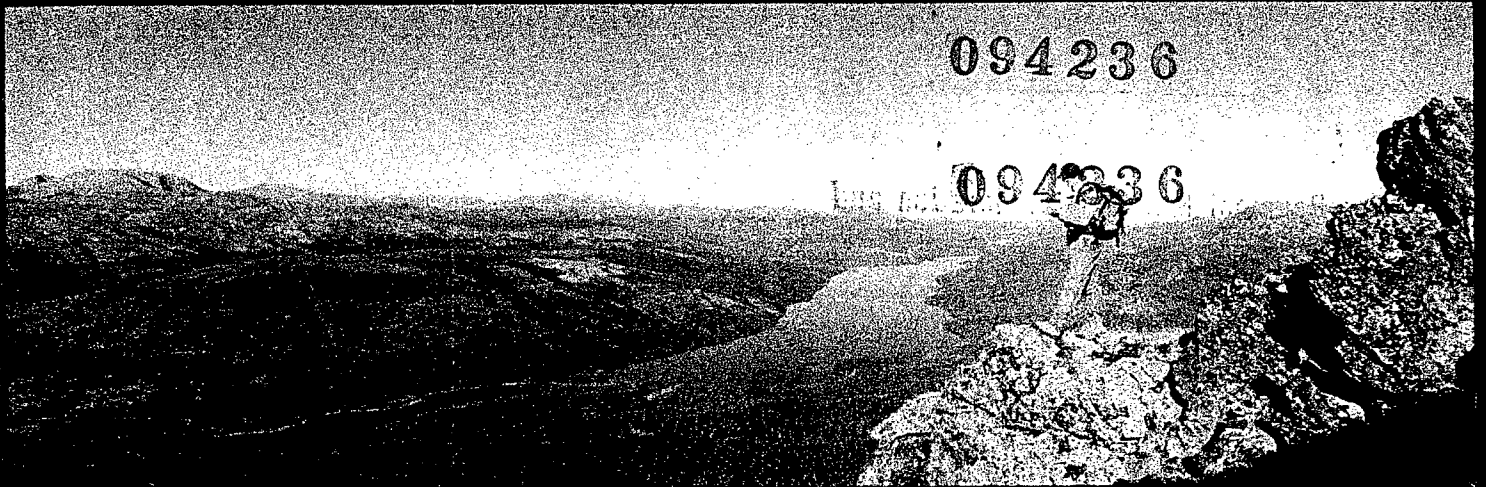


FINLAYSON



PROJECT DESCRIPTION REPORT

November 2000

094236

This report has been examined by
the Geological Evaluation Unit
under Section 53 (4) Yukon Quartz
Mining Act and is allowed as
representation work in the amount
of \$ 169,731.43 .

M. B. L.

for Regional Manager, Exploration and
Geological Services for Commissioner
of Yukon Territory.

2001 OCT -9 A 10: 56

**FINLAYSON PROJECT DESCRIPTION REPORT
CLAIMS – SEE ATTACHED LIST
AREA ONE – 413 CLAIMS
AREA TWO – 363 CLAIMS**

**Located in the Pelly Mountains
Watson Lake Mining District
NTS 105G/8
61° 26' North Latitude
130° 07' West Longitude**

094236

Prepared by

Justin Himmelright, B.Sc.

**EXPATRIATE RESOURCES LIMITED
Suite 701 – 475 Howe Street
Vancouver, BC, Canada
V6C 2B3**

October 2001

**DATES OF WORK PERFORMED
January to November 2000**

**FINLAYSON PROJECT DESCRIPTION REPORT CLAIM LIST
AREA ONE**

WJV	Foot	473	488	0	16	YB61246	YB61261	Watson Lake
WJV	Foot	499	506	0	8	YB61272	YB61279	Watson Lake
WJV	Foot	525	0	0	1	YB61290	0	Watson Lake
WJV	Foot	527	0	0	1	YB61292	0	Watson Lake
WJV	Foot	529	0	0	1	YB61294	0	Watson Lake
WJV	Foot	531	0	0	1	YB61296	0	Watson Lake
WJV	Knot	1	6	0	6	YB89415	YB89420	Watson Lake
Pelly Project	Low	1	12	Fr	12	YB85382	YB85393	Watson Lake
Pelly Project	Low	13	14	Fr	2	YB85394	YB85395	Watson Lake
Pelly Project	Strike	321	337		17	YB89608	YB89624	Watson Lake
Pelly Project	Strike	338		Fr	1	YB89625		Watson Lake
Pelly Project	Strike	339			1	YB89626		Watson Lake
Pelly Project	Strike	340		Fr	1	YB89627		Watson Lake
Pelly Project	Strike	341	346		6	YB89628	YB89633	Watson Lake
KZK Project	Tag	462	471	0	10	YB49004	YB49013	Watson Lake
KZK Project	Tag	478	483	0	6	YB49020	YB49025	Watson Lake
KZK Project	Tag	488	0	0	1	YB49030	0	Watson Lake
KZK Project	Tag	517	539	0	23	YB49593	YB49615	Watson Lake
KZK Project	Tag	544	546	0	3	YB49620	YB49622	Watson Lake
KZK Project	Tag	551	552	0	2	YB49627	YB49628	Watson Lake
KZK Project	Tag	557	0	0	1	YB49631	0	Watson Lake
KZK Project	Tag	1115	1122	0	8	YB51332	YB51339	Watson Lake
KZK Project	Tag	1151	1157	0	7	YB51368	YB51374	Watson Lake
KZK Project	Tag	1189	1191	0	3	YB51406	YB51408	Watson Lake
KZK Project	Tag	1205	1227	0	23	YB51422	YB51444	Watson Lake
KZK Project	Tag	1243	1268	0	26	YB51460	YB51485	Watson Lake
KZK Project	Tag	1269	0	0	1	YB55801	0	Watson Lake
KZK Project	Tag	1270	1271	Fr	2	YB55802	YB55803	Watson Lake
KZK Project	Tag	1272	1275	0	4	YB51486	YB51489	Watson Lake
KZK Project	Tag	1276	1297	0	22	YB51490	YB51511	Watson Lake
KZK Project	Tag	1297	1312	0	16	YB55804	YB55819	Watson Lake
KZK Project	Tag	1313	0	Fr	1	YB52267	0	Watson Lake
KZK Project	Tag	1314	1325	0	12	YB52268	YB52279	Watson Lake
KZK Project	Tag	1326	0	Fr	1	YB52280	0	Watson Lake
KZK Project	Tag	1327	1330	0	4	YB52281	YB52284	Watson Lake
KZK Project	Tag	1331	1340	0	10	YB52285	YB52294	Watson Lake

KZK Project	Tag	1341	1364	0	24	YB55820	YB55843	Watson Lake
KZK Project	Tag	1365	1374	0	10	YB55844	YB55853	Watson Lake
KZK Project	Tag	1375	1380	0	6	YB52295	YB52300	Watson Lake
KZK Project	Tag	1381	1404	0	24	YB55301	YB55324	Watson Lake
KZK Project	Tag	1405	1412	0	8	YB55855	YB55862	Watson Lake
KZK Project	Tag	1413	0	Fr	1	YB55863	0	Watson Lake
KZK Project	Tag	1414	1429	0	16	YB55864	YB55879	Watson Lake
KZK Project	Tag	1430	0	Fr	1	YB55880	0	Watson Lake
KZK Project	Tag	1431	1448	0	18	YB55881	YB55898	Watson Lake
KZK Project	Tag	1518	1519	0	2	YB55359	YB55360	Watson Lake
KZK Project	Tag	1534	1535	0	2	YB55375	YB55376	Watson Lake
Pelly Project	Wol	79	94	0	16	YB48839	YB48854	Watson Lake
Pelly Project	Wol	132	0	0	1	YB48892	0	Watson Lake
Pelly Project	Wol	134	0	0	1	YB48894	0	Watson Lake
Pelly Project	Wol	136	0	0	1	YB48896	0	Watson Lake
Pelly Project	Wol	138	0	0	1	YB48898	0	Watson Lake
Pelly Project	Wol	140	0	0	1	YB48900	0	Watson Lake
Pelly Project	Wol	142	0	0	1	YB48902	0	Watson Lake
Pelly Project	Wol	144	0	0	1	YB48904	0	Watson Lake
Pelly Project	Wol	147	156	0	10	YB48907	YB48916	Watson Lake
Pelly Project	Wol	202	209	0	8	YB55399	YB55406	Watson Lake
TOTAL CLAIMS					413			

AREA TWO

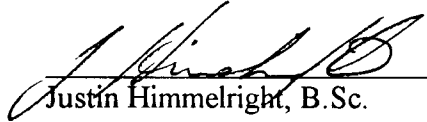
Pelly Project	Mony	1	146	0	146	YB50290	YB50435	15-Jun-01	Watson Lake
Pelly Project	Mony	147	288	0	142	YB55437	YB55578	15-Jun-01	Watson Lake
Pelly Project	Mony	290	348	0	59	YB55579	YB55637	15-Jun-01	Watson Lake
Finlayson Project	Dan	1	16	0	16	YB92726	YB92741	2-Aug-01	Watson Lake
TOTAL CLAIMS					363				

**SUMMARY OF QUALIFICATIONS -TO ACCOMPANY
'FINLAYSON PROJECT DESCRIPTION REPORT, NOVEMBER 2000.**

I, Justin Himmelright, Consulting Biologist of 23084-126th Ave., Maple Ridge, British Columbia, Canada, hereby certify that:

- 1) I am a consulting biologist with an office at 701-475 Howe St., Vancouver, British Columbia, V6C 2B3.
- 2) I am a graduate of the University of Simon Fraser (B.Sc. Biology, 1995)
- 4) I have practiced my profession as an environmental consultant to the mining industry since 1994 in many parts of Canada, Central America, and South America.
- 5) I personally reviewed, summarized and compiled the work presented in the aforementioned report. The information reviewed is believed to be reliable and accurate.
- 7) I hereby grant my permission for Expatriate Resources Ltd. to use this report for whatever purposes it wants, subject to the disclosures set out in this Certificate.

Signed in Vancouver, British Columbia on the 30th day of August 2001.


Justin Himmelright, B.Sc.

094236



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To the Reader:

This letter covers the Finlayson Project Description Report. The Finlayson Project is a major mining project proposed for the Finlayson District in the south east Yukon. The Finlayson Project considers the combination of two previously separate mining projects; the Wolverine Project and Kudz Ze Kayah Project.

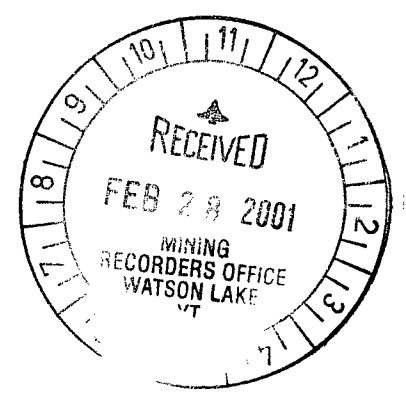
This report is a synthesis and summary of the extensive information collected for these projects, applied in the context of a combined project. This report is intended to be the first step in the environmental review process as required under the Canadian Environmental Assessment Act.

This report consists of two volumes. The first volume includes the main body of the text and accompanying tables and figures. The second volume contains appendices that include data and reports prepared by independent consultants over a period of several years on behalf of the Kudz Ze Kayah and Wolverine Projects.

If there are any questions or concerns regarding this report, please contact Justin Himmelright, Manager of Environment for Expatriate Resources Ltd. at the number indicated above.

Sincerely,
EXPATRIATE RESOURCES LTD.

Justin Himmelright
Manager of Environment



EXPATRIATE RESOURCES FINLAYSON PROJECT

PROJECT DESCRIPTION REPORT

TABLE OF CONTENTS

EXECUTIVE SUMMARY	xi
1 INTRODUCTION	1-1
1.1 Purpose of the Project Description Report	1-1
1.1.1 Project Outline	1-1
1.1.1.1 Site Conditions	1-1
1.1.1.2 Project History	1-2
1.1.1.3 The Finlayson Project	1-2
1.1.2 Need for and Purpose of the Project	1-3
1.1.3 Project Alternatives	1-3
1.2 Project Proponent	1-4
1.2.1 Management and Policy	1-4
1.2.1.1 Management Team	1-4
1.2.1.2 Management Approach to the Permitting Process	1-6
1.2.1.3 Expatriate's Environmental Policy	1-6
1.2.2 Project Rights and Interests	1-7
1.2.2.1 Mineral Assets	1-7
1.2.2.2 Permits and Agreements	1-7
1.3 Regulatory Context	1-8
1.3.1 The Project and the Canadian Environmental Assessment Act	1-8
1.3.1.1 Applicability of the Act	1-8
1.3.1.2 Level of Environmental Assessment	1-9
1.3.1.3 The Law List and Federal Triggers	1-9
1.3.1.4 Potentially Applicable Federal Policies and Strategies	1-10
1.3.2 Land Use Designations Effecting Project Development	1-13
1.3.3 Project Description Report Circulation	1-13
1.4 Project and Assessment Scope	1-14
1.4.1 Project Scope	1-14
1.4.2 Assessment Scope	1-14
2 PROJECT DESCRIPTION	2-1
2.1 Wolverine	2-2
2.1.1 Exploration and Data Collection	2-2
2.1.2 Ore Outline and Block Model Development	2-2
2.1.3 Resource and Reserve Summary and Classification	2-3
2.1.4 Underground Mining	2-3
2.1.4.1 Ore Reserves and Underground Design	2-3
2.1.4.2 Geotechnical	2-4
2.1.4.3 Production Plan	2-4
2.1.4.4 Backfill	2-5
2.1.4.5 Access and Test Mining	2-6
2.1.4.6 Description of Operation	2-6
2.1.5 Infrastructure	2-7

2.1.6	Wolverine Site Power Requirements	2-7
2.1.7	Manpower Requirement	2-8
2.2	Ore Haul Road	2-8
2.2.1	Route A	2-8
2.2.2	Route B	2-9
2.3	Kudz Ze Kayah	2-9
2.3.1	Exploration and Data Collection	2-9
2.3.2	Ore Outline and Block Model Development	2-9
2.3.3	Resource and Reserve Summary and Classification	2-10
2.3.4	Mine Ore Reserves and Open Pit Design	2-10
2.3.4.1	Pit Slopes	2-11
2.3.4.2	Pit Phases	2-12
2.3.4.3	Reserves	2-12
2.3.5	Production Plan	2-12
2.3.5.1	Summary	2-12
2.3.5.2	Production Scheduling and Pit Sequencing	2-12
2.3.5.3	Pre-Production Mine Development	2-17
2.3.5.4	Mine Development and Access	2-17
2.3.5.5	Haul Roads	2-17
2.3.6	Description of Operation	2-17
2.3.6.1	General Parameters	2-17
2.3.6.2	Production Blasting	2-17
2.3.6.3	Loading Equipment	2-18
2.3.6.4	Haulage Trucks	2-18
2.3.6.5	Mine Support Equipment	2-18
2.3.7	Process	2-19
2.3.7.1	Introduction	2-19
2.3.7.2	Ore Characterization	2-19
2.3.7.3	Process Testwork	2-19
2.3.7.4	Flowsheet Development	2-20
2.3.7.5	Process Description	2-21
2.3.8	Infrastructure	2-23
2.3.8.1	Description of Kudz Ze Kayah Main Complex	2-24
2.3.8.2	Workforce Accommodation	2-24
2.3.8.3	Fuel Supply and Storage	2-24
2.3.8.4	Fresh Water Distribution and Fire Protection	2-24
2.3.8.5	Communications	2-25
2.3.8.6	Ancillary Buildings	2-25
2.3.9	Power Generation	2-25
2.3.10	Site Access	2-26
2.3.11	Manpower Requirement	2-26
2.3.12	Concentrate Shipping	2-27
2.4	Wolverine - Waste and Water Management	2-27
2.4.1	Solid Waste Management	2-27
2.4.1.1	Waste Rock	2-27
2.4.1.2	Water Treatment Plant Precipitates	2-29
2.4.1.3	Sewage	2-29
2.4.1.4	Domestic Waste	2-29
2.4.1.5	Miscellaneous Special Wastes	2-29
2.4.2	Water Management	2-29
2.5	Kudz Ze Kayah- Waste and Water Management	2-30
2.5.1	Solid Waste	2-30

2.5.1.1	Waste Rock	2-30
2.5.1.2	Tailings	2-32
	Water Treatment Plant Precipitates	2-39
2.5.1.3	Solid Waste Management	2-39
2.5.2	Water Management	2-41
2.5.2.1	Open Pit Catchment	2-41
2.5.2.2	Fault Creek Diversion	2-41
2.5.2.3	WPAG Waste Rock Storage Area Catchment	2-41
2.5.2.4	Tailings Area Catchment	2-42
2.5.2.5	Runoff Control	2-43
2.6	Reclamation and Closure Plans	2-46
2.6.1	Mine Site Decommissioning and Restoration	2-47
2.6.2	Access and Ore Haul Road Closure	2-48
2.6.3	Water Management and Water Quality Control Measures	2-48
2.7	Project Opportunities	2-49
2.7.1	Mine Planning	2-49
2.7.2	Waste and Water Management	2-50
2.8	Project Schedule	2-50
2.8.1	Summary	2-50
2.8.2	Project Construction Schedule	2-51
2.8.2.1	Kudz Ze Kayah Mine	2-51
2.8.2.2	Wolverine Mine	2-51
2.8.3	Surface Facilities	2-51
2.8.4	Tailings Impoundment	2-51
3	ENVIRONMENTAL SETTING AND SOCIOECONOMIC CONDITIONS	3-1
3.1	Physical Environment	3-1
3.1.1	Climate	3-1
3.1.1.1	Regional Stations	3-1
3.1.1.2	Project Site Data	3-2
3.1.2	Geology	3-5
3.1.2.1	Regional Geology	3-5
3.1.2.2	Kudz Ze Kayah Geology	3-5
3.1.2.3	Wolverine Geology	3-6
3.1.3	Physiography	3-7
3.1.3.1	Geomorphology	3-7
3.1.3.2	Terrain Hazards	3-7
3.1.4	Soils and Surficial Geology	3-8
3.1.4.1	Kudz Ze Kayah	3-8
3.1.4.2	Wolverine	3-9
3.1.5	Water Resources	3-10
3.1.5.1	Surface Hydrology	3-10
3.1.5.2	Limnology	3-16
3.1.5.3	Hydrogeology	3-18
3.1.5.4	Surface Water Quality	3-18
3.1.5.5	Groundwater Quality	3-27
3.1.5.6	Sediments	3-28
3.2	Biological Environment	3-31
3.2.1	Aquatic Environment and Fisheries Resources	3-31
3.2.1.1	Kudz Ze Kayah	3-31
3.2.1.2	Wolverine	3-41
3.2.2	Vegetation	3-59
3.2.2.1	Kudz Ze Kayah	3-59

3.2.2.2	Wolverine.....	3-66
3.2.3	Ecosystems and Wildlife.....	3-73
3.2.3.1	Ecosystems.....	3-74
3.2.3.2	Wildlife Values.....	3-76
3.3	Heritage Resources.....	3-81
3.3.1	Background.....	3-81
3.3.1.1	Precontact.....	3-81
3.3.1.2	Traditional Land Use and Lifestyle.....	3-83
3.3.1.3	Post-contact.....	3-84
3.3.2	Kudz Ze Kayah Mine Site and Access Road.....	3-87
3.3.3	Wolverine and Ore Haul Route.....	3-88
3.3.3.1	Traditional Land Use Areas.....	3-89
3.3.3.2	Archaeological Sites.....	3-91
3.3.3.3	Sites Not Yet Documented/Relocated.....	3-93
3.4	Socioeconomic Conditions.....	3-94
3.4.1	Overview of Yukon Land Claims.....	3-94
3.4.2	Yukon Statistics.....	3-95
3.4.3	Yukon Communities.....	3-96
3.4.3.1	Ross River.....	3-96
3.4.3.2	Watson Lake.....	3-97
3.4.3.3	Whitehorse.....	3-97
3.4.3.4	Faro.....	3-98
3.4.4	Transportation.....	3-99
3.4.4.1	Air Transport.....	3-99
3.4.4.2	Road Transport.....	3-99
3.5	Valuable Ecological and Cultural Components (VECC).....	3-100
3.6	Additional Studies and Analysis.....	3-100
3.6.1	Climate.....	3-100
3.6.2	Soils, Surficial Geology and Terrain Hazards.....	3-101
3.6.3	Water Resources.....	3-101
3.6.4	Fisheries and Aquatic Resources.....	3-101
3.6.5	Vegetation.....	3-101
3.6.6	Wildlife and Ecosystems.....	3-102
3.6.7	Archaeology and Heritage Resources.....	3-102
4	ENVIRONMENTAL EFFECTS ASSESSMENT.....	4-1
4.1	Assessment Process.....	4-1
4.1.1	Assessment Scope.....	4-1
4.1.2	Assessment Approach.....	4-2
4.2	Cumulative Environmental Effects.....	4-4
4.3	Environmental Health and Safety and Accidents and Malfunctions.....	4-5
4.4	Follow-up Programs.....	4-5
4.5	Preliminary Environmental Assessment and Potential Mitigation Measures... ..	4-6
4.5.1	Air Quality.....	4-6
4.5.2	Topography and Landscape Appearance.....	4-6
4.5.3	Hydrogeology.....	4-7
4.5.4	Groundwater Quality.....	4-8
4.5.5	Surface Hydrology.....	4-8
4.5.6	Surface Water Quality.....	4-9
4.5.7	Aquatic Resources.....	4-10
4.5.7.1	Habitat Alteration and Loss.....	4-10
4.5.7.2	Potential Effects of Predicted Stream Water Quality.....	4-11
4.5.7.3	Effects on Fish Stocks.....	4-12

4.5.8	Vegetation.....	4-13
4.5.9	Wildlife.....	4-13
4.5.9.1	Kudz Ze Kayah.....	4-14
4.5.9.2	Wolverine Operations and Ore Haul Route.....	4-20
4.5.10	Socioeconomic Conditions.....	4-20
4.5.10.1	Community Issues.....	4-21
4.5.10.2	Work Force.....	4-23
4.5.10.3	Transportation.....	4-23
4.5.11	Heritage Resources.....	4-25
4.5.12	Land Use.....	4-26
4.5.13	Human Health.....	4-27
5	PUBLIC CONSULTATION.....	5-1
5.1	Kudz Ze Kayah, 1994-98.....	5-1
5.2	Wolverine 1996-97.....	5-3
5.3	Finlayson, 2000.....	5-6
5.4	Future Consultation.....	5-6
	REFERENCES.....	R-1

List of Appendices

- Appendix 1A Summary of Information Presented in this Report; Indication of Information Previously Reviewed for the Kudz Ze Kayah Project
- Appendix 1B Permits and Agreements Pertaining to the Kudz Ze Kayah Project
- Appendix 2A Acid Rock Characterization for the Wolverine Property
- Appendix 3A Climate Data from the Kudz Ze Kayah and Wolverine Weather Stations
- Appendix 3B Wolverine Area – Water Quality by Station
- Appendix 3C Wolverine Area – Sediment Quality Data
- Appendix 3D Wolverine Area – Benthic and Zooplankton Data
- Appendix 3E Wolverine Area – Fisheries Investigations
- Appendix 3F Wolverine Area – Vegetation Studies
- Appendix 5A Meetings and Consultations Held for the Wolverine Project – Westmin Resources Limited, 1996-97
- Appendix 5B Minutes of Consultation Meetings – Finlayson Project, October 2000

List of Tables

- 2.1 Wolverine Indicated Resource Estimate
- 2.2 Wolverine Probable Reserves
- 2.3 Rock Strength – Field Test Runs
- 2.4 Stope Sizes at Various Vertical Thicknesses for the Wolverine Operation
- 2.5 Kudz Ze Kayah Resource Estimate
- 2.6 Kudz Ze Kayah Probable Reserve Estimate
- 2.7 Recommended Pit Wall Slopes
- 2.8 Pit Design Parameters
- 2.9 Kudz Ze Kayah Probable Reserve
- 2.10 Kudz Ze Kayah Mine Production Forecast
- 2.11 Metallurgical Balance for Wolverine and Kudz Ze Kayah Blended Ores
- 2.12 Kudz Ze Kayah Mine and Mill Staffing Plan (Mine Plan @ 3000 tpd)
- 2.13 Acid-Base Accounting Results – Discrete Hanging Wall Samples
- 2.14 Acid-Base Accounting Results – Discrete Foot Wall Samples
- 2.15 Acid-Base Accounting Results – Discrete Massive Sulphide Samples

- 2.16 Acid-Base Accounting Results – Miscellaneous Discrete Samples
- 2.17 Summary of Site Selection Study for Tailings Storage Facility

