrels scattered on the tundra may be vented, then closed, and then transported to a barrel sorting area for sampling and possible consolidation.

C. Testing:

- 1 Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analyzed on-site to confirm that they are indeed water, and contain less than 2 % glycols or alcohols by fourier transform infrared spectroscopy (FTIR).
- 2 The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for PCBs, total chlorine, cadmium, chromium and lead, in addition to identification of the major components e.g. fuel oil, lubricating oil. Samples containing greater than 1000 ppm chlorine shall be further tested to identify the chlorinated compounds present.
- 3 Contents of barrels which contain two or more phases shall have all phases analyzed; the organic phases as described above and the aqueous phases to ascertain whether it contains less than 2 % organics. In addition, the aqueous phases shall be tested for any components found in the organic phases above the criteria described below.

D. Disposal of Barrel Contents:

- 1 Barrels containing only rust and sediment shall be treated as empty barrels.
- 2 Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to a open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water may then be discarded on to the ground that is a minimum of 30 meters distance from natural drainage courses. Used oil absorbent material shall be treated as described in section D.5.
- 3 Barrel contents which are composed of water with glycols and/or alcohols or organics phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium, and 100 ppm lead, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to be not leachate toxic shall be disposed of as DCC Tier II contaminated soil. Leachate toxic material shall be treated as hazardous waste, packaged in accordance with TDGA and/or IATA regulations as required, and disposed of off-site at a licensed disposal facility.

- 4 Barrel contents which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 100 ppm lead shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes (note section E.1). Flash point may be required to be determined if they cannot be inferred from the product identification.
- 5 Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility, unless it is shown to be uncontaminated with PCBs (< 2 ppm), chlorine (< 1000 ppm) cadmium (< 2 ppm), chromium (< 10 ppm) and lead (< 100 ppm) in which case it may be incinerated on site.

E. Cleaning and Disposal of Barrels:

- 1 Empty barrels resulting from consolidation of contaminated material (section D.4) shall be triple rinsed with solvent (varsol, diesel etc.) prior to steam cleaning; solvent washings shall be added to the bulked contaminated products unless analyzed separately and shown to be suitable for incineration. Alternatively, the empty barrels may be shipped off-site and labeled appropriately (TDGA).
- 2 Only empty barrels resulting from consolidation of small volumes (section B.6), from incineration (section D.3) and from solvent washing (section E.1) require steam cleaning; after cleaning they shall be treated as described in E.3. Recycling of rinsate is permitted. The resulting wash water shall have any organic material removed by agitation with a pillow or segment of oil absorbent material. The water shall then be analyzed for cadmium, chromium and lead. If these metals are present at less than 0.01, 0.10 and 0.10 ppm respectively, then the water may be discarded on land that is a minimum of 30 meters from natural drainage courses, but if not then it shall be disposed of off-site at a licensed disposal facility. Alternatively, the wash water may be shipped off-site without testing for disposal at a licensed disposal facility. Used absorbent material shall be disposed of as described in section D.5
- 3 Empty barrels may be crushed or shredded and be landfilled on-site as non-hazardous wastes. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.

V. SITE ANALYSIS

A. General

A field team from the Environmental Sciences Group (ESG) visited Aishihik Airstrip and five other sites in the same region on 11 June 1994. The purpose of the visit was to carry out a small sampling program in order to assign priority to the sites for further evaluation. Following this initial survey, it was decided that Aishihik Airstrip would be chosen for a larger sampling program. The site was visited again during 7 - 10 July 1994 to conduct an assessment of chemical contamination. The objectives of this study were laid out in a letter of agreement between Indian and Northern Affairs Canada and Royal Roads Military College, and were to:

- collect soil, water and plant samples and analyze them for inorganic elements and PCBs;
- analyze selected samples for other substances of environmental concern, including suspected sources of local contamination which may affect the terrestrial food chain or which may migrate into aquatic systems;
- catalogue physical debris at the site; and,
- perform a detailed asbestos analysis and inventory.

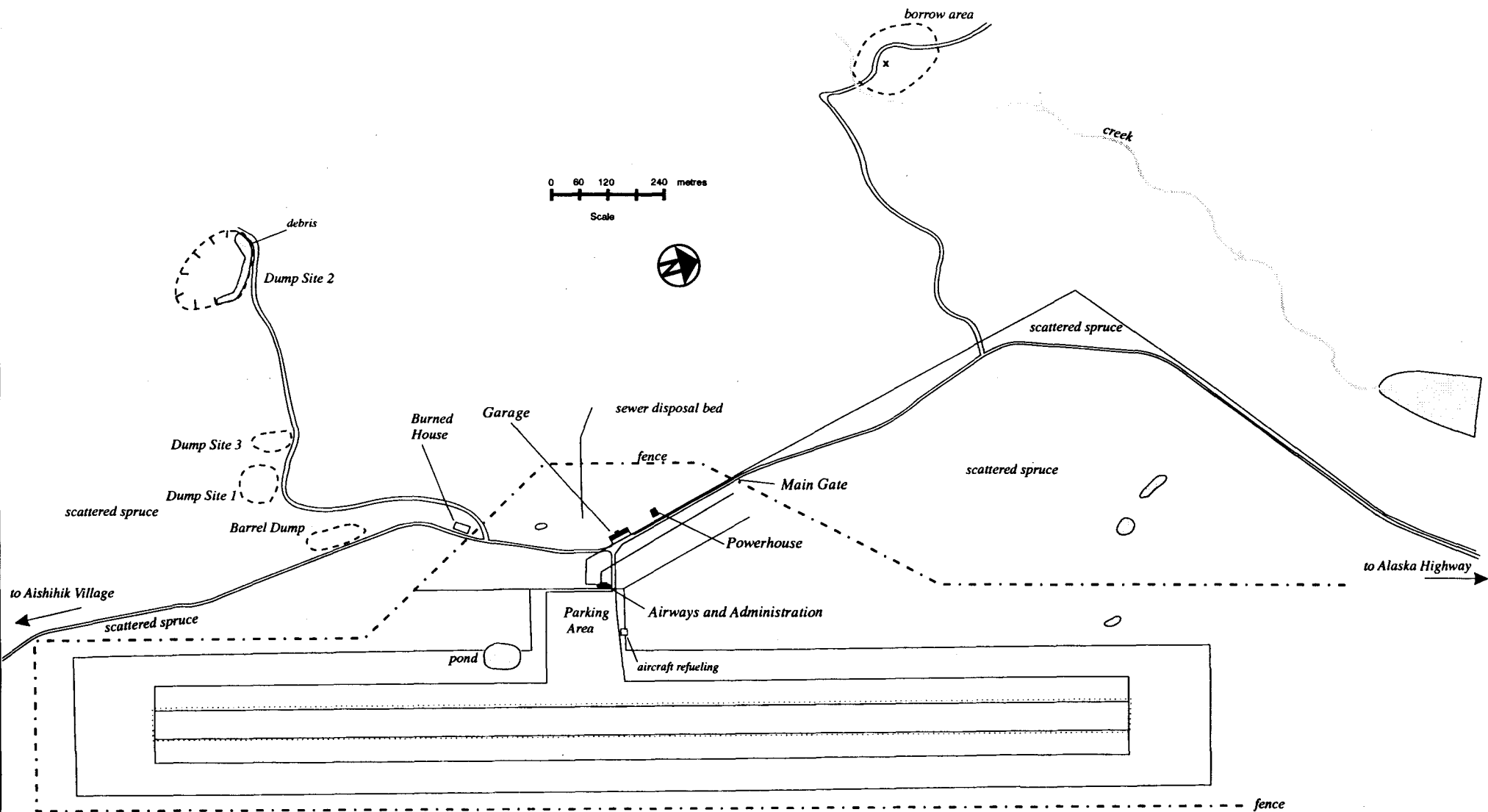
The investigation was to be limited to surface contamination and hazards and to determining whether there was a need for sub-surface contaminant investigations.

Aishihik Airstrip is situated at the head of Aishihik Lake and is accessed by gravel road from the Alaska Highway between Whitehorse and Haines Junction (see Map V-1). The airstrip is situated at approximately N 61° 39', W 137° 30'. The general layout of the site is shown in Map V-2. Most of the buildings at the site have been demolished. The three large buildings remaining (see Photograph V-1) were the powerhouse, garage and airways building. In addition, several small cabins were located to the north of the airways building.

The airways building has been extended by the Champagne-Aishihik band and is used as accommodation and kitchen facilities for summer field camps.

The surface characteristics of this area are heavily influenced by recent glaciation events. Glacial deposits in the region of Aishihik Airstrip are gravel and sand up to 30 m deep. Permafrost is not common in this area and the presence of well drained stable deposits allows the use of septic sewage disposal systems.

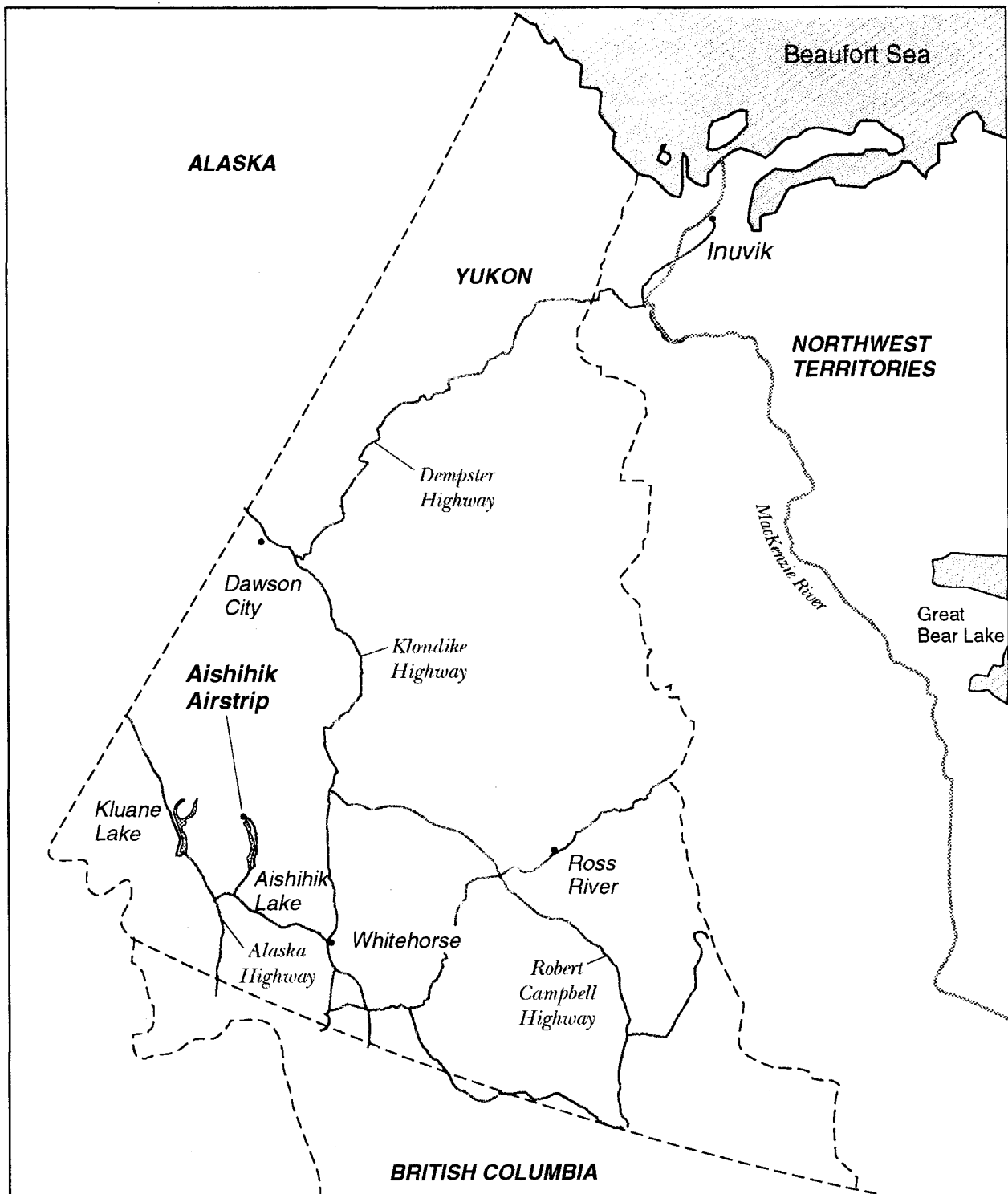
The site is also home to a variety of wildlife. The region around the airstrip building is dotted with Arctic ground squirrel burrows. During the visits, buffalo were frequent grazers around the airways building (Photograph V-2), woodland caribou and grizzly bear were also seen and wolf carcasses were noted in the dumps.



Map adapted from DND Construction Engineering Branch DWG, No. AK-0-3. 29/Nov/1949

Map V-2: Aishihik Airstrip General Site Layout

Map I-1: Location of Aishihik Airstrip





Photograph V-1: Aerial view showing Airways Building, Garage and Powerhouse.



Photograph V-2: Buffalo grazing next to the Airways Building.

B. Sampling Program

1. General

The sampling program was designed to target areas of the site based on their known uses. Particular attention was paid to the powerhouse and to areas that were known to contain transformers, where there was the possibility of PCB contamination. Areas around the POL facilities were also sampled along with the garage and airways building. All the original locations of buildings are shown in Map V-3.

Seventy nine (79) soil samples, including six field duplicates, were collected in order to investigate contaminant presence and migration (Table V-1). Plant samples were also obtained to determine whether contaminants had been introduced into the terrestrial food chain. These were obtained in the same location as soils wherever possible. Twenty two (22) plant samples were obtained including two root and shoot sub-samples. Detailed descriptions of the individual sampling locations are provided in the appendices (Section C). Maps and photographs showing key sampling locations are given at the end of this section.

Samples of paint were also obtained and the buildings were swabbed to investigate the possibility of PCB contamination. Fuel and oil drums containing product were opened, and samples obtained for analysis. The sampling program is summarized in Table V-1.

The site was divided into the following areas in order to facilitate discussion:

1. Background
2. Powerhouse and Vicinity
3. Dumps and Southern Areas
4. Other Buildings and Sites

These geographic areas, and samples obtained from them, are discussed in more detail in the following sub-sections.

Table V-1: Sampling Program Summary

Area	Soils	Plants	Oil/Fuel	Building Swabs	Water	Paint
1. Background	5	3			1	
2. Powerhouse and Vicinity	20	3	1	9		3
3. Dumps and South Area	14	5	5			
4. Other Buildings and Sites	40	11	1	3	1	
TOTALS	79	22	7	12	2	3

2. Background

Five background soil samples, including one field duplicate, were obtained in order to characterize the uncontaminated substrate around Aishihik Airstrip. Three sites were selected at distances of 4, 9 and 16 km southwest of the airstrip and a fourth was chosen approximately 15 km south of the airstrip next to a small creek crossing the road to the Alaska Highway. The sites were isolated from any activities of the site and sufficiently remote from any industry that contaminants found in these samples should be the result of long range transport; that is, aerial transport of contaminants from other areas. Vegetation samples were collected at three of the sites and a water sample was obtained at one of the sites.

3. Powerhouse and Vicinity

The powerhouse is structurally intact but the doors and windows are missing (Photograph V-3). This building had been used as a canteen during a First Nations convention but at the time of the ESG visit was not in use. The main generator room had a concrete floor (Photograph V-4); the generators had been removed and dumped in a depression about 200 m to the north. There were two more small rooms in the powerhouse on the southwest and southeast corners of the building. The floor was littered with wooden debris and ceiling cladding, and two radiators still remained on the north wall.

A "soil" sample was obtained from the floor of the powerhouse (AA100: Photograph V-5) in a small square hole where the generator would have been. A paint sample was also collected from a concrete bench in the small room on the northwest side of the powerhouse (AAPC01) and a triplicate swab sample was also taken on the wall above this bench (AASW04-6). An additional triplicate

swab sample (AASW01-3) and a paint sample (AAPC02) were taken in the small room on the southeast corner of the powerhouse. One more paint sample (ASPC03) was obtained from the concrete floor in the main generator room.

The as-built plan (Map V-3) shows four transformers on the south side of the powerhouse. The wooden supports for this rack were still present, but there were no transformers (Photograph V-6). The soil in the area around the pole stumps was not vegetated and had a hydrocarbon odour. This area was gridded and a total of eleven soil and two plant samples were obtained. The sample locations are shown on the inset to Map V-5. Care was taken to obtain samples that would represent migration away from this potentially contaminated area.

An underground fuel tank containing approximately 10 cm of product was situated on the west side of the powerhouse. A sample of the tank contents (AAB7) and two soil samples from the same area (Photograph V-7) were collected.

Six more soil samples and one vegetation sample were obtained on the north and east sides of the powerhouse. A well was located on the northwest side of the powerhouse. Unfortunately, a water sample could not be obtained since the well was completely frozen.

4. Dumps and South Area

All samples from this area are shown on Map V-4. There were three obvious dump sites on the south side of the site. Dump Site 1, situated on a steeply sloping south-facing hillside (see Map V-4), contained drums, wooden and metallic debris and a transformer case. Two soil samples were obtained, one at the base of the dump (AA031: Photograph V-8) and one just below the transformer (AA032: Photograph V-9).

Dump Site 2 was at the far southwest end of the site and was the biggest of the three dumps (Photograph V-10). The debris was spread over an area measuring 30 m × 85 m and consisted of a mixture of debris ranging from modern domestic garbage to very old barrels and metallic debris clearly dating back to the construction of the airstrip. Three soil samples were taken in this area. One was obtained at the base of the dump, where any leachate from the debris would be

concentrated. The two other samples were taken below a large number of transformer plates and an incinerator - two possible sources of contamination.

Dump Site 3 was relatively small and located between dump Sites 1 and 2. The small flat-based depression contained engine parts, an old vehicle and airstrip rollers. Further inspection located two large piles of batteries. Three soil samples including one field duplicate were taken in this area (Photograph V-11). A plant sample was obtained next to one of the piles of batteries and was separated into root and shoot sub-samples.

The main road forks approximately 250 m south of the garage. Just beyond this fork is the foundation of a burned building (Photograph V-12). Several kitchen fixtures are present in the vicinity along with many partially full tar barrels, some of which have leaked tar onto the ground. Three soil and one plant sample were taken in the vicinity of the building. A sample was also taken of the tar.

Approximately 250 m southwest of the burned building is a barrel dump. This area contains about 150 barrels, only ten of which contain any fluid (mainly water). Several stained areas are associated with leaking drums in this area (Photograph V-13). Two soil samples were collected in stained areas next to the barrels and one soil and plant sample was obtained in a low wet area that would concentrate drainage from the barrel dump. Four barrels containing fluid were opened and a sample obtained from each.

5. *Other Buildings and Sites*

The garage was located just to the south of the powerhouse (Map V-5: Photograph V-14). There were eight bays in the garage; seven are being used to store boats and/or maintain vehicles and the last bay is locked and is used by the Canadian Wildlife Service for storage. The roof is relatively new, but the rest of the garage is in poor condition; the floor has sagged in many areas and the concrete has cracked. A total of eight soil samples were collected, four on the front (east) side of the building and four on the back (west) side. Triplicate swab samples were obtained from the interior west wall of the garage.

There were no buildings to the west of the garage or powerhouse but the as-built map (Map V-3) shows four accommodation buildings and the main septic

line and field for the site. During the site investigation, a transformer casing was found to the southwest of the garage (Photograph V-15). A field duplicate soil sample was taken at this location and an additional sample was obtained in a shallow depression next to the transformer case. The remains (plates) of another transformer were found about 60 m west of the garage; a soil and plant sample were obtained here.

The septic line ran approximately west across the site and the field was located about 200 m west of the garage. A soil sample was obtained in the depression where the line ran about 100 m west of the garage. Four more soil samples were obtained in the vicinity of the field and the drainage from it. This area was a shallow valley that had also been used as a small dumpsite (Photograph V-16); the area was free of loose debris but several drums could be seen protruding from small vegetated hillocks. Two plant samples were obtained in the vicinity of the partially buried drums.

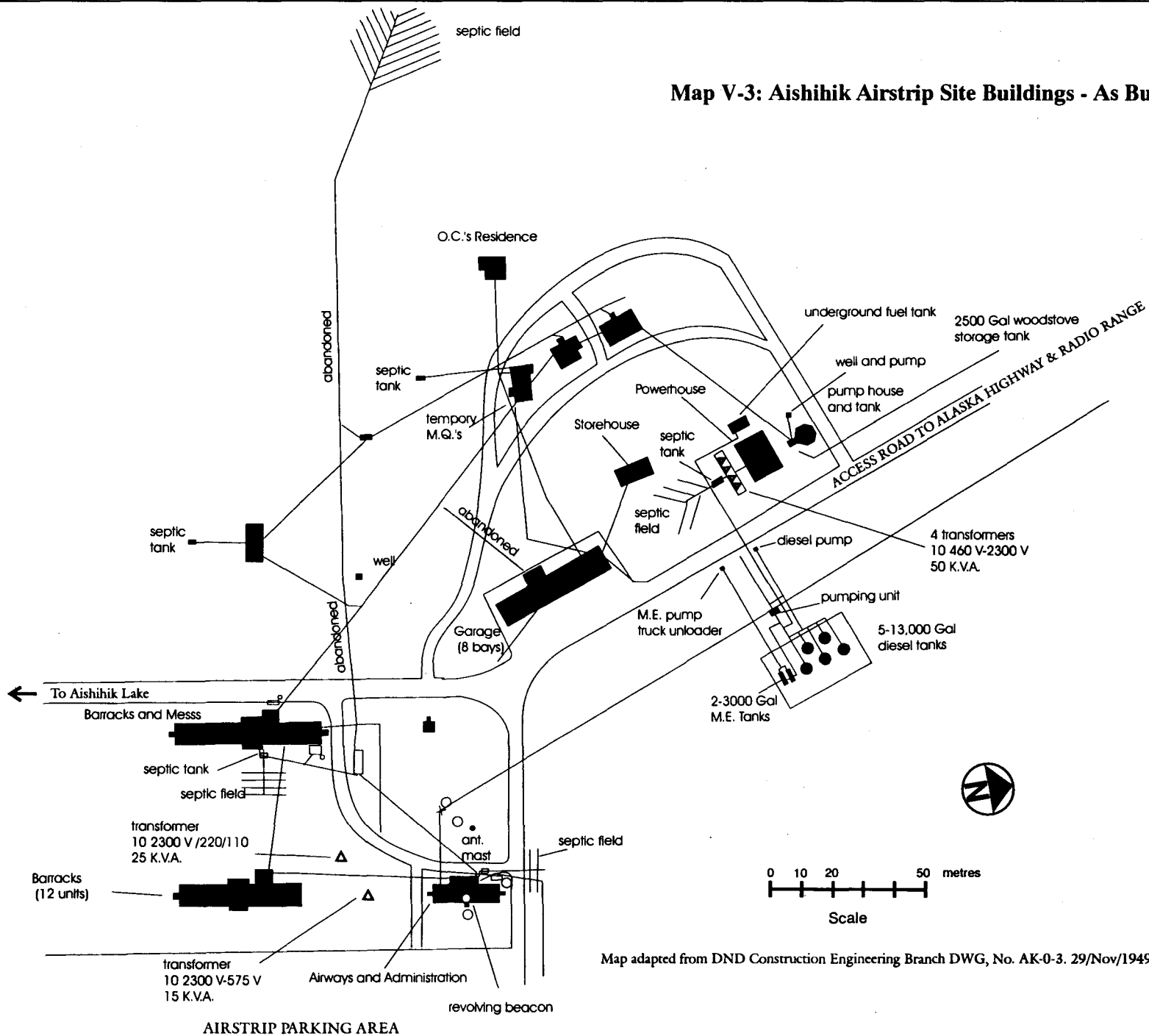
The fueling facilities at Aishihik Airstrip are shown in Map V-3. Fuel was unloaded from a truck and pumped to the holding tanks. From here, fuel was pumped to a truck refueling pump at the road or to the aircraft refueling point on the apron in front of the airways building. Little now remains of these facilities. The boxes that contained the pumps are still present but all the tanks are missing (Photograph V-17). The underground lines are probably still in place. Three soil samples were taken in what was the vicinity of the POL tanks; several small cabins are now in this area. Two duplicate soil samples and a plant sample were taken where the aircraft refueling tanks would have been (Photograph V-18).

The airways and administration building was situated at the east end of the site with the runway further to the east. An addition has been placed on the west side of the building by the Champagne-Aishihik band. The building is in good condition and is used on a regular basis (Photograph V-19). Four soil samples and one plant sample were obtained around the doors to the airways building. Three soil samples were obtained in the area to the south of the building. The as-built map (Map V-3) shows that this area contained two transformers and buildings (accommodation and dining hall). These buildings were not present and sampling was carried out in the vicinity of the poles that would have held the transformers, and around a transformer case (Photograph V-20).

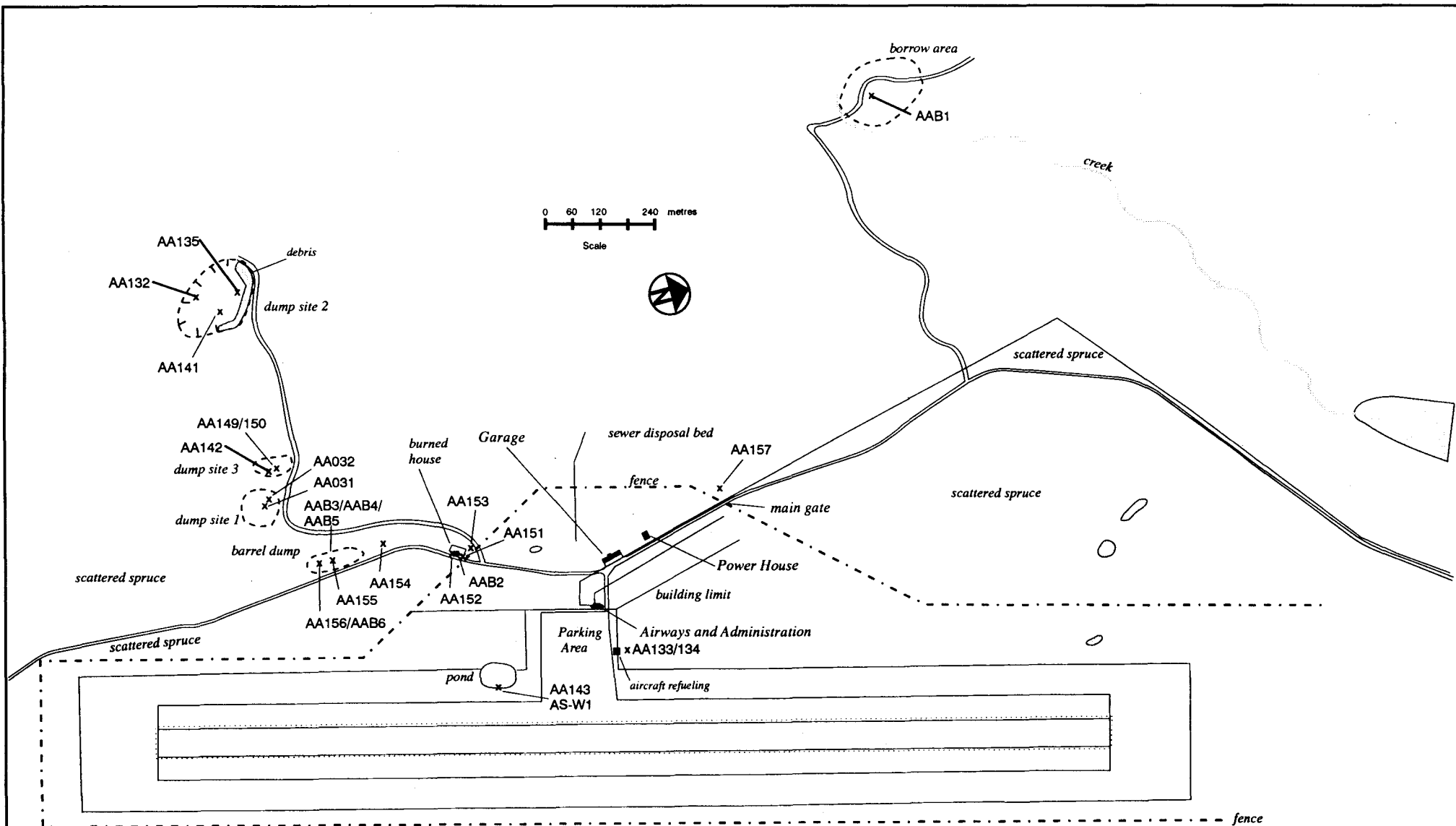
A sediment sample and water sample were obtained from the pond adjacent to the airstrip (see Map V-4). The generators that had been removed from the powerhouse were found in a shallow depression on the west side of the road outside the main gate (Photograph V-21). A soil sample was obtained in the base of the depression. A barrel sample was obtained from a single grease drum that was found in a gravel borrow area.

There were two additional sites that were distinct from the airstrip. Approximately 8 km north-northwest of the airstrip was a beacon site used for navigation and communications (Photograph V-22), accessible by ATV on a gravel road. None of the buildings were standing. Five soil samples and three plant samples were taken around the disturbed areas. The last site was located about 5 km north-northwest of the airstrip and just off the road leading to the beacon site (Photograph V-23). All that remained were several large pole stumps and a transformer case. It is assumed the site had a function related to power distribution and/or communication. Three soil samples and one plant sample were taken in the vicinity of the transformer case. These two sites are discussed in this report as the upper and lower beacon sites, respectively.