- 3.1 Estimated Mean Monthly Precipitation, Evaporation, and Temperature Values for the Kudz Ze Kayah Operations Area
- 3.2 Summary of Precipitation Data from Project Weather Stations (mm)
- 3.3 Comparison of Temperatures at Project Weather Stations (°C)
- 3.4 Comparison of Humidity of Project Weather Stations
- 3.5 Wind Speed and Direction at Kudz Ze Kayah
- 3.6 Stage-Discharge Measurements at Station W12 (Go Creek)
- 3.7 Stage-Discharge Measurements at Station W21 (Nougha Creek)
- 3.8 Spot Measurements of Stream Flows in the Wolverine Area
- 3.9 Watershed Characteristics of Automated and Manual Hydrology Stations in the Wolverine Area
- 3.10 Summary of Baseline Surface Water Quality Sampling Program for the Kudz Ze Kayah Area
- 3.11 Water Quality Analysis Method Detection Limits – Kudz Ze Kayah Baseline Sampling Program
- 3.12 Sampling Schedule for Water Quality in the Wolverine Area
- 3.13 Water Quality Analysis Methods and Detection Limits – Wolverine Baseline Program
- 3.14 Water Quality of Little Wolverine Lake
- 3.15 Water Quality of inflow to Wolverine Lake
- 3.16 Water Quality of Wolverine Lake
- 3.17 Piezometer/Borehole Details for Groundwater Samples, Kudz Ze Kayah 1995
- 3.18 Groundwater Quality, Kudz Ze Kayah 1995
- 3.19 Summary of Baseline Sediment Sampling Program for Kudz Ze Kayah
- 3.20 Concentrations of Metals in Sediments – Kudz Ze Kayah Baseline
- 3.21 Average Metals Concentrations in Sediments from the Kudz Ze Kayah Area Compared to Metals Levels in Sediments from the Southeastern Yukon
- 3.22 Correlation Between Concentrations of Metals in Stream Sediments, Kudz Ze Kayah Area
- 3.23 Correlation Between Concentrations in Metals in Sediments, Wolverine Area
- 3.24 Chronology of Fisheries Fieldwork Methods and Observations in the Kudz Ze Kayah Area, 1994&95
- 3.25 Summary of Benthic Invertebrate Sampling Results in the Kudz Ze Kayah Study Area, September 1995
- 3.26 In-situ Water Quality at the Kudz Ze Kayah Zooplankton Sampling Sites, September 1995
- 3.27 Summary of Zooplankton Sampling Results in the Kudz Ze Kayah Study Area, September 1995
- 3.28 Fish Catches in the Kudz Ze Kayah Study Area, 1995
- 3.29 Habitat Types, Food Preferences and Body Sizes of the Invertebrate Organisms most Prevalent in Fish Stomach Samples from the Kudz Ze Kayah Study Area
- 3.30 Background Concentrations of Metals in Fish Tissues Near the Kudz Ze Kayah Project
- 3.31 Morphoedaphic Indices for the Lakes in the Kudz Ze Kayah Study Area
- 3.32 Summary of Stream Benthic Invertebrate Communities – Wolverine Area
- 3.33 Summary of Wolverine Creek Benthic Community
- 3.34 Summary of Lake Benthic Invertebrate Communities – Wolverine Area
- 3.35 Summary of Zooplankton Data for Lakes in the Wolverine Area

- 3.36 Catch Composition by Lake, Species and Mesh Size for Index Gillnetting in the Wolverine Area
- 3.37 Species Composition from Spring Index Gillnetting Surveys, Wolverine Area 1996
- 3.38 Mean Length, Weight, and Condition Factor (K) by Species, Wolverine Area Fisheries Surveys, 1996
- 3.39 Biological Data by Length Class for Fish Captured in the Wolverine Area, 1996
- 3.40 Metals Concentrations in Vegetation
- 3.41 Comparison of Vegetation Types Described for the Kudz Ze Kayah and Wolverine Study Areas

- 4.1 Sample Significance Criteria Definitions
- 4.1a Potential Direct Project-Environment Interactions
- 4.2 Summary of Base Case Water Quality Predictions for the Operations Phase of the Finlayson Project
- 4.3 Parameters that Exceed CCREM Guidelines in Response to Different Model Assumptions
- 4.4 Habitat Types Affected by the Kudz Ze Kayah Operations Area

List of Figures

- 1.1 Expatriate Resources' Mineral Properties
- 1.2 Mineral Claim Tenure and Land Designation in the Finlayson District
- 1.3 Proposed Spatial Extent of the Finlayson Project Environmental Assessment

- 2.1 Area of Potential Development for the Wolverine Operations
- 2.2 Wolverine Mine Plan
- 2.3 Wolverine Ground Floor Plan
- 2.4 Potential Access and Transport Routes
- 2.5 Kudz Ze Kayah Site Arrangement
- 2.6 Pit Design and Cross-section
- 2.7 Finlayson Simplified Flow Sheet
- 2.8a General Arrangement Ground Floor Plan
- 2.8b General Arrangement Operating Floor Plan
- 2.8c General Arrangement Upper Floor Plan
- 2.9 Wolverine Flowsheet
- 2.10 Summary Project Schedule

- 3.1 Finlayson Project Region
- 3.2 Regional Hydrometric and Climate Stations
- 3.3 Locations of Climate and Hydrology Monitoring Stations at Kudz Ze Kayah
- 3.4 Wind Direction and Speed at the Kudz Ze Kayah High Elevation Weather Station
- 3.5 Wind Direction and Speed at the Kudz Ze Kayah Low Elevation Weather Station
- 3.6 Location of the Finlayson Lake VHMS District
- 3.7 Geology of the Finlayson Lake Region
- 3.8 Plan View of Kudz Ze Kayah Area Geology
- 3.9 Simplified Cross-Section of the Kudz Ze Kayah Deposit
- 3.10 Wolverine Deposit Cross-section
- 3.11 Wolverine Deposit Plan View
- 3.12 Site Plan – Surficial Geology, Geona Valley
- 3.13 Surficial Geology of the Wolverine Lake Area
- 3.14 Locations of Hydrology Monitoring Stations at Kudz Ze Kayah

- 3.15 Climate and Hydrology Monitoring Stations- Wolverine Area
- 3.15a Rating Curve for Station W12 (Go Creek)
- 3.16 Stream Discharge at Station W12 (Go Creek)
- 3.17 Stream – Discharge Curve for Station W21 (Nougha Creek)
- 3.18 Stream Discharge at Station W21 (Nougha Creek)
- 3.19 Stream Discharge at Station W9 (Wolverine Creek)
- 3.20 Stage – Discharge Calibrations at Manual Hydrology Stations – Wolverine Baseline Studies
- 3.21 Runoff Characteristics at Automated Hydrology Stations W12, W21 and W9 – Wolverine Baseline Studies
- 3.22 Temperature Profile of Wolverine Lake
- 3.23 Dissolved Oxygen Profile of Wolverine Lake
- 3.24 Temperature Profile of Little Wolverine Lake
- 3.25 Dissolved Oxygen Profile of Little Wolverine Lake
- 3.26 Dissolved Oxygen Profile of Little Jimmy Lake
- 3.27 Water Quality Monitoring Sites – Kudz Ze Kayah
- 3.28 Mean and Range of Total Alkalinity at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.29 Mean and Range of Total Hardness Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.30 Mean and Range of Specific Conductance at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.31 Mean and Range of Total Phosphorous Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.32 Mean and Range of Nitrate + Nitrite Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.33 Mean and Range of Sulphate Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.34 Mean and Range of Total Iron Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.35 Mean and Range of Total Zinc Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.36 Mean and Range of Total Copper Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.37 Mean and Range of Total Selenium Measured at Water Quality Sites, Kudz Ze Kayah Property, 1994-95
- 3.38 Locations of Surface Water Quality Stations in the Area Surrounding Wolverine Lake
- 3.39 Mean and Range of pH at Water Quality Sites, Wolverine Property, 1995-97
- 3.40 Mean and Range of Total Dissolved Solids Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.41 Mean and Range of Total Hardness Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.42 Mean and Range of Sulphates Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.43 Summary Averages of Nutrients at Water Quality Sites, Wolverine Property, 1995-97
- 3.44 % Detection of Heavy Metals in Water Samples from the Wolverine Drainage
- 3.45 Mean and Range of Total Copper Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.46 Mean and Range of Total Zinc Measured at Water Quality Sites, Wolverine Property, 1995-97

- 3.47 Mean and Range of Total Iron Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.48 Mean and Range of Total Aluminium Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.49 Mean and Range of Total Selenium Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.50 Mean and Range of Total Cadmium Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.51 Mean and Range of Total Silver Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.52 Mean and Range of Total Nickel Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.53 Mean and Range of Total Arsenic Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.54 Mean and Range of Total Lead Measured at Water Quality Sites, Wolverine Property, 1995-97
- 3.55 % Detection of Heavy Metals in Water Samples from the Go/Money Creek Drainage
- 3.56 Locations of Groundwater Sampling Points – Kudz Ze Kayah
- 3.57 Copper Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.58 Iron Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.59 Lead Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.60 Zinc Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.61 Total Organic Carbon (TOC) Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.62 Acid Volatile Sulphide (AVS) Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property , 1995
- 3.63 Sediment Monitoring Stations – Finlayson Project Area
- 3.64 Fish, Water Quality, Benthic Invertebrate, and Zooplankton Sampling Sites – Kudz Ze Kayah
- 3.65 Fish Sampling Sites - Kudz Ze Kayah
- 3.66 Zooplankton Sampling Sites – Kudz Ze Kayah
- 3.67 Benthos Monitoring Stations – Wolverine Lake Area
- 3.68 Benthos Monitoring Stations – Finlayson Project Area
- 3.69 Plankton Haul Sites – Wolverine Area
- 3.70 Species Composition by Weight for Fish in Lakes in the Wolverine Area
- 3.71 Locations of Non-destructive Gillnet Sets – Wolverine Area
- 3.72 Length-Frequency Data for Arctic Grayling in Lakes in the Wolverine Area
- 3.73 Locations and Titles of Lake Tributaries, Inlets and Outlets, Sampled during Fisheries Investigations – Wolverine Area
- 3.74 Length-Frequency Data for Lake Trout in Lakes in the Wolverine Area
- 3.75 Locations and Titles of Creek Sampling Sites – Wolverine Fisheries Investigations
- 3.76 Metals in Fish Tissue – Wolverine Area
- 3.77 Biophysical Mapping Plot and Walking Transect Locations in the Kudz Ze Kayah Area
- 3.78 Vegetation Mapping in the Area of the Proposed Kudz Ze Kayah Operations
- 3.79 Vegetation Mapping in the Vicinity of the Tote Road – Kudz Ze Kayah
- 3.80 Vegetation Sampling Plots and Transect Locations – Wolverine Area
- 3.81 Regional Vegetation Communities – Wolverine Area
- 3.82 Finlayson Project: Ecoregions of the Project Area

- 3.83 Finlayson Project: Extent of Vegetation Mapping
- 3.84 Archaeological Sites in the Wolverine Area

EXECUTIVE SUMMARY

The Project

The Finlayson Project is located in the south eastern Yukon Territory. The project is roughly midway between the communities of Ross River and Watson Lake immediately west of the Robert Campbell Highway.

The Finlayson Project consists of the combination of the Kudz Ze Kayah and Wolverine Projects. Kudz Ze Kayah was subject to a complete feasibility study in 1998 by Cominco Ltd., who initially discovered and delineated the deposit. The project was approved under the Canadian Environmental Assessment Act (Screening Level Assessment) and received its Water Licence. The Wolverine Project was advanced as a joint venture between Westmin Resources Ltd. (60%) and Atna Resources Ltd. (40%) during 1995-97. Expatriate Resources Westmin's 60% interest in the Wolverine Project in March of 1999. The company further consolidated its land position in the Finlayson District through acquisition of most of Cominco's claims in the area, including the Kudz Ze Kayah Project.

The Finlayson Project consists of an open pit and milling operation at Kudz Ze Kayah and an underground mining operation at Wolverine. Run-of-mine ore from Wolverine would be trucked directly to the mill located at Kudz Ze Kayah. The mill will run at 4250 tonnes per day (tpd) throughput, 3000 tpd from the Kudz Ze Kayah open pit and 1250 tpd from the Wolverine underground mine. Major facilities at the Kudz Ze Kayah site will not be significantly different from those planned by Cominco. The site will contain the open pit, mill, waste rock storage facilities, tailings storage facility, worker housing, and an airstrip. The major components of the closure plan will be identical including a flooded open pit and tailings facility.

The Wolverine operations will include the portal and underground operations and supporting infrastructure. Site facilities will include a maintenance shop, backfill and shotcrete plants, a water treatment plant, warehouse, and temporary ore storage and fuel storage facilities. A small diesel generator will be needed to power these facilities. The Wolverine operations will include an emergency camp to house shift workers in the event of winter road closure. A small gravel borrow area will be developed near the underground mine to supply backfill materials for the operations. The majority of backfill materials will be tailings, brought from the operations at Kudz Ze Kayah as backhaul by ore trucks.

The solid wastes associated with the Finlayson Project have been identified to include, waste rock, tailings, water treatment plant precipitates, sewage, domestic wastes, and miscellaneous special wastes. Waste management plans have been developed for the project and are presented in Section 2 of the Project Description Report. The effluent streams identified for the Finlayson Project include water treatment plant discharges at the Wolverine operations and controlled discharges from the tailings storage facility at Kudz Ze Kayah. Water management plans have been developed for the project and are described in detail in Section 2 of the Project Description Report.

The capital cost of developing the project is estimated to be roughly \$185 million (CDN\$). The current development schedule considers a 20-month window for permitting and feasibility studies and an additional 18 to 20 months for construction. The operations will provide approximately 250 full time, salaried positions and numerous contracting opportunities.

The Regulatory Framework

For base metal mining projects, such as the Finlayson Project, operations that meet or exceed 3000 tonnes per day of ore throughput are required to undergo a Comprehensive Study under the Canadian Environmental Assessment Act. The Finlayson Project will be designed to have a daily throughput of 4250 tonnes and as such will be subject to a Comprehensive Study under CEAA.

The permits and approvals required for the Finlayson Project fall under three major sets of acts and regulations. Firstly, the project will require a Type A Water Licence under the Yukon Waters Act. The Yukon Territory Water Board issues this licence which requires approval by the federal Minister of DIAND. The Water Resources Division of DIAND, Yukon Region provides an inspection function to ensure compliance by the proponent. Secondly, the project will require a Quartz Mining Licence under the Yukon Quartz Mining Act. The issuance of this licence is administered by the Mining Land Use Division of DIAND, Yukon Region and requires approval by the Federal Minister of DIAND. Thirdly, the project will require additional Surface Leases under the Territorial Lands Act (TLA) that is administered by Lands Resources Division of DIAND, Yukon Region.

Valuable Cultural Components of the Project Area

The Finlayson Project falls within the traditional territory of the Kaska Nation. The Kaska Nation is comprised of three principle groups, the Kaska Dena Council representing all Kaska communities in B.C., the Liard First Nation located near Watson Lake YT, and the Ross River Dena Council based in Ross River. The traditional territory of the Kaska Nation is considered to be shared equally by all groups; however the communities recognize the traditional use of portions of the territory by a particular group. The Finlayson Project area falls within the area recognized as the traditional territory of the Ross River Dena. The Wolverine area has been traditionally used for hunting and heritage resources exist in the area.

The important cultural and heritage issues identified during Kudz Ze Kayah Project and Wolverine Project consultations include:

- Traditional hunting and fishing areas
- First Nations grave sites
- Caribou fence sites
- Ross River group trapline
- Ross River community issues (jobs, training)
- Cross cultural understanding of mine employees

Valuable Ecological Components of the Project Area

Wildlife in project area includes the Finlayson Caribou herd, moose, bears, and various small furbearers. The Tintina trench, a major land feature of the region, is a migration route for several bird species, including the Sandhill crane, Trumpeter swan and Whitefronted goose. Golden eagles, Bald eagles and gyrfalcons have also been observed in the Kudz Ze Kayah – Wolverine Lake area although no nesting sites are known to occur near the proposed development areas. Regional streams and lakes

support populations of Arctic greyling, Lake trout, Dolly Varden char (Bull trout), and Longnose suckers.

The environmental issues of importance identified during the Kudz Ze Kayah and Wolverine consultations include:

- Air quality
- Water quality
- Fisheries resources
- Wildlife resources
- Moose populations
- Finlayson Caribou herd
- Wilderness setting
- Recreational fishing and hunting

The public consultation program to be carried out during the Environmental Assessment Process will verify that this list of VECC's remains appropriate and comprehensive.

The Environmental Assessment

In the environmental effects analysis, the definition of the environment will be extended beyond biological and physical aspects of the project area. The definition of project environment will include consideration of the biological and physical environment, socioeconomic effects, effects on regional and aboriginal land use, effects on archaeological and heritage resources, and effects on human health.

The environmental assessment will be considered through all development phases including construction, operations, reclamation and decommissioning, and final closure

The environmental effects analysis of the Finlayson Project will consider this project environment through the following components:

- Analysis of alternative means of carrying out the project and the potential environmental effects of those alternatives.
- Identification of project-environment interactions.
- Potential effects of project-environment interactions.
- Measures taken to mitigate these effects.
- Determination of significance of effects.
- Analysis of cumulative effects resulting from project development in combination with other regional activities.
- Identification of potential accidents and malfunctions associated with the project and analysis of their environmental effects.

Expatriate intends to carry out a thorough consultation program throughout the regulatory and review process. The Company will hold open houses in Whitehorse, Ross River and Watson Lake at regular intervals as the project develops. The open houses will be well publicized and open to all members of the public. Expatriate Resources will endeavour to identify potentially effected groups and address concerns raised by the public and stakeholders.

EXPATRIATE RESOURCES LTD. FINLAYSON PROJECT

PROJECT DESCRIPTION REPORT

1 INTRODUCTION

This introduction provides a brief summary of the Finlayson Project. The Finlayson Project consists of the combination of the Kudz Ze Kayah and Wolverine Projects. This introduction includes a broad discussion of project components and site conditions, an introduction to the proponent and a summary of the regulations and laws governing the development of the project. The introduction also includes a proposed assessment scope to be used in development of the Environmental Assessment Report.

1.1 Purpose of the Project Description Report

The Project Description Report is intended to give the reader a comprehensive review of the Finlayson Project and the general conditions of the project area. This report includes a discussion of the project history, the principle components of the project, the rationale for developing the project, and possible alternatives to the project.

1.1.1 Project Outline

1.1.1.1 Site Conditions

The Finlayson Project is located in the south eastern Yukon Territory. The project is roughly midway between the communities of Ross River and Watson Lake immediately west of the Robert Campbell Highway. The climate of the area is cold and dry. Annual average precipitation is approximately 655 mm equally divided between rain and snow. Average temperatures range between 15°C and -25°C.

The topography and landscape of the area are typical of montane glacially effected areas with rounded peaks and U-shaped valleys. Higher elevation areas are generally mantled with morainic deposits, colluvium and bedrock with vegetation which includes dwarf birch and willow, alpine fir and grasses, sedges and lichens. Valley bottom areas contain thick glaciofluvial, glaciolacustrine and alluvial deposits with wetlands and mixed spruce boreal forests. The area around the Finlayson Project has discontinuous permafrost with poorly drained depressional areas containing peat plateaus, patterned fen and bog complexes. Scree covered slopes are most prominent along steep upper mountain slopes. Deep colluvium occurs on steeper mid to lower slopes.

Wildlife values around the Finlayson Project include the Finlayson Caribou herd, moose, bears, and various small furbearers. The Tintina Trench, a major physiographic feature of the region, is a migration route for several bird species, including the Sandhill crane, Trumpeter swan and Whitefronted goose. Golden eagles, Bald eagles and gyrfalcons have also been observed in the Kudz Ze Kayah – Wolverine Lake area although no nesting sites are known to occur near the proposed development areas. Regional streams and lakes support populations of Arctic greyling, Lake trout, Dolly Varden char and Bull trout, Longnose suckers, and Slimey sculpin.

1.1.1.2 Project History

The Finlayson District is a newly discovered mining camp. The area was discovered as a potentially mineral rich area in the mid-1990's which resulted in a staking rush and extensive exploration activity. During this period of exploration, two important deposits were identified to contain high zinc, copper, lead, silver and gold contents. The Kudz Ze Kayah and Wolverine Projects were taken to an advanced exploration level.

Kudz Ze Kayah was subject to a complete feasibility study by Cominco Ltd., who initially discovered and delineated the deposit. The feasibility study outlined the project as an open pit operation producing 2950 tonnes per day of ore. The project as proposed would have produced zinc, lead, and copper concentrates using standard flotation technology. The major facilities associated with the project included a 200 person camp, the open pit and mill, permanent surface storage of non-acid generating waste rock, a temporary stockpile of potentially acid generating waste rock, and a tailings storage facility. At closure, the potentially acid generating waste rock was to be rehandled back into the pit and the pit permanently flooded. The tailings facility would also be permanently flooded. The project was approved under the Canadian Environmental Assessment Act (Screening Level Assessment) and received its Water Licence. Appendix 1A presents a comparison of the information presented in this report to the information presented in earlier reports prepared by Cominco.

The Wolverine Project was advanced as a joint venture between Westmin Resources Ltd. (60%) and Atna Resources Ltd. (40%). During the period 1995-97, the orebody was partially delineated. In 1997, it was discovered that the orebody contained high levels of selenium and that the zinc concentrate would likely not be acceptable to smelters. Interest in the project rapidly declined. A short time later, Westmin Resources was subject to a takeover by Boliden Limited and all work on the Wolverine Project stopped.

Expatriate Resources, a junior mining company with large, strategic land position in the Finlayson District, acquired Boliden Westmin's 60% interest in the Wolverine Project in March of 1999. The company further consolidated its land position in the Finlayson District through acquisition of most of Cominco's claims in the area, including the Kudz Ze Kayah Project. Today, Expatriate's claims cover most of the favourable geology in this new massive sulphide district.

1.1.1.3 The Finlayson Project

The Finlayson Project is the combination of the two development projects, Kudz Ze Kayah and Wolverine. The metallurgical issue of selenium in the Wolverine deposit has been resolved through the blending of the ores from the two deposits. Discussions with smelters in Asia and eastern Canada suggests that the concentrate produced by the blended ore is acceptable for their operations. It is important to remember that the former Kudz Ze Kayah Project has received legal authority to proceed to the mining stage. The Finlayson Project proposes to follow essentially the same approach developed by Cominco with some overall improvements in terms of the mining plan and progressive reclamation for both the Kudz Ze Kayah and Wolverine operations.

The Finlayson Project consists of an open pit and milling operation at Kudz Ze Kayah and an underground mining operation at Wolverine. Run-of-mine ore from Wolverine would be trucked directly to the mill located at Kudz Ze Kayah. The mill will run at 4250 tonnes per day (tpd) throughput, 3000 tpd from the Kudz Ze Kayah open pit and 1250 tpd from the Wolverine underground mine. Major facilities at the Kudz Ze Kayah site will not be significantly different from those planned by Cominco. The site will contain the open pit, mill, waste rock storage

facilities, tailings storage facility, worker housing, and an airstrip. The major components of the closure plan will be identical including a flooded open pit and tailings facility.

The Wolverine operations will include the portal and underground operations and supporting infrastructure. Site facilities will include a maintenance shop, backfill and shotcrete plants, a water treatment plant, warehouse, and temporary ore storage and fuel storage facilities. A small diesel generator will be needed to power these facilities. The Wolverine operations will include an emergency camp to house shift workers in the event of winter road closure. A small gravel borrow area will be developed near the underground mine to supply backfill materials for the operations. The majority of backfill materials will be tailings, brought from the operations at Kudz Ze Kayah as backhaul by ore trucks.

The capital cost of developing the project is estimated to be roughly \$185 million (CDN\$). The current development schedule considers a 20-month window for permitting and feasibility studies and an additional 18 to 20 months for construction. Concentrates would be produced and marketed by 2003/2004.

1.1.2 Need for and Purpose of the Project

At present, the world demand for zinc is exceeding the available supply. North America has not been self sufficient in it's zinc production for the past 5 years. The deficit in available zinc is being made up by exports from China. World zinc markets have operated at a deficit for approximately 5 years, substantially reducing the stock of available zinc (Newcrest Capital, 2000).

The long-term picture for zinc production shows no relief in sight for the current market trend. The increasing demand for zinc will continue to outpace the forecasted modest increases in production. There are no major world zinc projects scheduled for development over the next 3 years that could make up the market shortfall. The timing for the development of a low cost zinc producer is excellent. The market for zinc concentrates is strong, bringing favourable purchase terms and providing long-term security to project economics.

Expatriate Resources intends to take advantage of this excellent market opportunity and the exceptional ore resource of the Finlayson Project to create profits for its shareholders.

The Finlayson Project will also provide a much-needed boost to the Yukon economy that has experienced a serious downturn in recent years, particularly in the mining sector. The project will provide many employment opportunities, a solid tax base, support for infrastructure development, and workforce development opportunities for local communities.

1.1.3 Project Alternatives

For a Comprehensive Study under CEAA, the project may be required to consider alternatives to the project and alternative means of carrying out the project. The assessment of alternative means of carrying out the project will be completed in detail as part of the Environmental Assessment Report. It will consider the various alternatives considered for each of the project components and the potential environmental effects of these alternatives.

In consideration of the business objectives of the Company, Expatriate Resources sees no feasible alternative to Finlayson Project. The Finlayson Project is the principle asset of the Company. Given the current and future global market for zinc, the government approvals that have been granted for the Kudz Ze Kayah deposit and the mining and environmental

approaches that will be used for the Finlayson Project, the project is exceptional and the best available project to achieve the business goals of the Company.