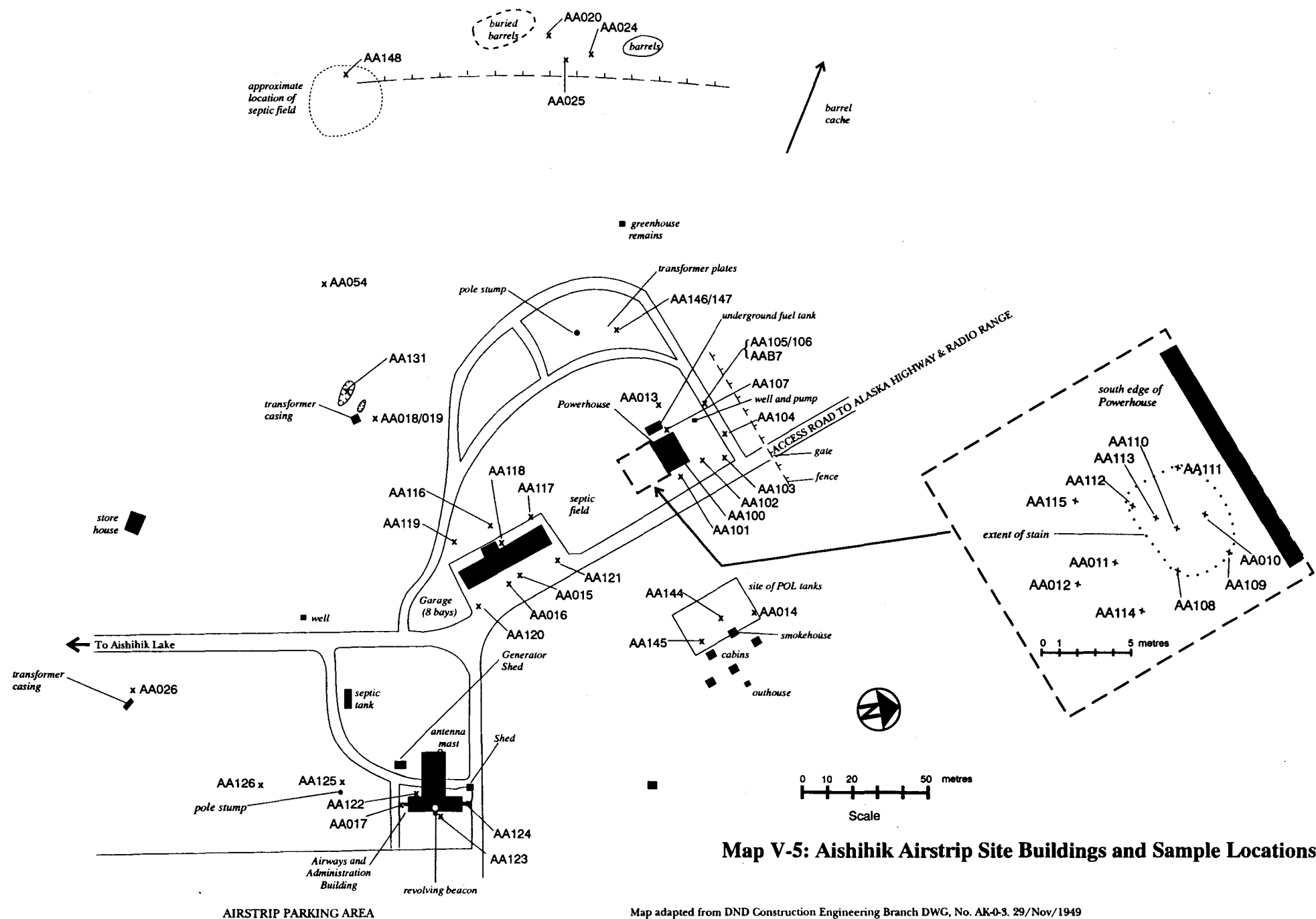
Map V-3: Aishihik Airstrip Site Buildings - As Built



Map adapted from DND Construction Engineering Branch DWG, No. AK-0-3. 29/Nov/1949



Map V-4: Aishihik Airstrip General Site Sample Locations





Photograph V-3: View from the northwest side of the powerhouse.



Photograph V-4: Inside the powerhouse in the room that contained the generators.



Photograph V-5: A sample was obtained from the floor of the powerhouse (AA100).



Photograph V-6: The pole stumps are all that remains of the transformer rack that contained four transformers.



Photograph V-7: Underground fuel tank on the west side of the powerhouse.



Photograph V-8: General view of Dump Site 1, a transformer case can be seen half way up the hill.



Photograph V-9: Close up view of the transformer in Dump Site 1. This transformer had an oil capacity of 12.5 gallons.



Photograph V-10: Dump site 2 was the largest of the three dump sites and contained recent domestic garbage as well as very old debris.



Photograph V-11: Dump Site 3 contained two large piles of broken batteries (Sample AA142).



Photograph V-12: Remains of a burned building on the south side of the site.



Photograph V-13: The barrel dump on the south side of the site contained approximately 150 barrels, mostly hidden in the trees.



Photograph V-14: The garage was used by local people for vehicle repair and boat/general storage.



Photograph V-15: A transformer casing found approximately 70 m southwest of the garage (AA018/019).



Photograph V-16: The septic field was located in a shallow valley approximately 200 m west of the garage.



Photograph V-17: The flat area in the foreground was the location of seven POL tanks. The powerhouse can be seen in the background.



Photograph V-18: The aircraft refueling points were located next to this small depression. The pipes and tank ribs can be seen in this area.



Photograph V-19: The airways building was in good condition and was used to house summer field camps by the Champagne-Aishihik band.



Photograph V-20: Soil sample AA026 was taken next to this transformer casing to the south of the airways building.



Photograph V-21: These generators and engines were found in a shallow depression outside the main gate to the airstrip.



Photograph V-22: The upper beacon site, located about 8 km from the airstrip. Note wooden and metallic debris in upper left corner.



Photograph V-23: The lower beacon site was located between the airstrip and the beacon site.

C. Analytical Program

Analyses were initially targeted for representative samples from the most severely stained areas; these samples were analyzed for a broad range of substances. It became apparent from this initial analytical screen that PCBs were the main contaminants of concern and, as a consequence, the majority of soil samples were analyzed for PCBs. Elevated levels of inorganic elements are often found in stained areas and therefore a large number of samples were analyzed for inorganic elements. A summary of the analytical program by site can be found in Table V-2.

1. Polychlorinated Biphenyls (PCBs)

Fifty-seven soil samples (72% of the total collected) were analyzed for PCBs either by gas chromatograph / electron capture detector (GC/ECD) or gas chromatograph / mass spectrometer (GC/MS). The results are reported as Aroclor equivalents. Fifteen soil samples were also analyzed for 47 congeners in order to provide a more complete representation of PCB concentrations. The results are presented in Section H and J of the Appendices.

Seventeen plant samples (74% of those collected) were analyzed for PCBs as Aroclors using GC/ECD analysis. Three plant samples were analyzed for 47 congeners. The results are presented in Section I and K of the Appendices.

Twelve building swabs, three paint samples, four barrel and two water samples were all analyzed for PCBs as Aroclors using GC/ECD. The results are presented in Sections L, G, Q and H of the Appendices respectively.

2. Inorganic Elements

Forty eight soil samples (61% of those collected) were analyzed for inorganic elements. The inorganic element suite consisted of: copper, nickel, zinc, cobalt, cadmium, lead, chromium, arsenic and mercury. The results are presented in Section E of the Appendices.

Seventeen plant samples (74% of those collected) were also analyzed for inorganic elements using the same suite of elements. The results are presented in Section F of the Appendices.

All three paint chip samples were analyzed for the following inorganic elements copper, nickel, zinc, cobalt, cadmium, lead, chromium and arsenic. Six barrel samples were analyzed for lead, chromium, cadmium and total chlorine. The results for the paint and barrel samples are given in Section G and Q of the Appendices.

3. *Acid/Base/Neutral Extractables (ABNs)*

Two soil samples were subjected to the ABN screen. Analytical detection limits were often high because of interferences due to the high hydrocarbon content in some of the samples. This is an unavoidable limitation of the ABN method of analysis which only allows certain sample cleanup techniques. The ABN screen consists of the following substances:

- bis(2-chloroethoxy)methane
- bis(2-chloroisopropyl)ether
- 2-chloronaphthalene
- 2,4-dinitrotoluene
- isophorone
- N-nitrosodi-n-propylamine
- hexachlorobenzene
- hexachlorocyclopentadiene
- 1,2,4-trichlorobenzene
- 4,6-dinitro-o-cresol
- 2-nitrophenol
- phenol
- 4-chloro-3-methylphenol
- 2,4,6-trichlorophenol
- pentachlorophenol
- acenaphthylene
- fluorene
- anthracene
- pyrene
- chrysene
- benzo(a)pyrene
- indeno(1,2,3-cd)pyrene
- 3,3-dichlorobenzidine
- bis(2-chloroethyl)ether
- 4-bromophenylphenylether
- 4-chlorophenylphenylether
- 2,6-dinitrotoluene
- nitrobenzene
- N-nitrosodiphenylamine
- hexachlorobutadiene
- hexachloroethane
- 2,4-dimethylphenol
- 2,4-dinitrophenol
- 4-nitrophenol
- 2-chlorophenol
- 2,4-dichlorophenol
- 2,4,5-trichlorophenol
- naphthalene
- acenaphthene
- phenanthrene
- fluoranthene
- benz(a)anthracene
- benzo(a)fluoranthene
- dibenz(ah)anthracene
- benzo(ghi)perylene
- 1,3-dichlorobenzene

- 1,4-dichlorobenzene
- dimethylphthalate
- dibutylphthalate
- bis(2-ethylhexyl)phthalate
- 1,2-dichlorobenzene
- diethylphthalate
- butyl-benzylphthalate
- di-N-octylphthalate.

The results are presented in Section O of the Appendices.

4. *Polycyclic Aromatic Hydrocarbons (PAHs)*

Since PAHs, at elevated concentrations are known toxins and carcinogens, four soil samples were analyzed specifically for PAHs. This analysis substantially improves the detection limits obtained from the ABN analysis. The following chemicals are included in the PAH suite:

- naphthalene
- fluorene
- fluoranthene
- chrysene
- benzo(a)pyrene
- indeno(1,2,3-cd)pyrene
- acenaphthylene
- phenanthrene
- pyrene
- benzo(a)fluoranthene
- perylene
- benzo(ghi)perylene
- acenaphthene
- anthracene
- benz(a)anthracene
- benzo(e)pyrene
- dibenz(ah)anthracene

The results are presented in Section N of the Appendices.

5. *Pesticides*

Four soil samples were analyzed for persistent pesticides. This suite included the following pesticides:

- HCB
- gamma BHC
- trans-chlordane
- p,p'-DDE
- o,p'-DDD
- mirex
- dieldrin
- alpha BHC
- heptachlor
- cis-chlordane
- trans-nonachlor
- p,p'-DDD
- heptachlor epoxide
- endrin
- beta BHC
- aldrin, oxychlordane
- o,p'-DDE
- cis-nonachlor
- p,p'-DDT
- alpha-endosulphan
- methoxychlor

The results are presented in Section M of the Appendices.

6. *Polychlorinated dibenzodioxins and furans (PCDDs and PCDFs)*

Three soil samples were analyzed for PCDDs and PCDFs. The results are reported (Section P in the Appendices) as individual concentrations and from those a TEQ is calculated that compares all the concentrations to the most toxic

congener (2,3,7,8-tetrachlorodibenzodioxin). This procedure is discussed in Chapter IV.

Table V-2: Analytical Program Summary

	PCBs	Inorganic Elements	Pesticides	ABNs	PAHs	Dioxins and Furans	Chlorine
SOILS							
1. Background	5	4					
2. Powerhouse and vicinity	15	13	2	1		3	
3. Dumps and South area	12	10	1		2		
4. Other buildings and sites	25	21	1	1	2		
PLANTS							
1. Background	3	3					
2. Powerhouse and vicinity	3	3					
3. Dumps and South area	4	4					
4. Other buildings and sites	7	7					
MISC.							
Barrel Samples	4	6					4
Building Swabs	12						
Water	2						
Paints	3	3					

D. Results

1. Background Levels in Soils and Plants

Five background soil samples were analyzed for PCBs as Aroclors. PCBs were detected, using high resolution analysis, in three of the samples resulting in a mean total Aroclor concentration of 0.68 ppb. In order to obtain useful background information three soil samples and three vegetation samples were submitted for high resolution PCB congener analysis. The average sum of congeners for the three background soil samples was 0.42 ppb (ng/g) and 0.07 ppb for the three vegetation samples. A great deal of information is found within the congener signatures of PCBs. One way of simplifying this information is Principal Components Analysis (PCA). This multivariate statistical technique is described in detail in Section 3 of Appendix A, and allows samples to be compared graphically. The principal component plot for all of the soils and plants for which PCB congener data was obtained is shown in Figure V-2. This plot clearly shows that the PCBs in the background soils and plants are derived from different sources than those at the site. In fact, the PCB signature of the background sites is consistent with a signature derived from long-range atmospheric transport (Bright et al., 1995). Long-range atmospheric transport is the mechanism whereby contaminants generated in southern areas are transported over large distances and re-deposited (for a current view of Arctic airborne contamination see Science of the Total Environment, Volume 160/161).

Four background soil samples and three background vegetation samples were analyzed for inorganic elements. The average concentration for these samples is shown in Table V-3. Values of half the limit of detection were used where necessary for averaging.

Table V-3: Background Concentrations for Inorganic Elements

	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg
	ppm								
Soil	15	9.6	8.1	<1.0	<10	61	29	6.9	<0.1
Plants	8	6.5	<5	2.1	<15	95	13	<0.2	-

2. *Powerhouse and Vicinity*

a. Powerhouse

One soil sample (AA100) contained PCBs in excess of 50 ppm requiring action under regulations arising from the Canadian Environmental Protection Act (CEPA). This sample was taken from the floor of the powerhouse in the main generator room and contained 1100 parts per million (ppm) PCBs; a paint sample taken from the floor in the same location (AAPC03) contained 154 ppm PCBs. **These two samples indicate that the floor of the powerhouse is highly contaminated with PCBs.** The congener pattern for sample AA100 is almost identical with Aroclor 1254 (see Figure V-2) indicating that this was probably the commercial mixture used in this building. Two other paint samples were obtained from the powerhouse. AAPC01 was taken off a concrete bench in the rear room and contained 21900 ppm PCBs, well over the limit regulated by CEPA. The remaining paint sample (AAPC02) was obtained from the wall in the small front room and contained 26 ppm PCBs. **Clearly, the paint in the powerhouse is also contaminated with PCBs.** Six hexane swab samples were taken in the powerhouse, three from above the concrete bench where AAPC01 was taken and three from the location where AAPC02 was taken. The PCB concentration in these swabs was very low (<100 ng/swab) and well below the Health Canada advisory level. These low swab values indicate that the PCB contamination is "locked" within the paint and is not readily available for inhalation. Inorganic element concentration were also elevated in AA100; lead (620 ppm), zinc (2020 ppm) and copper (118 ppm) were all greater than CCME R/P (DCC Tier II) criteria.

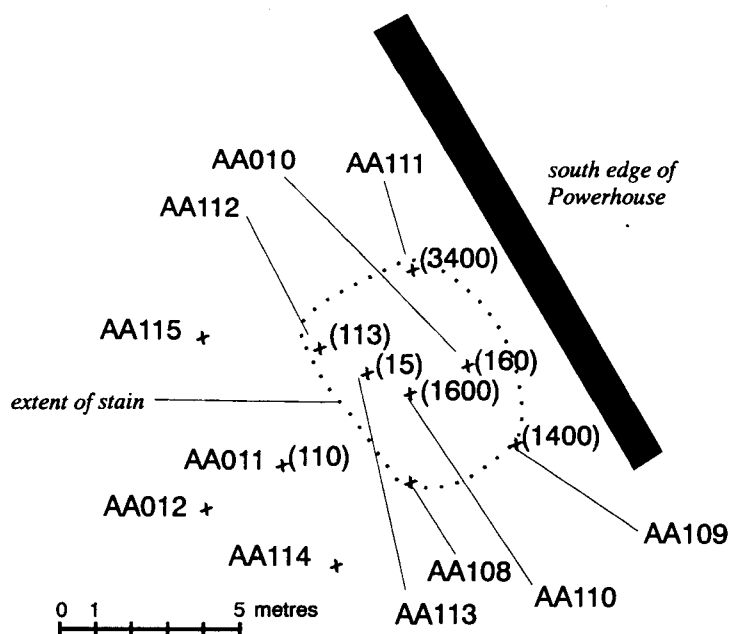
b. South and East of Powerhouse

A soil sample taken outside the front (east) door to the powerhouse also contained very high levels of PCBs. This sample (AA101) was obtained approximately 2 m east of the powerhouse in a slight depression and contained 10 ppm PCBs. The concentration of PCBs in this soil sample was in excess of the CCME R/P criteria and DCC Tier II. A sample taken 10 m to the north (AA102) and in drainage from the area of AA101 contained 160 ppb PCBs, and the levels were reduced to 52 ppb a further 10 m out in the drainage (AA103). Vegetation taken at AA103 contained low levels of PCBs (2.2 ppb as Aroclor 1254).

Although this is well above background concentrations, it is substantially lower than any animal toxicity or phytotoxicity threshold (Reimer et al., 1993). **These results indicate that the PCB spill is localized and is not migrating.** It should be noted that the area of the spill is not defined by staining and so further delineation during cleanup will be necessary. This is discussed further in Section E of this chapter. Inorganic element concentrations were comparable to background concentrations for samples in this area except for slightly elevated zinc levels (139 ppm) in sample AA103 located in a low area to the northeast of the powerhouse. This was not reflected in the plant sample from the same location where zinc levels (270 ppm) were almost three times the average background level.

A transformer rack was originally present on the south side of the powerhouse. All that remained were several pole stumps that would have been the support for the rack. The area underneath the rack was sandy and devoid of vegetation. Eleven soil samples were obtained from this area, seven from the region directly around the poles and four in drainage from this area (see Map V-5). The PCB results are illustrated in Figure V-1 (the PCB concentrations in ppb are given in parentheses).

Figure V-1: Sample Locations and PCB Concentration at Former Site of Transformers on South Side of Powerhouse



The PCB concentration is greatest towards the northern end of the stained area. There exists the possibility that greater concentrations of PCBs may be found closer to the building. That would be the case if the PCBs were not originating from the transformer rack but from seepage from the building. This is not unlikely given the PCB levels found on the floor of the building, and could be ascertained using field test kits during cleanup. This is discussed further in Section E of this chapter. Three of the samples (AA111, AA110 and AA109) contain PCB concentrations greater than DCC Tier I. Sample AA113, taken at a depth of 35 cm, contained a low concentration of PCBs, indicating little or no vertical migration is occurring. PCB concentrations of 110 ppb at AA011, which was in the direct drainage path from the stained area, indicates that horizontal migration may be occurring. A vegetation sample was obtained at AA011 and analyzed for PCBs. The sample was divided into roots and shoots; the roots contained 25 ppb PCBs and the shoots contained 8.0 ppb. Both were significantly elevated over the background level. The concentration of PCBs in the roots and shoots of this sample also provides evidence that PCB migration may be occurring. **The soil and vegetation samples away from the stained area both indicate the necessity for source control.**

Inorganic element results for this area were all comparable to background with the exception of elevated lead (118 ppm) in soil sample AA110. This level was still below the CCME R/P criteria (500 ppm) and the DCC Tier I (200 ppm).

Two samples (AA111, AA113) in this area were analyzed for pesticides. DDT was detected in very small quantities indicating that some use may have been made of this substance. The natural degradation products from DDT (DDE and DDD) were found in small quantities in sample AA111. The same two samples were also analyzed for acid/base/neutral extractable organic compounds (ABNs). None of the 54 compounds in this suite were above the limit of detection. Two samples (AA111 and AA101) were submitted for PCDD and PCDF analysis. The TEQ for AA111 was 58.2 pg/g and 76.7 pg/g for AA101; both were well below the CCME R/P criteria of 1000 pg/g. A 3-dimensional principal component plot is shown in Figure V-3. There is clearly a large difference in signature for the two samples. Soil sample AA101 projects very close to two points, electrical equipment incineration and Aroclor 1260. Clearly,

the dioxin and furan contamination at AA101 is due either to the incineration of PCB and/or chlorobenzene containing electrical equipment or was present as an impurity in the Aroclor formulation that was spilled at that location. The latter is more likely, since there was no evidence of a large electrical burn in the vicinity. Soil sample AA111 projects at a completely different point on the PCA plot. In fact, the congener signature of this sample is very similar to the dioxin and furan signature from impurities in chlorophenol formulations. This is not unlikely, given that sample AA111 was taken under the wooden frame of a large transformer rack that was probably treated with chlorophenol wood preservatives.

c) North and West of the Powerhouse

Four samples were analyzed for PCBs and inorganic elements in this area. The Aroclor PCB concentrations were all less than 50 ppb and the levels of inorganic elements were comparable to background concentrations.

On the west side of the powerhouse was an underground storage tank. A sample of the contents was obtained and analyzed. All analyte levels were less than the limits of detection and the gas chromatograph signature was characteristic of diesel fuel.

3. *Dumps and South Area*

Two samples (AA031, AA032) were analyzed for PCBs from Dump Site 1 (see Map V-4). PCBs were not detected in either sample. Sample AA031 was analyzed for inorganic elements and concentrations, with the exception of lead, were comparable to background levels. Lead was found at elevated levels (176 ppm) but still below the CCME R/P criteria (500 ppm) and DCC Tier I (200 ppm).

Two samples (AA132, AA135) taken from Dump Site 2, the largest of the three dumps, were analyzed for PCBs and inorganic elements. PCBs were elevated (100 ppb) in the sample taken at the lowest point in the dump (AA132). Levels of inorganic elements were comparable to levels in background samples. Sample AA132 was also analyzed for pesticides and PCDDs and PCDFs. Very low levels of PCDDs and PCDFs were found and the TEQ was calculated as 2.5 pg/g. This range is consistent with background concentrations in many parts of the world (Creaser et al, 1989; EPA, 1985). A range of pesticides was detected at

very low levels (maximum 8 ppb for p,p-DDE), well below any remediation criteria. In a vegetation sample also taken at AA132, PCBs were not detected and levels of most inorganic elements were low. The relatively high level of zinc present in the plant sample (840 ppm) but not found in the corresponding soil, is probably due to the natural ability of *Salix* to accumulate zinc (Reimer et al., 1993).

Three samples including one analytical duplicate, taken from Dump Site 3, were analyzed for PCBs and inorganic elements; PCBs were not detected in any of the samples. Levels of inorganic elements were comparable to levels in background samples with the exception of lead in sample AA142. This sample was collected next to some broken lead batteries and not surprisingly contained 513 ppm lead, exceeding both the CCME R/P criteria and DCC Tier II. A root and shoot sample of *Salix richardsonii* was also taken at this location. Levels of lead were significantly elevated from background levels, both in the shoots and the roots. The lead concentration in the shoots was 234 ppm whilst in the roots it was 67 ppm. This indicates that here the mechanism for lead transport to plants from soil may well be predominantly airborne and not through the soil. In the NWT, there is evidence for lead uptake in plants at considerable distance from sources and the presumed mechanism is aerial (Reimer et al., 1993). The level of lead in the soil is greater than DCC Tier I and the elevated level in the plants indicates that some source control is necessary.

Two soil samples, taken in the vicinity of the burned building on the south side of the site, were analyzed for PCBs and inorganic elements. Concentrations of inorganic elements were comparable to background levels. PCB concentrations were elevated in both samples (490 ppb in AA151 and 58 ppb in AA152), but lower than DCC Tier I (1000 ppb). A sample of vegetation taken from the same location as AA151 contained very low levels of PCBs (1.4 ppb) indicating that biological uptake is not significant. Sample AA152 was obtained from a black oily stain and was also analyzed for polycyclic aromatic hydrocarbons (PAHs). The analysis was difficult, as is often the case with heavily oiled samples, and so not all the PAHs could be accurately quantified. Even so, when the poorly quantified compounds are included as actual values, the total PAH concentration in this sample is 340 ppb, considerably lower than any applicable criteria. In fact

the total concentrations of all PAHs in this sample were less than the CCME agricultural criteria.

Two samples were analyzed for PCBs and inorganic elements in the barrel dump area to the south of the burned building. There was some heavy staining around some of the barrels. The maximum concentration of PCBs was 13 ppb and concentrations of inorganic elements were comparable to background levels with the exception of slightly elevated zinc levels at AA156 (171 ppm), taken in a black-stained area around one of the barrels. The CCME R/P (DCC Tier II) criterion for zinc is 500 ppm. The analysis of sample AA156 was complicated by interferences and the fact that many of the PAHs were close to the limit of detection. However it is clear that the levels of PAHs in this sample are well below any applicable criteria. Four liquid samples were obtained from the barrels in this area. Two of the barrels (AAB3 and AAB4) contained only water, and the concentrations of lead, chromium and cadmium were less than the detection limits. The other two barrels (AAB5 and AAB6) contained an oily layer and a water layer. The only detectable analytes were found in the oil phase of sample AAB6 which contained 63 ppm lead and 11.9 ppm cadmium. The level of cadmium is above the allowable levels for incineration according to the DLCU protocol for barrels.

4. *Other Buildings and Sites*

Three soil samples, taken in stained areas around the garage, were analyzed for inorganic elements and two soil samples were analyzed for PCBs. PCBs were detectable in both samples and the maximum concentration, found at AA121, was 110 ppb. Levels of lead were also elevated in all three samples and in one case (AA116) were comparable (200 ppm) with the DCC I criteria. All other levels of inorganic elements were comparable to background concentrations. Three swab samples taken in the garage were analyzed for PCBs, and the maximum concentration found was 250 ng/100 cm², significantly lower than the proposed residential criteria of 10,000 ng/100 cm² (see Chapter IV, Section I).

A number of samples were obtained in the vicinity of the buildings at the airstrip site, primarily from stained areas, suspected transformer placements and buried material. Fifteen soil samples were analyzed for inorganic elements and

seventeen were analyzed for PCBs. The concentrations of PCBs in the samples were low, the highest concentration (110 ppb) was found in a sample (AA121) taken next to the steps of the airways building. Concentrations of inorganic elements were also low and were only elevated in one sample (AA124) taken outside the north door of the airways building. Concentrations of lead (172 ppm) and zinc (93 ppm) were higher than other samples but were still below relevant remediation criteria. A water sample taken from the small pond next to the airstrip was analyzed for PCBs; the concentration in this sample was lower than the limit of detection. Two soil samples obtained around the remains of the POL facilities were analyzed for PAHs. Although the analysis was complicated by interferences, the results (Appendix N) clearly show that the levels of PAHs are about two orders of magnitude lower than the relevant CCME R/P criteria. Four vegetation samples were analyzed for PCBs and inorganic elements. PCBs were detected in only one sample, taken outside the airways building, and the concentration (1 ppb) was very low. Inorganic element concentrations in all the vegetation samples were comparable to background levels.

A barrel sample (AAB1) was obtained from the gravel borrow at the northwest side of the site. The sample was classified as lube oil and grease and contained cadmium (9.8 ppm) above the limit for incineration. All other analytes were below the limit set for incineration.

There were two beacon sites used for approaches to the Aishihik Airstrip. The lower beacon site was approximately 5 km northwest of the airstrip. Two samples (AA136 and AA138) were analyzed for PCBs and inorganic elements. Levels of PCBs were low (maximum concentration 50 ppb) and the congener signature was almost identical to Aroclor 1260 (see PCA plot, Figure V-2). Inorganic element concentrations were also low and, in most cases, directly comparable to background levels. A vegetation sample (AA138P) taken at the lower beacon site was also analyzed for PCBs and inorganic elements. PCBs were found at very low levels (1.7 ppb) and concentrations of inorganic elements were comparable to background levels. A soil sample (AA138) was also analyzed for pesticides and the ABN suite of organic compounds. Pesticides were present at very low levels and were predominantly the DDT group and associated degradation products. These results are similar to the pesticide results at the

airstrip site. All 54 compounds in the ABN suite were below the limit of detection.

Two soil samples, taken from the upper beacon site, were analyzed for PCBs and one soil sample for inorganic elements. Levels of PCBs were low (maximum concentration 5.8 ppb) and the concentrations of inorganic elements were comparable to background levels with the exception of lead (23 ppm) at AA 140, which was slightly elevated. Two samples of vegetation were analyzed for PCBs and inorganic elements. The concentrations of inorganic elements were comparable to background levels and PCBs were not detected.

Figure V-2: Principal Component Plot for PCBs in Soils and Plants

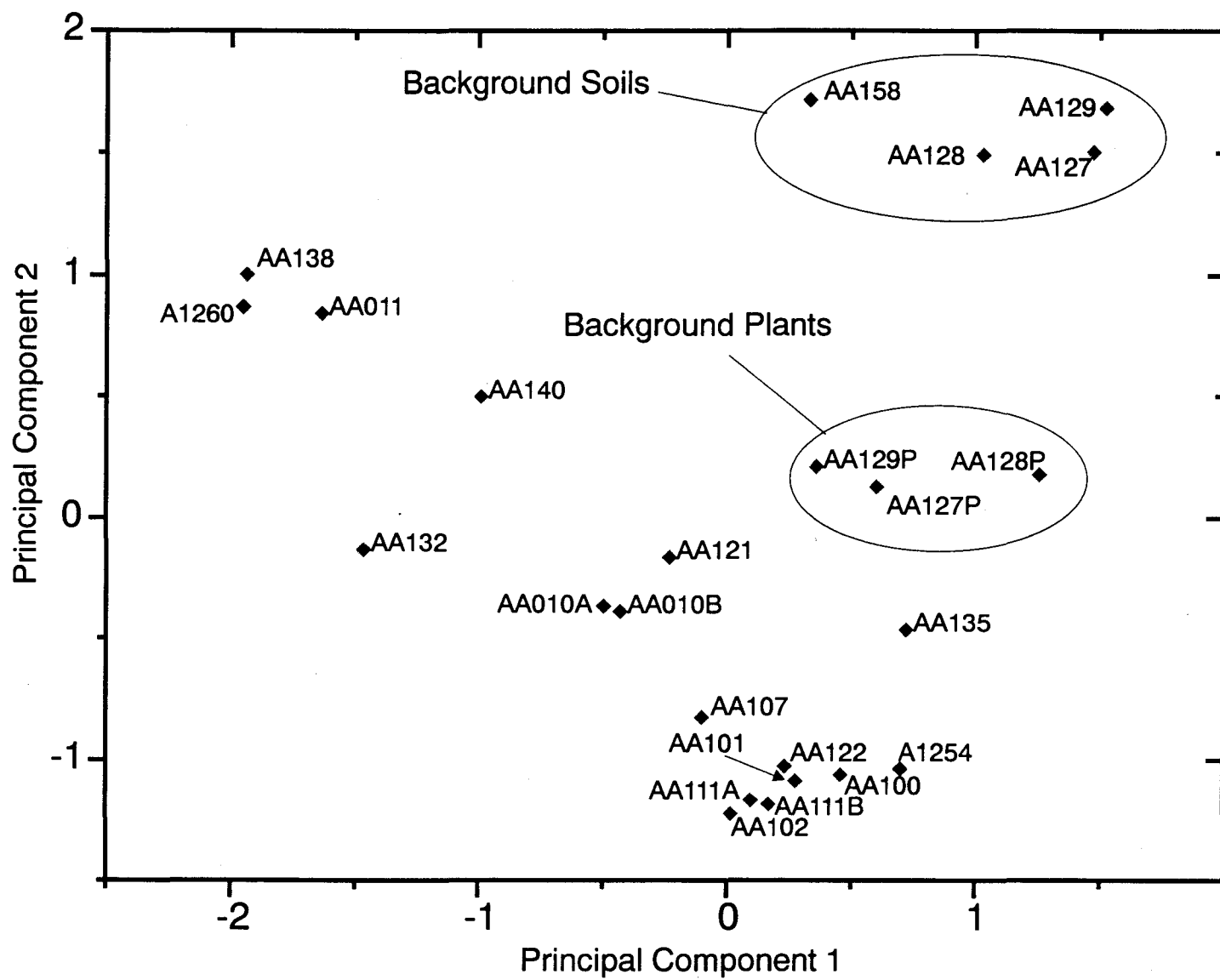
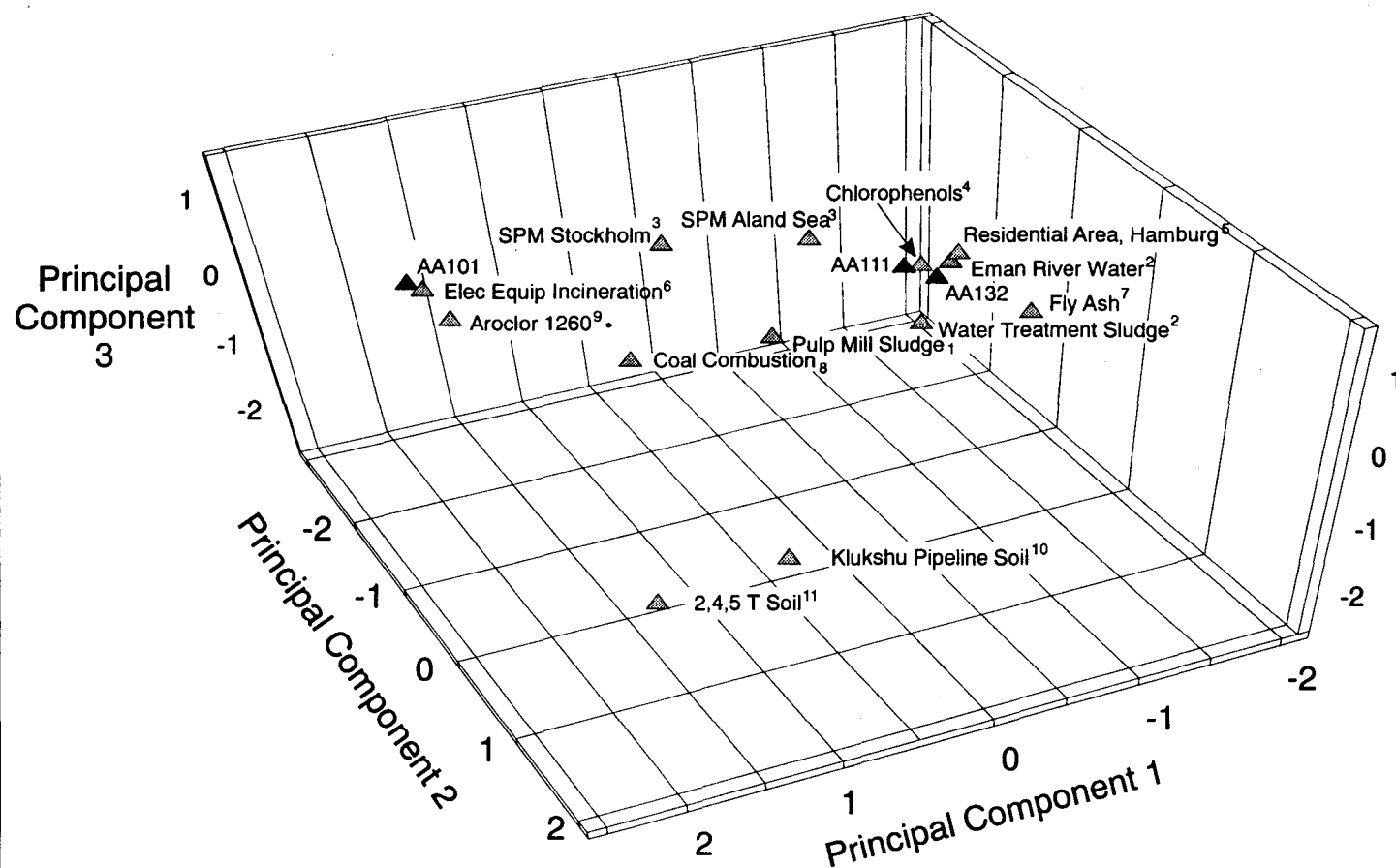


Figure V-3: Principal Component Plot for Dioxin and Furan Signatures from Various Sources



Notes:

1. Kuehl et al., 1987.
2. Rappe et al., 1989.
3. SPM = Settling Particulate Matter. Broman et al., 1989.
4. Hagenmaier and Brunner, 1987.
5. Rappe et al., 1988.
6. Electrical Equipment Incineration. Gonzales et al., 1991.
7. Miyata et al., 1988.
8. Harrad and Jones, 1992.
9. Wakimoto et al., 1988.
10. Fowler, 1993.
11. Rappe et al., 1978.

E. Recommendations

1. Contaminant Summary

PCB contamination is limited to the powerhouse and vicinity. The results which are in excess of the criteria are given in the table below.

Table V-4: Samples Exceeding Criteria for PCBs

Sample	Concentration (ppm)	Applicable Criteria
AA100	1100	CEPA
AAPC01	21915	CEPA
AAPC03	126	CEPA
AAPC02	26	CCME R/P, DCC-II
AA101	10	CCME R/P, DCC-II
AA109	1.4	DCC-I
AA110	1.6	DCC-I
AA111	3.4	DCC-I

Inorganic element contamination is limited to a stain at the garage, soil adjacent to some broken batteries, and the floor of the powerhouse, and are given in the table below.

Table V-5: Samples Exceeding Criteria for Inorganic Elements

Sample	Element:Concentration (ppm)	Applicable Criteria
AA100	Cu:118, Pb:620, Zn 2020	CCME R/P, DCC-II
AA142	Pb:513	CCME R/P, DCC-II
AA116	Pb:200	DCC-I

2. Suggested Actions

The floor and walls of the powerhouse are contaminated with PCBs and inorganic elements. Soil on the east and south sides of the powerhouse are contaminated with PCBs. On the west side of the powerhouse there is an underground storage tank containing diesel fuel. Next to the tank is a potable water well. The following actions are recommended regardless of the future use of the building:

- Remove all loose paint on the walls;
- sweep and vacuum the floor and place all material in a suitable container for PCB waste;
- coat the floor with a PCB decontamination agent (Sanisolv) and allow to stand for at least 30 minutes;
- sweep the floor again and place residue in a suitable container for PCB waste;
- wipe all surfaces with an oil absorbant material and again place this in a container suitable for PCB waste; and,
- repeat the solvent wash three times.

If the building is not required, it can then be demolished and buried. If the building is required, holes and cracks in the floor should be filled and the floor sealed with epoxy paint; also the walls should be painted.

The extent of PCB contamination in the soils on the east and south sides of the powerhouse should be delineated using PCB field test kits during and after cleanup. Soils with PCB concentrations greater than 50 ppm should be placed in the same containers as the decontamination residue from the interior of the powerhouse. Soils with PCB concentrations greater than 5 ppm but less than 50 ppm should be containerized separately and removed from the site. Soils with PCB concentrations between 1 and 5 ppm should be excavated but may be buried on site.

The underground storage tank on the west side of the powerhouse should be removed. The soil underneath the tank should be tested for contamination according to the Alberta guidelines for underground storage tanks (Alberta MUST, 1991).

The potable water well must not be used until tested for compliance with the Canadian Drinking Water Standards. Particular attention should be paid to the analysis of Volatile Organic Compounds (VOCs), phenols, PCBs and inorganic elements.

The stained soil at the garage marked by AA116 should be removed and placed in the new on-site engineered landfill. The same treatment should be applied to the soil underneath the broken battery at AA142.

The three dump sites should be consolidated at Dump Site 2, the dump farthest to the west. All material at the dumps should be sorted into hazardous and non-hazardous material. The hazardous material must be removed from the site, and the non-hazardous material should be buried in the base of the depression at Dump Site 2 and covered with 1 m of clean fill. The landfill should be engineered such that water infiltration is minimized. The oil drums in the barrel cache should be removed, using the guidelines in the DEW Line Cleanup protocol for barrels.

A groundwater investigation is probably not warranted at this time. The following observations support the view that groundwater contamination is minimal: there are no historical records of large spills at this site; there is no evidence for water-borne migration of petroleum contaminants in drainage paths, and the levels of PCBs in water samples were very low. However, it is suggested that either of the two following findings should trigger a groundwater investigation at this site:

- The potable water well is highly contaminated; or,
- An excavation of the soil underlying the former POL facilities reveals extensive contamination.

VI. REFERENCES

- Alberta MUST Project (1991) Subsurface remediation guidelines for underground storage tanks. Alberta Department of Environment and Labour.
- Bastedo, J.D.; Theberge, J.B. (1986) Aishihik Lake resource survey biotic aspects. Yukon Environmentally Significant Areas Series No. 3. Presidents Committee on Northern Studies, University of Waterloo, Waterloo, Ontario, Canada.
- Brebner, P. (1985) The Alaska Highway. Boston Mills Press, (Erin, Ontario).
- Bright, D.A.; Dushenko, W.T.; Grundy, S.L.; Reimer, K.J. (1995) Evidence for short range transport of polychlorinated biphenyls in the Canadian Arctic using congener signatures of PCBs in soils. *Sci. Tot. Environ.*, 160/161:251-263.
- Broman, D.; Näf, Zebhür, C; Lexén K. (1989) The composition, distribution and flux of PCDDs and PCDFs in settling particulate matter (SPM) - A sediment trap study in the Northern Baltic, *Chemosphere*, 19:445-450.
- Carr, E.R. (1949) Great Falls to Nome: The inland air route to Alaska, 1940-1945. Thesis. University of Minnesota.
- Coates, K.; Morrison, W. (1992) The Alaska Highway in World War II. Norman and London Inc. (University of Oklahoma).
- Creaser, C.S.; Fernandes, A.R.; Al Haddad, A.; Harrad, S.J.; Homer, R.B.; Skett, P.W.; Cox E.A. (1989) Survey of background levels of PCDDs and PCDFs in UK soils. *Chemosphere*, 21:931-938.
- Dushenko, W.T.; Reimer, K.J.; Bright, D.A. (1994) Environmental study of a military installation at Resolution Island, BAF-5. Environmental Sciences Group, Royal Roads Military College, Victoria, British Columbia.
- Dziuban, S.W. (1954) United States military collaboration with Canada in World War II. Office of the Chief of Military History, Dept. of the Army, (Washington DC).
- EPA (1985) Soil screening survey at four Midwestern sites. Westlake, Ohio: Region V. Environmental Services Division, Eastern District Office. EPA-905/4-805-005, June 1985.

- Fowler, Brian (1993) Champagne-Aishihik Klukshu specific claim. Final report field sampling and dioxin/furan analyses. Axys Analytical Services, Victoria, BC Canada.
- Gonzales, M.J.; Jimenez, B.; Fernandez, M.; Hernandez, L.M. (1991) PCBs, PCDDs, and PCDFs in soil samples from uncontrolled burning of waste electrical material for metal reclamation. *Toxicol. Environ. Chem.* 33:169-179.
- Hagenmaier, H; Brunner, H. (1987) Isomerspecific analysis of pentachlorophenol and sodium pentachlorophenate for 2,3,7,8-Substituted PCDD and PCDF at sub-ppb levels. *Chemosphere*, 16:1759-1764.
- Hans-Bastedo, B. (1986) Aishihik Lake resource survey cultural aspects. Yukon Environmentally Significant Areas Series No. 4. Presidents Committee on Northern Studies, University of Waterloo, Waterloo, Ontario, Canada.
- Harrad, S.J.; Jones, K.C. (1992) A source inventory and budget for chlorinated dioxins and furans in the United Kingdom environment. *Sci. Tot. Environ.* 126:89-107.
- Hughes, Owen L. (1990) Surficial geology and geomorphology, Aishihik Lake, Yukon Territory. Geological Survey of Canada, Paper 87-29.
- Kuehl, D.W.; Butterworth, B.C.; DeVita, W.M.; Sauer, C.P. (1987) Environmental contamination by polychlorinated dibenzo-p-dioxins and dibenzofurans associated with pulp and paper mill discharge. *Biomed. Environ. Mass Spec.*, 14:443-447.
- Miyata, H.; Takayama, K.; Ogaki, J.; Kashimoto, T. (1988) Formation of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in typical urban incinerators in Japan. *Toxicol. Environ. Chem.* 16:203-218.
- Nelson, J.G.; Theberge, J.B. (1986) Aishihik Lake Resource Survey institutional aspects. Yukon Environmentally Significant Areas Series No. 5. Presidents Committee on Northern Studies, University of Waterloo, Waterloo, Ontario, Canada.
- Porsild, A.E.; Cody, W.J. (1980) Vascular plants of the continental Northwest Territories, Canada. National Museums of Natural Sciences, National Museums of Canada, Ottawa, Canada.

- Rappe, C.; Buser, H.; Bosshardt, H.P. (1978) Identification of polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in 2,4,5-T-ester formulations and Herbicide Orange. *Chemosphere*, 5:431-438.
- Rappe, C.; Kjeller, L.; Bruckman, P.; Hackhe K-H. (1988) Identification and quantification of PCDDs and PCDFs in urban air. *Chemosphere*, 17:3-20.
- Rappe, C.; Kjeller, L.; Andersson, R. (1989) Analyses of PCDDs and PCDFs in sludge and water samples. *Chemosphere*, 19:13-20.
- Reimer K.J.; Bright D.A.; Dushenko W.T.; Grundy S.L.; Poland J.S. (1993a) The Environmental Impact of the DEW Line on the Canadian Arctic, Volumes One and Two. Prepared by the Environmental Sciences Group at Royal Roads Military College, Victoria, B.C. for the Director General Environment, Department of National Defence.
- Reimer K.J.; Dodd, M.; Dushenko W.T.; Grundy S.L.; Johnston, K (1993b) Environmental Study of Eleven DEW Line Sites. Prepared by the Environmental Sciences Group at Royal Roads Military College, Victoria, B.C. for the Director North Warning Systems Office and Director General Environment, Department of National Defence.
- Reimer K.J.; Bright D.A.; Dodd, M.; Dushenko W.T.; Johnston, K (1993c) Environmental Study of Abandoned DEW Line Sites: I. Five Intermediate Sites from the Western and Central Arctic. Prepared by the Environmental Sciences Group at Royal Roads Military College, Victoria, B.C. for Department of Indian and Northern Affairs Canada and Environment Canada.
- Reimer K.J.; Dodd M.; Dushenko W.T.; Grundy S.L.; Yunker M.B.; Poland J.S. (1991) North Warning System Environmental Study, Volumes One to Three. Prepared by the Environmental Sciences Group at Royal Roads Military College, Victoria, B.C. for the Director North Warning Systems Office.
- Sauchyn, D. (1986) Aishihik Lake Resource Survey abiotic aspects. Yukon Environmentally Significant Areas Series No. 2. Presidents Committee on Northern Studies, University of Waterloo, Waterloo, Ontario, Canada.

- Sauchyn, M.A. (1987) Aishihik Lake Resource Survey grasslands study. Yukon Environmentally Significant Areas Series No. 7. Presidents Committee on Northern Studies, University of Waterloo, Waterloo, Ontario, Canada.
- Scoggan, H.J. (1978) The flora of Canada. National Museums of Natural Sciences, National Museums of Canada, Ottawa, Canada.
- Stalling D.L.; Schwartz T.R.; Dunn W.J.; Wold S. (1987) Classification of polychlorinated biphenyl residues: Isomers vs. homologue concentrations in modeling Aroclors and polychlorinated biphenyl residues. *Anal. Chem.* **59**, 1853-1859.
- Theberge, J.B.; Neslon, J.G.; Fenge T. (1980) Environmentally significant areas of the Yukon Territory. CARC Research Monograph Four. Ottawa, Ontario.
- Wakimoto, T.; Kannan, N.; Ono, M.; Tatsukawa, R.; Masuda Y. Isomer-specific determination of polychlorinated dibenzofurans in Japanese and American polychlorinated biphenyls. *Chemosphere*, 17:743-750.
- Wenning, R.J.; Harris M.A.; Paustenbach D.J.; Bedbury H (1992) Potential sources of 1,2,8,9-tetrachlorodibenzo-p-dioxin in the aquatic environment. *Ecotoxicol. Environ. Safety*, 23:133-146.
- Workman, W.B. (1978) Prehistory of the Aishihik - Kluane Area, Southwest Yukon Territory. National Museums of Canada, (Ottawa, Ontario).
- Zitko V. (1989) Characterization of PCBs by principal component analysis (PCA of PCB). *Mar. Pollut. Bull.* **20**, 26-27.

VII. APPENDICES

- A. Methods
- B. Quality Assurance/Quality Control
- C. Site Descriptions and Sample Locations
- D. Vascular Plant Check List
- E. Inorganic Element Results for Soil and Water
- F. Inorganic Element Results for Vegetation
- G. Inorganic Element and PCB Results for Paint Samples
- H. Aroclor PCB Results for Soil and Water
- I. Aroclor PCB Results for Vegetation
- J. PCB Congener Results for Soils
- K. PCB Congener Results for Vegetation
- L. Aroclor PCB Results for Swabs
- M. Pesticide Results for Soils
- N. Polycyclic Aromatic Hydrocarbon Results for Soils
- O. Acid/Base/Neutral Extractable Organic Compound Results for Soils.
- P. Polychlorinated Dioxin and Furan Results for Soils
- Q. Inorganic Element and PCB Results for Barrel Samples

A. Methods

1. *Field Sampling*

a. Approach

There are two approaches to sampling in large areas. A probabilistic approach, which involves laying out a grid and sampling some number of randomly chosen coordinates, is thorough, but inappropriate due to the size of the site. In the alternative deterministic approach, used in this work, the team generally chose areas likely to be contaminated and sampled near the sources of such contamination. The overall approach was designed to obtain samples that would:

- be representative of the status of the site - samples were obtained from all of the major areas of the site;
- determine the nature and distribution of major chemical contaminants - samples were collected from both stained and non-stained soils; and
- indicate the presence of any contaminant migration within the ecosystem - soil samples from drainage courses and plants to indicate uptake.

In addition, considerable effort was made to obtain background samples remote from the sites and free of any local inputs. The number of samples collected at the site was dependent on the topography and the extent of landfill and spill activity.

b. Soil/Sediment and Water

On arrival at the site, the team familiarized themselves with the area by means of a reconnaissance. Sampling locations were selected and samples collected. Two types of soil samples were collected at most locations. The one designated for inorganic analyses was obtained using a plastic scoop and stored in a Whirl Pak™ bag. Organic samples were collected using a stainless steel scoop (which had been pre-washed, baked and stored in baked aluminum foil to

preclude organic contamination) and placed in a 1 litre amber jar fitted with a Teflon lined lid. These jars were obtained commercially (I-CHEM Ltd.) and were certified free of organic materials. Soil samples were generally restricted to the upper 10 cm and care was taken to obtain representative material.

The samples were shipped by guaranteed air freight to Victoria (for organic analysis) and Queen's University (for inorganic analysis). Upon receipt in the laboratory, the samples were kept frozen while awaiting analysis.

Water samples were collected in acid washed 250 mL polyethylene bottles for inorganic elements analysis and in 1 litre Teflon bottles for PCB analysis. Upon receipt in the laboratory, they were stored at 4 °C until analysis.

Each sample collection was witnessed by at least two team members and in all cases a photographic and video record was made. The sampling location and sample description were independently recorded by the team members, and each sample was sealed and labeled. Co-ordinates of the sample location, where appropriate, were determined using a Garmin Global Positioning System (GPS). Sample containers were labeled with pre-made labels.

c. Swabs

Surface wipe samples were obtained from smooth non-porous surfaces. An adsorbent gauze pad was dampened with hexane by using stainless steel forceps (the forceps had been washed, baked and stored in aluminum foil to preclude organic chemicals). This was then used to wipe a marked 10 x 10 cm surface a single time. The wipe sample was placed in a 125 mL precleaned and baked glass jar, sealed with an aluminum foil-lined lid, labeled, and stored in the dark until analysis (Environment Canada, 1987).

d. Plant Samples

Collection of Vegetation

Higher plants were collected from the same locations as soil samples wherever sufficient material could be obtained. These plants included shrubs, grasses, sedges, and forbs (wildflowers); these provided a representative cross-section of the vegetation potentially encountered and grazed by herbivores. The

plants were collected within a one metre square area of the soil sample and included mostly new-year growth of leaves, stems and root tissue (where possible). A sufficient quantity was collected both for chemical analysis as well as reference for later identification and/or verification. In the case of shrubs, young twigs were collected and a small section of the roots was excavated and subsequently removed. All vegetation samples were placed in air-tight zip-lock bags and stored until processed.

Processing and Identification of Plants

Samples were rinsed in water from Aishihik Lake; only above-ground growth (i.e., leaves and stems) found to be soiled were rinsed. Samples were allowed to dry before packaging. One representative sample of each plant species collected at a site was subdivided into root and shoot sub-samples (where possible). All processed samples were divided into two homogeneous sub-samples for inorganic and organic (PCB) analysis, respectively. Samples designated for inorganic element analysis were placed in plastic zip-lock bags which were subsequently rolled up and double-sealed with tape. Samples for organic analysis were wrapped in aluminum foil, sealed with tape and also placed in zip-lock bags. All samples were immediately frozen and stored as such for later chemical analysis.

Reference samples for identification/verification were keyed out on-site as much as possible (using field guides), and pressed (preserved) for future reference. Plant species were verified using the relevant literature (Scoggan, 1978; Porsild and Cody, 1980)

e. Chain of Custody

In order to conform with regulations regarding sample control, a rigorous chain of custody was maintained. Chain of custody forms were filled out and checked for each sample before shipment from the north, and the contents of shipments were verified upon receipt in the laboratory. The relevant documentation is available on request.

f. Quality Assurance/Quality Control (QA/QC)

One soil field duplicate sample was collected for every ten samples. The soil sample was homogenized and split into two containers which were labeled with consecutive numbers.

Most of the analytical work was contracted out to carefully selected analytical laboratories. QA/QC functions were carried out by means of the standard techniques of blind replicates and spiked samples. A detailed discussion is given in Section B of the Appendices.

2. *Chemical Analysis*

a. Soils

i. *Inorganic Elements*

Samples were analyzed by the Analytical Services Unit of Queen's University. The elements arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), nickel (Ni) zinc (Zn) and mercury (Hg) were determined.

The analyses were carried out using the following procedure. Samples were air-dried and ground to a fine powder with a mortar and pestle; large stones were removed as they would not be expected to contain any anthropogenic environmental pollution. Approximately 0.5 g of this dried material was heated with 2 mL HNO₃ and 6 mL HCl overnight so that the volume was reduced to 1-2 mL. This solution was then made up to 25 mL and analyzed by atomic absorption spectrophotometry (AAS). While it is recognized that the digestion procedure used may not bring all metals into solution (some metals may be locked into silicate minerals), it was felt that the metals released into solution are of greater environmental significance than true total metals. Analyses were done in batches of 36 which comprised 28 samples, 2 blanks, 4 duplicates and 2 samples of reference material (NRC MESS-1).

ii. Acid/Base/Neutral Extractable Suite

Summary

This analysis was carried out by Axys in accordance with USEPA Methods 3540/3650A/8270. The sample was extracted and separated into acid extractable and base/neutral fractions. Each fraction was analyzed by GC/MS. All samples were spiked with surrogate standards (nitrobenzene d5, 2-fluorobiphenyl, terphenyl d14, 2,4,6-tribromophenol, phenol d5 and 2-fluorophenol).

Extraction

Following sample homogenization, a weighed subsample (20 g) of soil was mixed with anhydrous sodium sulphate, ground with a mortar and pestle and placed in a soxhlet thimble. The sample was spiked with aliquots of internal standard solution and solvent extracted for 16-20 hours with dichloromethane. The solvent was collected and reduced in volume prior to splitting into base/neutral and acid fractions.

Separation

The solvent extract was transferred to a separatory funnel and shaken with sodium hydroxide solution. The organic phase was collected for the analysis of base/neutral compounds. The combined aqueous washes were extracted for the acid extractable analysis.

Acid Extractable Fraction

The combined aqueous washes were shaken first with sulphuric acid solution and then extracted into a fresh aliquot of dichloromethane. The acid extract was dried over anhydrous sodium sulphate, reduced and analyzed by GC/MS.

Base/Neutral Fraction

The organic phase containing the base/neutral compounds was dried over anhydrous sodium sulphate, reduced in volume and spiked with an aliquot of recovery standard prior to ampouling and analysis by GC/MS.

Instrumental Analysis

The fractions were analyzed for ABNs by GC/MS. Chromatographic separation was carried out on a DB-5 column (30 m, 0.25 mm i.d. x 0.25 µm film thickness). The mass spectrometer was operated in the total ion monitoring (TIM) mode, scanning between 35 and 400 amu.

iii. PCBs and Pesticides

PCB and pesticides analyses were conducted by Axys Analytical Services Ltd. of Sidney, B.C. Each sample was clearly labeled and locked in a secure frozen storage area until retrieved by the analyst.

All samples were spiked with an aliquot of surrogate standard (2,4,5,6-tetrachloro-m-xylene, PCB 209 and d₄-alpha endosulphan) prior to analysis by gas chromatography with electron capture detection (GC/ECD); for gas chromatography with mass spectrometry (GC/MS), the samples were spiked with aliquots of ¹³C labeled standard (PCB 101, PCB 180, PCB 209 and d₄-alpha endosulphan). Soils were extracted with a solvent on a shaker table. Tissues were ground with sodium sulphate, packed in a glass chromatographic column and eluted with solvent. Water was liquid/liquid extracted with dichloromethane. Sample extracts were separated into three fractions on a Florisil column. The first fraction was analyzed for PCBs as Aroclors, PCB congeners and chlorinated pesticides by GC/ECD or GC/MS. The second and third fractions were analyzed for chlorinated pesticides by GC/ECD.

The sediment sample was thoroughly homogenized and a subsample taken for the determination of wet weight/dry weight ratio.

Wet sediment or a swab sample (10 - 15 g), to which an aliquot of surrogate standard had been added, was extracted once with 80 mL of 1:1 dichloromethane/methanol by shaking on a shaker table for 30 minutes. The extraction procedure was repeated twice more with 80 mL of dichloromethane. The extracts were combined, washed with solvent-extracted water, dried over anhydrous sodium sulphate and concentrated by rotary evaporation. After the addition of activated copper to remove sulphur, the extract was separated on a Florisil column.