1.2 Project Proponent

Expatriate Resources Ltd. was founded in 1994. The company is publicly traded on the Canadian Venture Exchange (EXR) and is based in Vancouver, B.C. Direct contact information is presented below.

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Vancouver, British Columbia
Canada, V6C 2B3
Telephone: (604) 682-5474
Fax: (604) 682-5404
info@expatriateresources.com
www.expatriateresources.com

The company's mineral assets are located primarily in Canada, mainly in the Yukon Territory (Figure 1.1). The core asset of the company is its land position in the Finlayson District (YT) and specifically the properties that make up the Finlayson Project.

Through its wholly owned subsidiary, Latina Resources Ltd., the company holds a 100% interests in several exploration properties in Chile (Figure 1.1). Expatriate also owns Nitrosyl Technologies Corporation. This metallurgical process technology company holds a majority interest in two research companies and has patented four process technologies.

1.2.1 Management and Policy

1.2.1.1 Management Team

The company has a strong management team with a broad base of experience and expertise. Management team members are very experienced in the exploration, development, and permitting of major mining projects. All team members have previous experience with large mining companies and all phases of mine development, from grass roots exploration to closure and reclamation.

*Dr. Harlan Meade, B.Sc.(Geol), Ph.D. (Geol), MBA
President and C.E.O.*

Dr. Meade has over 20 years of experience in the mining industry. Dr. Meade has experience with underground and open pit mining operations, permitting and environmental issues, financing, and management.

As the Vice-President of Exploration and Environment for Westmin Resources Limited, Dr. Meade was directly involved in the initial discovery and advancement of the Wolverine Project. This high-grade zinc-lead-copper-silver-gold deposit is a major component of the Finlayson Project. During the exploration and advancement of Wolverine, Dr. Meade maintained a successful and beneficial relationship with the Ross River Kaska Dena including the negotiation of a socioeconomic Agreement between the Westmin/Atna joint venture partnership and the Ross River Dena Council. This agreement was unfortunately never formalized.

Dr. Meade was responsible for management of environmental issues for Westmin Resources Limited. His management of environmental issues included the successfully implementation of the company's environmental audit system. During his time as VP of Exploration and

Environment, the company enjoyed an excellent record on environmental compliance and permitting issues. Dr. Meade also co-chaired the Aquamin Review on behalf of the Mining Association of Canada. This review was a national, multi-disciplinary, review program of the impacts of metal mining on the aquatic environment.

*Mr. Brad Marchant, B.Sc.(BioChem.), M.A.Sc. (Mining)
Vice President, Mining and Development*

Mr. Marchant is a metallurgist with over 20 years in the mining industry. He has worked as a process metallurgist for Placer Dome's Project Development Group and as Chief Operating Officer for Triton Mining Corporation. Mr. Marchant is the founder of Coastech Research and Biomet Mining Corp, two engineering and process research companies. Mr. Marchant's principle role as VP of Mining and Development is the coordination and management of feasibility studies for the Finlayson Project.

*Mr. Robert Yeoman, B.Com, MA (Economics), MBA
Vice President, Corporate Development*

Mr. Yeoman is a business man with over 20 years of experience in natural resource companies. He has worked for Noranda and Anglo American Corporation, two of the largest natural resources companies in the world. He has held presidential and CEO positions in several natural resource and business consulting companies. Mr. Yeoman's principle role as VP of Corporate Development is to assist the company in its financing efforts.

*Ms. Carol Ellis, B.Sc.(Geol), MBA, P.Geo.
Vice President, Investor Relations*

Ms. Ellis has a valuable combination of skills and experience. She worked for the Department of Indian Affairs and Northern Development (Northwest Territories Division) for 13 years as a geologist. She has also worked for the past several years as a mining analyst for Vancouver based financial firms. Ms. Ellis' principle role as VP of Investor Relations is the management and coordination of the companies financing activities.

*Mr. Terry Tucker, B.Sc.(Geol), P.Geo.
Manager, Exploration*

Mr. Tucker is a geologist with extensive experience in the Finlayson District. As a project geologist for Westmin Resources Limited, Mr. Tucker managed the discovery and exploration of the Wolverine Project during the period 1995-96. From 1997 through 1999, he was the President of Nickelodeon Minerals, a junior mining company with mineral assets in Europe. Mr. Tucker's principle role as Manager of Exploration is the management of Expatriate's ongoing exploration activities in the Finlayson District.

*Mr. Justin Himmelright, B.Sc.(Biol)
Manager, Environment*

Mr. Himmelright is a biologist with a broad base of consulting experience in the mining industry. He has worked for the past several years a Project Biologist and Sr. Scientist with Knight Piesold (formerly Hallam Knight Piesold), a well-known engineering and environmental consulting firm. He has extensive experience in environmental permitting and compliance for major and junior mining companies. As a manager of Environmental Impact Assessment development, Mr. Himmelright has contributed to the permitting process for several major international mining projects. Mr. Himmelright's principle role as Manager of Environment is to bring the Finlayson Project forward through the environmental permitting process.

1.2.1.2 Management Approach to the Permitting Process

The approach of the company to the permitting process for the Finlayson Project is based on four principles:

1. **Dedicated Management** – through their Manager of Environment, the Company is taking a proactive role in the permitting of the Finlayson Project. The Manager of Environment will work directly with the company management team to ensure that environmental and permitting issues are considered in all management decisions.
2. **Experience and Expertise** – Expatriate has selected a team of consultants who have previous experience in the Finlayson District and have the expertise to assist the company in permitting and developing the project. This team includes:
Gartner Lee Ltd., Stephen R. Morison and Don McCallum – Gartner Lee is the lead consultant on permitting issues for the Finlayson Project. Steve Morison has extensive experience with permitting in the Yukon.
A.J. Keen Mining Consultants, Tony Keen – Mr. Keen was the project manager for the Kudz Ze Kayah Project while it was being developed by Cominco
Access Mining Consultants, Rob McIntyre and Dan Cornett – Access Mining Consultants developed and implemented the Wolverine Project environmental baseline studies during 1995-97.
URS (formerly Norecol, Dames, and Moore), Dave Harpley – Mr. Harpley was the project manager for Norecol, Dames, and Moore during the baseline studies of Kudz Ze Kayah and development of the project IEE.
3. **Existing Documentation** – there is an extensive library of studies and other documentation related to the Finlayson Project. The exploration properties that comprise the project have been subject to feasibility level engineering studies, environmental baseline studies, and environmental screening through the permitting process. The company intends to utilize this documentation and information to the maximum extent possible when developing report submissions for the regulatory agencies.
4. **Joint Work Planning** – using principles outlined in a recently developed administration protocol (the “Blue Book” protocol), Expatriate Resources will work closely with regulatory agencies to develop joint work plans for approval and permitting processes. The Company and the review groups will work together in developing a joint work plans which allow both groups to anticipate and allocate the resources required to meet the timelines associated with each step in the permitting process.

1.2.1.3 Expatriate's Environmental Policy

Although Expatriate is not a member of the Mining Association of Canada, the company has chosen to adopt environmental policies of this organization. As a junior mining company with no operating mines, only certain components of the Mining Association of Canada's environmental policies apply to Expatriate Resources. These components include the following:

1. **Integrated Management** - Integrate environmental policies, programs, and practices into all activities of the organization.
2. **Environmental Management** - Monitor the performance of environmental programs and management systems to ensure compliance with company and legislative requirements.

3. Continual Improvement - Establish and ongoing program of review and improvement of environmental performance.
4. Risk Management - Identify, assess, and manage environmental risks.
5. Incident Management - Develop, maintain, and test emergency preparedness plans to ensure protection of the environment, workers, and the public.
6. Public Policy - Work with government and the public to develop effective, efficient, and equitable measures to protect the environment based on sound science.
7. Contractors and Suppliers - Require contractors to comply with company environmental policies and work co-operatively to improve environmental performance.
8. Communications - Encourage dialogue on environmental issues with employees and public and be responsive to concerns.
9. Employees - Ensure that all employees understand and are able to fulfill their environmental responsibilities.
10. Closure - Reclaim sites in accordance with site-specific criteria in a planned and timely manner.

1.2.2 Project Rights and Interests

1.2.2.1 Mineral Assets

Expatriate's mineral rights in the Finlayson District are based on three groups of claims (Figure 1.2). The Expatriate claim group is comprised of claims originally staked by Expatriate Resources Ltd. in the mid-1990's. The company retains a 100% interest in these claims. Expatriate's interest in the second claim group (the Wolverine Joint Venture) was acquired from Westmin in 1999. Expatriate is now the 60% owner and operator of this joint venture. Atna Resources Ltd. retains the remaining 40% participating interest in this block of claims. The third claim group was acquired from Cominco Ltd. in March, 2000. This group of claims includes the Kudz Ze Kayah Project and its access road from the Robert Campbell Highway. The Kudz Ze Kayah acquisition agreement allows a period of four years to complete the purchase obligations. Until the terms of the agreement are completed, Expatriate Resources cannot unilaterally alter any of the assets acquired under Kudz Ze Kayah agreement, including all permits, leases and agreements associated with the Kudz Ze Kayah Project.

1.2.2.2 Permits and Agreements

Through the acquisition of the Kudz Ze Kayah Project, Expatriate will take on all of the permits and agreements associated with that project. These include the following:

1. Type A Water Licence – The Kudz Ze Kayah Water Licence was issued to Cominco in December of 1998. This water licence allows the development and operation of the Kudz Ze Kayah mine based on the plans presented in the Kudz Ze Kayah Water Licence Application (Cominco Ltd., 1997).
2. Surface Lease for the Mine Area – Cominco has recently acquired and transferred to Expatriate the lease on surface rights for the Kudz Ze Kayah Mine area. This lease allows the development and long-term operation of the Kudz Ze Kayah Mine.
3. Surface Lease for the Access Road – The Kudz Ze Kayah access road connects the project area to the Robert Campbell Highway. The surface lease contains provisions for closure and reclamation of the road including the requirement for an environmental bond. The leasing of the access road corridor allows the lessee to restrict access on the road. Restriction of access is an important component of the environmental mitigation

program of the project. It provides control of access for hunters and reduces pressure on wildlife resources in the area. The lease on the road access corridor is linked to the mine area lease. It cannot be assigned or otherwise transferred to another party without also transferring the mine area lease.

4. Wildlife Agreement – Upon assignment, Expatriate will assume the responsibilities of the Wildlife Monitoring Agreement reached between Cominco and Yukon Territorial Government Renewable Resources Division. This agreement includes provisions for continuing security on the Kudz Ze Kayah Access road through round the clock supervision and maintenance of a locking gate. This agreement also lays out a spirit of cooperation between Renewable Resources and the Company on monitoring and reporting of wildlife resources in the project area.
5. Fisheries Compensation Agreement – The development of the Kudz Ze Kayah Project as described in the project Water Licence Applications (Cominco, 1997) would require the removal of a small amount of fish habitat in the headwaters of Geona Creek. Cominco and the Department of Fisheries and Oceans (DFO) reached agreement on compensation to offset this habitat loss. This agreement contains provisions for a fish salvage and placement operation to protect the current fish population and habitat compensation plans to replace the habitat removed during project development. The agreement also includes a requirement for bonding to cover the terms of the Fisheries Compensation Agreement.
6. socioeconomic Agreement – Cominco successfully negotiated a socioeconomic Agreement with the Ross River Dena Council. This agreement outlines mechanisms, policies and agreements on the issues of community communication and consultation, contracting, job training and employment opportunities, land use interruption compensation, and mutual respect and cooperation.

Copies of agreements and permits are presented in Appendix 1B.

1.3 Regulatory Context

1.3.1 The Project and the Canadian Environmental Assessment Act

1.3.1.1 *Applicability of the Act*

The Finlayson Project is subject to the Canadian Environmental Assessment Act (CEAA). The applicability of CEAA to any project is dependant on three component questions:

1. Does it meet the definition of a “project” under CEAA?

The CEAA definition of a project includes undertakings in relation to physical work as well as some activities not related to physical work. CEAA contains “Inclusion List Regulations” which outline the types of activities that would require Environmental Assessment. The Finlayson Project does meet the definition of a project under CEAA.

2. Does the project include a federal “trigger”?

Activities which constitute a “federal trigger” include the involvement of the federal government as a proponent of the project, as a provider of funds in support of a project, as seller or lessor of lands enabling the project, or as a regulator and administrator of Federal acts which govern the project (i.e. provider of permits and approvals). The Finlayson Project requires permits and approvals from the Federal government and as such the project includes a federal “trigger”.

3. Is the project excluded by the Exclusion List Regulations?

The CEAA Exclusion List Regulations make provisions for certain types of activities to be excluded from federal environmental assessment process. These activities include

emergency actions and repairs to existing physical works. The Finlayson Project does not fall under the Exclusion List Regulations.

1.3.1.2 Level of Environmental Assessment

CEAA prescribes five levels of environmental assessment; screening, class screening, comprehensive study, mediation, and panel review. The applicable level of environmental assessment for a project can be determined by consulting the Comprehensive Study List of CEAA. This list outlines which projects will be subject to a Comprehensive Study. At any time during the environmental assessment process, the proponent or the federal government can request that the project go to panel review or mediation.

For base metal mining projects, such as the Finlayson Project, operations that meet or exceed 3000 tonnes per day of ore throughput are required to undergo a Comprehensive Study under the Canadian Environmental Assessment Act. The Finlayson Project will be designed to have a daily throughput of 4250 tonnes and as such will be subject to a Comprehensive Study under CEAA.

1.3.1.3 The Law List and Federal Triggers

The permits and approvals required for the Finlayson Project fall under three major sets of acts and regulations. Firstly, the project will require a Type A Water Licence under the Yukon Waters Act. The Yukon Territory Water Board issues this licence which requires approval by the federal Minister of DIAND. The Water Resources Division of DIAND, Yukon Region provides an inspection function to ensure compliance by the proponent. Secondly, the project will require a Quartz Mining Licence under the Yukon Quartz Mining Act. The issuance of this licence is administered by the Mining Land Use Division of DIAND, Yukon Region and requires approval by the Federal Minister of DIAND. Thirdly, the project will require additional Surface Leases under the Territorial Lands Act (TLA) that is administered by Lands Resources Division of DIAND, Yukon Region.

Additional acts and regulations that may need to be considered for the project include:

- The Navigable Waters Protection Act (Canadian Coast Guard) – Expatriate Resources is reviewing several options for development of an access road between the Kudz Ze Kayah and Wolverine operations. Depending on the route selected, large stream crossings involving bridgework may be required. Such works would require approval under the Navigable Waters Protection Act.
- The Fisheries Act (Fisheries and Oceans Canada) – The major fisheries and fish habitat issues associated with this project have been addressed through the Kudz Ze Kayah Fisheries Compensation Agreement. The addition of the underground operations at Wolverine is not anticipated to have any effect on fisheries or fish habitat. The connector road joining the Wolverine and Kudz Ze Kayah operations may require some stream crossings, depending on the selected road alignment. These crossing may have a minor effect on local fish habitat, depending on the attributes of the crossing location and design.
- The Explosives Act (Natural Resources Canada) – During the development and permitting of the Kudz Ze Kayah Project, Cominco's stated plan was to source explosives from a licensed explosive manufacturing plant located in Faro. Expatriate would use the same approach for all major explosives manufacture. There will be no explosives manufacturing at the Finlayson Project and a permit under the Explosives Act is likely not required.

1.3.1.4 Potentially Applicable Federal Policies and Strategies

The Federal government has several strategies and policies related to environmental issues that may influence the project, both in terms of development plans and the approach to the Environmental Assessment Report. A summary of those policies and strategies is presented below.

Canadian Biodiversity Strategy

The Canadian Biodiversity Strategy was developed as a guide for the implementation of the United Nation's Biodiversity Convention, signed by Canada and 160 other countries at Rio de Janeiro in 1992.

The objectives of the Convention are to conserve the ecosystem, species and genetic diversity; ensure the wise use of the earth's resources; and ensure that the economic benefits from these resources are shared fairly and equitably. The Canadian Biodiversity Strategy is generally based on these three objectives. There are five goals that provide the framework for the Canadian Biodiversity Strategy:

1. Conserve biological diversity and sustainable use of biological resources.
2. Improve our understanding of ecosystems and increase our resource management capacity.
3. Promote an understanding of the need to conserve biodiversity and the sustainable use of biological resources.
4. Maintain or develop incentives and legislation that support biodiversity conservation and sustainable use.
5. Co-operation at an international level to conserve biodiversity, the sustainable use of biological resources and share equitably the benefits of genetic resources.

National Action Plan on Climate Change

In June 1992, Canada and more than 150 countries signed the Framework Convention on Climate Change at the United Nations Conference on Environment and Development in Rio de Janeiro. The ultimate objective of this Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The National Action Program on Climate Change (NAPCC) outlines the federal/provincial strategy for achieving this goal and provides guidance for action beyond the turn of the century. The Program developed in 1995 outlines a long-term strategic approach, whereby all key stakeholders, working with governments, are involved in developing and implementing actions that concentrate on reducing greenhouse gas emissions at the point of use and not the source. In Kyoto Japan, in December 1997, Canada agreed to work toward reducing the emissions of six greenhouse gases to 6% below 1990 levels by the year 2012. Such a goal requires flexibility and strong federal, provincial and territorial co-operation to develop actions that will work to reduce Canada's net greenhouse gas emissions.

The NAPCC was developed to ensure that human activity does not further intensify greenhouse gas levels and that their associated effects on climate. In the context of this policy, the EA should consider air quality and emissions, potential or known, in relation to the project.

Kyoto Protocol

The purpose of the Kyoto Protocol is to achieve quantified limitations and reductions in the emission of greenhouse gases and other pollutants to promote the objectives of sustainable development. The key objectives of the Kyoto Protocol are:

- enhancement of energy efficiency in relevant sectors of the national economy;
- protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, accounting for international environmental agreements and promotion of sustainable forest management practices;
- promotion of sustainable forms of agriculture in light of climate change considerations;
- research on, promotion, development and increased use of new and renewable forms of energy, of carbon dioxide sequestering technologies and innovative environmentally sound technologies;
- progressive reduction of market imperfections, subsidies and other financial incentives in all greenhouse gas emitting sectors that run counter to the objectives of the Convention;
- encouragement of appropriate reforms in sectors aimed at promotion of policies limiting or reducing emissions of greenhouse gases not controlled by the Montreal Protocol;
- limits and /or reductions in emissions in the transport sector that are not controlled by the Montreal Protocol; and
- limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy.

Canada was a participant in the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987, and has continued to be involved in initiating programs and initiatives in reducing air pollutants. Entering into agreements with the United States, it has made specific commitments on the reductions of nitrogen oxides and sulphur dioxides, in an effort to curb transboundary air pollution.

From an environmental assessment perspective, the EA will determine if there is a potential for a project to emit greenhouse gases, make suggestions regarding the use of best available technology for emissions control and energy efficiency and address the potential for cumulative effects and implications for climate change. Proponents should be encouraged to develop action plans and follow-up programs aimed at identifying sources and reduction options for greenhouse gas emissions

Pollution Prevention – Federal Strategies for Action

The federal government defines Pollution Prevention as, "...the use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste, and reduce overall risk to human health or the environment". This strategy provides a framework to achieve a proactive approach to pollution in all sectors of society.

The federal strategy for action on Pollution Prevention is supported by five key goals.

1. Institutionalizing pollution prevention across all government activities.
2. Working with the private sector to achieve a climate in which pollution prevention becomes a major consideration.
3. Providing access to all Canadians to the information and tools required to implement pollution prevention practices.
4. Participating in international pollution prevention initiatives.

This policy instrument was developed to ensure that processes or products that avoid or minimize the creation of pollution and waste are developed and implemented. In the context of this policy, the EA will consider air, land and water pollution issues, as it relates to the project. The focus of such comments should be on opportunities for the project to incorporate pollution prevention programs, energy recovery programs and remediation efforts. Programs that would improve the environmental performance of projects should be encouraged and detailed within an environmental assessment.

Migratory Bird Convention

The Migratory Bird Convention allows for co-operation between Canada and the U.S. in the protection and management of migratory birds. The 1995 protocol to amend the Convention emphasizes the need to provide for and protect necessary habitat for the conservation of migratory birds. This is consistent with other approaches, such as the establishment of Migratory Bird Sanctuaries, under the *Migratory Birds Convention Act* and the National Wildlife Areas under the *Canada Wildlife Act*.

Northern Mineral Policy

The broad objectives of the Northern Minerals Policy are to improve the climate for investing in, and the competitive position of the minerals sector in Canada's northern territories by:

- providing the industry with an atmosphere of certainty;
- increasing industry competitiveness by providing improved geoscientific services and by minimizing federal government imposed costs; and,
- encouraging a dialogue among the mining industry, the public and both levels of government.

It is hoped that the approach being proposed by Expatriate Resources, such as joint workplanning, will foster the broad objectives outlined in the Northern Mineral Policy which is still in effect.

Sustainable Development Strategy for the Department of Indian Affairs and Northern Development

The Department of Indian Affairs and Northern Development (DIAND) has developed a strategy to meet the overall goals, objectives and ideals associated with Sustainable Development. DIAND has accepted a series of Sustainable Development Principles (Toward Sustainable Development, Volume 1: A Strategy for the Department of Indian Affairs and Northern Development) which includes:

- sustainable development as a continually evolving process bringing together cultural, social, economic and environmental concerns;

- development is needed to create opportunities, prosperity and choices for First Nations and northern peoples; and,
- development must proceed in a way that leaves choices available for future generations.

1.3.2 Land Use Designations Effecting Project Development

The Finlayson District is not part of any special land use planning process. Land use stakeholders in this area include guide outfitters and local First Nations. Doug Smarch of Teslin Outfitters holds the commercial guiding rights for the project area. Mr. Warren LaFave operates a tourist facility called Inconnu Lodge on McEvoy Lake, north of Finlayson Lake. Neither of these operations includes special designations or land use rights which effect the project.

The local First Nation is the Kaska Nation whose traditional territory crosses the B.C. – Yukon border. The Kaska Nation is comprised of three principle groups, the Kaska Dena Council representing all Kaska communities on the B.C. side, the Liard First Nation located near Watson Lake YT, and the Ross River Dena Council based in Ross River. The traditional territory of the Kaska Nation is considered to be shared equally by all groups; however the communities recognize the traditional use of portions of the territory by a particular group. The Finlayson Project area falls within the area recognized as the traditional territory of Ross River Kaska.

The Ross River Dena Council holds the group trapping rights for the project area. No one person owns a trapline, but trapping takes place on Group Traplines. The Ross River Dena Council has management responsibility for the Group Traplines. The Kudz Ze Kayah socioeconomic Agreement includes provisions for compensation for interruption of trapping land use.

As part of the land claims negotiation process between the governments of Canada and the Kaska Nation, land selections designated as “R-Blocks” have been set aside for future consideration in the land claims process. There are three such R-Blocks in the Finlayson District (Figure 1.2). These lands are withdrawn from any future land use plans until such time as they are selected or released by the First Nation during the land claims negotiation process. Although these blocks are in close proximity to the project operation areas and access corridors, they will not directly effect the development of the project.

1.3.3 Project Description Report Circulation

Copies of this report have been circulated to the following groups:

- Ross River Dena Council
- Liard First Nation
- Victor Mitander, The Kaska Nation designate for Mining Issues.
- Yukon Territorial Water Board
- Government of the Yukon including Department of Renewable Resources, Economic Development, and Executive Council Office
- Yukon Conservation Society
- Canadian Environmental Assessment Agency, Pacific and Northern Region
- DIAND, Yukon Region – it is assumed that through the Federal Coordination Regulations, DIAND will undertake to distribute copies of this report to other federal agencies (e.g. Environment Canada, Natural Resources Canada, Fisheries and Oceans Canada) that are potential responsible authorities under CEAA.

1.4 Project and Assessment Scope

1.4.1 Project Scope

The scope of the project to be assessed includes the following components:

- The open pit and processing operations and supporting infrastructure and facilities at Kudz Ze Kayah
- The underground operations and supporting infrastructure at Wolverine
- The access road connecting the two operations
- The concentrate haul route

1.4.2 Assessment Scope

The assessment will consider the following issues:

- The purpose of the project
- Alternative means of carrying out the project and the environmental effects of those alternatives.
- Technically and economically feasible measures that would mitigate any significant adverse environmental effects resulting from the project.
- The residual environmental effects of the project including the effects of potential accidents and malfunctions that may occur in connection with the project. This will include an assessment of effects on:
 - The physical and biological environment
 - Archaeological and heritage resources in the project area
 - Effects on aboriginal land use
 - socioeconomic effects in local communities
 - Effects on human health
- The cumulative environmental effects that may result from development of this project in combination with other projects that have been carried out or are proposed
- The significance of these effects
- Comments received from the public in accordance with CEAA.
- The need for and requirements of a follow-up program.