Cleanup for GC/ECD

The extract was quantitatively transferred to a Florisil column and eluted with three solvent systems consisting of hexane (Fraction-1), 15/85 dichloromethane/hexane (Fraction-2) and 50/50 dichloromethane/hexane (Fraction-3).

An aliquot of surrogate standard was added to each of Fraction-2 and Fraction-3 to allow quantification since the surrogate standard added at the beginning of the procedure eluted into Fraction-1. Each fraction was concentrated, transferred to a microvial, and an aliquot of recovery standard (4,4'-dibromooctafluorobiphenyl and PCB 204 to Fraction-1 and Fraction-2 and ¹³C-PCB 153 to Fraction-3) added prior to analysis by GC/ECD.

- Fraction-1 was analyzed by GC/ECD for PCBs as Aroclors, PCB congeners, and mildly polar chlorinated pesticides.
- Fraction-2 was analyzed by GC/ECD for moderately polar chlorinated pesticides.
- Fraction-3 was analyzed by GC/ECD for the most polar chlorinated pesticides.

Cleanup for GC/MS

The extract was quantitatively transferred to a Florisil column. The column was eluted with hexane followed by 15/85 dichloromethane/hexane. The eluates were combined (Fraction-1). The column was eluted with 50/50 dichloromethane/hexane (Fraction-2)

Each fraction was concentrated, transferred to a microvial and spiked with an aliquot of recovery standard (¹³C-PCB 153) prior to instrumental analysis.

- Fraction-1 was analyzed by GC/MS for PCBs as Aroclors, PCB congeners, and non-polar and moderately polar chlorinated pesticides.
- Fraction-2 was analyzed by GC/ECD for the most polar chlorinated pesticides.

GC/ECD Analysis

Each fraction was analyzed for pesticides by using a Hewlett Packard (HP) 5830A gas chromatograph equipped with a ^{63}Ni electron capture detector (GC/ECD), a 60 m DB-5 column (0.25 mm i.d. x 0.1 μm film thickness) and an HP 3392 integrator. Fraction-1 was simultaneously analyzed for PCBs as Aroclors and PCB congeners. Chromatographic conditions were as follows - Initial Temp: 100 °C; Injection: splitless, 1 min; Initial time: 2 min; Ramp: 10 °C/min to 150 °C, 3 °C/min to 300 °C; Final time: 5 min. Column conditions were: Carrier gas, helium; Pressure: 21 psi; Flow rate: 60 mL/min; and Split ratio: 15:1.

The instrument was calibrated daily using a solvent blank and standards of Aroclor 1242, Aroclor 1254 and Aroclor 1260. For each Aroclor, the sum of the areas of three characteristic peaks was used to calculate its response factor against the internal standard. The area of the same three peaks was used to determine the concentration of each Aroclor in the sample.

All values reported in the tables are in ppb (ng/g) on a dry weight basis for soil samples and on a wet weight basis for plant samples. Procedural blank information is given in Chapter III; the levels obtained demonstrated no blank interferences with the sample results.

PCBs were also quantified as individual congeners by calibrating the GC/ECD response with four well characterized mixtures of 51 congeners (total) obtained from the National Research Council (NRC), Halifax, NS. Aroclor mixtures of known composition were used for some congeners not present in the NRC mixtures.

Low Resolution GC/MS

Fraction-1 was analyzed for PCB congeners, Aroclors and non-polar and moderately polar chlorinated pesticides using a Finnigan INCOS 50 mass spectrometer equipped with a Varian 3400 GC, a CTC autosampler and a DG 10 data system running INCOS 50 (Rev 9) software. Chromatographic separation of pesticides was achieved with a 60 m DB-5 column (0.25 mm i.d. and 0.10 μm film thickness). The mass spectrometer was operated in the electron impact (EI) mode at unit mass resolution in the multiple ion detection (MID) mode acquiring two characteristic ions for each target analyte and surrogate standard.

High Resolution GC/MS

For high resolution GC/MS analysis, a VG 70 SE mass spectrometer equipped with a Hewlett Packard 5890 GC, a 60 m DB-5 chromatographic column (0.25 mm i.d. and 0.10 μ m film thickness) and a CTC autosampler was used. Data was acquired in the MID mode to enhance sensitivity. Two characteristic ions for each target analyte and surrogate standard were monitored.

iv. Polycyclic Aromatic Hydrocarbons

Summary

All samples were spiked with an aliquot of perdeuterated PAH surrogate standards (acenaphthene, chrysene, naphthalene, perylene, phenanthrene, pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene) prior to analysis. Sediments were ground with sodium sulphate, packed into a glass chromatographic column and eluted with solvent. The extracts were separated on a silica gel column and analyzed for PAHs by GC/MS.

Extraction

The sediment sample was thoroughly homogenized and a subsample dried for moisture content determination.

A portion of the sediment sample (10 - 15 g wet), which had been spiked with an aliquot of surrogate standard, was ground with anhydrous sodium sulphate to a free flowing powder. This powder was transferred to a glass chromatographic column containing methanol and eluted with additional methanol followed by dichloromethane. Isooctane was added to the eluate and back washed with potassium hydroxide and solvent extracted water. The resulting solution was dried over anhydrous sodium sulphate, concentrated in a Kuderna Danish flask and cleaned on a silica gel column.

Column Cleanup

The sample extract was loaded onto a silica gel column and eluted with pentane (discarded) followed by dichloromethane. The dichloromethane fraction was concentrated in a Kuderna Danish flask and an aliquot of recovery standard

(containing benzo(b)fluoranthene d-12, fluoranthene d-10, and acenaphthylene d-8) was added. The extract was then transferred to a microvial, concentrated under a stream of nitrogen and analyzed by GC/MS.

Instrumental Analysis

The concentrated extracts were analyzed for PAHs by gas chromatography with detection by mass spectrometer (GC/MS). The GC/MS system consisted of a Finnigan INCOS 50 mass spectrometer equipped with a Varian 3400 gas chromatograph which had a CTC autosampler and a DG 10 Data system. Chromatographic separation was carried out using a Restek_x-5 column (30 m, 0.25 mm i.d. x 0.25 µm film thickness). The mass spectrometer was operated in the electron impact (EI) mode (70 eV) using multiple ion detection (MID) to enhance sensitivity, acquiring two characteristic ions for each target analyte and surrogate standard. A split/splitless injection sequence was used.

v. Dioxins and Furans

All samples were spiked with an aliquot of ¹³C-labeled surrogate standard solution (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran and octachlorodioxin) prior to analysis. Each soil sample was ground with sodium sulphate and soxhlet extracted. The extracts were subject to a series of cleanup steps and then analyzed by high resolution mass spectrometric detection.

Extraction

Samples were homogenized and a subsample of soil was dried for moisture determination. A wet soil sample was ground with sodium sulphate to a free-flowing powder. The mixture was loaded onto a soxhlet thimble, an aliquot of surrogate standard solution added and the soxhlet refluxed with acetone:toluene for 16-20 hours. The cooled extract was sequentially washed with potassium hydroxide solution, distilled water, concentrated sulphuric acid and distilled water. The organic layer was dried over anhydrous sodium sulphate, the solvent evaporated to dryness and redissolved in hexane.

Column Chromatography

The extract was transferred to 10 g layered silica gel columns (neutral:basic:neutral:acidic:neutral) and eluted with hexane. The eluate was loaded onto a 10 g basic alumina column and eluted with 3% dichloromethane:hexane followed by 1:1 dichloromethane:hexane. The latter extract was loaded onto a carbone celite column. The first fraction (F1), which eluted with 1:1 cyclohexane:dichloromethane followed by 1:1 toluene:ethyl acetate was discarded. The column was then inverted and eluted with toluene. This fraction was evaporated to near dryness and then redissolved in hexane and loaded onto an alumina column. The first fraction, eluted with 3% dichloromethane:hexane was discarded. The next fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated to 1 mL.

Gas Chromatography/Mass Spectrometry (GC/MS)

The 1 mL hexane solution was evaporated just to dryness and an aliquot of recovery standard solution (^{13}C -labeled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin) was added. The analysis was carried out on a VG 70 SE mass spectrometer equipped with an HP 5890 GC using a 60 m DB5 column (0.25 mm i.d $\times$ 0.1 μm film thickness) and a CTC autosampler. Data were acquired in the voltage selected ion recording (SIR) mode to enhance sensitivity. At least two ions were monitored for each group of isomers. Two ions were used to monitor each of the ^{13}C -labeled surrogate standards and five additional ions were monitored to check for interference from chlorinated diphenyl ethers.

b. Plants

i. Inorganic Elements

The plant specimens were dried in an oven overnight at 70 °C and ground in a mill to pass through a 1 mm sieve. Approximately 1.0 g of dried sample was then weighed into a 100 mL beaker, 20 mL of nitric acid was added and the mixture heated for 1 h. Perchloric acid (10 mL) was added and heating continued until the volume was reduced to about 1-2 mL. The digest was then made up to 25 mL and analyzed by AAS as for soils. Analyses were done in sets of 20 samples

comprising 15 samples, 3 duplicates, one blank and one reference material (NBS1547 Peach Leaves or NBS 1515 Apple Leaves).

ii. Aroclor PCBs

The wet tissue was homogenized and a subsample was dried for the determination of wet weight/dry weight ratio.

Homogenized wet tissue (5 - 10 g), anhydrous sodium sulphate and an aliquot of surrogate standard were ground with a glass mortar and pestle to a free-flowing powder. This powder was transferred to a glass chromatographic column containing dichloromethane/hexane and eluted with additional solvent at 3 - 5 mL/min. The eluate was subsampled for gravimetric lipid analysis and concentrated by rotary evaporation. The concentrate was placed on a calibrated Biobead SX-3 gel permeation column and eluted with dichloromethane/hexane. The 140 - 280 mL fraction was collected and evaporated to a small volume, prior to separation on a Florisil column.

The method of analysis for the extracts was identical to that for the soil extracts.

c. Barrel Contents

Many of the samples were found to contain two phases. The upper phases were generally organic in nature while lower ones were aqueous. Single phase samples were initially examined to classify them as organic or aqueous. This was achieved by running FTIR spectra.

The organic samples were analyzed to determine the relative amounts of fuel oil and lubricating oil and grease so as to provide information that would be useful for the subsequent incineration of these oils; incineration of lubricating oils alone can be difficult. In addition these samples were analyzed for PCB, total chlorine content, cadmium, chromium and lead.

Organic analysis for identification of oils was performed by gas chromatography with flame ionization detector (GC/FID); only mixtures of petroleum products were found. PCBs were determined by GC/ECD after appropriate cleanup to permit accurate quantitation. Chlorine content was determined

by neutron activation analysis (NAA) using the SLOWPOKE reactor at Royal Military College in Kingston. Metals in the organic fractions were determined by spark source atomic emission spectrophotometry except in cases where the liquids had low flash points in which case acid dissolution / atomic absorption spectrophotometry was employed.

The aqueous samples were analyzed for their water and ethylene glycol contents. They were also examined for total chlorine content and to see if they contained other organic compounds in appreciable quantities as well as their total chlorine content.

Fourier transform infrared spectroscopy was employed to screen for organic components in the aqueous phases. As none were found no other work was required.

d. Wall Swabs

i. Aroclor PCBs

The wall swabs were analyzed for PCBs using a method identical to that given above for soils.

3. *Principal Components Analysis (PCA)*

It is often difficult to glean information on overall trends in large, often confusing data sets with many variables such as the 47 PCB congeners analyzed in this study. Principal Components Analysis (PCA) is a multivariate technique which allows the identification of patterns and trends in such data, and provides clues to the underlying causes of these patterns. A principal component analysis provides a much smaller number of principal components which are linear combinations, and capture the sample-to-sample variation of the original variables. Analysis of the scores of the original samples on the first few principal components provides a strong visual comparison of the overall similarities of the samples, i.e. how strongly they were correlated based on simultaneous examination of *all* of the original variables. **The closer together individual samples plot on their principal components, the greater their overall similarity.** A visual inspection of the loadings of variables on the first few principal components shows the relative similarities of the original variables; in other words, which variables tended to explain similar across-sample variation.

Those variables which ultimately have the highest absolute loading values on a given principal component are the ones which contribute the most to overall differences between individual samples (Stalling et al., 1987; Zitko, 1989).

PCA was performed on the PCB congener data for soil and plant samples collected from Aishihik Airstrip using the statistical software package SYSTAT 5.0™. Analytical data for standard commercial PCB mixtures (Aroclor 1254, 1260) were also included in the model as a comparison of PCB "fingerprints" or signatures which could be compared to that of PCB-containing fluids originally used at the sites. This also provided an indication of changes to their original composition since their introduction into the environment.

Only congeners which were detectable in 30% or more of the samples were used in the PCA model. A total of 42 of the 47 congeners were selected for the model based on the above criteria. The data were treated in the following fashion before the PCA model was run:

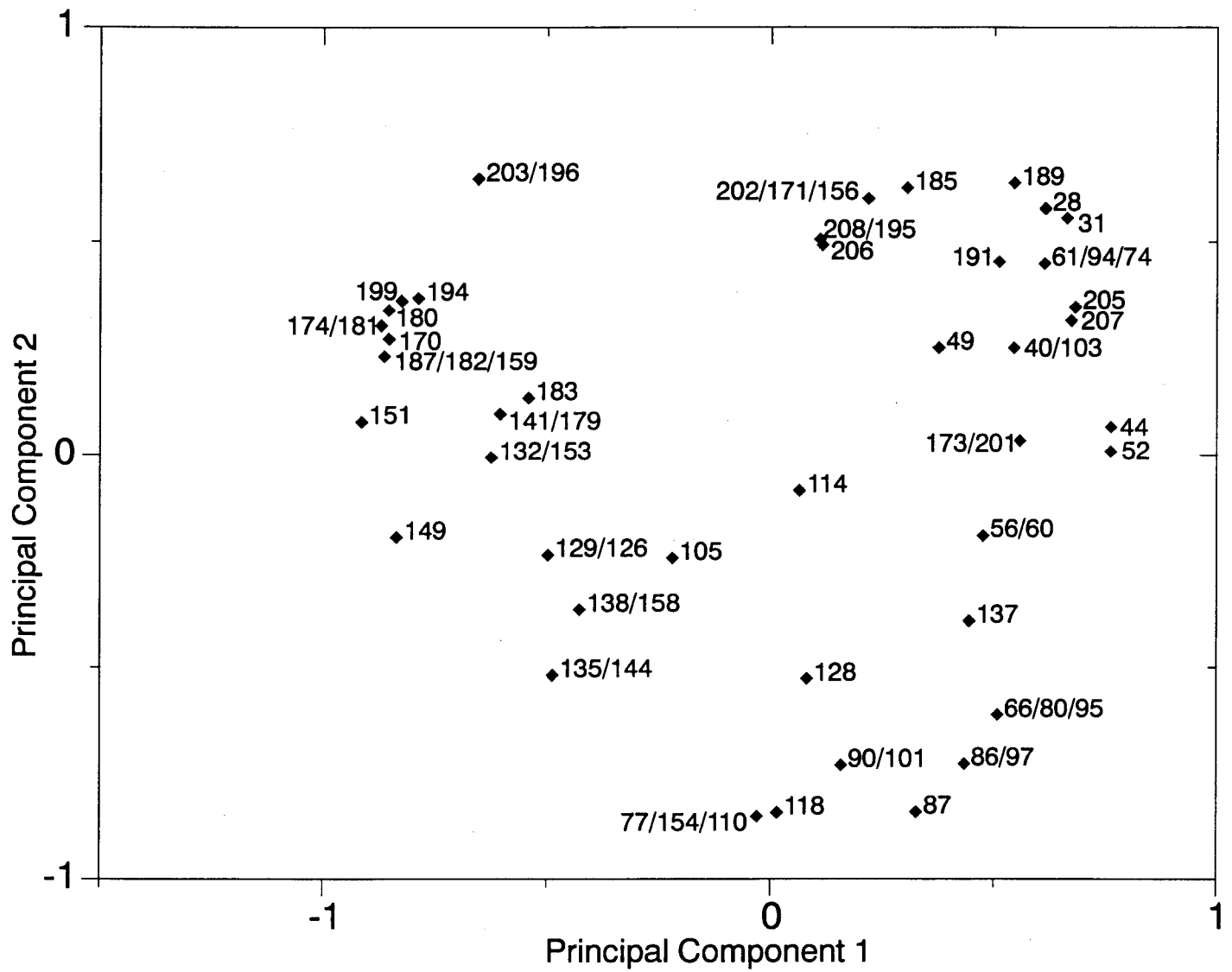
- peaks observed but not quantified (NDR) were converted to their estimated values;
- values quoted as less than detection were converted to a random number between zero and half the detection limit; and,
- the data for each sample was unit normalized, mean centred (by subtracting the mean) and scaled (by dividing by the standard deviation).

The first three principal components of the resulting PCA model accounted for approximately 65% of the original variation within the data set. Loadings of the 42 congeners are shown in Figure B-1. It can be observed from this plot the lightest and heaviest congeners project in the upper right on this plot. If samples project in this upper right area, then congener signatures must be studied to see if the sample is weighted with heavy or light congeners.

A principal component analysis was also carried out on the results from dioxin and furan analysis. In this case, the total concentration for each isomeric set was used i.e., dioxins and furans consisting of four, five, six, seven and eight chlorines, resulting in eight variables. In addition to the three soil samples analyzed in this study, thirteen additional samples were selected from the

literature that represent a broad range of possible sources and sinks for dioxins and furans. The data were prepared for analysis in the same fashion as that described above for PCBs. The first three principal components accounted for 35%, 20% and 17% of the variation in the data set.

Figure B-1: Loading Plots for PCB Congeners on the First Two Principal Components.



B. Quality Assurance/Quality Control

An internal quality assurance/quality control program was implemented to allow the monitoring of data quality on an ongoing basis. All samples were given sequential, numerical codings before submission to the analytical firm; these codings masked any information concerning the site location, sample type (for instance, whether it came from a stain, landfill etc.) or possible concentration. Aspects of the QA/QC program and the results are discussed below.

1. *QA/QC for Inorganic Analysis*

a. Accuracy

Queen's University ASU monitored accuracy internally using three replicates of NRC Canada Certified Sediment Material BCSS-1 (Table B-1a). These were run concurrently with sample batches throughout the analytical program. Good agreement with the certified values was obtained for all elements, with the exception of chromium. Agreement for chromium is still considered acceptable, however, since the results for the reference material were consistently low, indicating that the discrepancy is most likely due to the digestion method.

Similar internal monitoring was employed for the analysis of plants using one sample of NBS 1515 APPLE LEAVES (Table III-3). This standard has been certified for copper, nickel, lead, zinc and arsenic. Only copper and zinc, however, were present in these standards at concentrations which were detectable, and good agreement with the certified values was obtained in both cases. The concentrations of nickel, lead and arsenic in the leaf standards determined by ASU and the certified values were all below the detection limits for ASU, as were the certified value and do, therefore, represent the best possible agreement which could be obtained.

b. Precision/Repeatability

Precision was monitored externally by the ESG using six pairs of soil duplicates, which were homogenized in the field and submitted as separate samples (blind) to ASU for analysis (Table B-2). In the case of one pair only one of the samples was analyzed. The average relative standard deviations or coefficients of variation (standard deviation divided by the mean) were expressed

as percentages and used as part of the evaluation of laboratory precision. Acceptable limits are generally considered to be less than 30% relative standard deviation, with 20% or less considered good agreement. The average relative standard deviations for inorganic elements in soil were approximately 20% or lower indicating good agreement between the sample pairs and, therefore, good laboratory precision through the analytical program (Table B-2).

In addition to the use of blind field duplicates, internal monitoring of precision was carried out by ASU through the use of analytical replicates. Seven soil samples and two plant samples were analyzed in duplicate (Table B-3). Precision for analytical duplicates is expected to be better than for field duplicates due to errors resulting from unavoidable sample heterogeneity. The average relative standard deviations for inorganic elements were all below 15% for the soil analytical replicates, and are considered to be well within acceptable limits; concentrations of cadmium and mercury were below detection in all of the samples (Table B-3).

Only copper, zinc and chromium were detected in the two plant samples analyzed; levels for all other elements were below detection. Average relative standard deviations for copper and zinc were 20% or less for the plant analytical duplicates indicating good precision. The value for chromium was somewhat higher (32%) and was considered fair, but still acceptable in terms of repeatability.

2. *QA/QC for PCB Analysis*

The QA/QC protocol utilized by Axys Analytical Services Ltd. (Axys) for PCBs consisted of the batch method, whereby samples were worked up in batches with associated quality control samples. Each batch consisted of nine samples, along with one QA/QC sample (externally certified or internal spiked reference material), one analytical duplicate and a procedural blank. Spiked material was also used in cases where analytical results were anticipated to be outside of the concentration ranges of the available certified reference materials. Each batch was carried through sample workup, instrumentation and interpretation as a unit, and the sample results were interpreted in relation to the associated QA/QC results. All QA/QC data from each batch were considered together in order to evaluate the overall quality of the analytical program. The results of the organic QA/QC

program are discussed below, and the QA/QC data from Axys is summarized in Tables B-4 through B-17.

a. Accuracy

Axys monitored the accuracy of PCB analysis of soils and plants internally, using NRC Certified Marine Reference Sediment HS-1 (for Aroclor 1254) for soils and N.I.S.T. Certified Reference Material 1588 for plants (all three Aroclor mixtures); these were analyzed twice and once, respectively (Table B-4). Excellent agreement (100%) was found for one of the soil reference materials analyzed, whereas the second was slightly low (73%); overall, however, reasonably good accuracy was obtained. A good level of accuracy was also obtained for the plant reference material in which determined values for the three Aroclor mixtures fell within 20% of the certified values.

Additional monitoring for accuracy was performed by analyzing internal spiked material for soils (18 times), plants (twice), swabs (four times) and water (once) (Table B-5). Good agreement was found on average for Aroclors 1242 (100%), 1254 (82%) and 1269 (89%) indicating good accuracy for soil analyses throughout the analytical program. Accuracy for the analysis of Aroclor mixtures in the spiked material for plants, swabs and water also ranged from good to excellent overall with average recoveries ranging between 70 and 111% (Table B-5).

Accuracy in analysis of PCB congeners in soils was monitored using internal spiked reference material which was previously determined for nine chlorinated biphenyls: congeners 18, 31, 28, 52, 66/80/95, 118, 138/158, 180 and 203/196. These were analyzed twice during the analytical program (Table B-6). Good to fair agreement was found for each of the congeners analyzed, with average recovery values ranging between 84 and 129%.

Interferences for PCB analysis as Aroclors were monitored internally throughout the program using 19 soil blanks, four plant blanks, one water blank and four wall swab blanks (Table B-7). None of these blanks contained detectable Aroclor mixtures. Similar monitoring for interferences was performed for PCB congener analysis using two soil blanks and one plant blank (Table B-8). Only the

two soil blanks contained detectable concentrations for a single congener: 206. All other congeners in these soil blanks and the plant blank were below detection.

b. Precision/Repeatability

Precision was monitored externally by the ESG using seven pairs of soil sample duplicates which were homogenized in the field during collection and submitted blind to Axys for analysis (Table B-9). In the case of two pairs only one of the samples was analyzed; three of the other pairs were below detection. The average relative standard deviation, expressed as a percentage, was 34% and was considered fair in relation to the acceptable limit of 30%. As mentioned previously, there is a greater tolerance for variability between field duplicates than between analytical duplicates.

Precision was also monitored internally by Axys, through the use of 11 soil analytical replicates and one plant analytical replicate (Table B-10); five of the plant duplicates were found to contain PCBs below detection. The average relative standard deviation, or coefficient of variation (standard deviation divided by the mean), for the remaining soil duplicates was 20% which represents a variability within acceptable limits. The concentrations of PCBs in the one pair of plant duplicates were also below detection.

c. QA/QC Aspects of Principal Components Analysis (PCA) for PCBs

Although PCA was used as a tool for PCB congener data analysis and interpretation (see Methods, Section A), the plots or projections produced by this technique also served an important quality assurance function in the analysis for PCBs. If congeners were missed or incorrectly assigned at the chemical analysis or data coding stage, the result would be a sample with a highly unusual pattern (and hence projection); the error could then be found and corrected. This reduced number of replicate samples that needed to be coded for congeners, and reduced costs without compromising quality. The distance or separation between sample analytical replicates in a given plot also provided a good measure of analytical variation and precision.

The PCA projections of two pairs of analytical replicates and are shown along with other samples Figure V-2 of Chapter V. The original soil congener and Aroclor formulation analytical replicate results are presented in Table B-11.

Small separations or distances between most samples with the same number in the plot indicated good analytical precision for congeners in soils (Figure V-2). The separations for these duplicates were small compared to the differences between the Aroclor formulations, and indicated that the PCA technique provided a suitable tool for assessing and interpreting the PCB data from the sites.

3. *QA/QC for Organochlorine Pesticides*

a. Accuracy

Accuracy was monitored internally by Axys using spiked soil reference material which was analyzed three times during the analytical program (Table B-12). Average recoveries for organochlorine compounds ranged between 58 and 136%, indicating fair to poor analytical accuracy ($\pm 20\%$).

Interferences were checked internally by Axys through the use of analytical blanks (Table B-13). Three blanks were analyzed; values for nearly all organochlorine concentrations were below the detection limits.

b. Precision/Repeatability

Precision was also monitored internally by Axys through the use of one analytical duplicate for soils (Table B-13). Good agreement was found between the four compounds which were detectable in the sample and indicated good precision.

4. *QA/QC for Polycyclic Aromatic Hydrocarbons (PAHs)*

a. Accuracy

Axys monitored accuracy for the PAH analysis of soils using Certified N.I.S.T. Marine Reference Sediment HS-6 (Table B-14). This reference material was analyzed twice during the analytical program. Good agreement with the available certified values was found for most of the compounds analyzed, with the exception of acenaphthene.

Interferences for PAHs were monitored internally throughout the analytical program using two analytical blanks (Table B-15). Interferences were

found in several of the blanks; most of these, however, were close to the detection limits and therefore minor.

b. Precision/Repeatability

The precision of the PAH analysis was monitored internally using one pair of analytical duplicates of soil samples (Table B-15). Reasonable agreement was found for all of the compounds analyzed, including those which could not be adequately quantified due to interferences, indicating good analytical precision.

5. *QA/QC for Polychlorinated Dibenzo Dioxins and Dibenzo Furans*

a. Accuracy

Accuracy was monitored by Axys using a sample of internal spiked reference material for soils (Table B-16). Recoveries for the various dioxin and furan compounds ranged from 75 and 112% indicating good to excellent accuracy in analysis ($\pm 20\%$ is usually the acceptable range). Surrogate standard recovery results for this spiked material are also provided in this same table.

Interferences for dioxin and furan compounds were monitored using a soil blank presented in Table B-17; results for all compounds were below detection. Surrogate recoveries are also provided near the bottom of this table.

b. Precision/Repeatability

Analytical duplicates were not included as part of the dioxin/furan analysis due to the small number of samples analyzed. Precision, therefore, could not be monitored.