Throughout the assessment, the definitions of “environment” and “environmental effect” will be defined as per the Canadian Environmental Assessment Act. This is as follows:

- environment - the components of the earth and includes land, air and water and all layers of the atmosphere, all organic and inorganic matter and living organisms, and the interacting natural systems including the previously mentioned components; and
- environmental effect – any change that the project may cause in the environment including any effect of any such change on health and socioeconomic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance; any change to the project that may be caused by the environment.

The scope established by these definitions does not consider socioeconomic effects which do not result from changes in the environment. It is historically established that major projects in remote areas can result in socioeconomic effects to original inhabitants as a result of rapid immigration of outsiders seeking work. Major projects also bring many positive socioeconomic benefits through employment and tax revenues. In this case, the social and economic effects do not result from changes to the environment (as defined by the Canadian Environmental Assessment Act) but from changes to the local social and economic conditions. For the

purposes of this environmental assessment, the Company intends to include the social and economic conditions of the area in the definition of the project “environment”.

The capacity of renewable resources that are likely to be significantly affected to meet present and future needs should not be considered by the Environmental Assessment. While the present and future needs for the metal products produced by the operation can be assessed, the global availability of these resources cannot be determined. There are certainly other mineral deposits in the world which have not been discovered and for those that have been discovered, their development is predicated on many unpredictable circumstances including political and economic conditions in the jurisdiction in which they occur.

As discussed in previous sections, Expatriate Resources does not have any feasible alternatives to the project that would achieve its business objectives. As such, it is proposed that the EA Report not consider “alternatives to the project”. It is acknowledged that a determination on this issue is ultimately for the Responsible Authority to make.

It is proposed that the approximate spatial boundaries for assessment be selected based on the potential geographic extent of effect. The spatial boundaries proposed for assessment of biological environment, physical environment, aboriginal land use, and archaeological and heritage resources is shown in Figure 1.3. Physical works related to the mining operations will influence these components of the assessment. The boundary shown in Figure 1.3 is intended to outline a reasonable buffer zone around the physical footprint of the operations. The proposed spatial boundary for assessment of socioeconomic and human health effects is proposed to extend along the concentrate haul route to the point of transfer to an independent carrier. The assessment of economic effects would be presented in a regional context, including the Yukon Territory as a whole.

The temporal boundaries of the assessment are proposed to include the construction, operations, reclamation and decommissioning, and final closure phases of the project.

2 PROJECT DESCRIPTION

The Finlayson Project will consist of two major components, an underground mine at Wolverine operating at 1250 tpd and an open pit mine and milling operation at Kudz Ze Kayah operating at 3000 tpd production. Run-of-mine ore will be trucked from the Wolverine mine to the mill at Kudz Ze Kayah. Ores from both operations will be blended and processed together at the Kudz Ze Kayah mill, operating at 4250 tpd.

Tailings from the mill at Kudz Ze Kayah will be cycloned and the coarse fraction (approximately 800 tpd) trucked in backhaul shipments to Wolverine for use as backfill in the underground operations. There will be no permanent surface waste rock or tailings storage facilities at the Wolverine operations. Mine water will be used as water supply for all operations at Wolverine. Excess mine water will be treated and released. Potable water will be sourced separately, from either a groundwater well or surface water intake. There will be minimal infrastructure associated with the underground mine. All mine crews will be housed at the main complex at Kudz Ze Kayah.

The Kudz Ze Kayah operations will process ore from both the underground and open pit mines. Infrastructure at the Kudz Ze Kayah operations is similar to that proposed by Cominco in their Kudz Ze Kayah Project Water Licence Application. The facilities proposed include tailings and waste rock storage, topsoil stockpiles, open pit, mill, power plant, housing, incinerator and waste management area, warehouse and maintenance shops, and an airstrip. Water for the operations will come from groundwater wells in operations area, surface runoff captured in the tailings impoundment, and mine water collected from the open pit. The tailings impoundment is located downstream of all facilities and will capture runoff from all mine areas. The tailings facility is expected to operate at a net water surplus and will discharge to Geona Creek at certain times of the year. The discharge will be controlled and "paced" to natural surface runoff patterns.

Zinc, copper, and lead concentrates will be produced using a process flowsheet similar to that previously proposed for Kudz Ze Kayah. These concentrates will be trucked to Skagway for shipping. Work crews will be transported by air, landing at an airstrip proposed near the Robert Campbell Highway. From there they will be bussed to permanent housing at the mine site. With the current reserve estimates, the open pit at Kudz Ze Kayah is expected to operate for 11 years and the Wolverine underground mine for 8 years. The reserve estimates (and mine life) may increase as project development plans continue.

The principle differences between the Finlayson Project and the Kudz Ze Kayah Project as proposed by Cominco are:

- The Wolverine underground mine and associated infrastructure
- The ore haul corridor linking Kudz Ze Kayah and Wolverine
- The use of a portion of the tailings material as backfill for underground operations
- Increased mill throughput (2950 tpd for Kudz Ze Kayah increased to 4250 tpd for Finlayson)
- Increases in manpower requirements to accommodate the Wolverine operations

Physical and chemical changes in waste streams associated with the changes to the operations will be:

- discharge of treated mine water at Wolverine;
- additional solid wastes from the Wolverine operations; and

- changes in tailings impoundment water quality (volume and chemical quality) at Kudz Ze Kayah resulting from a slightly different management plan (ie. cycloning of tailings solids, increased volume over the life of mine, addition of Wolverine ores to the process).

This section includes a detailed description of the production and operating plans, infrastructure requirements, and waste and water management plans for the Wolverine and Kudz Ze Kayah Operations. This description is based on the "base case" project design. Options for optimization and improvement being considered by the company are presented as a concluding section to this project description.

2.1 Wolverine

The general site arrangement for the Wolverine area has not been finalized. The general area under consideration for infrastructure placement is shown in Figure 2.1. The final location will be selected based on minimizing environmental effects and risk, utilization of natural features (i.e. topography and drainage patterns) to enhance operational efficiency, and minimizing capital and operating costs. The final location of infrastructure required for the Wolverine operation is relatively flexible due to its small footprint.

2.1.1 Exploration and Data Collection

The resource inventory published by Westmin Resources Limited in February 1998 was based on drill hole data acquired during the 1995-1997 exploration drilling programs. All core was halved, with half assayed at Chemex Labs in Vancouver for Zn, Cu, Pb, Au, and Ag, using standard assay and analytical methods. The assay program included duplicate samples and standards for assuring assay quality. Individual density measurements were made at the same time and are available for most of the samples in the database. All assay intervals in each drill hole with the same geological code were averaged into a single composite, using sample length and density as the weighting factors. The Westmin database used in the modelling included all assay, density and coded geological information. The QA/QC program is currently being evaluated by Strathcona Mineral Services.

2.1.2 Ore Outline and Block Model Development

The Wolverine Deposit is a volcanogenic polymetallic massive sulphide body with a defined strike length of 700 m and a down dip length of at least 400 m. The main zone strikes northwest-southeast and has a dip that ranges from near flat locally, to 30° to 40° to the north east. The favourable mineralized horizon is open in the down dip direction. Within the proposed mining area there are two distinct areas where the mineralization thickens to between 8 m to 15 m. These zones are known as the Wolverine and the Lynx, and they occur as lozenge shaped pods that extend over a minimum of 100 square metres at their thicker centres. At the distal edges of the lozenges the thickness is generally 4 m or less. The average thickness of the Wolverine Zone is 5.1 m, whereas the average thickness of the Lynx Zone is 6.7 m. Overlying the Lynx Zone is the Upper Lynx Zone. The Upper Lynx Zone has limited aerial extent with a thickness sufficient for underground mining.

The Wolverine assay database was loaded into a MEDSYSTEM® format. The assay data was composited for the length of the mineralized zone intercept. A preliminary Gridded Seam Model was developed for all the mineralized horizons that include the Upper Lynx Zone, the Wolverine-Lynx Zones and the Footwall Zones.

The Lower Lynx and Wolverine Zone hanging wall and footwall surfaces were modelled by gridding the drill hole intercept data. These top and bottom surfaces were used to calculate the

gridded seam thickness. The copper, zinc, lead, silver and gold grades for blocks in the ore model were interpolated by the inverse distance cubed method.

2.1.3 Resource and Reserve Summary and Classification

For the purposes of developing preliminary production schedules the mine design parameters, operating costs, economics, etc. have been applied in deriving the following reserve estimates (Nilsson, 2000):

Table 2.1: Wolverine Indicated Resource Estimate

	Indicated	Inferred	Total
Millions dmt	4.941	0.498	5.439
Zn,%	13.0	13.61	13.06
Pb,%	1.58	1.70	1.59
Cu,%	1.43	1.36	1.43
Ag,g/t	379.4	365.3	378.1
Au,g/t	1.76	1.51	1.74

It should be noted that Strathcona Mineral Services has been retained by Expatriate to review the Finlayson resource database and the Nilsson resource and reserve estimates.

2.1.4 Underground Mining

A preliminary geotechnical assessment of the property, entitled "**Preliminary Geotechnical Assessment of the Wolverine Project**", dated April 9, 1997, was completed by Golder Associates (Golder). An updated geotechnical assessment of the property was provided by BGC Engineering, entitled "**Wolverine Deposit – Geomechanics Assessment**", September 28, 2000. The preliminary mine plan is based on the geotechnical recommendations as outlined and provided in the BGC report.

2.1.4.1 Ore Reserves and Underground Design

Ore extraction from the Wolverine deposit has been scheduled on the basis of stoping and ground control recommendations set out by BGC Engineering Inc.'s report "Wolverine Deposit - Geomechanics Assessment". In their report, BGC recommend an overhand cut-and-fill technique in which slices and slots of ground are extracted in longitudinal panels. A key element of the mining method is the need to restrict exposure of the very weak hanging wall, while attempting to take advantage of the relatively stronger ground within the ore limits. The probable reserve, based on this mine plan, is shown in Table 2.2.

Table 2.2: Wolverine Probable Reserves (Nilsson, 2000)

	Total Probable Reserves
Millions dmt	3.469
Zn, %	12.43
Pb, %	1.44
Cu, %	1.37
Ag, g/t	336.6
Au, g/t	1.59

2.1.4.2 Geotechnical

Ground Conditions

The intact strength of the various rock types was estimated by using standard ISRM procedures and by using a point-load tester. A summary of the rock strengths as defined by BGC is shown in Table 2.3.

Table 2.3: Rock Strength – Field Test Runs

Surface	Strength	Comments
Hanging Wall	R1 to R3 (1 Mpa to 50 MPa)	Very weak to medium rock. Generally weak.
Iron Formation	R3 – R4 (50 Mpa to 100 MPa)	Medium to Very Strong. Generally Strong.
Ore	R3 to R5 (50 Mpa to 250 MPa)	Medium to Very Strong rock.
Footwall	R1 to R3 (1 Mpa to 50 MPa)	Very Weak to Medium rock. Generally Weak.

The rock mass rating for the hanging wall and footwall are poor and in the ore zone it is considered fair to good. Due to the strongly foliated and friable nature of the rock, excavation spans and must be maintained as narrow as possible for a short a time as possible to avoid costly ground support. The "stand up or exposure time" of the argillite and rhyolite in the hanging wall is estimated to be in the order of hours for spans greater than 3 m. In the ore zone, the "stand up or exposure time" for spans in the range of 3 m to 9 m is in the order of years in areas where the back is comprised of sulphides.

Ground Support

Design recommendations have been made that limit the allowable exposed hanging wall span to 4 m measured along the dip. Installation of temporary support is estimated to be adequate for supporting the span over approximately 1 month. When the hanging wall is exposed in the back, support will consist of 1.8 m long resin grouted #6 rebar on one meter staggered spacing. Weld mesh will also be installed in the back. Spot bolting with 1.8 m long mechanical anchored rock bolts will be carried out in the harder rock in the walls as required. In very poor ground it may be necessary to apply a 25 mm thick layer of shotcrete on the hanging wall, covering bolts and screens.

The size of permanent openings will be limited to 4.5 m by 5.0 m arch with 75 mm of fibre reinforced shotcrete in the back and 25 mm in the walls. Rock bolts will be installed on 1 m centres in the back and 2 m centres on the walls. In both permanent and temporary openings, ground support will be installed immediately after a round is mucked out.

2.1.4.3 Production Plan

Mining Method

The mine plan has been developed using a retreating cut-and-fill mining method. The access plan and proposed mining areas are shown in Figure 2.2. A combination of drift-and-fill and overhand cut-and-fill methods will be required to extract the resource. Drift-and-fill methods will be employed in those sections of the deposit where the true thickness is between 2 m and 6.0 m. The drift sizes are also summarized in Table 2.4.

Initial drifts will be driven along the deposit footwall contact. Once the ore has been removed, the mined stope will be tight filled with a suitable backfill material. It is proposed to divide the

deposit into distinct sections and mine each section from the bottom up, advancing up-dip. The mining areas have been scheduled so that at least two mining blocks are available simultaneously.

Broken muck from active headings will be transported back to the main access ramp where it will be stored in muck bays. The material will then be reloaded into haul trucks using a dedicated hauling crew for transport to the surface.

Table 2.4: Stope Sizes at Various Vertical Thicknesses for the Wolverine Operation

Vertical Thickness	Stope Size
4.0 m	1 @ 3.5 m wide x (3.5 – 5.8 m) high
6.0 m	1 @ 3.5 m wide x (3.5 – 6.0 m) high
8.0 m	1 @ 6.0 m wide x 5.0 m high 1 @ 3.0 m wide x (2.2 – 4.2 m) high 1 @ 3.0 m wide x (4.2 – 6.4 m) high
10.0 m	1 @ 6.0 m wide x 5.0 m high 1 @ 3.0 m wide x (2.6 – 4.8 m) high 1 @ 3.0 m wide x (4.8 – 6.9 m) high
12.0 m	1 @ 9.0 m wide x 5.0 m high 1 @ 3.0 m wide x (2.6 – 4.6 m) high 1 @ 3.0 m wide x (4.6 – 6.8 m) high
14.0 m	1 @ 5.0 m wide x 5.0 m high 1 @ 9.0 m wide x 5.0 m high 1 @ 3.0 m wide x (2.6 – 4.6 m) high 1 @ 3.0 m wide x (4.6 – 6.8 m) high

A downcast ventilation system is proposed for the Mine. Air will enter the Mine through the main access ramp. Ventilation raises will be driven at both east and west extremities of the deposit as shown in Figure 2.2. These raises will be driven in ore and they will break through to surface. Access to the raises will be possible at the elevation of each drift that is driven along the strike of the orebody. Air down cast through the main access ramp will pass through the ore drifts left open at selected elevations as required to balance airflow and pressure in the mine. The ventilation air will discharge to surface via the ventilation raises. The ventilation raises will also serve as a means of emergency exit from the Mine.

Mine Production Development Plan

The primary access to the Mine is developed as part of the test mining phase. Mining Area A and B will be required for ore production in Year 1 of the Mine Plan (Figure 2.2). Access development to both of these areas will be carried out in the pre-production phase. In general, for the balance of the mine life, the development of the mining areas takes place in the year prior to scheduled ore production. Mine development is completed by Year 5 of the 8-year mine plan.

2.1.4.4 Backfill

The poor quality of the hanging wall rock will require that all mined openings be backfilled. The most suitable method for mining the Wolverine deposit is a combination of mechanized, overhand cut-and-fill and drift-and-fill. In shallower dipping sections of the deposit, this technique will closely resemble drift-and-fill stoping. Backfill will consist of the coarse fraction of cycloned tailings supplemented with the addition of development muck and local gravel borrow material.

Tailings will be hydrocycloned and dewatered at Kudz Ze Kayah and hauled to the Wolverine Mine, in trucks with heated boxes, where they will be re-slurried and delivered hydraulically to the fill stopes. Preliminary hydrocyclone simulation performed by Krebs Engineers Ltd. on the tailings grain size distribution indicates a recovery of approximately 26%. At a mill throughput rate of 4,250 tpd, there should be adequate sand production for the backfill requirement. Cement will be added as required depending on the stope sequencing and short range planning requirements. Approximately 25% of the backfill will require 4% cement addition.

The backfill will require gravel. A gravel borrow area is proposed near the Wolverine operations. Sufficient gravel deposits exist near the proposed Wolverine operations.

2.1.4.5 Access and Test Mining

The deposit is located near surface and access will be by means of a decline ramp. This decline will be collared in a valley southeast of the deposit as shown in Figure 2.2. The decline will be driven using trackless equipment at a grade of -15%. It will measure 4.5 m by 5.0 m in cross-section. The decline will intersect the footwall of the Wolverine Zone at approximately 1,750 m elevation, where it will follow the footwall down-dip. Access to both the Wolverine and Lynx Zones can be achieved at any elevation from this main ramp.

Access will be provided within the Lynx Zone and Wolverine Zone from the main access ramp by means of 4.5 m x 4.5 m development ramps as shown in Figure 2.2. These development ramps will provide multiple working faces and ventilation.

Access to the orebody will be developed in two phases. Phase I will consist of developing the main ramp access from surface to a depth that will permit development of the top portion of both the Lynx Zone and the Wolverine Zone. During Phase I, test mining of the upper portion of the Wolverine Zone will be carried out to more accurately assess ground conditions in and around the ore zone so that the optimum stope dimensions, expected mining dilution and ground control requirements can be confirmed.

During Phase I, the main access ramp will be collared and driven 665 m. From the main ramp, a development decline will be driven for 135 m to access the 1225 elevation area at the top portion of the Wolverine Zone. Lateral drifts will be driven for a total length of 300 m within the mineralized zone to determine ground conditions and establish dilution factors. In addition, a 150 m Alimak raise will be driven at the eastern edge of the zone to surface to provide an emergency exit and enhance ventilation during normal mining operations.

2.1.4.6 Description of Operation

General

The underground mine at Wolverine will supply ore to a processing facility to be located at the Kudz Ze Kayah site. Management and support facilities can, therefore, be shared between the sites.

The Mine will operate on a 10-hour shift basis, 2 shifts per day, 7 days per week. Since the site is in a remote location, it is planned that the Mine will operate 365 days per year with crews rotating in and out on a regular scheduled basis.

Backfill Access

A preliminary concept has been developed for backfill delivery. This concept consists of a classified tailings re-slurry plant and pumping system with final delivery of fill to the stopes

through a pipe. Future engineering may show that the delivery system can be optimized by using borehole delivery to lower levels from diamond drilling stations that access drifts.

As there will not be a mill at this site, it will be necessary to transport classified tailings overland to the mixing plant. Trucks hauling ore from Wolverine to Kudz Ze Kayah will back haul classified tailings from the mill. This material will be dumped into a hopper and conveyed into a covered storage area. Approximately 5,000 t storage heated capacity would provide enough material to allow surge in the fill placement or delivery process.

Equipment

The mining method will be trackless cut-and-fill. The key elements of the fleet included jumbo production drills, mechanical bolters and supporting scissors lift vehicles, shotcrete delivery vehicle, as well as 4 m³ load haul dump units and 36 t haulage trucks. The haulage trucks will carry muck to the surface where it will be stockpiled and re-handled into transport vehicles that will carry the material to the process facility.

2.1.5 Infrastructure

The mine at Wolverine has certain associated surface requirements. These have been combined into a single complex to minimize power, heating and associated infrastructure costs. A layout of the facility is given in Figure 2.3.

Processes that form part of the complex include:

- Backfill storage (5,000 t stockpile).
- Backfill plant and reagent storage.
- Shotcrete area.
- Water treatment plant.
- Maintenance shop.
- Mine dry
- Office
- Power generation
- Surface stockpile area for underground ore
- 20 man emergency camp.

The emergency camp for 20 people will be constructed adjacent to the main complex. This camp will only be used in the event of access road closures during poor winter driving conditions. Only the underground crews will use the mine dry at Wolverine. Surface workers will change at a centrally located dry facility, which will be located at the Kudz Ze Kayah mill site.

- Mine water will be used to supply the operations. A source of water will be required for the construction camp and emergency camp. This will be provided either through a groundwater well or surface water intakes in nearby creeks.

2.1.6 Wolverine Site Power Requirements

The electric power requirements for the Wolverine Mine would be provided from a small diesel power plant with two engines. Only one will be in use at any given time. The other will provide backup power in the event of malfunction or scheduled maintenance. The major loads at this site are the underground mine and the surface facilities building. In the underground mine, ventilation is the single largest power consumer. The diesel power plant would either be located within the facilities building, as shown on the general arrangement drawing, or alternatively could be located in modules adjacent to the main building.

The alternative of three smaller gensets could be considered once the mine load is finalized. These may be operated to better match the mine load and would offer improved security of supply. The engines would be equipped with day tanks which would be automatically filled from the adjacent bulk storage.

The bulk storage facility would consist of standard shop fabricated 50,000 litre double walled (i.e. with integral leak containment), manifolded together to provide the necessary fuel storage. Three such tanks for a total storage of 150,000 litres for the power plant have been allowed for.

2.1.7 Manpower Requirement

The direct mine manpower includes 13 staff. The total operations manpower allocated in the direct labour classification is 36. In addition to the direct labour force, an additional 36 employees will be allocated to the indirect labour classification including Mechanics, Electricians, Utility Crew and Backfill Plant Operators. The total manpower requirement anticipated for the Wolverine operations is 85. All accounting, warehouse, purchasing and general administration functions will be carried out by staff of the combined open pit and underground operations.

2.2 Ore Haul Road

The ore haul road will connect the Wolverine and Kudz Ze Kayah operations. This road will be used to transport ore from Wolverine to Kudz Ze Kayah, backhaul tailings sands for backfill in the underground mine, transport workers to and from the Wolverine site, and provide general access for transporting supplies to the operations area. There are currently two options under consideration for this road (Figure 2.4).

2.2.1 Route A

Route A travels along the north-eastern side of Wolverine Lake. It crosses Nougha (Wolverine) Creek at the outlet from Wolverine Lake and continues west, along the northern side of Wind Lake. The route then travels southwest, crossing the inlet stream to Wind Lake and continues to Kudz Ze Kayah.

Positive Attributes

This route is the shortest option with a total length of approximately 35 km. The elevation range is between approximately 1200 and 1480 masl. This alignment follows a relatively flat trajectory and presents little in the way of challenging topography. In combination, these factors indicate a reduced risk of vehicle accidents, lower capital cost for construction, lower operating costs for road maintenance and lower fleet operation costs for ore trucks. This alignment also provides good potential for access to other exploration targets. Based on a very quick review of caribou survey data, this route does not appear to pass through calving or rutting grounds for the Finlayson caribou herd.

Development Considerations

This route passes through the center of the Wolverine Lake drainage basin. Certain sections of the road alignment may be visible from the lake, presenting a slight aesthetic impact to the area. Preliminary evaluation of ground conditions in the area indicates the potential for deep organic and permafrost conditions along portions of the road. As experienced during the construction of the Kudz Ze Kayah access road, these conditions present a certain amount of risk in terms of construction and maintenance costs and potential environmental effects. There are cabins at the outlet of Wolverine Lake and the area has recently been used by the First Nations of Ross

River. The stream crossing at this location would almost certainly require the construction of a bridge and is an environmental consideration for this route.

2.2.2 Route B

Route B travels south from Wolverine, crossing the watershed divide between the Wolverine and Money Creek drainages. It turns west near Money Creek, travelling upstream until it turns north, passing along the eastern shore of the lakes at the Redline Property. The route then continues north-west to Kudz Ze Kayah.

Positive Attributes

This road alignment passes outside the Wolverine Lake Drainage. There are no major stream crossings along this route, although several minor streams would need to be crossed. An initial assessment of ground conditions indicates a low potential for permafrost or deep organic deposits along this alignment. It is believed that the majority of this route would be relatively easy and inexpensive to construct.

Development Considerations

This is the longest proposed alignment with a total length of approximately 50 km, 15 km longer than Route A. The road may pass close to rutting grounds for the Finlayson caribou herd that are located on the plateau between Wolverine and the lakes near the Redline Property. Mine operations will need to consider the necessity of short-term ore stockpiles and reduced activity along the road alignment while caribou are occupying the area. The area of the alignment along the north shore of Money Creek has been traditionally used by the First Nations of Ross River.

2.3 Kudz Ze Kayah

The Kudz Ze Kayah operations area will include all of the major infrastructure for the Finlayson Project, including the mill, tailings storage facility, waste rock storage facilities, waste management facilities, worker housing etc. (Figure 2.5). The general site arrangement is designed to have all mine facilities located upstream of the tailings impoundment. This design provides maximum control of runoff from the operations area and maximizes protection for downstream resources.

2.3.1 Exploration and Data Collection

The following information is taken from the Nilsson Mine Services report "Kudz Ze Kayah, Pre-Feasibility Study Mine Plan" dated October 2000.

Cominco completed 21,663 m of NQ diameter drill core in 162 holes. In addition, 2,090 m of HQ core was obtained in 15 holes, which were used in the metallurgical testing. Mineralized and host lithologies were logged in detail and coded in a GEORES format. Drill hole survey data, rock codes and assay data were merged into the GEORES database. All core with the exception of the initial eight holes was photographed prior to sampling (Nilsson, 2000).

Strathcona Mineral Services (Strathcona) has been retained by Expatriate to document QA/QC procedures and to verify the database used to construct the block model.