Table B-1a: Summary of Inorganic Element Analysis Results for Soil Internal Standards (NRC Certified Sediment Material BCSS-1)

Element	Certified Value	Average Found (n=3)	
Concentrations in $\mu\text{g/g}$ or ppm			
Cu	18.5 ± 2.7	20	± 1.9
Ni	55.3 ± 3.6	51	± 2.5
Co	11.4 ± 2.1	13.1	± 1.2
Cd	0.25 ± 0.04	<1.0	-
Pb	22.7 ± 3.4	21	± 3.8
Zn	119 ± 12	116	± 12.1
Cr	123 ± 14	85	± 8.5
As	11.1 ± 1.4	9.8	± 1.0
Hg	0.129 ± 0.012	<0.1	-

Table B-1b: Inorganic Element Analysis Results for Plant Tissue Internal Standards (NBS 1515 APPLE LEAVES, n=1)

Element	Certified Value	Determined Value
Concentrations in $\mu\text{g/g}$ or ppm		
Cu	5.64 ± 0.24	6.1
Ni	0.91 ± 0.12	<5
Co	-	<5
Cd	-	<0.5
Pb	0.47 ± 0.024	<15
Zn	12.5 ± 0.3	12.9
Cr	-	<10
As	0.038 ± 0.007	<0.2
Hg		<0.1

Table B-2: Inorganic Results for Duplicate Soil Samples Collected in the Field

Sample	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
ppm										
AA129	16.6	15.1	12.1	<1.0	<10	64	59	11.9	<0.1	Background 13 km distant
AA130	12.7	11.4	7.7	<1.0	<10	84	40	11		Background 13 km distant
Std.Dev.	2.8	2.6	3.1	-	-	14.1	13.4	0.4		
Rel.Std. Dev.	18.8	19.7	31.4	-	-	19.1	27.1	3.0		
AA105	12.7	9.1	11.1	<1.0	<10	44	28	10.7	<0.1	20 m NW of powerhouse
AA106	7	10.7	6.4	<1.0	<10	50	29	10.1	<0.1	20 m NW of powerhouse
Std.Dev.	4.0	1.1	3.3	-	-	4.2	0.7	0.4		
Rel.Std. Dev.	40.9	11.4	38.0	-	-	9.0	2.5	4.1		
AA149	30	18.7	9.5	<1.0	10.8	82	37	11.7	<0.1	Central area in Dump Site 3
AA150	25	17.9	9.7	<1.0	<10	73	34	10.9	<0.1	Central area in Dump Site 3
Std.Dev.	3.5	0.6	0.1	-	-	6.4	2.1	0.6		
Rel.Std. Dev.	12.9	3.1	1.5	-	-	8.2	6.0	5.0		
AA146	11.5	8.9	5.6	<1.0	<10	92	25	6.5	<0.1	60 m W of powerhouse, transformer plates
AA147	11.5	10.7	6	<1.0	<10	83	26	5.9	<0.1	60 m W of powerhouse, transformer plates
Std.Dev.	0	1.3	0.3	-	-	6.4	0.7	0.4		
Rel.Std. Dev.	0	13.0	4.9	-	-	7.3	2.8	6.8		
AA018	14	11	9	<1.0	<10	56	<15	4.4	<0.2	Beside transformer casing, ~50 m N of Garage
AA019										Beside transformer casing, ~50 m N of Garage
Std.Dev.	-	-	-	-	-	-	-	-	-	
Rel.Std. Dev.	-	-	-	-	-	-	-	-	-	
AA133	12.2	8.8	7.1	<1.0	<10	38	27	4.5	<0.1	Depression adjacent to aircraft refueling points
AA134	7.9	7.4	5.7	<1.0	<10	32	31	7.9	<0.1	Depression adjacent to aircraft refueling points
Std.Dev.	3.0	1.0	1.0	-	-	4.2	2.8	2.4		
Rel.Std. Dev.	30.3	12.2	15.5	-	-	12.1	9.8	38.8		
Average	20.6	11.9	18.2	-	-	11.1	9.6	11.5	-	
Std.Dev.	15.8	5.9	16.1	-	-	4.8	10.2	15.3	-	

Table B-3a: Inorganic Element Results for Soil and Plant Analytical Replicates

Sample	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
ppm										
a) Soils										
104	15.7	10.6	8.9	<1.0	<10	71	32	6.3	<0.1	20 m N of generator building
104	16.6	8.7	8	<1.0	<10	83	39	7.2	<0.1	
Std.Dev.	0.6	1.3	0.6	-	-	8.5	4.9	0.6	-	
Rel.Std.Dev.	3.7	13.9	7.5	-	-	11.0	13.9	9.4	-	
113	7.1	<5.0	<5.0	<1.0	<10	25	<20	5.9	<0.1	Grid sample, S side of generator building
113	6.3	6	<5.0	<1.0	<10	22	<20	6	<0.1	
Std.Dev.	0.6	-	-	-	-	2.1	-	0.1	-	
Rel.Std.Dev.	8.4	-	-	-	-	9.0	-	1.2	-	
116	15.3	<5.0	6.7	<1.0	204	210	26	6.1		15 m W of centre of garage
116	14.7	6.2	8	<1.0	197	182	25	4.6		
Std.Dev.	0.4	-	0.9	-	4.9	19.8	0.7	1.1		
Rel.Std.Dev.	2.8	-	12.5	-	2.5	10.1	2.8	19.8		
129	14.9	15.6	10.8	<1.0	<10	70	65	12	<0.1	Background 13 km distant
129	18.4	14.6	13.4	<1.0	<10	57	53	11.7	<0.1	
Std.Dev.	2.5	0.7	1.8	-	-	9.2	8.5	0.2	-	
Rel.Std.Dev.	14.9	4.7	15.2	-	-	14.5	14.4	1.8	-	
138	6.3	<5.0	5.7	<1.0	<10	14.5	<20	1.8	<0.1	Old power site: 8 m N of transformer
138	8.3	<5.0	6	<1.0	<10	14.6	<20	2.3	<0.1	
Std.Dev.	1.4	-	0.2	-	-	0.1	-	0.4	-	
Rel.Std.Dev.	19.4	-	3.6	-	-	0.5	-	17.2	-	
142	31	17.4	10.8	<1.0	600	98	34	18.7		Adjacent to broken batteries in Dump Site 3
142	29	22	10.6	<1.0	430	73	49	12.7		
Std.Dev.	1.4	3.3	0.1	-	120.2	17.7	10.6	4.2		
Rel.Std.Dev.	4.7	16.5	1.3	-	23.3	20.7	25.6	27.0		
151	6.4	8.8	<5.0	<1.0	<10	35	<20	6.4	<0.1	N side of burned building (tar in vicinity)
151	5.4	8.3	<5.0	<1.0	<10	31	<20	6.9	<0.1	
Std.Dev.	0.7	0.4	-	-	-	2.8	-	0.4	-	
Rel.Std.Dev.	12.0	4.1	-	-	-	8.6	-	5.3	-	
Average	9.4	9.8	8.0	-	12.9	10.6	14.2	11.7	-	
Std.Dev.	6.3	6.3	5.8	-	14.8	6.1	9.3	9.9	-	

Table B-3: Inorganic Element Results for Soil and Plant Analytical Replicates (Cont.)

Sample	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
						ppm				
b) Plants										
020P	8.4	<5	<5	<0.5	17.1	394	17.4	<0.2		In Landfill close to AA024 & 025
020P	6.7	<5	<5	<0.5	<15	387	12.5	0.2		
Std.Dev.	1.2	-	-	-	-	4.9	3.5	-		
Rel.Std.Dev.	15.9	-	-	-	-	1.3	23.2	-		
151P	9.2	19.2	<5	3.3	<15	193	86	0.3		N side of burned building (tar in vicinity)
151P	6.5	14.6	<5	3.1	<15	180	47	0.5		
Std.Dev.	1.9	3.3	-	0.1	-	9.2	27.6	0.1		
Rel.Std.Dev.	24.3	19.2	-	4.4	-	4.9	41.5	35.4		
Average	20.1	-	-	-	-	3.1	32.3	-	-	
Std.Dev.	5.9	-	-	-	-	2.6	12.9	-	-	

Table B-4: Determination of PCBs (Aroclors) in Sediment and Plant Reference Material

a) NRC Certified Marine Reference Sediment HS-1 (Aroclor 1254)

Sample	Determined ppb	Certified Value.	Recovery %
CRM 154	16	22 ± 1.1	73
CRM 153	22	22 ± 1.1	100

b) N.I.S.T. Certified Reference Material 1588 for Plants

		Aroclor 1242			Aroclor 1254			Aroclor 1260		
Sample	Sample Size	Det.	Certified ppb	% Recovery	Det.	Certified ppb	% Recovery	Det.	Certified ppb	% Recovery
TCRM 173	0.49 g	140	150 +/- 60	93	1600	1500 +/- 500	107	1000	840 +/- 210	119

Table B-5: Determination of PCBs (Aroclors) in Internal Spiked Material

a) Soils

Sample I.D.	Sample Size (g)	<u>AROCLOR 1242</u>			<u>AROCLOR 1254</u>			<u>AROCLOR 1260</u>		
		Det.	Expected	Recovery	Det.	Expected	Recovery	Det.	Expected	Recovery
		ppb		%	ppb		%	ppb		%
SOILS										
SPM 193	10.00	49	45	109	45	46	98	45	46	98
SPM 201i3	10.00	49	45	109	40	46	87	40	46	87
SPM187	N/A	41	45	91	31	46	67	42	46	91
SPM 189i	10.00	41	45	91	39	46	85	46	46	100
SPM 199	10.00	48	45	107	36	46	78	37	46	80
SPM 203	10.00	44	45	98	30	46	65	34	46	74
SPM 196 i	10.00	40	45	89	38	46	83	42	46	91
SPM 200	10.00	45	45	100	33	46	72	34	46	74
SPM 198 (895)	10.00	45	45	100	36	46	78	41	46	89
SPM 198-(896)	10.00	45	45	100	36	46	78	41	46	89
SPM 201 i3	10.00	49	45	109	40	46	87	40	46	87
SPM 195	10.00	38	45	84	31	46	67	33	46	72
SPM 225 i	10.00	46	46	100	40	45	89	50	45	111
SPM 219 i	10.00	51	45	113	36	46	78	36	46	78
SPM 224	10.00	44	45	98	43	46	93	38	46	83
SPM 291	10.00	43	45	96	43	46	93	47	46	102
SPM 311	10.00	46	45	102	45	46	98	46	46	100
SPM 321	10.00	45	45	100	35	46	76	42	46	91
n = 18		Average 100 ± 8			Average 82 ± 10			Average 89 ± 11		

b) Plants

Sample I.D.	Sample Size (g)	<u>AROCLOR 1242</u>			<u>AROCLOR 1254</u>			<u>AROCLOR 1260</u>		
		Det.	Expected	Recovery	Det.	Expected	Recovery	Det.	Expected	Recovery
		ppb		%	ppb		%	ppb		%
SPB 286-896	10.00	50	45	111	32	46	70	34	46	74
SPB 286-895	10.00	50	45	111	32	46	70	34	46	74
n = 2		Average 111			Average 70			Average 74		

Table B-5: (Cont.)

c) Swabs

Sample I.D.	Sample Size (g)	<u>AROCLOR 1242</u>			<u>AROCLOR 1254</u>			<u>AROCLOR 1260</u>		
		Det.	Expected	Recovery	Det.	Expected	Recovery	Det.	Expected	Recovery
		ppb	ppb	%	ppb	ppb	%	ppb	ppb	%
SPM 211	1	430	450	96	480	460	104	440	460	96
SPM 185	1	380	450	84	300	460	65	380	460	83
SPM 186	1	520	450	116	280	460	61	370	460	80
SPM 188	1	410	450	91	300	460	65	340	460	74
n = 4		Average 97 ± 13			Average 74 ± 20			Average 83 ± 9		

d) Water

Sample I.D.	Sample Size (litre)	<u>AROCLOR 1242</u>			<u>AROCLOR 1254</u>			<u>AROCLOR 1260</u>		
		Det.	Expected	Recovery	Det.	Expected	Recovery	Det.	Expected	Recovery
		ppb	ppb	%	ppb	ppb	%	ppb	ppb	%
CL-W-SPM 227 i	1.0	440	433	102	400	418	96	310	423	73

Table B-6: Determination of PCB Congeners in Internal Spiked Reference Material for Soils

Sample Sample size (g dry)	CL-S-SPM195			CL-S-SPM 224			Average %	Std. Dev
	10.00			10.00				
	Determined ppb	Expected	Recovery %	Determined ppb	Expected	Recovery %		
Compounds								
18	2.7	3.4	79	3	3.4	88	84	6
31	2.6	2.7	96	2.8	2.7	104	100	5
28	3.4	2.8	121	3.8	2.8	136	129	10
52	3.2	3.5	91	3.6	3.5	103	97	8
66/80/95	4.6	5.9	78	5.1	5.9	86	82	6
118	3.5	3.4	103	3.9	3.4	115	109	8
138/158	6.3	7.8	81	7.4	7.8	95	88	10
180	3.9	4.2	93	4.4	4.2	105	99	8
203/196	0.82	0.84	98	0.92	0.84	110	104	8

Table B-7: Analytical Blanks for PCBs (Aroclors)

Sample I.D.	Sample Size	AROCLOR 1242 ppb	AROCLOR 1254 ppb	AROCLOR 1260 ppb
	g dry			
<i>1. Soil Analytical Blanks</i>				
CL-S-BLK 250	9.50	<0.68	2.2	0.48
895-CL-S-BLK238	N/A	<0.38	<0.3	<0.26
895 CL-S-BLK 240	N/A	<0.29	<0.34	<0.21
895-CL-S-BLK 239	N/A	<0.49	<0.43	<0.35
CL-S-BLK 224	9.00	<0.85	<0.49	<0.53
CL-S-BLK 256	9.40	<0.93	<0.77	<0.48
CL-S-BLK 260	11.00	<0.63	<0.52	<0.32
CL-S-BLK 253	9.00	<0.66	<0.54	<0.38
CL-S-BLK 257	10.00	<0.58	<0.46	<0.28
CL-S-BLK 255-895	4.30	<1.0	<0.7	<0.5
CL-S-BLK 255-896	4.30	<1.0	<0.7	<0.5
CL-S-BLK 258 i2	5.00	<1.0	<1.1	<0.7
CL-S-BLK 252	9.00	<0.85	<0.71	<0.44
CL-S-BLK 287	6.44	<0.79	<0.99	<0.35
CL-S-BLK 281 i	5.15	<1.7	<1.2	<0.8
CL-S-BLK 286	5.01	<0.8	<2.1	<0.4
CL-S-BLK 351 i	8.0	<0.86	<0.72	<0.72
CL-S-BLK 383	5.0	<1.7	<1.7	<1.1
CL-S-BLK 400	3.00	<1.9	<1.9	<1.4
<i>2. Plant Analytical Blanks</i>				
	Sample Size g wet			
CL-T-BLK 346-896	3.3	<0.91	<0.63	<0.36
CL-T-BLK 346-895	8.93	<0.91	<0.63	<0.36
CL-T-BLK 384	10.0	<0.31	<0.73	<0.86
CL-T-BLK 362	10	<0.4	<0.21	<0.06
<i>3. Water Analytical Blank</i>				
	Sample Size liters			
CL-W-BLK 289 i	1	<6.9	<5.2	<3.1
<i>4. Swab Analytical Blanks</i>				
	Sample Size filter			
CLF-BLK 272	1	<4.4	<4.0	<2.8
CLF-BLK 236	1	<8.9	<7.7	<7.7
CLF-BLK 237	1	<9.4	<6.1	<6.3
CLF-BLK 242	1	<2.4	<5.3	<9.3

Table B-8: PCB Congener Analytical Blanks

1. Soil Sample Wt. (g)	CLS-BLK 259 9.00	CLS- BLK 286 5.00	2. Plant: CL-T-BLK 362 10.32	HR GC/MS
Congener	Concentration (ng/g)			
18	<0.05	<0.05	<0.004	
15/17	<0.06	<0.06	<0.02	
54	<0.04	<0.04	<0.002	
31	<0.04	<0.04	<0.002	
28	<0.04	<0.04	<0.002	
52	<0.04	<0.14	<0.002	
49	<0.04	<0.14	<0.003	
44	<0.03	<0.12	<0.003	
40/103	<0.03	<0.12	<0.007	
61/94/74	<0.03	<0.12	<0.002	
66/80/95	<0.03	<0.12	<0.004	
121	<0.03	<0.11	<0.004	
56/60	<0.03	<0.12	<0.001	
90/101	<0.03	<0.11	<0.005	
86/97	<0.02	<0.1	<0.006	
87	<0.02	<0.1	<0.006	
77/154/110	<0.04	<0.13	<0.006	
151	<0.04	<0.13	<0.002	
135/144	<0.04	<0.15	<0.002	
149	<0.04	<0.15	<0.002	
118	<0.04	0.17	<0.009	
143	<0.04	<0.15	<0.001	
114	<0.04	<0.15	<0.009	
132/153	<0.04	<0.14	<0.002	
105	<0.01	<0.04	<0.007	
141/179	<0.02	<0.1	<0.002	
137	<0.03	<0.11	<0.002	
138/158	<0.03	0.13	<0.002	
129/126	<0.03	<0.11	<0.002	
187/182/159	<0.03	<0.12	<0.002	
183	<0.03	<0.04	<0.001	
128	<0.03	<0.04	<0.002	
185	<0.02	<0.02	<0.001	
174/181	<0.02	<0.02	<0.005	
202/171/156	<0.02	<0.02	<0.004	
173/201	<0.03	<0.03	<0.001	
180	<0.03	<0.03	<0.003	
191	<0.03	<0.03	<0.003	
170	<0.03	<0.03	<0.003	
199	<0.03	<0.04	<0.001	
203/196	<0.02	<0.02	<0.002	
189	<0.03	<0.03	<0.001	
208/195	<0.02	<0.02	<0.002	
207	<0.03	<0.03	<0.002	
194	<0.03	<0.03	<0.002	
205	<0.03	<0.03	<0.002	
206	0.07	0.13	<0.002	

Table B-9: PCB (Aroclor) Results for Duplicate Soil Samples Collected in the Field

Sample Number	Aroclor 1242	Aroclor 1254	Aroclor 1260	Aroclor Total	Replicate Std. Dev.	Replicate Relative Std. Dev.	Location
	ng/g or ppb						
AA129	<0.62	<0.19	<0.03		-	-	Background 13 km distant
AA130	<0.52	<0.54	<0.31				Background 13 km distant
AA105	<0.71	5.5	6.5	12	4.9	31.9	20 m NW of powerhouse
AA106	<1.2	13	5.6	19			20 m NW of powerhouse
AA149	<0.6	<0.55	<0.3		-	-	Central area in Dump Site 3
AA150	<0.52	<0.42	<0.23				Central area in Dump Site 3
AA146	<6.9	52	21	73	21.2	36.6	60 m W of powerhouse, transformer plates
AA147	<7.0	29	14	43			60 m W of powerhouse, transformer plates
AA018	<0.29	3.8	0.76	4.6	-	-	Beside transformer casing, ~50 m N of Garage
AA019							Beside transformer casing, ~50 m N of Garage
AA133	<0.55	<0.54	<0.4		-	-	Depression adjacent to aircraft refueling points
AA134	<0.72	<0.66	<0.47				Depression adjacent to aircraft refueling points
AA023							S side of small pond, in clearing with wood debris
AA139	<0.8	1.5	0.62	2.1			Upper Beacon site: S side of small pond
					Average	34.3	
					St. Dev	3.3	

Table B-10: PCB (Aroclor) Results for Soil Analytical Replicates

Sample Number	Sample size(g dry)	Aroclor 1242	Aroclor 1254	Aroclor 1260	Aroclor Total	Replicate Std. Dev.	Replicate Relative Std. Dev.	Location
		ng/g or ppb						
AA110	4.80	<9.2	2600	610	3200	212.1	6.3	Grid sample, S side of powerhouse
	4.76	<7.7	2900	580	3500			
AA018	N/A	<0.32	4.9	0.9	5.8	1.8	38.8	Beside transformer casing, ~50 m N of Garage
	N/A	<0.26	2.7	0.6	3.3			
AA001	N/A	<3.1	<9.7	<7.9		-	-	Stain, N end concrete slab
	N/A	<3.1	<8.0	<6.5				
AA010	N/A	<3.1	59	72	130	35.3	22.8	powerhouse transformer, ~ 5m W of shed
	N/A	<4.3	84	97	180			
Composite	7.4	<2.0	7.8	4.2	12	3.7	40.1	Upper beacon site
AA20-23	7.84	<2.1	3.5	3.2	6.7			
AA120	9.60	<0.66	13	10	23	2.1	9.9	13 m E of S end of garage
	9.78	<0.63	11	8.8	20			
AA134	9.07	<0.8	<0.7	<0.5		-	-	Depression adjacent to aircraft refueling points
	8.1	<0.63	<0.61	<0.44				
AA136	10.1	<0.72	<0.7	1.3	1.3	0.07	5.7	Lower beacon site: 8 m S of transformer
	9.35	<0.85	<0.78	1.2	1.2			
AA142	11.23	<0.46	<0.42	<0.26		-	-	Adjacent to broken batteries in Dump Site 3
	10.06	<0.77	<0.64	<0.38				
AA129	13.56	<0.6	<0.6	<0.26		-	-	Background 13 km distant
	13.53	<0.59	<0.56	<0.34				
AA104	9.87	<0.55	12	<2.7	12	-	-	20 m N of generator building
	10.17	<0.9	12	<3.1	12			
						Average	20.6	
						St. Dev	15.9	

Table B-11: PCB Congener Results for Soil Analytical Replicates

Sample Size (g dry)	AA010		AA111	
	9.72 g dry	9.57 g dry	4.80 g dry	4.73 g dry
Compounds	Concentration (ng/g)			
18	<0.36	<0.5	<0.67	<0.56
15/17	<0.36	<0.5	<0.74	<0.62
54	<0.38	<0.53	<0.57	<0.48
31	<0.2	<0.28	<0.59	<0.49
28	<0.2	<0.28	1.2	0.92
52	4	5.9	110	92
49	0.82	1.2	22	27
44	1.4	2	45	57
40/103	0.16	0.25	4.4	5.4
61/94/74	0.43	0.66	12	12
66/80/95	5.7	8.1	230	270
121	<0.05	<0.06	<0.42	<0.53
56/60	1.3	1.9	74	82
90/101	8	11	240	270
86/97	1.8	2.6	94	100
87	4	5.7	180	200
77/154/110	16	23	490	520
151	2.4	3.2	57	60
135/144	2.3	3.2	96	99
149	6.9	9.4	250	250
118	6.2	8.8	220	230
143	<0.06	<0.07	<0.6	<0.75
114	0.8	1.2	18	19
132/153	10	14	250	250
105	2.1	3.1	69	69
141/179	2	2.8	78	75
137	0.45	0.63	34	32
138/158	11	15	400	380
129/126	1	1.4	42	39
187/182/159	2.7	3.6	33	33
183	1.7	2.3	23	23
128	2	2.8	120	110
185	0.25	0.34	3.1	3
174/181	2	2.7	27	26
202/171/156	1.9	2.6	44	41
173/201	0.46	0.63	14	12
180	6	8.1	64	62
191	0.16	0.22	2.1	2
170	3.5	4.7	59	54
199	1.4	1.8	11	11
203/196	1.4	1.9	8.9	8.8
189	0.14	0.2	2.1	1.9
208/195	0.52	0.7	4.4	4.3
207	0.09	0.12	1	1
194	1.2	1.6	12	12
205	0.39	0.53	0.85	0.8
206	0.52	0.66	4.9	6.3

Table B-12: Determination of Organochlorine Pesticides in Internal Spiked Reference Material for Soils

Sample Sample size (g dry)	895-SSPM 187			CL-S-SPM 225 i2		
	10.00			10.00		
	Determined	Expected	Recovery	Determined	Expected	Recovery
	ppb		%	ppb		%
Compounds						
Hexachlorobenzene	5.6	5.6	100	4.9	5.3	92
alpha BHC	4.2	5.6	75	3.5	3.5	100
beta BHC	7.2	8.2	88	6.1	6.4	95
gamma BHC	4.3	5.4	80	4.8	4.8	100
Heptachlor	4.3	5.8	74	5.2	5.0	104
Aldrin	3.1	3.6	86	2.5	3.2	78
Oxychlordane	4.9	5.0	98	5.0	4.6	109
trans-Chlordane	2.8	3.2	88	3.5	3.2	109
cis-Chlordane	3.8	4.8	79	5.2	5.0	104
o,p'-DDE	4.8	5.7	84	3.7	5.0	74
p,p'-DDE	3.9	5.4	72	4.7	4.3	109
trans-Nonachlor	3.5	4.1	85	3.2	4.4	73
cis-Nonachlor	4.3	4.2	102	4.6	4.0	115
o,p'-DDD	5.2	5.6	93	4.7	5.4	87
p,p'-DDD	4.8	6.2	77	3.0	5.0	60
p,p'-DDT	6.0	6.2	97	7.3	5.4	135
Mirex	5.7	5.4	106	4.8	5.2	92
Heptachlor Epoxide	3.8	4.0	95			
alpha-Endosulphan	3.6	4.0	90			
Dieldrin	5.0	5.2	96			
Endrin	9.8	11	89			
Methoxychlor	27	25	108			

Table B-12: (Cont.)

Sample	CL-S-SPM 198				
Sample size (g dry)	10.00			Average	
	Determined	Expected	Recovery	%	Std. Dev.
	ppb		%	n=3	
Compounds					
Hexachlorobenzene	5.0	5.6	89	94	6
alpha BHC	2.8	5.6	50	75	25
beta BHC	5.1	8.2	62	82	17
gamma BHC	4.5	5.4	83	88	11
Heptachlor	5.0	5.8	86	88	15
Aldrin	2.2	3.6	61	75	13
Oxychlordane	4.0	5.0	80	96	15
trans-Chlordane	3.1	3.2	97	98	11
cis-Chlordane	4.2	4.8	88	90	13
o,p'-DDE	3.8	5.7	67	75	9
p,p'-DDE	3.8	5.4	70	84	22
trans-Nonachlor	3.1	4.1	76	78	7
cis-Nonachlor	4.0	4.2	95	104	10
o,p'-DDD	3.7	5.6	66	82	14
p,p'-DDD	3.8	6.2	61	66	10
p,p'-DDT	6.4	6.2	103	112	21
Mirex	4.4	5.4	81	93	12
Heptachlor Epoxide	4.2	4.0	105	67	7
alpha-Endosulphan	3.4	4.0	85	58	4
Dieldrin	5.1	5.2	98	65	1
Endrin	15	11	136	75	33
Methoxychlor	34	25	136	81	20

Table B-13: Pesticide Results for Analytical Blanks and Duplicates for Soils

Sample Wt. (g dry)	Analytical Blanks:			Analytical Duplicate:	
	CL-S-BLK 238	CL-S-BLK 287	CL-S-BLK 255	AA111	
	5.73 g	6.44 g	4.0 g	4.8	4.73
Compound	Concentration				
	ng/g				
Hexachlorobenzene	<0.014	<0.01	<0.02	<0.3	<0.48
alpha BHC	<0.022	<0.01	<0.03	0.25	0.3
beta BHC	<0.03	<0.02	<0.11	<0.1	<0.11
gamma BHC	<0.02	<0.01	<0.06	<0.05	<0.08
Heptachlor	<0.012	<0.02	<0.02	<0.26	<0.44
Aldrin	<0.018	<0.04	<0.02	<0.14	<0.23
Oxychlordane	<0.02	0.04	<0.06	<0.06	<0.07
trans-Chlordane	<0.02	<0.01	<0.06	<0.06	<0.07
cis-Chlordane	<0.032	<0.01	<0.06	<0.07	<0.08
o,p'-DDE	<0.05	<0.01	<0.11	17	22
p,p'-DDE	<0.018	<0.05	<0.02	<0.14	<0.23
trans-Nonachlor	<0.034	<0.01	<0.06	1.3	1.7
cis-Nonachlor	<0.02	<0.01	<0.06	<0.06	<0.07
o,p'-DDD	<0.04	<0.02	<0.09	7.8	9.2
p,p'-DDD	<0.05	<0.01	<0.08	<0.08	<0.09
p,p'-DDT	<0.09	<0.04	<0.25	<0.56	<0.83
Mirex	<0.02	<0.02	<0.02	<0.23	<0.38
Heptachlor Epoxide	<0.02	*	<0.06	<1.1	<0.94
alpha-Endosulphan	<0.02	*	<0.06	<1.2	<1.0
Dieldrin	<0.02	*	<0.06	<1.1	<1.0
Endrin	<0.04	*	<0.16	<3.0	<2.6
Methoxychlor	<0.11	*	<0.32	<5.8	<5.2

* F3 fractions not reported due to large interferences - Open Scan analysis performed on this batch

Table B-14: Determination of PAHs in Sediment Internal Standard (NIST Marine Reference Sediment HS-6)

Phase Sample Weight (dry)	Soil SCRM 166 1.05	Soil SCRM 188 i 1.00	Average Value	Std. Dev.	Certified Value
Compound	Concentrations (ng/g or ppb)				
Naphthalene	4100	4800	4450	495	4100 +/- 1100
Acenaphthylene	170	200	185	21	190 +/- 50
Acenaphthene	150	130	140	14	230 +/- 70
Fluorene	360	330	345	21	470 +/- 120
Phenanthrene	3300	3500	3400	141	3000 +/- 600
Anthracene	900	860	880	28	1100 +/- 400
Fluoranthene	3700	3500	3600	141	3540 +/- 650
Pyrene	2400	2900	2650	353	3000 +/- 600
Benz(a)anthracene	1600	1600	1600	0	1800 +/- 300
Chrysene	2500	2600	2550	71	2000 +/- 300
Benzo(a)anthracene	4800	5200	5000	283	4230 +/- 750
Benzo(e)pyrene	2200	2000	2100	141	-
Benzo(a)pyrene	1800	1700	1750	71	2200 +/- 400
Perylene	460	440	450	14	-
Dibenz(ah)anthracene	470	400	435	50	490 +/- 160
Indeno(1,2,3-cd)pyrene	2200	1900	2050	212	1950 +/- 580
Benzo(ghi)perylene	1600	1700	1650	71	1780 +/- 720

Table B-15: PAH Results for Analytical Blanks and Duplicates For Soils

Sample Wt. (g dry)	Analytical Blanks:		Analytical Duplicate:	
	895-PH-S-BLK 575	PH-S-BLK618 i	AA014	
	8.94	8.55	9.59	10.14
Compounds	Concentration ng/g			
Naphthalene	0.6	NDR(0.8)	NDR(6.0)	NDR(6.9)
Acenaphthylene	0.3	<0.1	<0.04	<0.04
Acenaphthene	0.4	<0.1	NDR(11)	NDR(9.0)
Fluorene	0.4	NDR(0.2)	NDR(14)	NDR(10)
Phenanthrene	0.4	1.0	NDR(12)	NDR(11)
Anthracene	NDR(0.2)	NDR(0.1)	NDR(11)	NDR(11)
Fluoranthene	NDR(0.2)	0.6	8.0	14
Pyrene	NDR(0.2)	NDR(0.2)	10	14
Benz(a)anthracene	<0.2	<0.08	NDR(3.0)	NDR(6.0)
Chrysene	NDR(0.3)	<0.09	7.0	11
Benzo(a)fluoranthene	NDR(0.3)	<0.1	7.6	12
Benzo(e)pyrene	<0.2	<0.1	4.0	6.0
Benzo(a)pyrene	<0.3	<0.1	4.0	8.0
Perylene	NDR(0.3)	<0.1	NDR(1.0)	NDR(2.0)
Dibenz(ah)anthracene	<1.0	<0.5	NDR(0.8)	NDR(1.0)
Indeno(1,2,3-cd)pyrene	<0.5	<0.3	NDR(3.0)	NDR(5.0)
Benzo(ghi)perylene	<0.5	<0.3	3.0	4.0

NDR = Peak detected but did not meet quantification criteria

Table B-16: Determination of Polychlorinated Dibenzo Dioxin and Dibenzo Furan in Internal Spiked Reference Material for Soils (High Resolution GC/MS)

Sample	DXS-SPM438		
Sample Wt. (g dry) 10.00 g		Expected	Recovery
	Determined		
Dioxins	pg/g		%
T4CDD - Total			
2,3,7,8	1.7	2.2	77
P5CDD - Total			
1,2,3,7,8	5.5	6.3	87
H6CDD - Total			
1,2,3,4,7,8	5.7	6.8	84
1,2,3,6,7,8	6.3	6.3	100
1,2,3,7,8,9	5.0	4.6	109
H7CDD - Total			
1,2,3,4,6,7,8	4.3	5.4	80
O8CDD - Total	6.9	9.2	75
<u>Furans:</u>			
T4CDF - Total			
2,3,7,8	4.3	4.7	91
P5CDF - Total			
1,2,3,7,8	5.2	5.8	90
2,3,4,7,8	4.7	5.7	82
H6CDF - Total			
1,2,3,4,7,8	8.1	9.1	89
1,2,3,6,7,8	8.4	9.5	88
2,3,4,6,7,8	6.4	5.7	112
1,2,3,7,8,9	4.5	5.7	79
H7CDF - Total			
1,2,3,4,6,7,8	7.5	7.5	100
1,2,3,4,7,8,9	4.4	5.9	75
O8CDF - Total	7.8	9.4	83
<u>Surrogate Standards</u>	<u>% Recovery</u>		
13C-T4CDF:	70		
13C-T4CDD:	68		
13C-P5CDF:	70		
13C-P5CDD:	83		
13C-H6CDF:	62		
13C-H6CDD:	60		
13C-H7CDF:	66		
13C-H7CDD:	66		
13C-O8CDD:	62		

Table B-17: Soil Procedural (Analytical) Blanks for Polychlorinated Dibenzo Dioxins and Dibenzo Furans (High Resolution GC/MS)

Sample: DXS-BLK1140
Sample Wt. (g dry) 7.3

<u>Dioxins:</u>	Concentration pg/g	<u>Furans:</u>	Concentration pg/g
T4CDD - Total	<0.1	T4CDF - Total	<0.1
2,3,7,8	<0.1	2,3,7,8	<0.1
P5CDD - Total	<0.1	P5CDF - Total	<0.2
1,2,3,7,8	<0.1	1,2,3,7,8	<0.2
		2,3,4,7,8	<0.2
H6CDD - Total	<0.2	H6CDF - Total	<0.3
1,2,3,4,7,8	<0.2	1,2,3,4,7,8	<0.3
1,2,3,6,7,8	<0.2	1,2,3,6,7,8	<0.3
1,2,3,7,8,9	<0.2	2,3,4,6,7,8	<0.3
H7CDD - Total	<0.3	1,2,3,7,8,9	<0.3
1,2,3,4,6,7,8	<0.3		
O8CDD - Total	NDR(0.8)	H7CDF - Total	<0.3
		1,2,3,4,6,7,8	<0.3
		1,2,3,4,7,8,9	<0.3
		O8CDF - Total	<0.4

NDR = Peak detected but did not meet quantification criteria

<u>Surrogate Standards</u>	% Recovery
13C-T4CDF:	68
13C-T4CDD:	75
13C-P5CDF:	73
13C-P5CDD:	72
13C-H6CDF:	77
13C-H6CDD:	70
13C-H7CDF:	62
13C-H7CDD:	52
13C-O8CDD:	27

C. Site Descriptions and Sample Locations

Three main buildings remained intact at Aishihik Airstrip: the powerhouse, the maintenance garage, and the airways administration building, which had been recently extended by the Champagne-Aishihik Band and was used for camp accommodations. Also in the immediate area around these three buildings were several smaller buildings, many of which were built more recently for use by the band. The remains of other buildings associated with operation of the airstrip were also present.

The road leading south from the maintenance garage, and branching southwest, terminated at a large dump site approximately 1 km southwest of the airstrip. Present along this road were a burned building, where some barrels had been dumped, a larger barrel dump and two smaller dump sites.

There were two beacon sites approximately 8 km and 5 km north of the airstrip.

The area surrounding the buildings and airstrip was generally sparsely vegetated. Recolonization of the coarse to fine sand substrate appeared to have been slow, probably due to continued use of the site. Grasses and other early colonizers were present on the sandy substrate, with cover varying from approximately 5% to 40-60% in the more densely vegetated areas. Outlying locations which in the same time period experienced physical disturbances of similar magnitude had been recolonized at a greater rate than had the main area of the site.

The site has been split into geographic areas to facilitate discussion. Detailed sample locations are given below for each of the geographic areas.

1. Background

Four soil samples, three plant samples, and one each sediment and water sample were collected from four locations not directly influenced by the operation of the airstrip and its facilities.

- AA127 - Background 4 km southwest of the site. No marker was placed.
- Coarse-medium sand, silt, organics.

- *Salix* sp. was sampled.
 - Vegetation present: *Poa* sp., *Solidago* sp., *Betula glandulosa*, *Phlox* sp., *Gentiana prostrata*, *Vaccinium vitis-idaea*.
 - 61° 37.16' N, 137° 32.12' W.
- AA128
- Background 9 km southwest of the site. No marker was placed.
 - Black organic soil with roots, moss cover.
 - *Salix brachycarpa* was sampled.
 - Vegetation present: *Epilobium* sp., *Betula glandulosa*, *Empetrum* sp., *Rosa* sp., *Vaccinium vitis-idaea*, *Aster* sp., *Saxifraga tricuspidata*, Reindeer lichen.
 - 61° 35.05' N, 137° 35.75' W.
- AA129
- Background 16 km southwest of the site. No marker was placed.
 - Moist fine to medium sand, roots.
 - *Salix brachycarpa* was sampled.
 - Vegetation present: *Vaccinium vitis-idaea*, *Dryas integrifolia*, *Betula glandulosa*, *Stellaria* sp., *Saxifraga tricuspidata*, Reindeer lichen.
 - 61° 32.04' N, 137° 40.75' W.
- AA130
- Field duplicate of AA129.
- AA158
- Background sediment in creek 15 km south of site, 7 m north of bridge over creek. No marker was placed.
 - Very rich dark brown organic sediment, slightly anoxic, some sand and stones.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla fruticosa*, *Equisetum arvense*, *Carex* sp., *Salix* sp., *Populus balsamifera*.
- AAW02
- Background water sample taken at AA158.

2. Powerhouse and Vicinity

At the time of the investigation, the powerhouse was structurally intact, but the doors and windows had gone and the interior was stripped. The building had a concrete floor and in the southern-most room there was a concrete support

(2.5m x 1.25m). The generators had been removed and dumped in a shallow depression just outside the gate to the site. Two radiators (labelled BUDA) were found in the building, as well as extensive pressboard debris, some metal debris, and foam and insulation pieces. There was evidence of a small fire on an interior wall above the concrete bench in the northwest corner of the building.

- AA100 - Interior floor of powerhouse. Sample was taken from 30 cubic cm hole in floor of room adjacent to generator foundation. No marker was placed.
- Wood, swallow nest material, feathers, foam, paper, wall material, some silty-sandy soil.
- No vegetation was present.

There was evidence of a transformer rack directly south of the powerhouse including the stumps of eight wooden poles which originally bore the transformers. The pole stumps defined a 6 m by 4 m stained sandy area devoid of vegetation. Transformer plates were present in the area.

- AA010 - Sample taken from centre of 6m x 4m stain directly in front of and 5 m away from south side of powerhouse. ESG tag #9.
- Medium to coarse sand, dead organic matter, burned wood ashes with a strong hydrocarbon odour.
- No vegetation was present in the sampling area.
- Bison tracks were present in the sampling area.

Six more samples were taken in this stain, all at a depth of 1-10 cm except AA113, which was taken 35 cm below the surface.

- AA108 - Southeastern perimeter of stain, 6 m south of powerhouse. ESG tag # 49.
- AA109 - Northeastern perimeter of stain, 2 m south of powerhouse. ESG tag #50.
- AA110 - Northern perimeter of stain, 2 m south of powerhouse. ESG tag #51.
- AA111 - Northwestern perimeter of stain, 2 m south of powerhouse. ESG tag #52.
- AA112 - Southwestern perimeter of stain, 6 m south of powerhouse. ESG tag #81.
- AA113 - Between centre of stain and AA112, 5 m south of powerhouse. ESG tag #82.

These six sites had the following common characteristics:

- Fine, medium and coarse sand with a sweet hydrocarbon odour.
- No vegetation was sampled.
- Sparse vegetation: *Festuca elatior*, *Poa* sp., *Chamaerhodos* sp., *Solidago* sp., *Epilobium* sp., *Potentilla* sp., *Elymus* sp., *Picea* sp.

Four samples were collected just south of the stained area. The soil was slightly more organic and more vegetation was present in this area.

- AA011 - Stain south of the powerhouse, 3 m west of AA010. Metal debris, foam, insulator material, ie. porcelain and glass were present in the area. Sample taken from red-stained zone which starts 4 cm into substrate and extends down for 1 cm. ESG tag #10.
- Medium-coarse sand, some organic matter and burnt wood with a strong hydrocarbon odour.
 - *Muhlenbergia glomerata* was sampled and had been grazed by Bison.
 - Other vegetation present: *Salix arbusculoides*, *Artemisia* sp., *Taraxacum* sp., *Calamagrostis* sp., *Bromus* sp.
 - Bison tracks were present in the sampling area.
- AA012 - 2 m west of and slightly elevated from AA011. No staining was evident in the area. ESG tag #11.
- Medium to coarse sand and stone, some dead organic matter and some burnt wood.
 - No vegetation was sampled.
 - Vegetation present: *Androsace* sp., *Taraxacum* sp., *Polemonium* sp., *Artemisia* sp., *Potentilla* spp., *Botrychium* sp.
 - Bison tracks were present in the sampling area.
- AA114 - Beyond the perimeter of the stain, 3 m south of AA108 and 8 m from the powerhouse. ESG tag #83.
- Medium to coarse sand and stone, some dead organic matter and some burnt wood.
 - No vegetation was sampled.
 - Vegetation present: *Epilobium* sp., *Festuca elatior*, *Poa* sp., *Solidago* sp., *Potentilla* sp., *Elymus* sp.
- AA115 - Beyond the perimeter of the stain, 3 m south of AA112 and 8 m from the powerhouse. ESG tag #84.
- Medium to coarse sand and stone, some dead organic matter and some burnt wood.
 - No vegetation was sampled.

- Vegetation present: *Artemisia* sp., *Epilobium* sp., *Antennaria* sp., *Festuca elatior*, *Poa* sp., *Solidago* sp., *Potentilla* sp., *Elymus* sp., *Oxytropis* sp.

An underground fuel storage tank was located behind and west of the powerhouse. Soil in the vicinity of the tank and the contents of the storage tank were sampled.

- AA107
- 4 m west of northwest corner of powerhouse, 4 m north of intake pipe for underground tank. ESG tag #48.
 - Fine to coarse sand and stones with a sweet odour.
 - No vegetation was sampled.
 - Sparse vegetation: *Chamaerhodos* sp., *Elymus* sp., *Poa* sp.

- AAB7
- Fuel from the underground storage tank west of the powerhouse. Approximately 10 cm of fuel were present in the bottom of the tank (single phase).

Several stains were evident north of the pumphouse. The total area affected was approximately 10m x 3m. Vegetation in the area was sparse as a consequence of the staining. A composite of the stains was collected.

- AA013
- Composite sample of several stains 15 m north of the northern corner of the powerhouse. ESG tag #12.
 - Medium to coarse sand with a strong hydrocarbon odour.
 - No vegetation was sampled.
 - Other vegetation present: *Salix* sp., *Picea* sp., *Calamagrostis* sp., *Arctostaphylos uva-ursi*, *Potentilla* sp., *Epilobium* sp.

A well and pump were located 15 m north of the northwest corner of the powerhouse.

- AA104
- 20 m north of the powerhouse, in low, burned area located on what appears to have been a road, just north of original location of water storage buildings. There was a foundation of a burned building 4 m south of sample location. Ash, metal, melted cocking, nails, melted insulation were present. Vegetation in the area was sparse. ESG tag #41.
 - Fine-medium sand.
 - No vegetation was sampled.
 - Vegetation present: *Gentianella* spp., *Solidago* sp., *Festuca elatior*, *Potentilla* sp., *Salix* sp., *Poa* sp., *Trisetum* sp.

- AA105 - Low area receiving drainage from west side of site 20 m northwest of powerhouse, 2 m from north edge of old road and 30 m directly north of AA013. Empty barrel adjacent to sample site. ESG tag #44.
- Fine-medium sand, some stones, moss cover.
 - No vegetation was sampled.
 - Vegetation present: *Epilobium* sp., *Potentilla* sp., *Solidago* sp., *Festuca elatior*, *Poa* sp., *Trisetum* sp., *Campanula* sp.

- AA106 - Field duplicate of AA105.

The remaining three powerhouse soil samples were taken on its east side.

- AA101 - 2 m east of large door on east side of powerhouse in slight depression in front of entrance. ESG tag #31.
- Fine sand, gravel and stones.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla pensylvanica*, *Epilobium* sp., *Poa glauca*, *P. abbreviata*, *Gentianella tenella*.
- AA102 - Disturbed, stained area (approximately 3m x 2m) 5 m northeast of the northeast corner of the powerhouse. Bison frass present in the area. ESG tag #32.
- Sandy gravel.
 - No vegetation was sampled.
 - Vegetation present: *Epilobium* sp., *Calamagrostis* sp., *Chamaerhodos* sp.
- AA103 - Low area 20 m northeast of powerhouse, 6 m east of a burned building, taking drainage from the north and northeast sides of the powerhouse. ESG tag #40.
- Fine sand, no odour.
 - *Salix glauca* was sampled.
 - Other vegetation present: *Solidago* sp., *Arctostaphylos uva-ursi*, *Oxytropis* sp., *Elaeagnus* sp., *Vaccinium uliginosum*, *Campanula* sp., *Trisetum* sp., *Festuca eliator*, *Gentiana* spp.

Six wall swabs were taken from the interior walls of the powerhouse. Three field blank swabs were prepared as well.

- AASW01 - Small southeast room on the west wall above a small bench.
- AASW02 - Field triplicate of AASW01.
- AASW03 - Field triplicate of AASW01.
- AASW04 - Small room in northwestern portion of the pumphouse on the north wall above a concrete bench. Evidence of burning on walls. (Environment Canada sampled here.)
- AASW05 - Field triplicate of AASW04.
- AASW06 - Field triplicate of AASW04.
- AASW07 - Field Blank.
- AASW08 - Field Blank.
- AASW09 - Field Blank.

Three samples of paint were obtained from powerhouse.

- AA PC01 - Off the concrete bench.
- AAPC02 - Off the wall outside the front room.
- AAPC03 - Off the floor in a room where the radiator was located.

3. *Dumps and South Area*

Dump Site 1 was on a steeply sloping south-facing hillside approximately 700 m south of the airstrip. It contained many barrels, metallic and wood debris, and domestic garbage and a 12.5 gallon transformer.

- AA031 - Wet mossy area at the base of the slope taking drainage from dump, amidst about 20 barrels. ESG tag # 34.
 - Organic soil, roots and detritus.
 - *Betula glandulosa* was sampled.
 - Other vegetation present: *Salix* sp., *Potentilla fruticosa*, species of grass and moss.
- AA032 - Stained area, 5 m south of transformer, 1/2 way up slope from AA031. Location less vegetated than surrounding area. ESG tag # 22.
 - Medium sandy soil with many roots.
 - No vegetation was sampled.
 - Vegetation present: *Artemisia* sp., *Carex* sp., species of grass.

Dump Site 2, 500 m west of Dump Site 1, was the largest dump. The debris was spread over an area 30 m at widest point by 85 m. Domestic garbage

was currently being dumped at this site. Other debris included engine parts such as radiators, mufflers, carburetors, oily rags, 720 barrels, a heater and insulation. A broken up transformer was also present. There was a burnt area containing burnt insulation and three barrels, one of which had come apart at its seam; metal cables, many quart bottles of engine oil, a "Durapower" battery, propane cylinders (SL, Coleman), a twenty litre kerosene can, three piles of transformer plates, two fuel pumps, and some motor oil cans.

- AA132
 - Lowest area of the depression below the dump receiving drainage from entire dump. Low area contained about 15 empty barrels and some metallic debris including pipes and bedsprings. ESG tag #58.
 - Rich organic soil, very moist.
 - *Salix barclayi* was sampled.
 - Other vegetation present: *Carex* sp., *Betula glandulosa*, *Potentilla fruticosa*, species of moss.

- AA135
 - In drainage from centre of dump, directly below a large assortment of metal debris, transformer plates and two old fuel pumps. ESG tag #59.
 - Sand, some stones and silt with roots.
 - No vegetation was sampled.
 - Vegetation present: *Artemisia* sp., *Epilobium* sp., *Solidago* sp., species of grass.

- AA141
 - In drainage from south side of dump approximately 15 m west of tall incinerator and 15 m south of AA135. ESG tag #60.
 - Coarse sand and gravel with some roots.
 - No vegetation was sampled.
 - Vegetation present: *Artemisia* sp., *Epilobium* sp., *Solidago* sp., *Calamagrostis* sp.

Dump Site 3 was immediately west of Dump Site 1. The debris at this site included two large piles of batteries, an old vehicle, engine parts and airstrip rollers.

- AA142
 - Adjacent eastern-most pile of broken batteries, 8 m north of old truck surrounded by metallic debris. ESG tag #61.
 - Coarse sand with stones.
 - *Salix richardsonii* was sampled.

- No other vegetation was present in the sampling area.
- AA149
- Drainage depression in centre of Dump Site 3, 9 m northwest of AA142. No obvious staining and no debris in immediate vicinity. Vegetation in the area exhibited symptoms of stress (chlorosis & gall infestation). No marker was placed.
 - Sandy gravel with large stones, fine sand below.
 - No vegetation was sampled.
 - Vegetation present: *Salix richardsonii*, *Populus balsamifera*.

- AA150
- Field duplicate of AA149.

A burned building was present at a fork in the road between the dump sites and the airport buildings, approximately 250 m south of the maintenance garage. It consisted of a wooden foundation and contained kitchen fixtures. Several partially full barrels were located on and around the building foundations. Three soils, one plant and a tar sample were collected in the surrounding area. The building is located at latitude 61° 38' 44" N, longitude 137° 29' 48" W.

- AA151
- Tar stain (2m x 1m) 5 m east of the north side of the foundation of the burned building. Approximately 20 barrels present in the vicinity, most of which were stuck in the tar. Roofing felt was also present in the sampling area. ESG tag #63.
 - Stained fine-medium sand with a hydrocarbon odour.
 - *Salix richardsonii* was sampled.
 - Other vegetation present: *Picea* sp., *Arctostaphylos* sp., *Betula glandulosa*, *Calamagrostis* sp.
- AAB2
- Black tar sample taken from tar spill just above AA151, on the north side of the burned building.
- AA152
- Black stain (2m x 1m) 10 m south of AA151, below the burned building. Stained area contained asphalt roofing tiles and metal pipe. ESG tag #64.
 - Sand stained black on top and brown underneath with hydrocarbon odour.
 - No vegetation was sampled.
 - Vegetation present: *Salix* sp., *Betula glandulosa*, *Hedysarum* sp., *Picea* sp., species of grass.

- AA153 - Drainage from tar spill area 5 m north of burned building. No obvious staining was present in the area. ESG tag # 65.
- Fine sand and silt.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla fruticosa*, *Salix* sp., *Betula glandulosa*, *Picea* sp., *Epilobium* sp., *Elymus* sp., *Solidago* sp., species of grass.
 - Horse or bison frass was present in the area.

There was a barrel dump on the southeast fork of the road about 250 m south of the burned building. It consisted of approximately 150 barrels, ten of which contained fluid. While some of the barrels contained hardened tar, most of them appeared to contain rain water. In addition, there were five or six small mounds in the area indicative of landfilling. The dump was located at latitude 61° 38' 36" N, longitude 137° 29' 48" W.

- AA154 - Wet depression 70 m south of burned building. Grass-covered mounds suggest barrels or other debris may be buried in the area. ESG tag #71.
- Black organic soil over coarse grey sand.
 - *Carex physocarpa* was sampled.
 - Other vegetation present: *Carex aquatilis*, *Hippuri* sp.
- AA155 - Composite of stains on east side of barrel dump. Total area affected by stains was approximately 20m x 10m. Four barrels were present in the area. ESG tag #72.
- Fine sand and stones stained black on top and dark brown underneath. A hydrocarbon odour was detected.
 - Vegetation present: *Betula glandulosa*, *Calamagrostis* sp., *Ledum* sp., *Salix* sp., *Empetrum* sp., *Arctostaphylos* sp., *Vaccinium vitis-idaea*, *Picea* sp., *Epilobium* sp.
- AA156 - Thick black stain beside a pressurized barrel (see below, AAB6), 15 m south of AA155. Vegetation was dead in immediate area of stain. ESG tag #73.
- Fine sand and stones stained black on top and dark brown underneath. A hydrocarbon odour was detected.
 - Vegetation present outside stained area: *Vaccinium vitis-idaea*, *Picea* sp., *Salix* sp., *Betula glandulosa*, *Epilobium* sp., *Achillea* sp.

- AAB3 - Tag #15. Rusted barrel contains about 5 cm of brown liquid of low viscosity.
- AAB4 - Tag #16. Rusted barrel, black on side, red and green on top, contains 10 cm of clear liquid with brown particulates.
- AAB5 - Tag #17. Rusted barrel, 5 cm brown liquid containing some oil.
- AAB6 - Tag # 18 A blue rusted barrel responsible for stain at AA156. Two phases present in barrel: About 5 cm a black oil and a clear liquid.

4. Other Buildings and Sites

The maintenance garage has eight bays in total, seven of which are being used to maintain vehicles and store boats. The bay on the north end of the garage is being used by Canadian Wildlife for storage.

- AA116 - Approximately 1.5 m northeast of creosoted 1 m tall timber, 15 m west of centre of garage. A wooden platform was present in the sampling area. ESG tag #55.
 - Fine sand and silt with moss covering, some roots.
 - No vegetation was sampled.
 - Vegetation present: *Epilobium* sp., *Festuca elatior*, *Picea* sp., *Poa* sp., *Androsace* sp., *Anemone* sp., *Gentianella propinqua*, *G. detonsa*, *Calamagrostis* sp.
- AA117 - Approximately 5 m west of northwest corner of the garage. Glass and wood debris in area. Dead moss and dead spruce in area. Vegetation was sparse in the sampling area. ESG tag #53.
 - Dark brown medium-coarse sand, rocks, some organics, moss covering.
 - No vegetation was sampled.
 - Vegetation present: *Solidago* sp., *Polemonium* sp., *Epilobium* sp., *Trisetum* sp., *Arctostaphylos* sp., *Calamagrostis* sp.
 - Bison mound present in the area.
- AA118 - Damp area 1 m west of west side of garage on the north side of the entry way. Debris in the area included asphalt roof tiles, large asphalt roll and a pipe extruding from building's south wall. ESG tag #54.
 - Coarse sand with some moss on top.
 - No vegetation was sampled.

- Vegetation present: *Poa palustris*, *Potentilla fruticosa*, *Epilobium* sp., *Salix* sp., *Stellaria* sp., *Gentianella propinqua*, *Calamagrostis* sp.
- AA119
- 15 m west of south end of garage, 2 m west of worked area. Metal, burnt wood, oil filter in sampling area. ESG tag #56.
 - Fine to medium textured sand, roots, no obvious staining.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla* sp., *Gentianella* sp., *Epilobium* sp., *Antennaria* sp., *Campanula* sp., *Polemonium* sp., *Elymus* sp., *Picea* sp., *Festuca elatior*.
- AA015
- Composite sample of dark stains, 10 m from centre of east side of garage. Two stains consisted of a black tar-like substance on the surface with light brown sand below. A third stain extended to at least 10 cm depth. Stained area is 15m x 15m. Vegetation in the area was sparse. ESG tag #14.
 - Tar cakes over fine sand and stone with a faint hydrocarbon odour.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla* sp., *Festuca* sp.
- AA016
- Drainage from east side of the garage, 5 m south of AA015 and 10 m east of garage. Vegetation was sparse to intermediate. ESG tag #15.
 - Compact sand and stone, dark grey/brown for 1 cm, light brown below.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla* sp., *Festuca* sp.
- AA120
- Low area 13 m east of south end of garage just west of the road, taking drainage from vehicle maintenance bays. ESG tag #57.
 - Coarse sand with rock.
 - Vegetation present: *Polemonium* sp., *Trisetum* sp., *Potentilla* sp., *Solidago* sp., *Androsace* sp., *Chamaerhodos* sp., *Festuca elatior*, *Elymus* sp., *Hordeum* sp.
- AA121
- Drainage 8m east of northeast corner of the garage. Six 45 gallon drums (all empty) and scattered asphalt pieces were present in the sampling area. ESG tag # 85.
 - Soil, fine sand, some organics, many rocks.
 - No vegetation was sampled.

- Vegetation present: *Potentilla* spp., *Solidago* sp., *Poa* sp., *Chamaerhodos* sp., *Trisetum* sp., *Campanula* sp., *Calamagrostis* sp.
- Buffalo frass was present in the sampling area.

Three wall swabs were taken from the interior of the maintenance garage.

- AASW10 - Swab of the back wall of the maintenance garage.
- AASW11 - Field replicate of AASW10.
- AASW12 - Field replicate of AASW10.

A number of residences, the main septic pipeline and field, a landfill and a gravel borrow area were located west of the main area of the site. None of the buildings were present, however their foundations or debris associated with them were evident. Ten soil samples, three plant samples and a barrel sample were collected in the western half of the site.

- AA146 - Low area and previous location of married quarters next to burned pole, 60 m west of the powerhouse. A large number of transformer plates and insulators were located nearby. Two barrels were located 15 m W of the sample location; one contained garbage, the other was empty. ESG tag # 98.
 - Fine-medium sand with a sweet odour, roots.
 - *Salix brachycarpa* was sampled.
 - Other vegetation present: *Epilobium* sp., *Potentilla* sp., *Arctostaphylos* sp., *Solidago* sp., *Betula glandulosa*, *Calamagrostis* sp.
- AA147 - Field duplicate of AA146.
- AA018 - Beside 14 gal capacity transformer casing, 70 m southwest of garage. The area was only sparsely vegetated. ESG tag #16.
 - Fine sand, some stones.
 - No vegetation was sampled.
 - Vegetation present: *Chamaerhodos* sp., *Picea* sp., *Arctostaphylos* sp., *Epilobium* sp., species of grass.
- AA019 - Field duplicate of AA018.
- AA131 - In a depression 70 m west of garage. Depression appeared to have resulted from the collapse of a buried object possibly an old septic tank. ESG tag #91.

- Fine-medium sand.
- No vegetation was sampled.
- Vegetation present: *Picea* sp., *Epilobium* sp., *Arctostaphylos* sp., *Solidago* sp., *Phlox* sp., *Calamagrostis* sp.

- AA054
- In a low depression 100 m west of the garage. The depression is likely the remains of an abandoned septic line. The sample was taken amongst some spruce trees, between two disturbed areas. ESG tag #100.
 - Medium-coarse sand and stones.
 - No vegetation was sampled.
 - Vegetation present: *Phlox* sp., *Epilobium* sp., *Trisetium* sp., *Picea* sp., *Calamagrostis* sp.

A gravel borrow area was located northwest of the airport, approximately 1.5 km along a western side road of the main access road. A barrel was located in the borrow area. The borrow area is located at latitude 61° 39' 12" N, longitude 137° 30' 41" W.

- AAB01
- Greasy substance from a barrel containing approximately 12 cm of liquid. A 1m x 5m stained area was present below the barrel.

The landfill located on the western edge of the site was approximately 150 m west of the powerhouse. A few barrels and other metal debris were observed protruding out of the mounds of fill. Revegetation of the previously disturbed area has been extensive.

- AA020
- Sample broken in transit. Drainage from west end of landfill located approximately 150 m west of the powerhouse. ESG tag #17.
 - Clay, organics and roots with a thick layer of moss on top.
 - *Betula glandulosa* was sampled.
 - Other vegetation present: *Carex* sp., *Stellaria* sp., species of grass, Reindeer lichen.
- AA024
- In a depression in the western landfill 10 m north of AA020. ESG tag #18.
 - Thick moss layer over fine to coarse sand with rocks and charcoal.
 - No vegetation was sampled.
 - Vegetation present: *Carex* sp., *Epilobium* sp., *Potentilla fruticosa*, *Betula glandulosa*, *Artemisia* sp., species of grass.