2.3.2 Ore Outline and Block Model Development

For the Kudz Ze Kayah deposit, mineralized outlines were drawn on computer generated north-south cross-sections spaced at 25 m intervals. Mineralized intervals of less than 3 m true thickness were excluded from the ore envelope. Internal waste intervals greater than 3 m true

thickness were also excluded from the mineralized envelope. Where the alteration assemblage contains 8% or more equivalent zinc grade adjoining massive sulphide, it has been included in the mineralized envelope. The zinc equivalent grade calculation was carried out using the following formula which was provided by Cominco and based on recovery and metal prices current at the time:

$$EQZn=Zn+Cux2.212 + AgX0.021524 + Aux1.06994$$

The eastern part of the Kudz Ze Kayah deposit forms a continuous sheet, which permits a high degree of confidence in the continuity of the mineralization. In the western part of the deposit many holes contain two or three discrete sulphide layers occurring between the distinctive footwall and hanging wall lithologies. The mineralized envelope has been drawn on the assumption that these layers coalesce to form the single horizon. More complex possibilities such as multiple lenses or tight folding are possible and additional drilling or underground development is required to resolve potential continuity questions. In general though, the drilling density is sufficient to be relatively confident of the interpretation.

Modelling on the Kudz Ze Kayah deposit was done by Cominco using Mintec's MEDSYSTEM®. The most recent block model was developed in late 1996 incorporating a revised geological interpretation and reduced model block size. The assay data was composited into 5 m fixed length intervals. The interpolation method used was Inverse Distance cubed. The block model dimensions are 6.25 m in the x direction and 5 m in both the y and z directions. The block model was based on sectional interpretation.

2.3.3 Resource and Reserve Summary and Classification

Resource estimates for the Finlayson Project have been taken from the Nilsson Mine Services reports dated October 2000 ("Kudz Ze Kayah Pre-Feasibility Study Mine Plan" and "Wolverine Project Conceptual Mine Plan").

The Indicated Mineral Resources tabled below are inclusive of those Mineral Resources modified to produce the reserve estimates.

Table 2.5: Kudz Ze Kayah Resource Estimate (Nilsson,2000)

	Indicated	Inferred	Total
Millions dmt	13.72	-	13.72
Zn,%	6.0	-	6.0
Pb,%	1.61	-	1.61
Cu,%	0.90	-	0.90
Ag,g/t	139.2	-	139.2
Au,g/t	1.38	-	1.38

2.3.4 Mine Ore Reserves and Open Pit Design

The Nilsson report describes the mine design parameters, operating costs, economics, etc., that have been applied in deriving the following reserve estimates:

Table 2.6: Kudz Ze Kayah Probable Reserve Estimate (Nilsson, 2000)

	Total Probable Reserves
Millions dmt	11.11
Zn,%	6.61
Pb,%	1.56
Cu,%	0.85
Ag,g/t	136.9
Au,g/t	1.33

It has been proposed to mine the Kudz Ze Kayah deposit using standard truck and shovel methods. Mineable reserves have been generated from the resource block model on the basis of the following design criteria:

2.3.4.1 Pit Slopes

Recommendations for the wall slope design geotechnical parameters are contained in the report "Feasibility Level Mining Geotechnical Design Criteria for the ABM Deposit, Kudz Ze Kayah Project" - Golder Associates Ltd. Wall slope design parameters are summarized in Tables 2.7 and 2.8. These recommendations were simplified and used as a guide for design. An inter-ramp slope angle of 46° was used. A 10 m wide berm was located on alternate benches. The inter-berm bench face slope was assumed to be 65°.

Table 2.7: Recommended Pit Wall Slopes

Sector	Wall Name	Azimuth		Bench Face	Berm Width	Bench Separation	Inter-ramp Degrees
		Degrees	Degrees	Metres	Metres	Metres	Degrees
1	West Endwall	210	340	70	8	20	52.5
2	North Highwall	340	20	65	8	20	49
3	East Endwall	20	70	70	10	20	49
4	East Endwall	70	150	70	8	10	41
5	South Wall	150	210	Determined by deposit orientation			

Note: Pit design standardized to double bench 10 m berm, 65° inter-bench face angle - 46° inter-ramp slope

Table 2.8: Pit Design Parameters

Inter-ramp Slope Angle	degrees	46.0
Bench Face Angle	degrees	65.0
Bench Height	metres	10.0
Berm Width	metres	10.0
Ramp Grade	%	8.0
Ramp Width	metres	22.0

2.3.4.2 Pit Phases

The open pit has been designed in MEDSYSTEM in three development phases, as shown in Figure 2.6. The Stage 1 Pit is developed as a low strip ratio starter pit on the west side of the deposit. The Stage 2 Pit is a higher strip ratio expansion to the depth of the Stage 1 Pit. The Stage 3 Pit is an expansion to the east and to a similar depth as the Stage 2 Pit.

2.3.4.3 Reserves

Based on the deposit's geological Indicated Mineral Resource and the pit design parameters, the in-situ resources have been reported as run-of-mine ore after factoring for 95% recovery and 10% dilution. The cut-off grade used was 3.5% equivalent zinc.

The total Probable Reserve in the ultimate pit has been estimated at 11.109 million tonnes of an average grade of 5.61% zinc, 0.85% copper, 1.56% lead, 136.9 g/t silver and 1.33 g/t gold. The equivalent zinc grade is 10.68% zinc.

Table 2.9 provides a summary of the reserves for the Kudz Ze Kayah deposit.

2.3.5 Production Plan

2.3.5.1 Summary

The resource extraction method proposed for Kudz Ze Kayah is conventional open pit mining using rotary blasthole drills, loaders and off-road haulage trucks supported by a fleet of track dozers, a grader, a wheel dozer and water trucks.

The current mine plan is based upon scheduling 3,000 tpd of open pit ore to the primary crusher. The general arrangement of the waste dumps and the mine relative to the mill-site is shown in Figure 2.5.

2.3.5.2 Production Scheduling and Pit Sequencing

The pit production schedule is shown in Table 2.10.

The mine production forecast has been derived by scheduling ore at a fixed cut-off grade of 3.5% EqZn. Ore has been scheduled to provide 1.095 million tonnes of open pit ore to the primary crusher annually. In addition, 456,250 tonnes of ore will be taken from the Wolverine underground mine. The mine/mill will operate 365 days per year with a nominal crusher throughput of 4,250 tpd.

Table 2.9: Kudz Ze Kayah Probable Reserve (by Nilsson Mining Services Ltd.)

Pit Stage	In-situ Ore Berm	In-situ Ore Tonnes	ROM Ore Tonnes	Reactive Tonnes	Wk-Reactive Tonnes	Non-Reactive Tonnes	Waste Tonnes	Strip Ratio
Stage 1 Pit 666	855,902	3,637,574	3,712,468	1,001,605	4,624,912	4,193,314	9,819,831	2.65
Stage 2 Pit 667	706,403	3,002,217	3,064,026	1,041,068	8,485,471	15,188,355	24,713,977	8.07
Stage 3 Pit 668	998,963	4,245,593	4,333,004	1,051,777	5,234,548	33,902,363	40,188,393	9.27
Total	2,561,268	10,885,384	11,109,498	3,094,450	18,344,931	53,284,032	74,722,201	6.73
Waste Distribution				4.1%	24.6%	71.3%	100.0%	

Pit Stage	Zinc %	Copper %	Lead %	Silver g/t	Gold g/t	EQZN %
Stage 1 Pit 666	5.82	0.59	1.68	142.4	1.43	10.53
Stage 2 Pit 667	5.34	0.97	1.35	111.5	10.5	10.04
Stage 3 Pit 668	5.63	1.00	1.61	150.3	1.44	11.27
Total	5.61	0.85	1.56	136.9	1.33	10.68
Waste Distribution						

Note: Pit nomenclature corresponds to the Nilsson 5 m resource blocks re-reported within the 648 series of pit phases from the 1995 Cominco Study.

Table 2.10: Kudz Ze Kayah Mine Production Forecast (Mining Schedule @ 3,000 tpd)

Year	-1	1	2	3	4	5	6	7	8	9	10	11	12	Total
Material Movement														
Stage 1 Pit														
Stage 2 Pit														
Stage 3 Pit														
Days	365	365	365	365	365	365	365	365	365	365	365	365	0	4380

Table 2.10: Kudz Ze Kayah Mine Production Forecast (Mining Schedule @ 3,000 tpd)

Open Pit Production																
Year		-1	1	2	3	4	5	6	7	8	9	10	11	12	Total	
Ore	(t x 1000)	94.9	1,000.7	1,094.5	1,095.1	1,094.8	1,095.0	1,095.0	1,095.0	1,095.0	1,095.0	1,095.0	1,095.0	162.5	-	11,112.5
Zinc	%	6.75	5.80	5.63	5.59	5.76	5.59	5.25	5.65	6.14	5.08	5.41	6.63	-	-	5.61
Copper	%	0.39	0.44	0.59	0.69	0.89	1.19	0.83	0.61	1.08	1.29	0.92	0.77	-	-	0.85
Lead	%	2.21	1.80	1.66	1.52	1.42	1.43	1.47	1.77	1.70	1.27	1.46	1.81	-	-	1.56
Silver	g/t	182.6	150.0	155.3	131.4	109.6	114.9	121.9	153.3	159.8	132.7	135.2	149.4	-	-	136.9
Gold	g/t	1.70	1.59	1.55	1.29	1.05	1.12	1.14	1.31	1.49	1.40	1.34	1.51	-	-	1.33
ZNEQ	%	11.96	10.47	10.59	10.20	10.30	10.88	9.91	10.49	12.14	10.94	10.57	11.91	-	-	10.68
Reactive Waste	(t x 1000)	92.1	345.3	261.0	305.5	335.6	385.7	356.8	329.3	284.5	184.2	179.8	34.8	-	-	3,094.6
Weakly Reactive Waste	(t x 1000)	639.1	2,413.9	2,220.4	3,285.8	2,319.8	1,686.3	1,212.5	1,799.5	1,912.1	652.0	202.4	1.1	-	-	18,345.0
Non-reactive Waste	(t x 1000)	1,303.4	4,372.7	5,348.3	6,206.0	7,311.9	9,863.2	10,352.2	5,346.7	2,256.3	572.7	321.1	29.3	-	-	63,283.9
Total	(t x 1000)	2,129.5	8,132.7	8,942.2	10,892.5	11,062.1	13,030.2	13,016.5	8,570.6	5,547.8	2,504.0	1,798.2	227.7	-	-	85,836.0
Total Mining	Tpd	5,800	22,300	24,400	29,800	30,300	35,700	35,700	23,500	15,200	6,900	4,900	600	-	-	19,600
Wolverine Ore Rehandle	(t x 1000)		456.3	456.3	456.3	456.3	456.3	456.3	456.3	456.3						3,650.0
Ore Stockpile Rehandle	(t x 1000)		50.0	54.7	54.8	54.7	54.8	54.8	54.8	54.8	54.8	54.8	8.1	-	-	550.9
Ore Stockpile Rehandle	(t x 1000)		506.3	511.0	511.0	511.0	511.0	511.0	511.0	511.0	54.8	54.8	8.1	-	-	4,200.9
Strip Ratio		21.44	7.13	7.15	8.95	9.10	10.90	10.89	6.83	4.07	1.29	0.64	0.40	-	-	6.72
Cumulative Ore		94.9	1,095.7	2,190.1	3,285.2	4,380.0	5,475.0	6,570.0	7,665.0	8,760.0	9,855.0	10,950.0	11,112.5	11,112.5		
Cumulative Reactive Waste		92.1	437.4	698.5	1,004.0	1,339.6	1,725.3	2,082.0	2,411.3	2,695.8	2,880.0	3,059.8	3,094.6	3,094.6		
Cumulative Wk-Reactive Waste		639.1	3,053.0	5,273.4	8,559.2	10,879.0	12,565.3	13,777.8	15,577.3	17,489.4	18,141.5	18,343.9	18,345.0	18,345.0		
Cumulative Non-Reactive Waste		1,303.4	5,676.1	11,024.4	17,230.5	24,542.4	34,405.6	44,757.8	50,104.6	52,360.8	52,933.6	53,254.6	53,283.9	53,283.9		

2.3.5.3 Pre-Production Mine Development

During the pre-production period the Stage 1 and Stage 2 Pits will be developed to the 1400 m elevation. Main haulage roads will be prepared and access will be developed to the tailings impoundment. A total of 4.3 million tonnes will be mined including 3.6 million tonnes of non-reactive rock and 0.7 million tonnes of weakly reactive rock.

2.3.5.4 Mine Development and Access

The mine development activities will include the following:

- Access road to the mine and pad construction
- Road construction to the magazines and drainage ditch and sump locations
- Supply of construction materials to the tailings impoundment
- Development of the access ramps to the waste dumps

For the most part, these activities will be undertaken by mine forces.

2.3.5.5 Haul Roads

Conceptual haul road alignments have been located and profiles developed for the purpose of estimating haulage productivity over the life of the mine. The main haul road to the primary crusher has been identified on the general arrangement layout. This haul road will be approximately 2400 m long as measured from the pit crest. Average profiles were developed for each bench of each pit expansion. A road will also be required to access the tailings dam for construction and also for placement of potentially acid generating waste rock in the tailings impoundment.

In general, haul roads will be built using non-reactive material stripped from the open-pit mine. Roads will have running surfaces three times the width of the largest truck used in the Mine, with additional allowances made for ditches and berms where required.

2.3.6 Description of Operation

2.3.6.1 General Parameters

The Mine will operate 24 hours per day, 365 days per year. Shift employees will work 12 hour shifts on a 28 day cycle of 4 days on and 4 days off. Detailed equipment productivity calculations have been made on an annual basis for drills, shovels and trucks. Support equipment operating time has been factored on an annual basis according to the annual material movement.

2.3.6.2 Production Blasting

Blasting will be done with ammonium nitrate and fuel oil (ANFO) when conditions in the hole are dry or if the hole can be pumped and lined. Wet conditions will be encountered seasonally and locally in the Mine.

Blastholes will be single primed and initiated using non-electric methods. An explosives supplier will deliver bulk ammonium nitrate to storage silos at site. The Mine will operate the bulk explosives truck, pump holes, deliver explosives, prime holes and initiate the blast. The blasting crew will be supervised by the General Foreman and guided by the Drill and Blast Engineer.

Ammonium nitrate storage silo, delivery truck and magazines will be leased from the explosives supplier on a monthly contract rate.

There will be no explosive manufacture at the operations area. Explosives purchasing will be the responsibility of the contractor. For the Kudz Ze Kayah Project, Cominco proposed sourcing explosives from a manufacturing plant at Faro.

2.3.6.3 Loading Equipment

The loading fleet will consist of 1-15 m³ hydraulic shovel and 2-10 m³ wheel loaders. In general, the shovel will load mine waste and the wheel loaders will re-handle Wolverine stockpile ore at the crusher and load ore trucks in the pit and work low face conditions after blasting. An excavator has also been included in the equipment fleet to mine waste in the hanging wall of the ore zone and rehandle some ore from the footwall to minimize dilution – when mining ore with loaders on a 10 m bench.

2.3.6.4 Haulage Trucks

The haulage trucks selected for the Kudz Ze Kayah open pit operation are 90 t capacity, mechanical drive-off, road end dump units. These trucks are a good match for the selected loading units and haulage profiles. Initially, 5 trucks will be required to match the production rate on a 24 hour/day operation schedule. The total fleet requirement by Year 5 is 8 haulage trucks.

Consideration should be given using the same haulage truck configuration for hauling ore from Wolverine and back hauling cyclone sand for backfill.

2.3.6.5 Mine Support Equipment

The mining support equipment includes track dozers, wheel dozers, graders, water trucks and sand trucks required for road, bench and dump maintenance. Miscellaneous ancillary equipment will also be required to service and maintain the major equipment, and support on-going pit operations.

Track dozers will operate on active benches, pushing back break and performing heavy dozing operations around operating shovels. In the open pit, they will also build access roads, prepare sinking cut faces, clean berms, scale walls and rip hard toes as required. On waste dumps and stockpiles, the track dozers will maintain 2% positive grades on bench surfaces and provide safe crest berms for truck dumping.

Road graders and rubber tire dozers will maintain road, dump and bench surfaces to provide level running surfaces and for snow removal.

Water trucks and sand trucks will be used in the road maintenance program to provide dust control and safe winter running conditions. The units specified for these tasks are 35 t class machines with a relatively low utilization and life expectancy.

Pick-up trucks will be used to provide transportation to and from work areas in the Mine during shift changes. Pick-up trucks will also be required for transportation of Supervisors, Technical Staff and Maintenance personnel.

The blasting crew will require support equipment to pump wet holes, deliver blasting accessories and stem holes. The bulk delivery trucks and storage facilities will be leased from the explosives contractor.

2.3.7 Process

2.3.7.1 Introduction

Section 5.0 Process has been completed by Hatch Associates Ltd. The following information sources were used in this report.

- Process Research Associates Ltd., 2000. "Filtration and Settling Studies on Products from Flotation of Wolverine Samples", September 5, 2000.
- Beattie Consulting Ltd., 2000. "Metallurgy of the Finlayson Project", July, 2000.
- Process Research Associates Ltd., 2000. "Flotation Study on a Composite Sample from Wolverine and Kudz Ze Kayah Deposits", July 7, 2000.
- Beattie Consulting Ltd., 2000. "Metallurgy of the Wolverine Deposit", June, 2000.
- Process Research Associates Ltd., 2000. "Flotation Study on Samples from the Wolverine Deposit", June 14, 2000.
- Cominco Ltd., 1995. "Feasibility Engineering Study – Kudz Ze Kayah Project Yukon Territory", November, 1995.

Prior to 2000, the Kudz Ze Kayah deposit had been studied extensively by Cominco using drill core and near-surface bulk samples, leading to a feasibility study in 1995. A flowsheet producing selective copper, lead and zinc concentrates of marketable grades had been demonstrated for Kudz Ze Kayah. Prior to 1997, only preliminary metallurgical testwork had been completed on the Wolverine deposit. AMTEL carried out flotation testwork on Wolverine ore in 1997 and International Metallurgical and Environmental Inc. published preliminary metallurgical testwork results in 1999.

Early in 2000, Expatriate Resources commissioned Process Research Associates to conduct further metallurgical testwork under the direction of Dr Morris Beattie. Tests were completed on Wolverine and Kudz Ze Kayah ores independently, and on a composite consisting of approximately 29% Wolverine ore and 71% Kudz Ze Kayah ore. The 2000 laboratory metallurgical program consisted of batch and locked cycle flotation tests. The testwork utilized drill core samples from the Lynx and Wolverine zones obtained in 1996 and 1997, and drill core samples from the Kudz Ze Kayah deposit obtained from Cominco.

2.3.7.2 Ore Characterization

Both the Wolverine and Kudz Ze Kayah deposits are highly pyritic massive sulphides containing copper, lead and zinc. The predominant minerals are chalcopyrite, galena and sphalerite. The galena contains elevated concentration of selenium while the sphalerite contains significant iron and cadmium. The mineralogy of both deposits is such that the flotation concentrates will contain impurity elements, some of which will incur smelter penalties. Arsenic, selenium, and antimony are anticipated to incur the largest penalties.

2.3.7.3 Process Testwork

The estimated metallurgical balance for blended ore projected for the first four years of operation is shown in Table 2.11. The balance has been based on the head grade observed in the test program.

Table 2.11: Metallurgical Balance for Wolverine and Kudz Ze Kayah Blended Ores

Product	Weight %	Grade, g/t, %					Recovery, %				
		Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
Cu conc.	2.6	16	4400	25	1.8	2.5	25	57	81	3	1
Pb conc.	2.0	35	2000	1.4	55	6.2	44	20	4	66	2
Zn conc.	13.0	0.8	120	0.3	1.5	55	6	8	5	12	91
Tail	82.4	0.5	36.5	0.1	0.4	0.6	25	15	10	19	6
Head	100	1.63	201	0.80	1.67	7.83					

2.3.7.4 Flowsheet Development

The initial work on Kudz Ze Kayah ore was conducted by Cominco Ltd and concluded with a feasibility study based on a selective copper, lead and zinc flotation flowsheet. Following the acquisition of the Kudz Ze Kayah deposit, Expatriate Resources Ltd. commissioned further studies in 2000 on the individual and blended Kudz Ze Kayah and Wolverine ores and the development of a single flotation flowsheet for the ores.

The following design philosophy and assumptions have been made in developing the flowsheet for the mill.

- Single stage crushing followed by SAG and ball milling is preferred over multi-stage crushing followed by ball milling. The crushing circuit will be simpler and have less dust containment requirements.
- A crushed ore stockpile will be used in place of a bin to allow for some blending of the Wolverine and Kudz Ze Kayah ores prior to milling.
- Chemical dust suppressants will be used in the crushing plant instead of the more costly mechanical dust collection system
- A two-stage grinding circuit has been selected over a three-stage circuit because the improvements in grinding efficiency and total power requirements of the three-stage do not justify the increased equipment requirements and capital costs.
- The SAG mill circuit will not include a recycle crusher because previous work had not indicated problems with critical size build-up. As a result, the SAG mill has been sized based on the Bond ball mill work index.
- The flotation circuits have been based on locked cycle flowsheets with closed-circuit cleaners for copper and lead and open circuit cleaner for zinc. Conventional cells will be used in all stages.
- Concentrate dewatering will be accomplished with conventional thickeners followed by membrane filter presses to obtain minimum cake moisture given the fine particle size.
- The mill tailings will be cycloned and filtered to provide the material for Wolverine backfill.

2.3.7.5 Process Description

General

The Finlayson plant has been designed to process 1,551,250 tonnes per annum ore containing copper, lead, zinc, gold, and silver. The plant will include facilities to produce separate copper, lead, and zinc flotation concentrates. The plant will comprise the following unit operations:

- Ore storage.
- Crushing.
- Two-stage grinding.
- Differential flotation.
- Rougher concentrate regrinding.
- Concentrate thickening.
- Concentrate filtration.
- Concentrate storage.
- Backfill.
- Tailings and process water reclaim.

Figure 2.7 is a summary of the proposed plant flowsheet.

The plant will operate 24 hours per day, 365 days per year with scheduled downtime for maintenance of equipment and will process an average of 4,250 tonnes of ore per calendar day.

The tailing solids from the plant will be pumped to a tailings containment facility. Water from the tailing impoundment will be reclaimed, conditioned and recycled to the process.

Selected process streams will be sampled and analyzed in an on-stream analytical system for operations monitoring and control purposes.

Crushing and Reclaim

Underground ore from the Wolverine deposit will be hauled to a stockpile located near the primary crusher station. The Wolverine ore will be reclaimed from the stockpile using a loader and trammed to the stationary grizzly/dump pocket.

The crusher station will be designed for direct dump of Kudz Ze Kayah open pit ore from 90 tonne haul trucks.

The crusher station will consist of:

- Fixed grizzly.
- Rock breaker.
- Dump pocket.
- Vibratory grizzly feeder.
- Jaw crusher.
- Collection conveyor.

Grinding

The ore will be reclaimed from the stockpile via apron feeders and ground in a two-stage circuit. The circuit will be designed with a primary semi-autogenous (SAG) and secondary ball mill circuit.

Fine ore will drop through the grizzly to the collection conveyor. Oversize ore will be fed to the jaw crusher. The fine ore will be conveyed to an enclosed coarse ore stockpile. Four apron feeders will be installed to reclaim ore from the stockpile to feed the grinding circuit.

The SAG mill will operate in closed circuit with a trommel screen. The screen oversize will be recycled to the SAG mill via conveyors. The screen undersize will discharge to the common SAG and ball mill sump.

The secondary grinding unit will operate in closed circuit with a cyclone pack. The combined product from the SAG mill screen undersize and ball mill discharge will be pumped to the cyclones. The cyclone underflow will be recycled to the ball mill and the overflow will be directed to the copper flotation circuit.

Flotation and Regrind

Cyclone overflow from the grinding circuit will be piped to the copper flotation conditioning tank where the slurry will be conditioned with sodium metasilphide and M2030 to enhance copper flotation. From the copper conditioner slurry will be piped to the copper rougher flotation circuit. Rougher concentrate will be pumped to the copper regrind circuit while the copper rougher tails will be pumped to the lead flotation circuit.

The copper cleaner flotation circuits consist of a vertical regrind mill operated in closed circuit with cyclones and two stages of cleaning. Cleaner flotation tails will be recycled back to the copper conditioner tank.

Copper flotation tails will feed the lead flotation conditioner. Primary lead flotation reagents will include lime and collectors (A3477 and SIPX). The lead flotation circuit will comprise rougher flotation and one stage of cleaner flotation with a regrind circuit. Lead rougher and cleaner flotation will be designed to use conventional mechanical flotation cells. Concentrate from the rougher will be reground in a vertical regrind mill operated in closed circuit with cyclones. The cleaner tails will be recycled back to the lead flotation conditioner.

Lead rougher tailings will be transported to the two stage zinc flotation conditioning circuit. Here the slurry will be conditioned with copper sulphate, lime and collector (SIPX) to promote zinc mineral flotation.

The zinc flotation circuit will consist of rougher flotation followed by three stages of cleaner flotation to achieve marketable concentrate grades.