- AA025 - In a depression on top of a mound in the western landfill close to AA020 and AA024 and 2 m from a buried barrel. ESG tag #19.
- Fine and coarse sand, roots.
 - No vegetation was sampled.
 - Vegetation present: *Potentilla fruticosa*, *Picea* sp., *Artemisia* sp., *Aster* sp., *Androsace* sp., *Stellaria* sp., *Phlox* sp., Reindeer lichen, species of grass.

The remnants of a septic pipeline were detected running east to west on the southwestern edge of the site. In addition, the 'As Built' Maps for the site indicate the presence of a septic field connected to the pipeline behind the area where the western landfill is located. No obvious stains were observed in the suspected septic field area, and the vegetation growing there exhibited no signs of stress suggestive of impact.

- AA148 - In a depression directly below and west of dropoff from presumed main area of septic field and above the western landfill. ESG tag #99.
- Sandy gravel.
 - *Salix richardsonii* was sampled.
 - Other vegetation present: *Picea* sp., *Phlox* sp., *Saxifraga tricuspidata*., *Solidago* sp.

A gully containing the two engines and generators from the powerhouse was located 100 m north of the main gate on the west side of the access road. A single soil sample was collected in the depression.

- AA157 - The lowest spot just west of the engines. Five barrels were present in the sampling area and were all partially burned. ESG tag #74.
- Firmly packed sand with rocks and roots over wet fine sand.
 - Vegetation present: *Picea* sp., *Epilobium* sp., *Solidago* sp., *Salix* sp.

A POL tank area was located east of and on the opposite side of the access road to the powerhouse. The five 13,000 gallon and two 3000 gallon fuel tanks previously situated in this area had been removed. The diesel pump associated with the POL area was still located adjacent to the road, approximately 35 m west of the former tank location. A group of four cabins, a smokehouse and an outhouse present on the eastern edge of the POL tank area were built more recently by the Champagne-Aishihik Band. The area formerly occupied by the

POL tanks was very sparsely vegetated and was approximately 20m x 30m. Three soil samples were collected in this area.

- AA014 - In a depression in the northeastern corner of fuel tank pad area, 5 m north of the smokehouse. ESG tag #13.
- Fine sand with a sweet hydrocarbon odour below 10 cm and stones.
 - No vegetation was sampled.
 - Vegetation present: *Stellaria* sp., *Chamaerhodos* sp., species of grass.
- AA144 - Between two square wooden supports, 10 m west of the southwest corner of the smokehouse. ESG tag # 96.
- Fine to medium sand and gravel with stones. No odour was detected.
 - No vegetation was sampled.
 - Vegetation present: *Hordeum* sp., *Elymus* sp., *Poa abbreviata*., *Calamagrostis* sp., *Taraxacum* sp.
- AA145 - At the southern end of the POL area, 6 m south of AA144, 1 m south of southern-most wooden support, 8 m from spruce hedge. ESG tag # 97.
- Fine to medium sand with stones and a slight hydrocarbon odour.
 - No vegetation was sampled.
 - Vegetation present: *Festuca elatior*, *Potentilla* sp., *Trisetum* sp., *Elymus* sp., *Epilobium* sp., *Chamaerhodos* sp., *Achillea* sp.

The aircraft refuelling facility was located approximately 100 m east of the airways building. Only shells of the structures remained.

- AA133 - In a depression 15 m north of the fuelling facilities. Depression contained the remains of fuel tanks including the steel ribs of the tanks and piping. ESG tag #88.
- Organics and moss over orange coarse sand over grey medium sand with roots.
 - *Salix richardsonii* was sampled.
 - Vegetation present: *Carex* sp., *Betula glandulosa*, *Picea* sp., *Arctostaphylos uva-ursi*, *Vaccinium vitis-idaea*, *Equisetum arvense*, *Antennaria* sp., *Pyrola* sp., *Sisyrinchium* sp., *Populus balsamifera*, *Oxytropis leucantha*.
- AA134 - Field duplicate of AA133.

The airways administration building was used for accommodation by the Champagne-Aishihik Band. A new addition on the western side of the building was built recently to provide additional accommodation for band members using the site as a retreat. Four soil samples and one plant sample were collected immediately outside the administration building.

- AA017 - The eastern corner of the administration building on the south side, 1 m from an exit. No marker was placed.
 - Medium-coarse sand with stones.
 - No vegetation was sampled.
 - Vegetation present: *Salix* sp., species of grass, *Chamaerhodos* sp., *Chenopodium* sp.

- AA122 - On the south side of the administration building, 1 m west of the radiotower portion of the main building, 4 m south of the new portion of the building. No marker was placed.
 - Coarse to medium sand, some stones, roots and organic matter.
 - No vegetation was sampled.
 - Vegetation present: *Festuca elatior*, *Epilobium* sp., *Potentilla* sp., *Poa* sp., *Trisetum* sp., *Chenopodium* sp.

- AA123 - 1m from the eastern-most door of the administration building facing the airstrip. Vegetation is sparse in the area due to disturbance by human traffic. Broken glass was present in the area. No marker was placed.
 - Fine sand and stones.
 - No vegetation was sampled.
 - Vegetation present: *Chamaerhodos* sp.

- AA124 - Outside the north door of the administration building 1 m north of the door. No marker was placed.
 - Fine and medium sand and stones.
 - *Salix glauca* was sampled.
 - Other vegetation present: *Epilobium* sp., *Poa* sp.

Two barracks buildings, a small septic field and transformer bearing poles were previously located south of the airways administration building. The rough

foundations of the buildings and some creosoted pole stumps are all that remain of these structures. Three soil samples were collected in this area.

- AA026 - Adjacent to a transformer casing approximately 20 m east of the road to Aishihik Lake. ESG tag #23.
- Clay, roots and organics.
 - Vegetation present: *Picea* sp., *Vaccinium* sp., *Betula glandulosa*, *Epilobium* sp., species of moss, grass and lichen.
- AA125 - Approximately halfway between two pole stumps that originally had transformers on them, in a shallow depression (3m x 2m) approximately 25 m south of the administration building. ESG tag # 86.
- Fine to medium sand and gravel with some roots and a slight hydrocarbon odour.
 - No vegetation was sampled.
 - Vegetation present: *Artemisia* sp., *Epilobium* sp., *Polemonium* sp., *Festuca elatior*, *Trisetum* sp.
 - Bison frass was present in the sampling area.
- AA126 - 50 m southwest of the administration building, adjacent to a pole stump and between the foundations of the two barracks buildings. The spruce seedlings were infected with woolly spruce aphids. ESG tag # 87.
- Medium and coarse sand, some roots.
 - No vegetation was sampled.
 - Vegetation present: *Picea* sp., *Potentilla pensylvanica*, *Artemisia* sp., *Epilobium* sp., *Polemonium* sp.

Sediment, water and plants were sampled from the pond located approximately 250 m southeast of the administration building.

- AA143 - Sediment sample taken from below the water line at the east end of the pond
- No marker was placed.
 - Rich organic sediment, slightly anoxic.
 - *Salix brachycarpa* was sampled
 - Other vegetation present: *Betula glandulosa*, *Epilobium* sp., *Carex* sp.
 - Evidence of use by animals; *Carex* had been grazed, sandpipers seen nearby.
- AS-W01 - water sample taken at AA143.

The lower beacon site was located on the road to the upper beacon site approximately 5 km north northwest of the airstrip. A transformer, some wire, transformer plates, large pole stumps and parts of poles were found strewn about this location. No buildings or building remains were present.

- AA136
 - An unvegetated area (3m x 5m), 8 m south of the transformer. ESG tag # 89.
 - Sand, silt and clay.
 - No vegetation was sampled
 - Vegetation present: *Picea* sp., *Arctostaphylos uva-ursi*, species of grass.

- AA137
 - Area containing transformer plates 8 m west of the transformer. ESG tag # 90.
 - Sand and organics with some clay.
 - No vegetation was sampled.
 - Vegetation present: *Arctostaphylos uva-ursi*, *Elymus* sp., *Antennaria* sp., *Epilobium* sp., species of moss.

- AA138
 - Unvegetated area 8m north of the transformer, next to a power pole, insulators, and transformer plates. No marker was placed.
 - Low sandy area.
 - No vegetation was present.
 - Vegetation present: *Epilobium* sp., species of grass.
 - 61° 41' 23" N, 137° 27' 44" W.

The upper beacon site was located approximately 8 km north northwest of the airstrip. It originally consisted of a building and some antennas. The building had been demolished and buried on site. There was still a considerable amount of wooden and metallic debris in the vicinity.

- AA021
 - Sample broken in transit. In low spot in drainage from and 20 m west of concrete foundation. ESG tag # 20.
 - Sandy soil.
 - No vegetation was sampled.
 - Vegetation present: *Populus balsamifera*, *Salix* sp., *Ledum* sp.

- AA022
 - Sample broken in transit. Low spot in drainage from buried buildings. ESG tag #21.
 - Wet sandy soil.
 - *Salix brachycarpa* was sampled.

- No other vegetation was present.
- AA023
- Sample broken in transit. South side of a small pond in a cleared area containing wooden debris. No marker was placed.
 - Silty sandy soil, anoxic just below surface.
 - No vegetation was sampled.
 - Vegetation present: *Salix* sp., species of grass
- AA139
- Field duplicate of AA023.
- AA140
- Area (2m x 1m) containing transformer plates 18 m east of AA022. Vegetation was dead in the area surrounding the plates. No marker was placed.
 - Sandy, organic soil.
 - *Salix glauca* was sampled.
 - Other vegetation present: *Betula glandulosa*, *Epilobium* sp., *Ledum* sp., species of moss.

D. Vascular Plant Check List

<u>Species</u>	<u>Common Name</u>
<u>Ophioglossaceae (Adder's-Tongue Family)</u>	
<i>Botrychium lunaria</i> (L.) Sw.	Moonwort
<u>Equisetaceae (Horsetail Family)</u>	
<i>Equisetum arvense</i> L.	Common Horsetail
<i>Equisetum scirpoides</i> Michx.	Dwarf-Scouring Rush
<u>Pinaceae (Pine Family)</u>	
<i>Picea glauca</i> (Moench) Voss	White Spruce
<u>Poaceae (Grass Family)</u>	
<i>Bromus inermis</i> Leyss. ssp. <i>inermis</i>	Hungarian Brome
<i>Calamagrostis purpurascens</i> R.Br. var. <i>purpurascens</i>	Reed-Bentgrass
<i>Elymus trachycaulus</i> (Link) Gould var. <i>latiglume</i> (Schribn. & Sm.) Beetle	Slender Wheatgrass
<i>Festuca elatior</i> L. var. <i>elatior</i>	Meadow Fescue
<i>Festuca ovina</i> L. var. <i>saximontana</i> (Rydb.) Gl.	Sheep Fescue
<i>Festuca rubra</i> L. var. <i>arenaria</i> (Osbeck) Fries	Red Fescue
<i>Hordeum jubatum</i> L.	Squirrel-tail Grass
<i>Poa abbreviata</i> R.Br.	Bluegrass
<i>Poa glauca</i> Vahl. ssp. <i>glauca</i>	Glaucous Bluegrass
<i>Poa palustris</i> L.	Fowl Meadow-Grass
<i>Poa pseudoabbreviata</i> Roshev.	Bluegrass
<i>Trisetum spicatum</i> (L.) Richt.	

Cyperaceae (Sedge Family)

Carex aquatilis Wahlenb.

Carex membranacea Hook.

Carex physocarpa Presl

Liliaceae (Lily Family)

Zygadenus elegans Pursh

Mountain Death Camas

Iridaceae (Iris Family)

Sisyrinchium montanum Greene

Blue-Eyed Grass

Salicaceae (Willow Family)

Populus balsamifera L.

Balsam Poplar

Populus tremuloides Michx.

Trembling Aspen

Salix arbusculoides Anderss.

Willow

Salix barclayi Anderss.

Barclay's Willow

Salix barrattiana Hook. var. *marcescens* Raup

Barratt's Willow

Salix bebbiana Sarg.

var. *perrostrata* (Rydb.) Schn.

Long-Beaked Willow

Salix brachycarpa Nutt. ssp. *brachycarpa*

Willow

Salix brachycarpa Nutt.

ssp. *niphoclada* (Rydb.) Argus

Willow

Salix glauca L.

Bluegreen Willow

Salix richardsonii Hook.

Richardson's Willow

Betulaceae (Birch Family)

Betula glandulosa Michx.

Ground/Dwarf Birch

Betula occidentalis Hook.

Black/Red/Mountain Birch

Chenopodiaceae (Goosefoot Family)

Chenopodium sp.

Goosefoot

Caryophyllaceae (Pink Family)

Arenaria stricta Michx.

var. *uliginosa* (Schleich.) Boivin

Minuartia yukonensis Hult.

Stellaria humifusa Rottb.

Sandwort

Larch-Leaved Sandwort

Chickweed

Ranunculaceae (Crowfoot Family)

Anemone patens L.

Pasque-flower/Prairie-smoke

Brassicaceae (Mustard Family)

Erysimum angustatum Rydb.

Yellow Wallflower

Saxifragaceae (Saxifrage Family)

Saxifraga tricuspidata L.

Prickly Saxifrage

Rosaceae (Rose Family)

Chamaerhodos erecta (L.) Bunge

Dryas drummondii Richards.

Dryas integrifolia M. Vahl

Potentilla egedii Wormsk.

Potentilla fruticosa L.

Potentilla pensylvanica L.

var. *glabrata* (Hook.) Wats.

Rosa acicularis Lindl.

Sorbus scopulina Greene

Chamaerhodos

Drummond's Mountain Avens

Mountain Avens

Cinquefoil

Shrubby Cinquefoil

Cinquefoil

Prickly Rose

Western Mountain Ash

Fabaceae (Legume Family)

Astragalus alpinus L.
Hedysarum alpinum L.
Oxytropis deflexa (Pall.) DC.
Oxytropis leucantha (Pall.) Pers.
Oxytropis sericea Nutt.
Oxytropis splendens Dougl.

Alpine Milk Vetch
Licorice Root
Stemless Locoweed
Stemless Locoweed
Stemless Locoweed
Stemless Locoweed

Linaceae (Flax Family)

Linum perenne L.

Wild Flax

Empetraceae (Crowberry Family)

Empetrum nigrum L.

Crowberry

Elaeagnaceae (Oleaster Family)

Elaeagnus commutata Bernh.

Silverberry

Onagraceae (Primrose Family)

Epilobium angustifolium L.

Fireweed

Haloragaceae (Water-Milfoil Family)

Hippuris vulgaris L.

Mare's-Tail

Pyrolaceae (Wintergreen Family)

Pyrola grandiflora Radius

Large-Flowered Wintergreen

Ericaceae (Heath Family)

Arctostaphylos uva-ursi (L.) Spreng.

Ledum decumbens (Ait.) Lodd.

Vaccinium uliginosum L. s. lat.

Vaccinium vitis-idaea L.

Common Bearberry

Labrador Tea

Bilberry

Mountain Cranberry

Primulaceae (Primrose Family)

Androsace septentrionalis L.

Fairy Candelabra

Gentianaceae (Gentian Family)

Gentiana prostrata Haenke

Gentianella detonsa (Rottb.) Don

Gentianella propinqua (Richards.) Gillett

Gentianella tenella (Rottb.) Börner

Moss Gentian

Fringed Gentian

Four-petalled Gentian

Gentian

Polemoniaceae (Polemonium Family)

Phlox richardsonii Hook.

Polemonium boreale Adams

Polemonium caeruleum L.

Richardson's Phlox

Northern Jacob's Ladder

Tall Jacob's Ladder

Boraginaceae (Borage Family)

Mertensia paniculata (Ait.) G. Don var. *paniculata* Tall Lungwort

Scrophulariaceae (Figwort Family)

Pedicularis sudetica Willd.

Penstemon gormanii Greene

Sudeten Lousewort

Gorman's Penstemon

Campanulaceae (Bluebell Family)

Campanula aurita Greene

Bellflower

Asteraceae (Aster Family)

Achillea millefolium L.

Antennaria rosea (Eat.) Greene

Artemisia frigida Willd.

Aster sibericus L. var. *sibericus*

Solidago decumbens Greene

Taraxacum lacerum Greene

Common Yarrow

Pink Pussy-Toes

Wormwood

Siberian Aster

Dune Goldenrod

Dandelion

E. Inorganic Element Results for Soil and Water

Sample	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
ppm										
<i>1. Background</i>										
AA127	17.1	<5.0	6.6	<1.0	<10	59	<20	2.4		Background 4 km distant
AA128										Background 9 km distant
AA129	16.6	15.1	12.1	<1.0	<10	64	59	11.9	<0.1	Background 16 km distant
AA130	12.7	11.4	7.7	<1.0	<10	84	40	11.4		Background 16 km distant
AA158	12	9.3	5.9	<1.0	<10	40	<20	1.9	<0.1	Background sediment in creek 15 km S of site
<i>2. Powerhouse and Vicinity</i>										
AA010	14	11	8	<1.0	12	68	19	4.7	<0.2	Powerhouse transformer, ~ 5m W of shed
AA011	13	11	9	1.3	33	71	23	2.6	<0.2	3 m W of AA010 (Tag 9)
AA012										2 m W of AA011 (Tag 10)
AA013										Stains ~ 15 m N of powerhouse
AA100	118	11.6	15	3.6	620	2020	29	5.3	<0.1	Interior floor of powerhouse
AA101	24	9.4	7.6	<1.0	41	78	32	6.1	<0.1	5 m E from E side of powerhouse
AA102	12.6	9	6.1	<1.0	<10	82	<20	5.9	<0.1	5 m NE from NE corner of powerhouse
AA103	26	10	8.1	<1.0	26	139	39	8.8	<0.1	Low area 20 NNE of powerhouse
AA104	16.1	9.6	8.5	<1.0	<10	77	35	6.8	<0.1	20 m N of powerhouse
AA105	12.7	9.1	11.1	<1.0	<10	44	28	10.7	<0.1	20 m NW of powerhouse
AA106	7	10.7	6.4	<1.0	<10	50	29	10.1	<0.1	20 m NW of powerhouse
AA107	19.4	7.1	11.5	<1.0	14.7	64	27	8.9	<0.1	4 m W of powerhouse above UGST
AA108										Grid sample, S side of powerhouse
AA109										Grid sample, S side of powerhouse
AA110	13.7	6.9	6.2	<1.0	118	84	<20	5.3	<0.1	Grid sample, S side of powerhouse
AA111										Grid sample, S side of powerhouse
AA112										Grid sample, S side of powerhouse
AA113	6.7	5.4	<5.0	<1.0	<10	24	<20	6	<0.1	Grid sample, S side of powerhouse
AA114	11.4	13	8.9	<1.0	25	60	34	6.9	<0.1	Grid sample, S side of powerhouse
AA115										Grid sample, S side of powerhouse
<i>3. Dumps and South Area</i>										
AA031	14	<5	<5	<1.0	176	37	<15	1.0	<0.2	At base of slope amidst ~ 20 barrels. Dump Site 1
AA032										5 m S of transformer, 1/2 way upslope from AA031
AA132	36	10.7	8.6	1	14.1	47	<20	3.9	0.2	Lowest area at base of Dump Site 2
AA135	22	7.2	7.8	<1.0	<10	42	27	5	<0.1	Below centre of Dump Site 2, transformer plates
AA141										15 m W of tall incinerator in Dump Site 2
AA142	30.2	19.7	10.7	<1.0	513	86	42	15.7	<0.1	Adjacent to broken batteries in Dump Site 3
AA149	30	18.7	9.5	<1.0	10.8	82	37	11.7	<0.1	Central area in Dump Site 3
AA150	25	17.9	9.7	<1.0	<10	73	34	10.9	<0.1	Central area in Dump Site 3
AA151	5.9	8.5	<5.0	<1.0	<10	33	<20	6.6	<0.1	N side of burned building (tar in vicinity)
AA152	9.4	7.8	<5.0	<1.0	173	105	<20	6.9	<0.1	Stain 10 m S of AA152
AA153										5 m N of burned building
AA154	12.8	10.9	5.5	<1.0	<10	27	<20	7.3	<0.1	Wet depression 70 m W of burned building
AA155										Composite of stains on E side of barrel area

Sample	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
ppm										
AA156	7.3	6.7	<5.0	<1.0	25	171	<20	1.9	<0.1	Black stain 15 m S of AA155
<i>4. Other Buildings and Sites</i>										
AA014	20	10	12	<1.0	18	52	26	5.2	<0.2	S corner fo fuel tank, 5 m N of cabin
AA015										Composite sample of stains, 10 m from N side Garage
AA016										Drainage from Garage
AA017	27	12	10	<1.0	22	58	30	4.9	<0.2	Western corner of Radio Tower Building, 1 m from steps
AA018	14	11	9	<1.0	<10	56	<15	4.4	<0.2	Beside transformer casing, ~50 m N of Garage
AA019										Beside transformer casing, ~50 m N of Garage
AA020										In Landfill close to AA024 & 025
AA021										20 m W of concrete foundations in low spot
AA022										In low area in drainage from buried buildings
AA023										S side of small pond, in clearing with wood debris
AA024	29	16	10	<1.0	<10	57	28	9.5	<0.2	In landfill close to AA020 & 025
AA025										In landfill close to AA020 & 024
AA026	21	10	11	<1.0	22	79	18	1.9	<0.2	S end of site adjacent to transformer casing
AA054										80 m W of garage on abandoned septic line
AA116	15	<5.0	7.4	<1.0	200	196	26	5.3	<0.1	15 m W of centre of garage
AA117										5 m W from NW corner of garage
AA118										1 m W of centre of garage
AA119										15 m W from S end of garage
AA120	26	13.4	9.6	<1.0	25	95	30	11.1	<0.1	13 m E of S end of garage
AA121	52	13.4	9.2	1.6	169	16.7	<20	8.1	<0.1	8 m E of N end of garage
AA122	14.6	11.1	8	<1.0	58	82	22	8.2	<0.1	SW side of airways building, 1 m from S wall
AA123										Outside W door to airways building
AA124	17.9	14.9	8.7	<1.0	93	172	28	8.6	<0.1	Outside N door to airways building
AA125	7.4	10	6.7	<1.0	15.4	44	34	5.2	<0.1	20 m SW from the SW corner of airways building
AA126										50 m SSW of airways building
AA131	16.7	16.3	9.4	<1.0	<10	51	42	8.8	<0.1	60 m W of garage in possible collapse feature
AA133	12.2	8.8	7.1	<1.0	<10	38	27	4.5	<0.1	Depression adjacent to aircraft refueling points
AA134	7.9	7.4	5.7	<1.0	<10	32	31	7.9	<0.1	Depression adjacent to aircraft refueling points
AA136	21	11.5	13.7	<1.0	18.3	58	54	7.2	<0.1	Lower beacon site: 8 m S of transformer
AA137										Lower beacon site: 8 m W of transformer
AA138	7.3	<5.0	5.9	<1.0	<10	14.6	<20	2	<0.1	Lower beacon site: 8 m N of transformer
AA139										Upper beacon site: S side of small pond
AA140	17.4	<5.0	8.1	<1.0	23	68	24	3.5	<0.1	Upper beacon site: 18 m E of AA22, transformer plates
AA143	6.9	5.8	7.5	<1.0	<10	34	29	4.4	<0.1	E end of pond 250 m SSE of airways building
AA144										8 m W of smokehouse on old POL area
AA145	15.4	9.7	5.5	<1.0	<10	39	24	4.5	<0.1	S end of old POL area
AA146	11.5	8.9	5.6	<1.0	<10	92	25	6.5	<0.1	60 m W of powerhouse, transformer plates
AA147	11.5	10.7	6	<1.0	<10	83	26	5.9	<0.1	60 m W of powerhouse, transformer plates
AA148										Low area immediately W of large septic field
AA157										100 m N of main gate, generators and engines

F. Inorganic Element Results for Vegetation

Sample	Species	Cu	Ni	Co	Cd	Pb	Zn	Cr	As	Hg	Description
ppm											
<i>1. Background</i>											
AA127P	<i>Salix brachycarpa</i>	12	8.0	<5.0	3.2	<15	127	20	<0.2		Background 4 km distant
AA128P	<i>Salix brachycarpa</i>	7	<5	<5	1.5	<15	83	<10	<0.2		Background 9 km distant
AA129P	<i>Salix brachycarpa</i>	5	9	<5	1.6	<15	76	13	<0.2		Background 16 km distant
<i>2. Powerhouse and Vicinity</i>											
AA011PS	<i>Muhlenbergia glomerata, shoots</i>	13.9	26	<5	0.6	<15	115	89	0.6	<0.1	3 m W of AA010 (Tag 9)
AA011PR	<i>Muhlenbergia glomerata, roots</i>	19.7	72	<5	0.9	<15	290	214	1.6	<0.1	3 m W of AA010 (Tag 9)
AA103P	<i>Salix glauca</i>	13.5	<5	<5	2.8	<15	271	17.1	<0.2	<0.1	Low area 20 NNE of powerhouse
<i>3. Dumps and South Area</i>											
AA031P	<i>Salix glauca</i>										At base of slope amidst ~ 20 barrels. Dump Site 1
AA132P	<i>Salix barclayi</i>	10.5	<5	<5	1.7	<15	840	<10	0.7	<0.1	Lowest area at base of Dump Site 2
AA142PS	<i>Salix richardsonii, shoots</i>	10.4	<5	<5	3.7	234	269	<10	<0.2	<0.1	Adjacent to broken batteries in Dump Site 3
AA142PR	<i>Salix richardsonii, roots</i>	40	40	<5	1.9	67	335	113	2.6	<0.1	Adjacent to broken batteries in Dump Site 3
AA151P	<i>Salix richardsonii</i>	7.9	16.9	<5	3.2	<15	186	67	0.4		N side of burned building (tar in vicinity)
AA154P	<i>Carex physocarpa</i>										Wet depression 70 m W of burned building
<i>4. Other Buldings and Sites</i>											
AA020P	<i>Betula glandulosa</i>	7.5	6	<5	<0.5	<15	391	14.9	<0.2		In Landfill close to AA024 & 025
AA022P	<i>Salix brachycarpa</i>	13.4	13.1	<5	1.8	<15	213	32	0.8		In low area in drainage from buried buildings
AA124P	<i>Salix glauca</i>	9.3	<5	<5	1.2	<15	175	<10	<0.2	<0.1	Outside N door to airways building
AA133PR	<i>Salix richardsonii, roots</i>	12.4	4.8	<5	2.1	<15	303	10.9	0.2		Depression adjacent to aircraft refueling points
AA133PS	<i>Salix richardsonii, shoots</i>	10.3	<5	<5	1.8	<15	153	22	<0.2		Depression adjacent to aircraft refueling points
AA138P	<i>Salix richardsonii</i>	9.3	<5	<5	2.3	<15	160	<10	0.2	<0.1	Lower beacon site: 8 m N of transformer
AA139P	<i>Salix brachycarpa</i>										Upper beacon site: S side of small pond
AA140P	<i>Salix glauca</i>	11.5	<5	<5	1.6	<15	288	14.1	<0.2		Upper beacon site: 18 m E of AA22, transformer plates
AA 143P	<i>Salix brachycarpa</i>										E end of pond 250 m SSE of airways building
AA146P	<i>Salix brachycarpa</i>										60 m W of powerhouse, transformer plates
AA148P	<i>Salix richardsonii</i>										Low area immediately W of large septic field

G. Inorganic Element and PCB Results for Paint Samples

	Co ug/g	Cd ug/g	Cr ug/g	Cu ug/g	Zn %	Pb %	As ug/g	Ni ug/g	PCBs ug/g
ASPC1	107	3.4	208	58	1.46	0.28	0.45	<0.5	21915
ASPC2	66	3.1	1090	35	1.58	0.58	0.6	7.6	26
ASPC3	159	9.8	144	147	4.83	1.98	1.47	<0.5	154

H. Aroclor PCB Results for Soil and Water

Sample	Aroclor 1242	Aroclor 1254 ppb	Aroclor 1260	Aroclor Total	Location
<i>1. Background</i>					
AA127	0.49	<0.1	<0.04	0.49	Background 4 km distant
AA128	0.56	0.17	0.16	0.89	Background 9 km distant
AA129	0.62	<0.19	0.03	0.65	Background 16 km distant
AA130	<0.52	<0.54	<0.31		Background 16 km distant
AA158	<1.9	<1.8	<1.1		Background sediment in creek 15 km S of site
<i>2. Powerhouse and Vicinity</i>					
AA010	<3.7	71	84	160	Powerhouse transformer, ~ 5m W of shed
AA011	<1.1	15	98	110	3 m W of AA010 (Tag 9)
AA012					2 m W of AA011 (Tag 10)
AA013					Stains ~ 15 m N of powerhouse
AA100	<11000	930000	140000	1100000	Interior floor of powerhouse
AA101	<1700	9000	1400	10000	5 m E from E side of powerhouse
AA102	2.4	120	35	160	5 m NE from NE corner of powerhouse
AA103	<1.4	43	8.6	52	Low area 20 NNE of powerhouse
AA104	<0.55	12	<2.7	12	20 m N of powerhouse
AA105	<0.71	5.5	6.5	12	20 m NW of powerhouse
AA106	<1.2	13	5.6	19	20 m NW of powerhouse
AA107	<1.1	36	9.1	45	4 m W of powerhouse above UGST
AA108					Grid sample, S side of powerhouse
AA109	<10	1100	320	1400	Grid sample, S side of powerhouse
AA110	<11	1300	340	1600	Grid sample, S side of powerhouse
AA111	<8.4	2800	590	3400	Grid sample, S side of powerhouse
AA112	<1.0	35	94	130	Grid sample, S side of powerhouse
AA113	<1.2	<1.8	15	15	Grid sample, S side of powerhouse
AA114					Grid sample, S side of powerhouse
AA115					Grid sample, S side of powerhouse
<i>3. Dumps and South Area</i>					
AA031	<6.0	<73	<46		At base of slope amidst ~ 20 barrels. Dump Site 1
AA032	<1.1	<1.2	<0.8		~ 5 m S of transformer, ~ 1/2 way upslope from AA031
AA132	<4.3	50	51	100	Lowest area at base of Dump Site 2
AA135	<0.98	2.9	1.3	4.2	Below centre of Dump Site 2, transformer plates
AA141					15 m W of tall incinerator in Dump Site 2
AA142	<0.62	<0.53	<0.32		Adjacent to broken batteries in Dump Site 3
AA149	<0.6	<0.55	<0.3		Central area in Dump Site 3
AA150	<0.52	<0.42	<0.23		Central area in Dump Site 3
AA151	<3.2	180	310	490	N side of burned building (tar in vicinity)
AA152	<18	46	12	58	Stain 10 m S of AA152
AA153					5 m N of burned building

Sample	Aroclor 1242	Aroclor 1254 ppb	Aroclor 1260	Aroclor Total	Location
AA154	<3.2	<1.3	<0.97		Wet depression 70 m SW of burned building
AA155					Composite of stains on E side of barrel area
AA156	<11	13	<5.0	13	Black stain 15 m S of AA155
<i>4. Other Buildings and Sites</i>					
AA014	<0.56	<0.64	<0.5		S corner fo fuel tank, 5 m N of cabin
AA015					Composite sample of stains, 10 m from N side Garage
AA016					Drainage from Garage
AA017	<0.49	57	50	110	Western corner of Radio Tower Building, 1 m from steps
AA018	<0.29	3.8	0.76	4.6	Beside transformer casing, ~50 m N of Garage
AA019					Beside transformer casing, ~50 m N of Garage
AA020					In Landfill close to AA024 & 025
AA021	<2.0	5.6	3.7	9.3	20 m W fo concrete foundations in low spot
AA022					In low area in drainage from buried buildings
AA023					S side of small pond, in clearing with wood debris
AA024	<0.47	1.3	1.2	2.5	In landfill close to AA020 & 025
AA025					In landfill close to AA020 & 024
AA026	<0.43	<0.46	<0.3		S end of site adjacent to transformer casing
AA054					80 m W of garage on abandoned septic line
AA116					15 m W of centre of garage
AA117					5 m W from NW corner of garage
AA118					1 m W of centre of garage
AA119					15 m W from S end of garage
AA120	<0.64	12	9.4	22	13 m E of S end of garage
AA121	<3.5	52	58	110	8 m E of N end of garage
AA122	9.5	26	6.4	42	SW side of airways building, 1 m from S wall
AA123	3.3	28	7.9	39	Outside W door to airways building
AA124	<0.49	17	5.2	22	Outside N door to airways building
AA125	<2.1	<1.6	25	25	20 m SW from the SW corner of airways building
AA126					50 m SSW of airways building
AA131	<0.77	1.2	<0.46	1.2	60 m W of garage in possible collapse feature
AA133	<0.55	<0.54	<0.4		Depression adjacent to aircraft refueling points
AA134	<0.72	<0.66	<0.47		Depression adjacent to aircraft refueling points
AA136	<0.78	<0.74	1.2	1.2	Lower beacon site: 8 m S of transformer
AA137					Lower beacon site: 8 m W of transformer
AA138	<1.6	7.6	42	50	Lower beacon site: 8 m N of transformer
AA139	<0.8	1.5	0.62	2.1	Upper Beacon site: S side of small pond
AA140	<2.4	NDR(3.6)	5.8	5.8	Upper Beacon site: 18 m E of AA22, transformer plates
AA143	<0.66	<0.62	<0.38		E end of pond 250 m SSE of airways building
AA144					8 m W of smokehouse on old POL area
AA145	<1.7	<2.3	<1.4		S end of old POL area
AA146	<6.9	52	21	73	60 m W of powerhouse, transformer plates
AA147	<7.0	29	14	43	60 m W of powerhouse, transformer plates
AA148					Low area immediately W of large septic field
AA157	<2.0	<2.9	<1.8		100 m N of main gate, generators and engines

Sample	Aroclor 1242	Aroclor 1254 ppb	Aroclor 1260	Aroclor Total	Location
--------	-----------------	------------------------	-----------------	------------------	----------

Water

AA W1	<7.0	<3.5	<2.4		Pond 250 m E of airways building
AA W2	<5.0	<2.7	<1.8		From creek at AA 158

I. Aroclor PCB Results for Vegetation

Sample	Species	Aroclor 1242	Arocl or 1254 ppb	Aroclor 1260	Aroclor Total	Description
<i>1. Background</i>						
AA127P	<i>Salix brachycarpa</i>	0.05	<0.22	<0.08		Background 4 km distant
AA128P	<i>Salix brachycarpa</i>	NDR(0.06)	<0.13	<0.13		Background 9 km distant
AA129P	<i>Salix brachycarpa</i>	NDR(0.05)	<0.2	<0.05		Background 16 km distant
<i>2. Power House and Vicinity</i>						
AA011PS	<i>Muhlenbergia glomerata, shoots</i>	<1.2	3.9	4.1	8.0	3 m W of AA010 (Tag 9)
AA011PR	<i>Muhlenbergia glomerata, roots</i>	<1.3	8.8	16	25	3 m W of AA010 (Tag 9)
AA103P	<i>Salix glauca</i>	<1.1	2.2	<0.42	2.2	Low area 20 NNE of power house
<i>3. Dumps and South Area</i>						
AA031P	<i>Salix glauca</i>					At base of slope amidst ~ 20 barrels. Dump Site 1
AA132P	<i>Salix barclayi</i>	<0.93	<0.65	<0.38		Lowest area at base of Dump Site 2
AA142PS	<i>Salix richardsonii, shoots</i>	<0.2	<0.4	<0.52		Adjacent to broken batteries in Dump Site 3
AA142PR	<i>Salix richardsonii, roots</i>	<0.15	<0.32	<0.35		Adjacent to broken batteries in Dump Site 3
AA151P	<i>Salix richardsonii</i>	<0.13	0.58	0.78	1.4	N side of burned building (tar in vicinity)
AA154P	<i>Carex physocarpa</i>					Wet depression 70 m W of burned building
<i>4. Other Buildings and Sites</i>						
AA020P	<i>Betula glandulosa</i>	<0.24	<0.48	<0.46		In Landfill close to AA024 & 025
AA022P	<i>Salix brachycarpa</i>	<0.27	<0.64	<0.72		In low area in drainage from buried buildings
AA124P	<i>Salix glauca</i>	<0.7	1.0	<0.26	1.0	Outside N door to airways building
AA133PR	<i>Salix richardsonii, roots</i>	<0.2	<0.4	<0.52		Depression adjacent to aircraft refueling points
AA133PS	<i>Salix richardsonii, shoots</i>	<0.15	<0.32	<0.35		Depression adjacent to aircraft refueling points
AA138P	<i>Salix richardsonii</i>	<0.88	0.99	0.68	1.7	Lower beacon site: 8 m N of transformer
AA139P	<i>Salix brachycarpa</i>					Upper beacon site: S side of small pond
AA140P	<i>Salix glauca</i>	<0.13	<0.28	<0.3		Upper beacon site: 18 m E of AA22, transformer plates
AA 143P	<i>Salix brachycarpa</i>					E end of pond 250 m SSE of airways building
AA146P	<i>Salix brachycarpa</i>					60 m W of power house, transformer plates
AA148P	<i>Salix richardsonii</i>					Low area immediately W of large septic field

J. PCB Congener Results for Soils

Sample	AA127	AA128	AA129	AA158	AA102	AA107	AA111	AA100	AA010
Area	1	1	1	1	2	2	2	2	2
Congener									
18	0.04	0.04	0.03	<0.02	0.19	<0.08	<0.62	<820	<0.43
15/17	0.04	0.06	0.04	<0.33	<0.1	<0.09	<0.68	<1000	<0.43
54	<0.001	<0.002	<0.001	<0.01	<0.07	<0.06	<0.53	<710	<0.46
31	0.05	0.05	0.07	<0.02	0.24	<0.07	<0.54	NDR(1400)	<0.24
28	0.05	0.05	0.07	<0.02	0.1	<0.07	1.1	<730	<0.24
52	0.02	0.03	0.02	0.02	7.6	0.64	100	46000	5
49	0.03	0.04	0.02	NDR(0.01)	2.2	1.2	24	14000	1
44	0.01	0.02	0.02	0.007	2.9	0.65	51	28000	1.7
40/103	<0.005	<0.005	<0.003	<0.007	0.29	<0.16	4.9	2000	0.2
61/94/74	0.02	0.03	0.02	<0.005	1.2	0.21	12	9500	0.5
66/80/95	0.02	0.03	0.03	<0.005	10	5	250	77000	6.9
121	<0.003	<0.003	<0.002	<0.02	<0.04	<0.13	<0.48	<630	<0.06
56/60	0.006	0.01	0.007	<0.005	0.8	<0.14	78	26000	1.6
90/101	0.006	0.02	0.008	<0.02	11	4	260	170000	10
86/97	<0.003	<0.008	<0.006	<0.03	4	1.4	97	30000	2.2
87	0.004	<0.008	<0.006	<0.03	8.3	2.3	190	61000	4.8
77/154/110	0.006	0.02	0.01	<0.008	22	9.1	500	140000	20
151	0.002	0.004	<0.001	<0.008	3.2	1.2	58	15000	2.8
135/144	<0.007	<0.004	<0.001	<0.007	5	2	98	26000	2.8
149	0.005	0.02	0.004	0.04	11	6.1	250	66000	8.2
118	<0.007	<0.008	<0.005	<0.04	15	4	224	110000	7.5
143	<0.005	<0.002	<0.001	NDR(0.01)	0.28	<0.19	<0.68	<900	<0.06
114	<0.007	<0.008	<0.005	<0.03	2.7	8	18	5600	1
132/153	0.007	0.04	0.007	NDR(0.03)	13	5	250	71000	12
105	<0.005	<0.009	<0.003	<0.04	2.1	1.7	69	17000	2.6
141/179	<0.003	0.004	<0.001	NDR(0.02)	3.6	1.1	76	21000	2.4
137	<0.003	<0.001	<0.002	<0.006	3.1	0.65	33	8500	0.54
138/158	0.006	0.02	0.004	NDR(0.07)	20	7.8	390	110000	13
129/126	<0.003	<0.002	<0.002	<0.006	3	0.76	40	9800	1.2
187/182/159	<0.003	0.008	<0.002	<0.03	1.9	0.99	33	7500	3.2
183	<0.003	<0.004	<0.002	<0.03	1.5	0.47	23	5400	2
128	<0.004	0.004	<0.002	NDR(0.02)	5.5	2.4	120	29000	2.4
185	<0.003	<0.004	<0.002	<0.02	0.47	<0.1	3	720	0.3
174/181	<0.004	<0.003	<0.002	<0.02	1.8	0.46	26	6100	2.4
202/171/156	<0.004	NDR(0.04)	NDR(0.007)	NDR(0.07)	3.3	0.67	42	12000	2.2
173/201	<0.001	<0.001	<0.001	<0.004	0.95	0.31	13	3200	0.54
180	<0.002	0.02	0.003	<0.02	3.7	1.1	63	14000	7
191	<0.002	<0.002	<0.001	<0.02	0.11	<0.12	2	480	0.19
170	<0.002	0.01	0.001	<0.03	3.2	0.63	56	12000	4.1
199	<0.001	<0.002	<0.001	<0.006	0.74	0.57	11	2700	1.6
203/196	<0.001	0.004	<0.001	NDR(0.01)	0.53	0.34	8.8	2000	1.6
189	<0.001	0.008	<0.002	<0.03	0.16	<0.14	2	<680	0.17
208/195	<0.002	<0.004	<0.002	NDR(0.09)	0.33	0.35	4.4	1400	0.61
207	<0.002	<0.004	<0.002	<0.01	0.2	<0.14	1	<710	0.1
194	<0.002	<0.003	<0.002	<0.009	1.2	0.44	12	3000	1.4
205	<0.002	<0.003	<0.002	<0.009	0.45	<0.14	0.82	<710	0.46
206	<0.002	<0.004	<0.002	0.09	1.1	0.52	5.6	2500	0.59

Sample Area Congener	AA011 2	AA101 2	AA135 3	AA132 3	AA121 4	AA138 4	AA140 4	AA122 4
18	<0.14	<100	<0.07	<0.3	<0.25	<0.13	<0.16	0.76
15/17	<0.14	<120	<0.08	<0.35	<0.32	<0.13	<0.2	0.46
54	<0.14	<85	<0.06	<0.25	<0.21	<0.09	<0.14	<0.04
31	<0.08	<95	<0.06	<0.25	<0.22	<0.08	<0.14	0.66
28	<0.08	<95	<0.06	<0.25	<0.22	<0.08	0.44	0.78
52	0.91	550	0.24	1.8	0.75	0.7	0.22	0.9
49	0.16	170	0.55	4.2	0.95	0.54	0.8	0.94
44	0.18	310	0.25	1.6	0.3	0.23	NDR(0.24)	1.1
40/103	<0.1	<23	<0.09	0.61	NDR(0.25)	<0.08	<0.15	0.27
61/94/74	<0.08	76	<0.08	1.1	<0.19	0.11	<0.14	0.66
66/80/95	3.4	1000	0.26	6.3	12	1.6	0.38	3.4
121	<0.07	<19	<0.08	<0.52	<0.17	<0.07	<0.13	<0.05
56/60	0.6	44	<0.08	1.1	0.6	0.46	<0.14	1.6
90/101	3.9	1100	0.31	5.7	5.1	1.9	0.42	3
86/97	0.47	390	0.09	1.8	2	0.21	NDR(0.25)	0.95
87	1.1	720	0.18	2.2	2.7	0.57	<0.12	1.6
77/154/110	4.8	1700	0.43	6.6	35	1.6	1.1	5.9
151	3	210	<0.09	4.1	4	2.3	0.29	0.79
135/144	2.3	310	0.15	3	5.4	1.6	<0.18	1.2
149	7.6	890	0.32	10	17	4.8	1	3.3
118	1.9	1300	0.31	6.6	5.3	0.97	0.23	3.3
143	<0.08	<27	<0.1	<0.71	<0.11	<0.08	<0.18	<0.08
114	1	50	<0.1	1.2	NDR(27)	0.14	<0.18	<0.08
132/153	12	940	0.31	14	13	5.9	1.2	3.4
105	2.7	110	0.05	0.77	4.1	0.61	0.12	0.59
141/179	2.4	260	<0.07	2.2	3.5	1.5	0.2	0.67
137	0.13	110	<0.07	1.2	2	<0.06	<0.13	0.38
138/158	11	1300	0.32	9.7	23	5.3	0.85	4.9
129/126	1	120	<0.07	1.6	2.8	0.72	0.18	0.46
187/182/159	4	94	0.13	7.1	4	2.5	0.51	0.49
183	2.6	62	0.22	2.6	2.2	1.5	0.19	0.27
128	1	230	0.13	1.3	8.9	0.42	0.23	1.2
185	0.39	<15	<0.06	0.48	0.36	0.33	<0.1	0.04
174/181	2.9	76	<0.06	3.2	2.4	1.7	0.21	0.28
202/171/156	1.9	110	<0.06	1.5	1.1	1	0.12	0.47
173/201	0.42	21	<0.07	<0.47	1.1	0.2	<0.12	0.18
180	9.3	170	0.07	6.5	6.5	5	0.72	0.69
191	0.22	<20	<0.07	<0.47	0.18	0.17	<0.12	<0.05
170	5.3	160	<0.08	2.8	4.7	3.6	0.44	0.55
199	2.2	33	<0.08	2.9	2.2	1.2	0.17	0.23
203/196	2.3	29	<0.06	1.8	1.5	0.97	0.13	0.14
189	0.25	<25	<0.08	<0.54	0.2	0.19	<0.14	<0.06
208/195	0.74	38	<0.06	1.3	0.91	0.53	<0.1	0.11
207	0.21	<26	<0.08	<0.55	0.22	0.06	<0.14	<0.06
194	2.1	37	<0.08	1.8	1.7	1.4	0.29	0.19
205	0.15	<26	<0.08	<0.55	0.18	0.1	<0.14	0.06
206	0.82	86	<0.08	1.6	1.8	0.44	0.14	0.22

Areas: 1. Background 2. Power house and vicinity 3. Dumps and south area 4. Other building and sites.

NDR: Peak detected but did not meet quantification criteria. All values are ppb (ng/g).

K. PCB Congener Results for Vegetation

Sample	AA127P	AA128P	AA129P
Area	1	1	1
Compounds			
18	0.004	0.005	<0.003
15/17	<0.02	<0.003	<0.02
54	<0.002	<0.002	<0.001
31	0.004	NDR(0.005)	0.004
28	0.004	0.004	0.004
52	0.006	0.008	0.006
49	0.003	0.002	0.002
44	0.002	0.003	0.003
40/103	<0.006	<0.005	<0.006
61/94/74	<0.002	<0.002	<0.002
66/80/95	NDR(0.008)	NDR(0.006)	0.007
121	<0.003	<0.003	<0.003
56/60	0.002	<0.002	<0.003
90/101	NDR(0.007)	0.008	0.01
86/97	<0.006	<0.004	<0.006
87	<0.006	0.004	<0.006
77/154/110	<0.005	0.007	0.009
151	<0.003	<0.002	0.002
135/144	<0.003	<0.002	<0.002
149	0.01	NDR(0.004)	0.008
118	<0.007	<0.008	0.008
143	<0.002	<0.001	<0.001
114	<0.007	<0.008	<0.007
132/153	0.01	NDR(0.01)	0.02
105	<0.005	<0.01	<0.006
141/179	<0.002	<0.002	<0.003
137	<0.003	<0.002	<0.003
138/158	0.02	0.01	NDR(0.01)
129/126	<0.003	<0.002	<0.003
187/182/159	<0.003	<0.002	<0.003
183	<0.003	<0.002	<0.001
128	<0.003	<0.004	<0.004
185	<0.002	<0.002	<0.001
174/181	<0.006	<0.004	<0.002
202/171/156	<0.006	<0.004	<0.003
173/201	<0.001	<0.002	<0.001
180	<0.004	0.004	0.004
191	<0.004	<0.003	<0.002
170	<0.004	<0.002	0.002
199	<0.003	<0.001	<0.002
203/196	<0.003	<0.001	<0.001
189	<0.002	<0.001	<0.001
208/195	<0.002	<0.003	<0.004
207	<0.002	<0.003	<0.002
194	<0.001	<0.002	<0.004
205	<0.001	<0.002	<0.004
206	<0.002	<0.003	<0.002

NDR: Peak detected but did not meet quantification criteria. All values are ppb (ng/g). Area 1 is background.

L. Aroclor PCB Results for Swabs

Sample	Aroclor 1242	Aroclor 1254 ng/swab	Aroclor 1260	Aroclor Total	Location
AA-01	<13	33	<11	33	Front room, power house
AA-02	<15	16	<4.1	16	Front room, power house
AA-03	<16	24	4.6	29	Front room, power house
AA-04	<12	36	<8.4	36	Wall above concrete bench, power house
AA-05	<24	37	6.3	43	Wall above concrete bench, power house
AA-06	<19	32	4.9	37	Wall above concrete bench, power house
AA-07	<11	<8	<8.4		Field blanks
AA-08	<7.0	<5.5	<2.3		Field blanks
AA-09	27	<6.9	<2.8	27	Field blanks
AA-10	<14	56	12	68	Back wall, garage
AA-11	<14	210	44	250	Back wall, garage
AA-12	<18	90	15	100	Back wall, garage

M. Pesticide Results for Soils

Sample	AA 113	AA111	AA132	AA 138
ppb (ng/g)				
Compound				
Hexachlorobenzene	<0.02	<0.3	0.31	<0.01
alpha BHC	<0.02	0.25	0.07	<0.07
beta BHC	<0.07	<0.1	<0.19	<0.27
gamma BHC	<0.03	<0.05	<0.1	<0.14
Heptachlor	<0.06	<0.26	<0.27	<0.02
Aldrin	<0.04	<0.14	<0.22	<0.01
Oxychlordane	<0.03	<0.06	<0.12	<0.07
trans-Chlordane	<0.02	<0.06	<0.12	0.21
cis-Chlordane	<0.02	<0.07	0.16	<0.05
o,p'-DDE	<0.05	17	<0.53	0.3
p,p'-DDE	<0.06	<0.14	8.0	0.41
trans-Nonachlor	<0.05	1.3	0.25	<0.04
cis-Nonachlor	<0.01	<0.06	<0.11	NDR(0.15)
o,p'-DDD	<0.03	7.8	0.5	0.36
p,p'-DDD	NDR(0.18)	<0.08	1.6	<0.08
p,p'-DDT	1.6	<0.56	2.7	1.3
Mirex	<0.07	<0.23	<0.32	<0.08
Heptachlor Epoxide		<1.1	1.0	
alpha-Endosulphan		<1.2	<0.29	
Dieldrin		<1.1	1.3	
Endrin		<3.0	<0.72	
Methoxychlor		<5.8	<1.4	

NDR: peak detected but did not meet quantification criteria

N. Polycyclic Aromatic Hydrocarbon Results for Soils

Sample	AA 014	AA 156	AA 152	AA 144
Compound	ppb (ng/g)			
Naphthalene	NDR(6.0)	16	NDR(16)	18
Acenaphthylene	<0.04	NDR(6.7)	NDR(5.2)	1.3
Acenaphthene	NDR(11)	<6.1	NDR(1.7)	<0.7
Fluorene	NDR(14)	NDR(13)	5.0	1.7
Phenanthrene	NDR(12)	<13	19	6.5
Anthracene	NDR(11)	<14	NDR(3.0)	NDR(1.1)
Fluoranthene	8.0	NDR(34)	45	9.5
Pyrene	10	NDR(82)	69	10
Benz(a)anthracene	NDR(3.0)	NDR(63)	<0.7	NDR(5.0)
Chrysene	7.0	NDR(140)	<0.8	9.5
Benzo(a)fluoranthene	7.6	NDR(18)	NDR(68)	13
Benzo(e)pyrene	4.0	NDR(24)	NDR(23)	6
Benzo(a)pyrene	4.0	NDR(35)	NDR(53)	5.2
Perylene	NDR(1.0)	NDR(32)	NDR(4.0)	NDR(1.2)
Dibenz(ah)anthracene	NDR(0.8)	<14	<1.7	NDR(0.9)
Indeno(1,2,3-cd)pyrene	NDR(3.0)	<17	NDR(23)	4.7
Benzo(ghi)perylene	3.0	<18	NDR(2.7)	NDR(5.5)

NDR: peak detected but did not meet quantification criteria

O. Acid/Base/Neutral Extractable Organic Compound Results for Soils

Sample	AA 113	AA 138	AA 111
Compounds	ppb (ng/g)		
Bis(2-chloroethoxy) methane	<6	<0.6	<0.6
Bis(2-chloroethyl) ether	<6	<0.6	<0.6
Bis(2-chloroisopropyl) ether	<5	<0.5	<0.5
4-Bromophenyl phenyl ether	<3	<0.3	<0.3
2-Chloronaphthalene	<7	<0.7	<0.7
4-Chlorophenyl phenyl ether	<4	<0.4	<0.4
2,4-Dinitrotoluene	<7	<0.7	<0.7
2,6-Dinitrotoluene	<20	<2	<2.0
Isophorone	<10	<1	<1.0
Nitrobenzene	<9	<0.9	<0.9
N-Nitrosodi-n-propylamine	<20	<2	<8.0
N-Nitrosodiphenylamine	<3	<0.3	<0.3
Hexachlorobenzene	<4	<0.4	<0.4
Hexachlorobutadiene	<20	<2	<2.0
Hexachlorocyclopentadiene	<100	<10	<10
Hexachloroethane	<80	<8	<2.0
1,2,4-Trichlorobenzene	<5	<0.5	<0.5
2,4-Dimethylphenol	<20	<2	<2.0
4,6-Dinitro-o-cresol	<100	<10	<10
2,4-Dinitrophenol	<100	<10	<10
2-Nitrophenol	<20	<2	<2.0
4-Nitrophenol	<20	<2	<2.0
Phenol	<7	<0.7	<0.7
2-Chlorophenol	<7	<0.7	<0.7
4-Chloro-3-methylphenol	<10	<1	<1.0
2,4-Dichlorophenol	<7	<0.7	<0.7
2,4,6-Trichlorophenol	<10	<1	<1.0
2,4,5-Trichlorophenol	<7	<0.7	<0.7
Pentachlorophenol	<20	<2	<2.0
Naphthalene	<6	<0.6	<0.6
Acenaphthylene	<7	<0.7	<0.7
Acenaphthene	<4	<0.4	<0.4
Fluorene	<4	<0.4	<0.4
Phenanthrene	<3	<0.3	<0.3
Anthracene	<2	<0.2	<0.2
Fluoranthene	<3	<0.3	<0.3
Pyrene	<2	<0.2	<0.2

Sample	AA 113	AA 138	AA 111
Compounds	ppb (ng/g)		
Benzo(a)anthracene	<3	<0.3	<0.3
Chrysene	<4	<0.4	<0.4
Benzo(a)fluoranthene	<11	<0.11	<0.11
Benzo(a)pyrene	<5	<0.5	<0.5
Dibenz(a,h)anthracene	<3	<0.3	<0.3
Indeno(1,2,3-cd)pyrene	<5	<0.5	<0.5
Benzo(ghi)perylene	<5	<0.5	<0.5
3,3-Dichlorobenzidine	<30	<3	<3.0
1,3-Dichlorobenzene	<9	<0.9	<0.9
1,4-Dichlorobenzene	<9	<0.9	<0.9
1,2-Dichlorobenzene	<8	<0.8	<0.8
Dimethyl phthalate	<6	<0.6	<0.6
Diethyl phthalate	<3	<0.3	<0.3
Dibutyl phthalate	<300	<30	<30
Butyl-Benzyl phthalate	<90	<9	<9.0
Bis(2-ethylhexyl)phthalate	<80	<8	<8.0
Di-N-Octyl phthalate	<8	<0.8	<0.8

P. Dioxin Results for Soils

Sample	AA111	AA132	AA101
	pg/g		
Dioxins			
T4CDD - Total	3.8	6.2	1.0
2,3,7,8	0.3	NDR(0.2)	<0.1
P5CDD - Total	31	3.5	<0.3
1,2,3,7,8	5.5	NDR(0.3)	<0.3
H6CDD - Total	300	26	7.8
1,2,3,4,7,8	17	0.6	0.3
1,2,3,6,7,8	56	2.5	0.8
1,2,3,7,8,9	40	1.4	0.8
H7CDD - Total	2000	120	28
1,2,3,4,6,7,8	1200	62	14
O8CDD - Total	5500	340	70
Furans			
T4CDF - Total	73	21	140
2,3,7,8	7.8	2.4	36
P5CDF - Total	230	16	430
1,2,3,7,8	2.5	0.6	4
2,3,4,7,8	11	NDR(0.9)	53
H6CDF - Total	850	24	910
1,2,3,4,7,8	44	1.5	280
1,2,3,6,7,8	38	1.0	140
2,3,4,6,7,8	21	1.0	18
1,2,3,7,8,9	<0.1	<0.3	1.2
H7CDF - Total	2100	37	280
1,2,3,4,6,7,8	710	19	110
1,2,3,4,7,8,9	27	NDR(0.5)	60
O8CDF - Total	2300	18	210
TEQ using NATO I-TEFs¹			
A ²	58.2	2.5	76.7
B ³	58.2	2.2	76.5

¹ 2,3,7,8-tetrachlorodibenzodioxin Toxic Equivalent using NATO Toxic Equivalent Factors (see Chapter IV).

² Calculated using values of half the detection limit for undetected congeners.

³ Calculated using a value of zero for undetected congeners.

Q. Inorganic Element and PCB Results for Barrel Samples

Sample	Signature	Cl	PCB	Pb	Cr	Cd
AAB1	lubricating oil and grease	<1000	<2.0	<100	<10	9.8
AAB3	water only			<0.1	<0.1	<0.01
AAB4	water only			<0.1	<0.1	1.1
AAB5	fuel oil	<1000	<2.0	<100	<10	<2.0
AAB5	water					
AAB6	fuel oil/lube oil and grease	<1000	<2.0	63	<10	11.9
AAB6	water			<0.1	<0.1	0.16
AAB7	diesel	<1000	<2.0	<100	<10	<2.0

All concentrations expressed as ppm ($\mu\text{g/g}$)