A vertical regrind mill will be installed on the scavenger concentrate stream. Cleaner scavengers tails will be combined with the cycloned zinc scavenger flotation tails for disposal in the tailings pond.

The following reagents will be used in the flotation circuit.

- Sodium Metabisulphite
- M2030
- A3477
- Sodium Isopropyl Xanthate
- Copper Sulphate
- Lime
- Zinc Sulphate
- Sodium Cyanide (Flotation)
- MIBC
- Frother 250

Dewatering

Flotation concentrates will be dewatered in respective circuits each consisting of a concentrate thickener followed by a concentrate storage stock tank and a pressure filter.

Tailings and Reclaim Water

Zinc rougher/scavenger flotation tails will be pumped to a sand cyclone circuit. Underflow from the sand cyclone will be used for the backfill system at the Wolverine Mine.

Cyclone overflow (slimes) will be combined with the zinc cleaner tails and pumped to the tailings impoundment.

Water will be reclaimed from the tailings impoundment and will be treated and pumped to the process water distribution system. Separate copper, lead and zinc process water tanks will be installed for water recycle within each circuit to minimize potential cross effects of reagents.

2.3.8 Infrastructure

The main complex at Kudz Ze Kayah will include:

- Mill, including grinding, flotation, dewatering and concentrate loadout.
- Power generating plant.
- Maintenance shops.
- Warehouse.
- Assay laboratory.
- Engineering office.
- Change rooms.
- Administrative office.

Other infrastructure at the mine will include:

- Accommodation complex.
- Fuels supply and storage.
- Sewage and waste disposal.
- Tailings disposal and water reclaim
- Fresh water distribution and fire protection.
- Communications.
- Access road and Kudz Ze Kayah site roads.

- Airstrip.
- Security.

2.3.8.1 Description of Kudz Ze Kayah Main Complex

The facilities will be housed within a 108 m long by 48 m wide building. It is proposed to have three main operating levels: ground level, the first floor at 48 m and the second floor at 7 m Figure 2.8.

The objective of this building is to house as much of the operation as possible under one roof in order to accomplish the following:

- Ease of operation and inter-departmental cooperation.
- Minimize the requirement for outdoor movement during cold weather.
- Minimize the heat loss and maximize the use of waste heat from power generation.
- Minimize the capital cost for an operation in Northern Canada.

The building size was established by the ground floor requirements. Extra space is available on the second floor for additional office or storage space if required in the future.

Overhead cranes and overhead doors will be provided at strategic locations in the main operating and maintenance areas to allow for ease of maintenance and access.

The power generation plant will consist of eight 1.1 MW diesel fuelled units and the plant is described below.

2.3.8.2 Workforce Accommodation

An accommodation complex will be provided about 500 m by road from the main complex. Each employee will be provided with a single room with a toilet and shower shared with the adjacent room. There will be a communal cafeteria style cookhouse together with limited indoor recreational facilities such as TV, reading, games and weight room.

2.3.8.3 Fuel Supply and Storage

An adequate supply of diesel fuel is available in Whitehorse which will allow the storage onsite to be kept at a minimum of about 2 weeks. Diesel will be trucked in with a 45,000 litre capacity road tanker. Four 5 m diameter x 8 m high tanks will provide 600 m³ of diesel fuel storage. The storage tanks will be constructed to meet safety and environmental requirements complete with liner and berm.

Fuel will be pumped to a small daytank in the power plant as well as to a dispensing station for fuelling trucks and loaders. Some heavy equipment will be fuelled at the worksite by a fuel truck.

It is the intention to minimize the use of gasoline powered equipment at the site. A small gasoline storage facility will be provided for fuelling pickups and other small gas engines.

2.3.8.4 Fresh Water Distribution and Fire Protection

Fresh water will be drawn from wells south of the mine operations and pumped into a 750 m³ storage tank located adjacent to the accommodation complex (10 m diameter x 10 m high). This tank will store fresh water for potable water and reagent mixing with the majority being available for fire protection.

Reclaim water from the tailings pond will be pumped into a tank adjacent to the mill. The main source of process water will be reclaim water with fresh water being added only to supplement the reclaim water usage.

A fire water distribution system will be installed around the plant site and camp area with wall hydrants at strategic locations. In order to achieve the desired insurance coverage, all the enclosed areas of the buildings and the conveyor galleries will be equipped with sprinkler systems. Electrical rooms will also be protected with dry chemical systems.

The potable water supply will be chlorinated prior to distribution to the various locations in the main building complex and accommodation complex.

2.3.8.5 Communications

Telecommunications will be provided by satellite service. Five trunk lines plus one fax line and one data line will be provided for telephones and data. Six pay telephones will be installed in the accommodation complex. A two way radio network will provide for on site communications particularly for both the mining operations. Communications between Wolverine and Kudz Ze Kayah will be via radios. Courier and mail services will be coordinated with air crews on shift changes.

2.3.8.6 Ancillary Buildings

Primary Crusher Building

The primary crushing building will be 8 m wide x 26.5 m long and will include the dump hopper, jaw crusher, conveyor system and dust handling equipment.

Cold Storage Building

A 15 m x 20 m cold storage building will be located adjacent to the warehouse portion of the main complex within the fenced warehouse area. This will contain bulk supplies which cannot be stored in the open but which do not require heated storage.

2.3.9 Power Generation

Diesel generated power will be used to provide for the Kudz Ze Kayah operation. Power will be generated by 1.1 MW diesel generators. The power plant will contain all the equipment required to operate and control each generator. This will include generator governor controls, voltage regulators, synchronization equipment and annunciator panels.

In consideration of the long heating season and high fuel costs, it has been determined economic to include full heat recovery including jacket water plate and frame heat exchangers and exhaust gas heat recovery units. The waste heat will be used to heat the process building and camp. Backup heating would be provided by fuel oil or propane fired hot water boilers and/or furnaces.

A bulk fuel storage facility would be provided consisting of two separate tanks of 450,000 litre capacity, located within a containment berm, which has an HDPE liner. The bulk storage tanks would supply both the power plant and mine. Sufficient storage is included for over two weeks operation of the power station plus mine operations. At any given point in time, one tank will be reserved for supplying fuel and the other will be in the process of being replenished, which provides settling time for the fuel.

Fuel would be automatically pumped from the bulk storage facility to day tanks located at the power plant. A fuel unloading and distribution module, containing truck off-loading and fuel distribution pumps, has been included.

The mill and accommodation complexes will each be equipped with a separate stand-alone emergency generator unit capable of sustaining heating and lighting requirements and critical

loads in event of emergencies. The mill emergency generators will also be used as a back-up to the powerstation black start genset. It will have synchronization capabilities.

Air strip power will be generated by a stand alone generator unit.

It has been assumed that the open pit will operate only diesel equipment. No provision has been made in the sizing of the power plant for possible electric powered equipment, eg. shovels, drills.

2.3.10 Site Access

Access to the site for personnel will generally be by aircraft. The major airport for the Yukon is located in Whitehorse and is serviced by regular jet service from Vancouver. Regional airports are located in Watson Lake, Ross River and Faro and are mainly served by small, twin engine turboprop aircraft from Whitehorse. It is proposed to build a 1,200 m long all weather gravel airstrip at the junction of the access road with the Robert Campbell Highway. This airstrip will typically handle twin engine turbo prop commuter planes. The airstrip will be equipped with a heated trailer for traffic control and a waiting room. This will necessitate the installation of a small diesel generating set to supply power for the trailer and landing lights. A locator beacon and wind sock will be the only navigational aids provided at the airstrip.

It is proposed to fly employees by chartered aircraft from Whitehorse, Ross River and Watson Lake to this airstrip. A bus will be operated between the airstrip and the camp, a distance of 23 km. The tote road that currently connects the Kudz Ze Kayah area to the Robert Campbell Highway has a width of approximately 4 m and a 15 m cleared right of way. This will be upgraded to at least a 6 km wide road surface with a 20 m wide right of way following receipt of permits.

The main haulage road between the mine and the plant area will be used for ore haulage and for access to the waste dumping area. The road to the tailings area will branch off the main access road. The road will be extended to the south of the open pit to provide access to the fresh water wells.

2.3.11 Manpower Requirement

The estimated manpower requirements for the Kudz Ze Kayah operations presented in Table 2.12. This table does not consider approximately 50 additional trucking jobs associated with concentrate shipping or other additional contracting opportunities.

Table 2.12: Finlayson Project Mine and Mill Staffing Plan

Project Year	-1	1	2	3	4	5	6	7	8	9	10	11
G&A	16	29	29	29	29	29	29	29	29	29	29	29
Underground Mine	85	85	85	85	85	85	85	85	85	85	85	85
Open Pit Mine	65	65	65	65	65	65	65	65	65	65	65	65
Mill	8	34	34	34	34	34	34	34	34	34	34	34
Maintenance	20	33	33	33	33	33	33	33	33	33	33	33
Power	6	6	6	6	6	6	6	6	6	6	6	6
TOTAL	200	252	252	252	252	252	252	252	252	252	252	252

Provisions have been made to provide training supervision on site. In addition, new equipment training will take place during start-up as equipment is delivered to site.

2.3.12 Concentrate Shipping

Concentrate will be shipped by truck to the port facilities at Skagway. Super B-train trucks will be used which haul up to 70 tonnes of concentrate. Approximately 4000 to 5000 trips per year will be required to carry the amount of concentrate that will be produced by the mine. Prefeasibility studies considered a traveling north on the Robert Campbell Highway to Carmacks and then along the Alaska highway to Skagway. The other option under consideration is to travel south along the Robert Campbell Highway to Watson Lake and from there to Skagway. The selected route will depend on road upgrade decisions made by the Yukon Territorial Government.

2.4 Wolverine - Waste and Water Management

2.4.1 Solid Waste Management

The waste streams associated with the Wolverine operations have been identified to include:

- Waste rock
- Water treatment plant precipitates
- Sewage
- Domestic wastes
- Miscellaneous special wastes

2.4.1.1 Waste Rock

Acid Generating Potential

Waste rock from mining operations has the potential to generate acid. When stockpiled waste rock comes in contact with water (direct precipitation, runoff, or groundwater infiltration), acid drainage from the stockpiles can occur. Acid generation occurs as the result of the oxidation of sulphide minerals when they are exposed to air (oxygen) and water. Chemical oxidation of the primary sulphide minerals is generally very slow but the process is often accelerated by bacterial assisted oxidation. Bacteria, known as *Thiobacillus ferrooxidans*, live off the iron sulphide minerals and release acidity and soluble metals. This process is referred to as Acid Generation, which is a natural phenomena which is enhanced by breaking up the rock and exposing new sulphide surfaces. If the acid is not naturally consumed by alkaline material, Acid Rock Drainage (ARD) may be produced.

Preliminary geochemistry work was initiated by Westmin Resources Ltd. in late 1996. Following is a summary of that program:

Sampling included 49 discrete samples from 5 drillholes, and covered lithologies in the hanging wall, foot wall and massive sulphide ore bodies. Analyses included acid-base accounting (EPA 600/2-78-054) and 30 element ICP metal scans on the sample solids. ABA analyses were conducted by Process Research Associates Ltd. (PRA) in Vancouver, and ICP metal scans by International Plasma Laboratory Ltd. (IPL) also of Vancouver. Summaries of the ABA results are presented in Tables 2.13 through 2.16.

Splits of six of the samples were sent to BC Research (BCR) for external QA/QC on the ABA analyses. The results are included in Appendix 2A.

Several of the 49 discrete samples, along with grab samples from other lithologic units, were combined to represent composite samples of the hanging and foot wall portions of the individual

drillholes. The composites included 4 of the hanging wall, 5 of the footwall, and one of a zone located between two massive sulphide ore zones, called a hanging/footwall zone. These samples were also submitted for ABA analyses and ICP metal scans. An additional three composites representing the massive sulphide zones (locations unspecified) were submitted for ICP metal scans only.

Two of the hanging wall composite samples, and two of the footwall composite samples were submitted for kinetic tests. These tests were conducted by PRA, and results are provided in Appendix 2A.

The Westmin sampling program has been reviewed for applicability to lithologies associated with the current Expatriate mine plan. The existing data provides:

- A good range of discrete samples which characterize the hanging wall rhyolite and argillite through which most of the development work will occur.
- Single samples of the iron formation, the overlying argillaceous rhyolite, and underlying exhalite layers.
- A good range of discrete samples which characterize the foot wall rhyolite and argillite, which will form the base of the active stopes.

There appears to be a potential shortage of data on the iron formation and the units immediately above and below the iron formation. Also a lack of extraction test data, which would address the potential for short term release of soluble products.

Most of extensive work conducted on the Kud ze Kayah deposit are associated with materials similar to the Wolverine footwall. Only 3 of the Kud ze Kayah kinetic tests may have validity for the Wolverine hanging wall materials.

Results

The Westmin geochemistry data is currently in the process of being verified and assessed with respect to the proposed Wolverine project plans. Based on the presented ABA data (Tables 2.13 through 2.16), the hanging wall and foot wall materials demonstrate a wide range of acid and neutralizing potential. The overall mean NP/mean AP value for the hanging wall samples of 1.27 (Table 2.13) indicates a probable potential for acid generation. The 3 samples representing the layer of potential waste between the two massive sulphides zones in drillhole WV96-72 have a mean NP/mean AP of 0.44 (Table 2.13) indicating a stronger potential for acid generation. As expected, the massive sulphide ore zone (Table 2.15) has a strong potential for acid generation, with an overall mean NP/mean AP of 0.07. The mean NP/mean AP value for the footwall samples of 1.52 (Table 2.14) indicates a somewhat lower overall potential for acid generation than the hanging wall, but would be considered a probable acid generator on the basis of generic criteria.

The results for the composite samples, composited by drill hole, indicates that the both the foot wall and hanging wall may have portions that are potentially acid consuming. For example, the hanging wall composite from drill hole WV96-63 gave an NP/AP ratio of 3.29, and foot wall composites in drill holes WV96-72 and 39 gave NP/AP ratios of 5.76 and 3.29 respectively.

Thus, the preliminary results indicates that the majority of development waste rock must be handled in a manner that anticipates the production of potentially acidic drainage with elevated metal levels. Potential management of waste rock will be refined on the basis of results from the kinetic tests, which will provide insight into the site specific nature of the buffering and acid producing minerals. Also, geochemical characteristics will be correlated to other parameters in

an attempt to develop waste management tools to better identify portions of the waste that may have a lower potential for acid generation and metal leaching.

Waste Rock Storage and Management

The Wolverine underground operations will generate approximately 7900 tonnes of waste rock during the development of the access and development declines. Portions of this material are expected to be mildly to strongly acid generating. This waste material will be temporarily stored on surface and returned to the mine as backfill as soon as possible. The surface storage location for this waste material has not been finalized. A storage location will be selected based on closer examination of ground conditions. Protection of the environment and ease of handling will be the primary considerations in selection of a temporary storage location. Management of drainage from this temporary stockpile is discussed below in Section 2.4.2.

Most of the underground workings will be developed in ore grade materials and therefore almost all of the rock produced from the Wolverine Mine will be shipped to Kudz Ze Kayah for processing. Any waste rock that is segregated from the ore material will remain underground and be placed with backfill in mined out areas.

2.4.1.2 Water Treatment Plant Precipitates

Precipitates from the water treatment plant will be directed to the backfill plant and mixed with the backfill materials.

2.4.1.3 Sewage

A small amount of sewage will be generated at the Wolverine complex. The mine buildings and emergency camp will likely share a septic tank and field for disposal of sewage.

2.4.1.4 Domestic Waste

A small amount of domestic waste including packaging, paper, scrap wood and metal, etc. will be generated at the Wolverine operations. Materials which could be reused (i.e. scrap wood and metal) will be stored in a central location near the complex. Garbage from the office, dry, and emergency camp will be collected in locking dumpsters and shipped to the waste management facilities at Kudz Ze Kayah (see below).

2.4.1.5 Miscellaneous Special Wastes

Special wastes associated with the Wolverine operations include ethylene glycol, waste oil, and miscellaneous solvents and lubricants. These materials will be shipped to the waste management facilities at Kudz Ze Kayah (see section 2.5.1.3) on a regular basis. These materials will not be allowed to accumulate at Wolverine and will be transported to Kudz Ze Kayah in small batches to minimize the environmental risk associated with vehicle accidents along the access road.

2.4.2 Water Management

The water management flow sheet for the Wolverine operations is shown in Figure 2.9. Mine water collected from the underground working will be used for all mine related operations (not potable water). Water will be pumped from the underground to a series of two settling ponds located at the surface near the portal entrance. Some of the water from these ponds will be redirected to the underground mine for use in operations. Overflow from the second pond will be directed by grouted ditch or pipeline to a water treatment plant at the Wolverine complex.

The Water Treatment Plant at Wolverine will be conventional high-density sludge lime treatment plant. Underflow from the clarifier will be selectively recycled through the treatment system or directed to the backfill plant. Clarifier overflow will be discharged to a polishing pond which will overflow to Go Creek.

Potable water for the office, dry, and emergency camp will be supplied from either groundwater wells near the complex or from surface water intakes upstream of the water treatment plant discharge point in Go Creek. A small chlorination plant will be used to treat the potable water.

Local diversion ditches will be used around the portal and vent raises to prevent surface runoff from entering to underground mine. These ditches will be either grouted or rip-rapped, depending on availability of materials. Ditches will either direct surface runoff to natural drainage channels of diffuse flow gradually over the surface through a series of small take off ditches and reduction in ditch depth. Surface facilities at Wolverine are largely indoors and as such will not require protection from surface runoff.

It is expected that the temporary waste rock stockpile at Wolverine will be acid generating. The temporary stockpile will be surrounded by a berm to prevent run-on. Direct precipitation within the bermed area will be collected in a lined sump and directed to the water treatment plant.

Post-closure water management at Wolverine will not be required. There will be no passive seepage from the mine workings since all surface connections will be developed as declines. There will be no permanent storage of waste rock or tailings on surface and therefore no acid generation issues associated with the operations area.

2.5 Kudz Ze Kayah- Waste and Water Management

2.5.1 Solid Waste

Solid waste streams associated with the Kudz Ze Kayah operations have been identified to include:

- Waste rock from the mine
- Tailings from the milling process
- Water treatment plant precipitates
- Sewage
- Domestic waste
- Miscellaneous special wastes

The management plan for these wastes and water is presented below.

2.5.1.1 Waste Rock

The waste rock quantity over the life of the current open pit mine plan will total approximately 75 million tonnes. The details of waste rock characterization program for the open pit operations are presented in the Kudz Ze Kayah Water Licence Application. Based on waste characterization work, the massive sulphide ore and associated waste material is strongly potentially acid generating (SPAG). It is likely that this material will start to turn acid in a matter of months if left exposed. At Kudz Ze Kayah approximately 4% of the waste rock will fall into this category. A larger amount of material, estimated at 25% of the total waste rock appears to be weakly potentially acid generating (WPAG). The remaining waste is of fairly low sulphide content with little or no neutralizing potential. This material is classified as potentially acid

consuming (PAC). Overburden and footwall rock is considered to be non-acid generating and represent approximately 12% and 5% of the waste respectively.

Waste Rock Storage Plan

Preliminary waste rock storage locations were recommended by Golder Associates for the 1995 mine designs. Field investigations were undertaken to provide engineering data. Geotechnical boreholes were drilled; test pit investigations were carried out to evaluate overburden materials and to determine permafrost levels; piezometers were installed to determine ground water levels and laboratory investigations were used to characterize samples.

Overburden

Overburden storage requirements were included in the Kudz Ze Kayah Water Licence Application. In general, it will be stockpiled separately from the rock waste and used in reclamation.

SPAG Waste Disposal

The waste rock which has been classified with a strong potential to generate acid (SPAG) occurs in mineralized zones. This material will be hauled and placed in the tailings impoundment. To prevent the on-set of acid generation, the waste will be flooded with water to reduce the availability of oxygen.

Approximately 3 million tonnes will be placed in the tailings impoundment. It will be placed by truck dumping and dozing.

WPAG Waste Storage

The current estimate of waste with weak potential for acid generation has been estimated at 18 million tonnes. Based upon preliminary humidity cell results and experience at other mines, it would appear that this rock will not turn acid in the short-term and can, therefore, be stored on the surface during the period of mine operation.

A waste stockpile has been located on the north-western rim of the open pit and will be re-handled back into the pit at the end of mine life where it can be stored in subaqueous conditions. This location is underlain by glaciofluvial, glaciolacustrine and glacial morrain and till sediments. The overburden thickness varies from 10 m at the south boundary, to 7.3 m in the northern boundary, to as little as 0.35 m within the central portion of the waste dump footprint. Permafrost was not observed in this dump location. The bedrock consists of weathered and fractured chlorite calcite schist with tuff fragments. Groundwater levels at the southern boundary were measured 4.5 m below surface within the sand gravel overburden layer at 1282.5 m elevation.

PAC Waste Storage

Potentially acid consuming and neutral waste rock will be stored in a permanent facility on the north eastern side of the Geona Creek Valley, upstream from the tailings impoundment (Figure 2.5). Glaciofluvial and weathered colluvial materials underlie the PAC waste rock storage facility. The overburden thickness varies from 4.7 m near the southern boundary to 12.8 m near the northern boundary. Test pits in the northern portion of this dump site footprint encountered permafrost to depths of 3.5 m. Test pits in the southern portion of this site did not encounter permafrost. The bed rock consists of weathered and fractures interbedded argillite, mudstone, mafic tuff and chlorite calcite schist. Groundwater levels were measured 0.5 m below the ground surface in the sand and gravel overburden layer at elevation 1390.7 m.

Stability Assessment

Stability analyses were carried out using a program for simplified Janbu-static and pseudostatic conditions. The angle of friction for rock was 38° with an overall dump slope of 2H:1V. According to the Geological Survey of Canada, this area is identified as acceleration Zone 2, with a zonal value of seismic coefficient 0.1 g. Stability analyses for the WPAG storage location gave a factor of safety of 3.92. The factor of safety for the PAC storage location was 1.98. Using a seismic coefficient of 1.1, the factor of safety dropped, but still exceeds the accepted threshold of 1.1.

It should be noted that the dump design drawings prepared for the Kudz Ze Kayah project and used in this report, have used a slope of 3H:1V. As such, there is even more conservatism built into the design. If a 2:1 slope were used, as proposed by the stability analysis, the WPAG dump slope could be increased and the dump footprint would be reduced.

2.5.1.2 Tailings

Tailings generated by the process will be strongly acid generating and as such require immediate and permanent subaqueous disposal. The tailings storage facility will provide these storage requirements. This facility will also be used to store SPAG waste rock from the open pit operations.

Tailings and SPAG Rock Impoundment

The Tailings and SPAG Rock Impoundment evaluation is based on the BGC Engineering Inc report "Tailings and SPAG waste Rock Components Pre-Feasibility Report", October 2000. BGC has reviewed geotechnical investigations, material characterizations, stability analyses and designs for the tailings and SPAG waste rock impoundments found in the following reports (prepared variously for Cominco and Expatriate)

Date	Name of Report	Author
December 1997	Tailings Embankment Design Report Kudz Ze Kayah Project Water Licence Application	Golder Associates
January 31, 1996	Feasibility Level Geotechnical and Hydrogeological Site Investigation ABM Deposit, Kudz Ze Kayah Project	Golder Associates
October 17, 1995	Kudz Ze Kayah Project Tailings Impoundment Design	Golder Associates

The tailings and SPAG storage facility will provide long-term protection of the environment when:

- The embankment impounding the tailings is stable and resistant to deterioration from extreme natural events such as floods and earthquakes and from progressive erosion; and,

- The water balance of the impoundment must be such that the materials are always saturated under water.

The embankment is required to be stable with minimal maintenance, either during operation or in the long-term. It will be raised in stages during the mine life, to meet the needs of the tailings and waste rock storage and water management. This approach minimizes the initial size of the construction and allows for monitoring of the performance of the dam during operation. In this way, design modifications may be incorporated as required during the life of the mine. The current design includes excess capacity for the mine plan and therefore provides some flexibility to the project. Also, it is expected that the final dam elevation and configuration will be adjusted to suit the actual requirements of the operation.

The Yukon Water Board has reviewed the plan summarized in the following sections and has approved a Water Licence for the project.

The following sections provide a summary of the geotechnical investigations and evaluations, and the embankment design (including stability analysis and seepage analysis).

Site Selection and Field Investigation

A site selection study was carried out in several phases and included the following principal components:

- Initial screening
- Site evaluation and selection
- Detailed geotechnical evaluation
- Feasibility design and final recommendation.

An initial site selection was carried out at Kudz Ze Kayah in November 1994, based solely on airphoto interpretation studies of the project area. The study identified a total of ten possible storage sites, five of which were considered to be too small to meet the project requirements. The remaining sites were evaluated further and ranked in order of their merit. The results of the initial screening and site evaluation and selection are provided in Appendix 2.5c of the Water Licence Application report.

A program of field investigation was carried out during the 1995 field season that included the following:

- Geophysical surveys
- Site reconnaissance and mapping
- Overburden and bedrock evaluation by test pits
- Overburden and bedrock evaluation by geotechnical drilling
- Hydrogeological and permafrost evaluations by instrumentation in drill holes.

The following table is a list of the sites considered during the final site evaluation and the concerns associated with each site.

Table 2.17: Summary of Site Selection Study for Tailings Storage Facility

Site	Concern
Geona Creek – Site A	>40 m of permeable sands and gravels
Geona Creek – Site B	~40 m of permeable sands and gravels
Geona Creek – Site C	~30 m of permeable sands and gravels
Geona Creek – Site D (Selected Site)	~20 m of permeable sands and gravels
Upper Finlayson Creek	>40 m permeable overburden
East Tributary to Geona Creek	Insufficient volume, 90 m high dam
East Creek	~30 m of permeable overburden, caribou rutting area
South Creek	~25 m of overburden, two dams, heritage significance
North Lakes	Heritage significance for Ross River Dena

Geotechnical drilling was carried out on several of the dam sites listed above, while others were only investigated by field and map studies. Based on the site selection studies, heritage issues, and geotechnical evaluations, Geona Creek Site D was selected for the basis of the feasibility design, economic evaluations, and Yukon Water Licence Application.

Dam Site D is located in the Geona Creek Valley, immediately down stream of the proposed Open Pit operation, at approximately 6,819,000N and 414,750E.

Results of Field Investigation Program

Surficial Geology

The surficial geology within the Geona Valley consists of interlayered glaciofluvial, glaciolacustrine and till sediments overlying bedrock. In general, these soils are thickest in the bottom of the valley and become thinner up the slopes of the valley. In the area of Dam Site D, the valley bottom deposits are up to 19 m thick, and it has been observed that these deposits increase in thickness downstream of the proposed dam site.

Along the axis of the dam, the interlayered glaciofluvial and glaciolacustrine deposits vary in the thickness from 14 m to 19 m in the base of the valley. On the west side of the valley the overburden soils range from 10 m to 20 m thick. The uppermost soil unit consists of loose to compact silty, sand and gravel. Near the centre of the valley, this material overlies compact gravel and above 1320 m elevation this material overlies a sequence of up to 15 m thick of compact to dense silty gravel and silty sand and gravel with occasional cobbles and boulders. A 3 m to 5 m thick layer of compact fine sandy silt occurs near the centre of this silty sand and gravel sequence.

Along the east valley slope, the overburden ranges from 4 m to 7 m and consists of loose to compact silty sand and gravel overlying compact gravel below about 1330 m elevation. Above 1330 m elevations the surficial silty sand and gravel overlies compact silty sand and gravel.

Bedrock Geology

Bedrock geology in the vicinity of the proposed dam has been investigated by drilling and air-borne and ground-based geophysical surveys. The bedrock foundation has been characterized as surficially weathered and strongly fractured mafic tuffs, chlorite-calcite schists and phylites, and argillite to argillaceous metasedimentary rocks. Weathering has resulted in a degree of fracturing of the rock surface that varies in depth and degree from 6 m to 8 m over the dam alignment. In general, with increasing depth the bedrock becomes increasingly competent and less fractured.

The weathered and fractured rocks represent an area of increased hydraulic conductivity that will need to be partially removed and partially grouted to meet the design objectives of the structure. This is described in more detail in subsequent sections.

Larger scale continuous rock structures that may provide direct hydraulic connection through the foundation were not observed in the field investigations. Both the drilling and the geophysical investigations carried out found no evidence of such a major through-going structure coincident with Geona Creek. However, the excavation of the core trench to bedrock, as is proposed, will provide visual confirmation and opportunities to remedy the presence of such a structure if it exists.

A fractured bedrock zone has been intersected in drill holes on the west abutment. The geotechnical investigation and characterization highlights that the only consistent orientation of these fractures was due to foliation (this would not be expected if all of the fractured ground was the result of a fault). Based on these observations, the fractured rock on the west abutment is not believed to be associated with any major through-going faults coincident with Geona Creek, but will require additional grouting and/or excavation prior to construction.

Seismicity

Data has been obtained from the Geological Survey of Canada regarding the predicted seismic characteristics of the site. The predicted horizontal accelerations are summarized in the Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

In summary, because of the low seismic activity in the project area and the absence of active faults, probabilistic and fault specific seismic assessments were not considered necessary for the final design of structures. An extrapolation of GSC data was used to provide an estimate of site ground motion and was based on a linear projection for a 10,000-year return period event (based on annual probability of exceedance). The result was that a peak estimated MCE (maximum credible earthquake) peak ground acceleration of 0.15 times gravity was estimated. This acceleration is estimated to be caused by a magnitude M6.5 event with 5 cycles of loading.

Assessment of the peak estimated MCE should be reviewed again and updated regularly through the life of the project to include new data and ensure that an appropriately conservative value has been selected for design.

Liquefaction Potential

Some low-density soils were identified in the foundation of the proposed dam during the 1995 site investigation. Concern that these soils may be liquefiable if saturated during a severe seismic event prompted the investigators to further characterize them. Details of this work are provided in the Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

In summary, based on field density measurements, the soils in the upper 1 m to 4 m of some of the test pits are expected to liquefy under the MCE if they are saturated. While they were not observed to be saturated, similar soils below the foundation of the dam are expected to be saturated once the dam is in operation. Loose soils, therefore, will be required to be identified and removed during construction.

Ground Temperature

The project is located in an area of discontinuous permafrost and frozen foundation conditions have the potential to adversely affect the performance of structures. In soils, this occurs due to thawing and a change in both strength and volume. In rocks, frozen fractures would limit the take and effect of grout, and when the rocks thawed new un-grouted seepage pathways would exist.

Ground temperature measurements and observations were made as part of the 1995 and 1996 field investigation program. Records of ice content and distribution were made during both seasons, and accurate temperature data was recorded from drill hole piezometers during 1996. Ice was encountered in the top 2 m of most of the test pit excavations. On the west abutment the depth of ice ranged from 0.9 m to 2.9 m. On the east abutment it was not present in all test pits but was observed to extend beyond 5m in others.

The distribution of frozen ground at the project site is variable and appears to depend upon a number of factors. These include elevation of the water table, aspect, elevation, soil type and groundcover. Where permafrost is present, the temperature is in the range of 0°C to -1°C. In general, seasonal frost appears to extend to a depth of about 2.5 m.

On the west slope, permafrost exists in unsaturated soils above 1370 m elevation. Ice contents in frozen soils are generally less than 10% except in the fine sandy silt horizon where ice contents may exceed 30%. On the east slope, permafrost appears to be present above about 1345 m elevation and zones of frozen ground may exist near the creek on the east slope. The depth of frozen ground is unknown but probably extends 10m or more into bedrock. Ice contents in the soils here vary from 10% to 15%.

Tailings Impoundment Design

Permanent underwater disposal of tailings and SPAG waste rock has been selected as the project alternative for preventing acid rock drainage - and a water license has been granted for this design approach. The primary objective is to prevent the opportunity for acid generation by preventing the exposure of acid generating minerals to oxygen in the atmosphere. The operating plan calls for tailings and SPAG waste rock to be placed directly below the impounded water surface. No tailings beaches (or otherwise exposed tailings) will be formed, and only the upper portions of waste rock dump points will be exposed during operation.

On closure the impoundment is intended to form a lake, in perpetuity, by maintaining a constant net water balance at this location and by remaining a stable structure requiring minimal maintenance.

Design Criteria

The design criteria for the tailings impoundment are summarized by the following;

- The impoundment is designed to store nominally 8.6 million m³ of tailings and SPAG waste rock;

- The amount of tailings to be stored is estimated to be 10,114,000 tonnes, based on the amount of ore processed minus concentrate produced minus the tonnage used as sand backfill at the Wolverine Mine;
- The in situ density of the tailings is estimated to be 1.25 tonnes/m³ resulting in a total stored tailings volume of 8,091,200 m³;
- The quantity of SPAG waste rock is estimated to 3,094,600 million tonnes;
- The broken density of the SPAG waste rock is estimated to be 1.9 tonnes/m³, resulting in a volume of SPAG waste rock of 1,628,737 million m³;
- The volume of PAC waste rock used in the construction of downstream rock shell of the dam is estimated to be 0.47 million m³; and,
- Tailings will be deposited underwater at an average rate of 1,041,000 tonnes per year.

Several assumptions have been made regarding the settled density of tailings and waste rock, and no allowance for tailings filling void spaces in waste rock have been made. It is suggested therefore that the actual storage of the impoundment may be understated and that the current design is capable of additional storage.

Site D Proposed Tailings Embankment

The proposed tailings embankment will consist of a compacted, low permeability, earth-fill core with supporting rock fill shells both upstream and downstream. At the ultimate height, the crest of the dam will be approximately 570 m in length and 53 m above the current valley floor. A multi-layer filter zone of select sand and gravel and select PAC rock will be placed between the core and the downstream shell to protect the core from piping failure. PAC rock will be used in the downstream shell and WPAG rock will be used in the upstream shell, below the final water level. The dam design has been reviewed and changed over the life of the project. The design report, Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application) is currently the definitive document on design issues related to the embankment.

The upstream and downstream slopes will be constructed at two horizontal to one vertical (2H:1V). The design slopes were selected to provide good performance with respect to slope stability, erosion and response to seismic events. The core will have a minimum thickness of 5 m at the crest and at any depth the thickness will not be less than 0.4 times the maximum hydraulic head at that depth. This is consistent with conventional engineering practise and provides good control of seepage and seepage related stability. The total crest width will be 10 m and will incorporate a frost protection cap to be added at closure.

The 10m wide crest at completion will allow for practical placement of the various zone material within the dam when nearing the ultimate height and provides flexibility for future raisings if required. A frost protection cap is included in the design of the dam to protect for degradation of saturated zones with the structure itself.

As described previously, the foundation conditions are characterized as permeable loose sands and gravels to silty sands and gravels. These soil units overlie fractured and weathered bedrock that generally improves with depth. These foundation conditions present special design issues for the construction of the dam, and a methodology for dealing with them is proposed in the design report, Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

It was also observed that the soils within the footprint of the downstream shell of the dam may be locally frozen or be sufficiently loose so as to be potentially liquefiable. It is planned to investigate the presence of these conditions by drilling and to remove these soils during construction.

Once the foundation excavation and preparation are completed, the core and filter zones of the dam will be placed in the core trench. The core will consist of select silty sand and gravel to be taken from a borrow area on the west side of the impoundment. The material has a silt content of about 30% and when compacted has a very low permeability, an average of 3.4×10^{-8} m/s.

Once the core and filter section of the dam have been placed to the existing soil surface in the valley bottom (1320 m elevation), it will be raised in three subsequent stages requiring the concurrent placement of core, filters, and upstream and downstream shells. The starter dam will have a crest elevation of 1350.5 m, and will be followed by a Stage II dam (crest elevation 1363.5 m), and a final Stage III dam (crest elevation 1373 m). Because the impoundment is intended to be flooded during all stages, the upstream shell of the dam must be constructed to its final design width in each stage.

Details of the construction methodology and a summary of construction quality assurance and quality control are provided in Tailings Embankment Design Report – Kudz ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

Stability Analysis

Stability analyses were carried out using the program XSTABL and Janbu method for static and pseudo-static conditions. The performance of the dam under earthquake conditions were assessed using the pseudo-static analysis.

Seismic coefficients were derived from data provided by the Geological Survey of Canada, and as described previously, the MCE is estimated to produce firm ground acceleration of 0.15 times gravity. A detailed description of the assumed strengths of materials and the various simulations carried out are provided in Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

In summary, the calculated factors of safety for the dam exceed the minimum factor of safety recommended by CANMET, Pit Slope Manual – Chapter 9 – Waste Embankments, 1977. Two sections were analysed, the centre-line and a west abutment section. In all cases, the calculated factor of safety was lower for the west abutment, and ranged from 1.5 using peak shear strength (static) to 1.1 for the MCE loading.

As previously described, some of the soils in the footprint area of the downstream shell may be liquefiable if they are saturated and under earthquake loading. If they did liquefy they may compromise the performance of the dam and affect its overall stability. Therefore, these materials will be investigated and removed or densified during construction. The criteria for this are described in the design report.

Deposition of Tailings and Mine Rock

All tailings will be discharged under water to avoid the interaction of the tailings with oxygen in the atmosphere and the possibility of minerals in the tailings generating acid. The plan provides for a minimum of 2 m of water cover over the upper surface of the deposited material during operation and at closure. To ensure this, the embankment must be water retaining and the impoundment must have a net positive water balance.

Underwater discharge will involve the use of a barge or floating tailings line. During winter months the barge will be situated over a deep portion of the impoundment to reduce the need to move the barge. During summer months the barge will be moved to fill selected areas around the impoundment.

During operation, excess supernatant water that is not required for process water will be discharged to the environment through a controlled discharge system. The discharge will be stepped to coincide with the natural runoff cycle as best as possible.

The placement of SPAG waste rock will be facilitated by the construction of four causeways or peninsulas into the impoundment. The SPAG rock will be placed in a way that it is quickly located and remains under the water level. The method should also minimize the impact on the tailings impoundment water balance. The top of the peninsulas will be constructed of WPAG rock, and will be approximately 2 m above the water level. Dozers will be used to push the SPAG below the water level. Four dumping points have been provided for to allow for potential instability in any of the peninsulas. It is estimated that only two of the dumps are required to accommodate the estimated quantity of SPAG rock.

Permafrost conditions have been identified in the East side of the impoundment, and the design includes the construction of PAC waste rock buttresses in these areas to prevent instability.

Water Treatment Plant Precipitates

Water treatment plant precipitates will be placed in the tailings storage facility.

2.5.1.3 Solid Waste Management

This section is based on a report by Access Consulting Group “Kudz Ze Kayah Project Solid Waste Management Plan”, October 2000. Four categories of solid waste would be generated at the proposed mine site: miscellaneous solid waste, domestic waste, sewage, and special wastes. These are described as follows:

Domestic Waste

Domestic wastes include camp waste, putrescibles, waste paper and burnable packaging material. This material will be collected and incinerated on site in an oil fired, dual chamber incinerator. Waste oil from routine equipment and vehicle servicing would be used as a fuel source for the incinerator. The incinerator will be operated in accordance with Federal Operations and Emissions Guidelines for Municipal Solid Waste Incinerators, and in accordance with the Yukon Environment Act, Air Emissions Regulations. The incinerator will be installed in a building located northeast of the site away from the immediate camp area.

Sewage

A primary and secondary sewage treatment facility has been incorporated into the project design. The reader is directed to that document for a detailed description of the proposed facility. This plant will be designed in accordance with applicable legislation, including Public Health Ordinance and an Environmental Health permit. Liquid waste from the sewage treatment plant will be discharged to the tailings facility. Digested sludge from the facility will be disposed bi-monthly or as required, in sediment containment pits located adjacent to the tailings area.

Special Wastes

Special wastes from the project include waste oil, ethylene glycol, and miscellaneous lubricants and solvents. As mentioned earlier in this document, milling operations at the Kudz Ze Kayah

Mine will also involve the use of a number of reagents and other chemicals, which will be covered by this plan during operations

Waste Oil

The major sources of waste oil will be from the mobile equipment and power plant generators. This oil will be collected in waste oil tanks located in the mobile equipment maintenance area and in the generator room. The oil will be centrifuged to remove particulate matter and then used as fuel in the incinerator and possibly the generators. The oil cleaning will be done in a contained area. The solid residue from the oil cleaning will be stored in a drum and periodically removed from the site by an authorized waste management contractor.

Waste oil management measures during operation will include the following:

- Outside storage area for waste oil will be covered to protect containers from the weather;
- All containers will be closed at all times;
- Secondary containment will be provided to prevent any leaks and spills from entering the surrounding soil or water;
- Records will be maintained including waste type, volume, origin and storage location;
- The storage area will be marked using WHIMIS signage; and
- Containers will be clearly labelled as to their contents.

Ethylene Glycol

Used ethylene glycol from mobile equipment coolant systems (antifreeze) and from the generator cooling/heat recovery system will be cleaned and re-used. A small packaged glycol recycling plant utilizing distillation and filtration will be installed to handle the anticipated volume. Glycol that cannot be cleaned and recycled will be placed in drums and removed from the site by an authorized waste management contractor.

Waste Solvents and Lubricants

Miscellaneous, small quantities of waste solvents and lubricants will be generated through routine maintenance and repair of equipment and vehicles used during mining operations. They will be collected on site, and, depending on the type, these wastes will either be burned in the incinerator, if burning can be done safely and efficiently, or collected in drums for disposal by a registered hazardous waste management company.

Miscellaneous Non-Hazardous Solid Waste

These wastes are defined as non-burnable materials (cans, bottles, etc), used rubber products, scrap metal, and wood. This waste will be deposited in a landfill site located within or beside a waste rock dump composed of Potentially Acid Consuming (“PAC”) rock. Hauling solid waste to municipal landfill sites in Ross River, Watson Lake, or Faro is not considered feasible since these sites are not designed to accept large volumes of industrial waste. The PAC waste rock dump is located on the east side of Geona Creek, upstream of the proposed tailings storage facility. No contaminated drainage is expected from this landfill. In any case, the downstream tailings facility ensures secondary containment of any water from the landfill/waste rock dump area, should any accidental deposit of contaminated drainage occur. No special wastes will be deposited at this location.

During operations, scrap metal will be kept near the mill, in an identified ‘boneyard’, so that they are readily available for use for maintenance or repair of equipment and/or structures at the mine. Once mining operations cease and the decommissioning and reclamation plan is being implemented, the scrap metal will be sold as scrap/salvage, or deposited in the landfill.

2.5.2 Water Management

The Kudz Ze Kayah site is ideally located at the top of the Geona Creek watershed thus minimizing the requirement to manage or divert water from higher up in the watershed. The whole of the Geona Creek watershed above the tailing dam site will be managed as part of the site water balance. This watershed has an area of 1253 hectares. The watershed has been divided into sub-watersheds according to the proposed use and management of each area.

A conventional high-density sludge water treatment plant will be installed adjacent to the mill to treat water collected from the WPAG waste rock storage area, open pit, and the reclaim water from the tailings pond. It will consist of two agitated tanks and a clarifier to remove the precipitated metals. The overflow from the clarifier will be the process water for the mill.

2.5.2.1 Open Pit Catchment

The open pit catchment area consists of two main components; the surface and overburden runoff and the deep ground water. The runoff area consists of the direct catchment area of the pit itself and the valley walls immediately east and west of the open pit. The open pit catchment has an area of 136 hectares. The deep groundwater component consists of flow from the north and south of the open pit. The flow of groundwater will increase as the depth of the open pit increases. The open pit water will be treated in the mine water treatment plant prior to discharge to the tailings area. Water from the catchment area to the south of the open pit will be unaffected by the mining operation. This water will be intercepted at the south rim of the pit and pumped back to the North Lakes watershed. The catchment area to the north of the pit is considered part of the WPAG runoff and is not included in the pit catchment.

2.5.2.2 Fault Creek Diversion

The Fault Creek diversion will drain Fault Creek, and the small watershed to the north of Fault Creek, which currently enter Geona Creek very close to the watershed boundary above the planned mine development. In order to prevent this water from entering the open pit, diversion to the south into the North Lakes watershed is planned. Fault Creek comes down a steeply sloping, rocky valley and then flattens out into an alluvial fan near the area of the current exploration camp. Fault Creek has established several channels across this alluvial fan, the southern-most of which has resulted in Fault Creek flowing south into the North Lakes drainage on occasion in the past. It is planned to re-establish the flow of Fault Creek to the south but this will be done before the creek reaches the alluvial fan. Interception and diversion of Fault Creek after it reaches the alluvial fan would be difficult because of the substantial groundwater flow in the permeable sand and gravel overburden.

The Fault Creek diversion system will consist of a rock-filled dam across Fault Creek at approximately the 1440 m elevation. A diversion ditch from the north will channel the small creek west of the pit (Pit Creek) into Fault Creek above the diversion dam. The alignment of the proposed diversion ditch from Fault Creek to South Creek passes over colluvium and the alluvial fan of Fault Creek, along a remnant channel of Fault Creek. The purpose of this channel is to carry the runoff to the south of the watershed that separates the pit from South Creek.

2.5.2.3 WPAG Waste Rock Storage Area Catchment

The WPAG dump catchment area consists of two main areas; the area above (to the west of) the access road and the immediate area of the dump. The area above the road is treated separately from the dump area because it is planned to divert as much of the runoff as possible. A ditch along the side of the road will be excavated such that the near surface flow can be intercepted and directed to the north to re-enter Geona Creek below the tailings dam. The

details of its design are described in Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

Due to the permeability of the overburden materials, it is anticipated that this ditch will only divert 50% of the total flow. During heavy precipitation events and spring freshet, it is expected that the ditch will be fairly effective but during times when there is predominantly overburden flow, effective diversion by the ditch is not expected.

Seepage and runoff from the WPAG dump will be collected and directed to the water treatment plant at the mill. A ditch along the west side of the mine haul road will intercept any surface flow and direct it to pump sumps. The sub-surface flow will be intercepted by a buried seepage collection system consisting of a large perforated pipe and pump sumps. The pipe will be laid at the bedrock interface or, if possible, excavated into the fractured bedrock. The ditch and the buried collection system will be located to provide adequate gradient for proper drainage. The pump sumps and buried collection systems will be connected to a pipeline that will carry water to the water treatment plant at the mill. This water will be used as process water for the mill.

2.5.2.4 Tailings Area Catchment

The tailings area catchment includes all of the remaining catchment above the tailings dam. As with the WPAG catchment, 50% of the runoff from the slope above the road on the west side of the valley will be diverted. The balance of the flow will enter the tailings impoundment as dilution. This catchment has an area of 152 hectares. The catchment area for the balance of the tailings area is estimated as 774 hectares.

The PAC waste dump, the concentrator and main service complex and all waste treatment, storage and disposal facilities will be constructed within this catchment area. Any unplanned discharges or spillage will be contained within in this catchment area thus assuring that the only discharge to receiving waters will be the controlled discharge of tailings supernatant and seepage through under the dam.

In addition to the runoff discussed above, this catchment receives the following inputs:

- Concentrator tailings - The concentrator tailings will be discharged to the tailings impoundment as a slurry.
- Treated mine water - The water from the open pit will be treated and then discharged to the tailings impoundment.
- Sewage treatment plant discharge.

The tailings facility is required to operate at a net water surplus to maintain a permanent water cover on the tailings and SPAG waste rock. During operations, excess water collected in the tailings facility during freshet will be released to Geona Creek using a siphon decant system. Testwork and modelling done by Cominco for the Kudz Ze Kayah Project concluded that active treatment of tailings supernatant would not be required to protect downstream water quality during these releases. A polishing pond would receive the decant water and the overflow from this pond would be released to Geona Creek. At closure, a spillway would be constructed at the tailings dam to allow passage of excess water. Passive biological treatment of excess water is considered for operations and post-closure phases of the development.

Polishing Pond

Release from the tailings pond will be directed to a polishing pond that will be used to precipitate any remaining metals in the effluent. The pond will consist of a bermed area on the spoil pile

generated from the core trench excavation. The pond will be lined with a geosynthetics liner to limit seepage from the pond. Discharge from the siphon will be directed to the west end of the pond and the pond will overflow at the east end.

Passive Biological Treatment

Preliminary studies completed for the Kudz Ze Kayah Water Licence Applications indicate that there is good potential for wetlands to be successful under the conditions at Kudz Ze Kayah. The report suggests that a wetland area on the order of 14.5 ha would be required to treat the peak discharge from the tailings impoundment during operation. Such a wetland might be developed by constructing a series of earthen/rock dikes downstream in Geona Creek valley which would create a series of ponds. These ponds would be fairly shallow, and with some encouragement of aquatic plant growth, could result in a natural and sustainable wetland polishing system. Such a wetland could potentially reduce the metal concentrations in the tailings pond discharge by up to 50 %.

Spillway

A major component of the tailings dam closure is the construction of a spillway that will allow for the unrestricted discharge of water to Geona Creek. The spillway will be constructed on the east side of the dam and will be designed to pass the probable maximum flood (PMF) of the entire watershed. Details of the spillway design are provided in Tailings Embankment Design Report – Kudz Ze Kayah Project, Water Licence Application, Golder Associates Limited, December 1997 (Appendix 2.5d of the Water Licence Application).

Seepage

Seepage analyses, carried out by Golder as part of the Kudz Ze Kayah study, estimated the total flow through the dam and through the foundation to be in the range of 250 m³/day to 400 m³/day. A seepage collection system will be installed downstream of the tailings dam and collected seepage returned to the tailings pond.

2.5.2.5 Runoff Control

Development

During the development of the mine, runoff and sedimentation control and surface and overburden dewatering will be required. The primary objective during development will be to minimize sediment discharge to Geona Creek. This will be accomplished by:

- Intercepting, diverting and discharging clean water from the surrounding areas;
- Controlling point sources of water and sediment at each excavation; and
- Intercepting and removing sediment from Geona Creek.

The elements of the project development that are considered;

Geona Lakes Dewatering

The upper end of the Geona Creek valley, overlying the planned open pit, are two beaver ponds herein referred to as the “Geona Lakes”. These ponds must be removed prior to starting any excavation in the area. The water level can initially be lowered by controlled removal of the beaver dams at the outflow of each pond. After the water has been lowered to the minimum, dewatering will be completed by pumping. The water will be discharged downstream into Geona Creek. Initially, the water will be good quality surface water and no control will be required.

Overburden Dewatering

Prior to starting stripping of the open pit area, the overburden will be dewatered. This will be done initially by a series of trenches or pits in the invert of the valley at the open pit area and to the south that will allow the near surface water to be drained or pumped to the south and out of the system. The majority of the water in the lower sediments and the fractured bedrock will be removed using a series of pumping wells which will be drilled in the open pit area. Water will be pumped from these wells into the South Creek watershed. Although this water is being removed from an undisturbed area, the water will be sampled to assure compliance. It is planned to dewater the whole area around the open pit prior to starting stripping and pre-development mining.

Open Pit Stripping

Open pit stripping will commence on the west side of Geona Creek valley. Although the area will be dewatered prior to starting stripping, rainfall and runoff from the surrounding area is expected to carry sediment towards Geona Creek. As much as possible, the water will be collected and pumped out before it enters the active excavation. Where possible, sediment fences and local sedimentation control structures will be used to minimize the sediment movement. Final sediment control will be accomplished by the use of a sedimentation pond on the west side of Geona Creek near the northern limit of the ultimate pit.

Plant Site Excavation

The plant site will be excavated on the west side of Geona Creek down valley from the mine area. Any runoff from this area will naturally flow down gradient towards Geona Creek. During the initial excavation period, while the overburden is being removed, the potential for sediment problems are severe. Once the top layer has been removed, most of the excavation will be in sand and gravel and bedrock and therefore the amount of sediment considerably less. Sediment fences and local sediment control will be used at the beginning to minimize the sediment movement into the Geona Creek valley. Once the area has been opened up, it is planned to develop a sedimentation pond at the bottom end of the borrow area used for tailings dam core material.

Tailings Dam Construction

The tailings dam will be constructed across the Geona Creek valley and will intercept the flow in Geona Creek. The construction involves three main phases:

- Excavation of the overburden from the dam foundation;
- Grouting of the bedrock foundation; and
- Placement of the embankment fill materials.

During the excavation of the overburden and placement of the dam core up to the original topography, water and sediment control will be critical elements. Prior to commencing these activities, it is planned that coffer dams will be constructed both upstream of the dam to intercept any remaining flow in Geona Creek. A sedimentation pond will be developed downstream to provide a settling basin for removal of sediment.

These sedimentation ponds and coffer dam will act as the final component of the run-off and sediment control program during the project development. Since the coffer dam will be located down stream from the mine, waste dump and process plant site, all run-off from these areas will flow by gravity to the sedimentation pond. The water and sediment in the tailing dam excavation will be collected in the downstream sedimentation pond. Any carried sediment resulting from excavation and construction activities will be settled out and stored in the sedimentation ponds. The upstream sedimentation pond overflow, will be either piped or

pumped around the tailings dam construction area and then discharged into Geona Creek. The downstream sedimentation pond will discharge directly to Geona Creek.

Operation

Once the development is complete, run-off control requirements will be minimal. Since the site is ideally situated and designed to assure that surface run-off from all disturbed areas will enter the tailings impoundment, any carried sediment or contaminant loadings are dealt with in the tailings area. The only discharge of water from the site will be the monitored and controlled discharge from the tailings area. The run-off control measures in each area are discussed in the following sub-sections.

Open Pit Mine

Inflows into the open pit will include direct precipitation, surface and shallow groundwater from the surrounding area and deeper ground water. The surface and shallow ground water will be intercepted at the rim of the pit near the overburden/bedrock contact. This surface and shallow groundwater from the south side of the pit, and some from the east and west sides is expected to be uncontaminated and will be pumped to the North Lakes watershed from a collection sump. The surface and shallow groundwater from the north side of the pit is expected to have elevated sediment and metals loadings because it comes from disturbed areas (roads, waste dumps, etc.) This water will be collected in a sump on the north rim of the pit and pumped along with the open pit water, to the mine water treatment plant. Direct precipitation and deep groundwater entering the open pit will contact potentially acid generating rocks and is expected to carry elevated metals levels. This water will be collected in temporary sumps in the bottom of the open pit and pumped to the sump on the north rim of the pit.

Potentially Acid Consuming (PAC) Waste Dump and East Side Geona Creek

The non acid generating waste dump is located on the east side of Geona Creek, between the open pit and the tailings impoundment. Direct precipitation plus groundwater from the sub-watershed on the east side of Geona Creek above the tailings dam will enter the tailings area.

Weak Potentially Acid Generating (WPAG) Waste Dump

The WPAG dump is located on the west side of Geona Creek between the open pit and the tailings impoundment. A diversion ditch is planned up slope (to the west) of the WPAG dump. This diversion will be excavated in permeable sand and gravel and thus is expected to be only 50% efficient. The 50% of the water that bypasses the diversion channel plus the direct precipitation and groundwater flow below (east of) the channel will flow into the tailings area. The water from the WPAG dump would be intercepted by a combination of a ditch and a subsurface collection pipe along the lower edge of the dump and pumped to the water treatment plant at the mill.

Process Plant and Infrastructure Area

Located on the west side of Geona Creek north of the WPAG waste dump, all water from the process plant area will drain towards the tailings area. The diversion channel discussed previously will intercept 50% of the water from the slope above the process area and direct it back into Geona Creek below the tailings area. The plant site itself will be graded and ditched to flow all surface water away from the buildings and facilities. Containment areas such as the fuel storage area, mill reagent area and the process sumps will be isolated from this general site drainage.

Tailings Storage Area

The tailings area receives the run-off water from all the disturbed areas at the mine site. All of the site run-off will flow into the tailings basin and be discharged in a controlled manner to Geona Creek. It is planned that the tailings pond effluent will be discharged by siphons. The siphon system will be set up to operate at three different flow rates so that the water can be discharged at various rates to partially match the flow in the receiving streams (designated a 'step discharge'). Discharge will be monitored and controlled to minimize the impact on the receiving waters.

Closure

Closure activities are discussed in greater detail in Section 2.6. This discussion reiterates the activities relating to run-off control. After cessation of mining, the WPAG waste rock will be relocated to the open pit. All of the surface run-off from the area will continue to flow to the tailings area and normal operational controls and discharge will be maintained. The Fault Creek diversion will be breached and flooding of the pit will commence concurrent with the rehandling of WPAG rock to the pit. Due to soluble metals (mostly zinc) in the WPAG waste material, the water quality in the pit during filling is expected to deteriorate unless treatment and control are exercised. The addition of sufficient neutralizing potential, likely in the form of lime, will be added to the Fault Creek water as it enters the open pit.

Once the pit is flooded, the water will naturally flow north towards the tailings impoundment. The natural drainage at the top of Geona Creek will be restored to pre-mining conditions, except there will be a much larger pond of water (the open pit) than currently exists.

The process plant will be removed and the area re-graded and vegetated. Once the vegetation has stabilized the surface soils, run-off is expected to return to near pre-development quality. The diversion channel on the west side of the Geona Creek valley will not be maintained after closure nor will it be purposely filled.

The major part of the tailings dam closure is the installation of the permanent spillway which will allow the run-off collected in the tailings to discharge unrestricted to Geona Creek below the dam. A permanent spillway will be constructed on the east side of Geona Creek. This spillway will be designed to pass the probable maximum flood (PMF) of the entire watershed, including all of the Fault Creek catchment and without the western diversion ditch.

The spillway will consist of a channel along the east abutment of the dam and is expected to have minimal post-closure maintenance.

2.6 Reclamation and Closure Plans

This section provides a conceptual plan for the decommissioning and closure of all facilities and infrastructure associated with the Finlayson Project. The restoration of land and habitat and the provision of access control to prevent excessive pressure on wildlife populations are key objectives of the plan. In view of the potential ARD properties of the deposits, permanent water quality protection is considered a primary goal. In this regard, there is a vital link between the development and operating plans for the project and its final closure. Planning for the Finlayson Project has adopted a "Design for closure" philosophy.

The best available technology for ARD prevention and management has been included in the project to protect water quality and minimize liabilities on closure. This has been combined with established practices for site restoration.

The detailed closure plan will be developed in phases, with the plan becoming more detailed as closure approaches. The first plan could be submitted after about two years of operation. This would provide a comprehensive scope definition for all closure measures not subject to research or operating experience. It would also define study programs and additional operating monitoring needed to support final closure. The second phase and final plan would be submitted at about two years prior to closure. It would serve to address areas of technical uncertainty based on operating and field trials, where appropriate.

2.6.1 Mine Site Decommissioning and Restoration

Reclamation of sites no longer required for exploration, construction or operation will be carried out as soon as possible. Reclamation of drill sites, borrow sources and road embankments has already commenced. The reclamation of drill pads, drill roads and borrow pits typically involves re-grading, scarifying if necessary and re-vegetation. These sites will serve as test sites to develop strategies for closure re-vegetation. The information that is developed on these sites can be used to develop the final closure plan. In addition to borrow pits and exploration sites, this policy will also be applied in other areas as opportunities arise. For example, once promising results are obtained from reclamation research, it may be possible to initiate reclamation on areas of the PAC waste dump at Kudz Ze Kayah.

Immediately after operation has permanently ceased, a program will be undertaken to restore the operations areas to pre-production conditions as much as possible or practical. All valuable equipment will be removed from the site and sold. One exception will be the lime handling and slurry preparation equipment at Kudz Ze Kayah which will be needed for post closure pit water treatment. After clean-up, buildings will be dismantled and/or demolished with materials being salvaged where feasible. Structural material and equipment which cannot be removed from will be buried within the final configuration of the non-acid generating waste dump at Kudz Ze Kayah. Residual fuels, chemicals and any hazardous waste materials will either be returned to suppliers in accordance with standard purchase agreements or removed from the site and disposed of in accordance with federal and territorial regulations. Concrete foundations will be broken down to below ground level and covered. The concrete will be buried with the structural materials in the landfill noted above.

At Kudz Ze Kayah, the WPAG material will be rehandled into the bottom of the open pit immediately upon cessation of operations. This will be done using the mine workforce and equipment. At the same time, the Fault Creek diversion will be removed and the flow re-established to the north to accelerate the rate of flooding in the open pit. It is expected that waste flooding and the rehandle operation will be completed at about the same time. Once the WPAG rock is fully under water cover, the rate of oxidation will be limited.

By design, and through careful adherence to separation and handling during operation, the permanent waste rock dump of non-acid generating material at Kudz Ze Kayah will not pose a water quality risk after closure. Furthermore, the permanent waste rock dump will be constructed with surface slopes of about 3:1 thus eliminating re-sloping at closure and ensuring permanent structural stability. Some minor surface dressing may be necessary to provide proper drainage.

Closure of underground operations at Wolverine will include plugging the main access adit and vent raises. The main portal will be blasted shut and the mine working will be left to flood as the phreatic surface returns to pre-mining levels. Exposed areas in the backfill borrow pit will be

recontoured and revegetated as necessary. All mine buildings and infrastructure will be decommissioned as outlined above.

The final restoration measures on all areas of surface disturbance including building sites, roads and the waste dump will include regrading and sloping. Revegetation techniques will be investigated in the course of preparing the detailed closure plan. The species mix to be used will be based on a combination of on-site trials and reclamation experience in the Yukon. The overburden dump will have been revegetated as stripping was completed during the operating phase of the mine. Reclamation research will be conducted to determine if the non-acid generating waste can be successfully revegetated without additional cover. It may be necessary to use some overburden as a cover to ensure the long term viability of vegetation without a high level of maintenance.

2.6.2 Access and Ore Haul Road Closure

This will be the final decommissioning and closure program carried out for the project as the road will be maintained until all necessary work has been completed at the mine site. This program will include measures necessary to ensure permanent water quality protection. Road access to the site will be maintained as long as reclamation activities continue and until permanent water quality protection is assured. During this period, security provisions at the intersection with the Robert Campbell Highway will be maintained.

A primary objective of road closure will be to restrict vehicle access in order to control hunting pressures. The overall approach will entail removing the road using the remaining mining equipment as it is withdrawn from the site. This will be followed by a one-time campaign of seeding by helicopter after all structures have been removed and the construction of access control measures completed. The work on the road to be conducted during the withdrawal will include:

- Removal of all bridge spans but not abutments if they are clear of the high water marks;
- Removal of culverts on stream courses and the restoration of natural drainage paths;
- Construction of additional ditch/berm combinations on road sections with deeper fill; and
- Transplanting “rafts” of young spruce or fir (~10 m x 10m) to the road surface at about two locations each kilometre.

In addition to the above, road surface scarification would be done in preparation for a late fall or early spring seeding campaign.

Inspection after decommissioning of the access roads will be undertaken on an annual basis as part of the reclamation program. The effectiveness of measures taken to prevent vehicular access will be evaluated and appropriate adjustments made. It is anticipated that deterrents to vehicular access placed as part of road decommissioning will be effective.

2.6.3 Water Management and Water Quality Control Measures

The objectives of this component of the overall decommissioning and closure plan are to restore the pre-mining watershed drainage pattern and to ensure permanent water quality protection. At Kudz Ze Kayah, major activities include the construction of a permanent spillway on the tailings dam, the restoration of Fault Creek flow towards Finlayson Creek and the in situ treatment of water during the relocation of the WPAG waste dump to the open pit.

No significant measures beyond the construction of the spillway will be required to provide for the environmental security of the tailings pond. It will be operated and closed as a shallow lake with a protective water cover on the potentially acid generating tailings. Operational experience may indicate that breaks in the pond to limit wave fetch and prevent erosion may be warranted. An alternative to this measure could be the reinforcement of the upstream face of the dam with rip rap.

The spillway will be excavated in the east dam abutment to control the water level in the tailings pond. It will be designed to handle the probable maximum flood event (including the complete area drainage and Fault Creek flow) and will include additional capacity to control discharge in the event of ice build-up.

Immediately after the termination of mine production, the WPAG waste rock will be rehandled into the open pit. At the same time, Fault Creek and 'Pit Creek' will be directed to the pit to accelerate the rate of flooding. Modelling of water quality indicates that the WPAG waste will have a substantial impact on pit water quality while filling is underway. High concentrations are possible as a result of soluble metals release during the inundation of the WPAG waste. As the water level rises, the exposed sulphides on the pit walls will also be inundated resulting in some additional metals release throughout the filling process. Concentrations will eventually stabilize and subsequently diminish once the flooded pit begins to discharge.

The quality of water in the pit while it is filling will be controlled through the addition of lime. Lime slurry would be pumped into the flow of Fault Creek as it enters the pit. The supply of slurry would be adjusted from time to time to ensure a modest excess of lime over that required to control soluble metals as the WPAG is inundated. In the period between inundation of the WPAG and pit overflow, water quality will be optimized through intermittent lime additions. Any WPAG surfaces on the pit wall above the flooded level will be removed if it is determined that they are contributing to poor water quality in the pit.

At Wolverine, very little should be required in the way of active management of water quality following closure. The location of the portal (above the phreatic surface) and downward slope of the adit will ensure that there is no passive drainage from the mine workings. In addition, the adit will be plugged and the portal closed off.

2.7 Project Opportunities

The following section outlines alternatives for project development currently being considered by Expatriate. These alternatives represent potential improvements to the "base case" project presented above. These alternatives are being studied as they may significantly reduce environmental liability associated with the project and improve project economics. These alternatives may or may not be considered in the final project design presented in the Finlayson Project Environmental Assessment Report.

2.7.1 Mine Planning

The mine plan proposed for Wolverine may be subject to additional refinement, based on underground test mining planned for the feasibility study. The deposit is open down dip and the final plan presented in the Environmental Assessment Report may consider a larger resource than estimated in this report. Mining methods and specific design parameters may be improved based on geotechnical conditions encountered during the test mining phase.

There is also some consideration for development of an underground mine at Kudz Ze Kayah. The Kudz Ze Kayah orebody cannot be economically mined to completion due to the high strip ratio required to access the ore at the depth. Exploration drilling and additional planning will define the potential for an underground mine at Kudz Ze Kayah. The open pit mine plan may be optimized based on further exploration drilling and potential underground mining plans.

Other exploration targets exist in the Finlayson District. Continuing exploration of these targets may result in the inclusion of other identified mineral resources to add to the Finlayson Project development plan.

2.7.2 Waste and Water Management

The management plan for waste rock at Kudz Ze Kayah is being reviewed in the context of the optimization of the open pit development plan. A reduced strip ratio from the open pit will result in a lower volume of waste rock being brought to surface. In addition, it may be possible to stage the pit design to keep a large portion of the WPAG waste rock in the pit by storing it in mined-out areas. Current consideration includes development of the pit in 3 stages with the WPAG waste materials from Stage 2 being stored in the Stage 1 pit and the Stage 3 WPAG waste being stored in the Stage 2 pit. The only WPAG waste brought to surface would be from the Stage 1 pit. If the volume is sufficiently small, this material may be placed directly into the tailings facility with the SPAG material. This would eliminate the WPAG waste rock storage area from the mine development footprint and eliminate the need to rehandle waste materials at the end of mine life.

Expatriate is also considering changes to handling procedures for the SPAG material. The plan proposed by Cominco for the Kudz Ze Kayah Project considered the construction of finger dykes into the tailings impoundment and direct dumping of SPAG material to the tailings facility from those dykes. Expatriate is investigating the possibility of developing a separate containment area with the tailings impoundment that would be dedicated to the storage of the SPAG material. This would prevent potential increases in suspended solids in the tailings pond resulting from dumping operations. It would also isolate the SPAG material and allow development of mitigation measures specifically for that material should any unforeseen problems arise in the future.

There are no major alternatives under considerations for water management practices at the Finlayson Project. Project alternatives under consideration may require changes or present opportunities for water use optimization at the project.

2.8 Project Schedule

2.8.1 Summary

The anticipated schedule is presented as Figure 2.10. Production of concentrate from the Finlayson Project is anticipated in January 2004.

The schedule indicates the Pre-Feasibility Study ending at the end of 2000. Year 2001 is referred to in this respect as Year -3. During this year, a Feasibility Study will be completed and additional drilling will be carried out as identified for a Bankable Feasibility. In 2001, a portal will be established and a decline developed to the test mining area.

During 2002 and 2003, engineering, construction and mine development will take place. Both mines are sequenced to start-up towards the end of Year 2003.

This schedule is subject to timely progress of permitting and financing activities.

2.8.2 Project Construction Schedule

2.8.2.1 Kudz Ze Kayah Mine

In the pre-production period the Phase 1 and Phase 2 Pits are developed to the 1400 m elevation. Main haulage roads are prepared and access is developed to the tailings impoundment. A total of 4.3 million tonnes are mined, including 3.6 million tonnes of non-reactive rock and 0.7 million tonnes of weakly reactive rock.

The mine development activities include the following:

- Access road to the mine and pad construction;
- Road construction to the magazines and drainage ditch and sump location;
- Supply of construction materials to the tailings impoundment;
- Development of the access ramps to the waste dumps.

For the most part, these activities will be undertaken by Mine forces.

2.8.2.2 Wolverine Mine

Access to the Wolverine orebody will be developed in two phases. Phase I will consist of developing the main ramp access from surface to a depth that will permit development of the top portion of both the Lynx Zone and the Wolverine Zone. During Phase I, test mining of the upper portion of the Wolverine Zone will be carried out to more accurately access ground conditions in and around the ore zone so that the optimum stope dimensions, expected mining dilution and ground control requirements can be confirmed. Phase 2 will commence in 2003 and will commence with access development to ore zones scheduled for production in the first year of operation.

Phase 1, including test mining has been assumed to commence in 2001. The costs for this phase have been included with the pre-production costs and have been excluded from the Project capital cost estimate.

2.8.3 Surface Facilities

During the summer months of 2002, site preparation will commence. This will include construction, inter-connecting roads and infrastructure. It will be critical to get the process building enclosed so that construction can continue into the winter months. The mill will be completed towards the end of 2003 to coincide with ore production from both mines.

2.8.4 Tailings Impoundment

Construction of the tailings embankment will commence as early as possible 2002 so as to allow the bedrock excavation to remain open for two field seasons assisting in the thawing near the bedrock surface.

3 ENVIRONMENTAL SETTING AND SOCIOECONOMIC CONDITIONS

Environmental conditions in and around the Finlayson Project are well understood as a result of extensive baseline studies that were conducted in support of the Kudz Ze Kayah and Wolverine Projects from 1994 to 1997. Environmental baseline information for the area around Kudz Ze Kayah mining project was presented in the Initial Environmental Evaluation or IEE (Cominco Ltd., 1996) and in the Kudz Ze Kayah Water Licence Application (Cominco Ltd. 1997) at the regulatory approval stage. Baseline studies for the Wolverine Project have not yet been published.

The Finlayson Project is located in the northern foothills of the Pelly Mountains on the Yukon Plateau, and on the east side of the divide between the Pelly River and Liard River drainage basins. The Kudz Ze Kayah operations area is located in the Finlayson Creek/River drainage, which forms part of the Liard basin. Elevations in the area range from about 1300 to 2000 m above sea-level (asl). Wolverine is located approximately 35 km to the south-east at an elevation of 1123 masl. The development area is located on the watershed divide between the Wolverine Lake and Go Creek drainages, both of which form part of the Liard basin (Figure 3.1).

The following sections provide a description of the studies that have been completed for both Wolverine and Kudz Ze Kayah areas and a summary of their findings.

3.1 Physical Environment

3.1.1 Climate

The Finlayson Project is in an area has a typical northern Cordilleran interior climate with over 50% of precipitation falling as snow. Typical temperatures in the region range from a daily mean of around -25°C in January to a daily mean of around 15°C in July. Extreme temperatures in the region range from -60°C to +35°C.

The snow-pack generally peaks in early April at most snow course stations although snow may continue to accumulate later in the year at higher elevations. Precipitation is higher on the windward side of mountain ranges, and there is a general trend toward higher precipitation in the direction of the Selwyn and Logan Mountains, to the north-east of the site. Snow-melt and ice break-up in area streams generally occurs between late April and early May. Summer rainstorms can result in significant flood peaks throughout the months of May to September, although such events are most likely to occur in June or July.

3.1.1.1 Regional Stations

Climatic normals for the area around Kudz Ze Kayah mining project are presented in Appendix 3.1 of the Kudz Ze Kayah Water Licence Application. These values were developed through review and analysis of long-term records from stations in the region (regional analysis). Data from both the Atmospheric Environment Service (AES) and Water Survey of Canada (WSC) networks were utilized (see Figure 3.2 for station locations). These data were analyzed for regional trends, and allowed estimation of appropriate site parameters. The principal climatic parameters are precipitation and evaporation which, together with stream-flow estimates, are used in developing a water balance and for predicting receiving water quality for the proposed mine development.

Estimated mean monthly precipitation, evaporation and temperature values for the project area based on regional data are listed in Table 3.1. The mean annual precipitation (MAP) was estimated at 655 mm, consisting of 265 mm of rainfall and 390 mm of snowfall, in terms of water equivalent. Total lake evaporation was estimated at 330 mm. Therefore, for water bodies, precipitation is approximately double the evaporation.

Frequency analysis, using data from long-term regional stations, was used to estimate extremes in annual precipitation for the project area. This analysis yielded 100-year return period high and low annual precipitation estimates of 990 mm and 411 mm, respectively. Corresponding 10-year return period estimates were 819 mm and 506 mm, respectively.

No such regional analysis has been completed for the Wolverine development area. There should be little difference between climatic conditions at Wolverine and Kudz Ze Kayah as these two areas are at similar elevations and are only 35 km apart. Concurrent precipitation records indicate similar levels of rainfall (see below). The regional analysis presented for Kudz Ze Kayah is thought to be generally representative of conditions at Wolverine.

3.1.1.2 Project Site Data

Two climate stations were established in the Kudz Ze Kayah area during 1995, as shown in Figure 3.3. A low elevation station (1400 masl) was located just east of Geona Creek adjacent to the proposed location of the tailings impoundment, and was in full operation between April 13 and September 3. A high elevation station (1680 masl) was initially located (on April 12) at the Kudz Ze Kayah exploration camp at the head of Geona Creek, before being moved to its high elevation location on May 8. The station was also in full operation until September 3.

Site data collected in 1995 were used to verify the results obtained from regional analysis. The stations continued to operate, although inconsistently, from April to August of 1996.

A manual weather station was in operation at Wolverine during the summers of 1996 and 1997. This station monitored maximum and minimum temperatures, precipitation, and relative humidity. An automated station was installed in October of 1997 but the project was shut down shortly after and the station abandoned. This station was refurbished in June of 2000 and is currently in operation.

Data collected from these stations during the 1995-97 period is presented in Appendix 3A and summarized below.

Precipitation

Precipitation data is summarized in Table 3.2. Precipitation records from Kudz Ze Kayah indicate that early spring months (April to June) tend to be drier than summer months. The Kudz Ze Kayah IEE states that for 1995 "April and May were quite dry, with monthly totals not exceeding 20 mm". A similar pattern occurs in 1996. Monthly precipitation totals for June, July and August at the low elevation station were similar at 54 mm, 59 mm and 47 mm, respectively. Total precipitation was similar at the higher station at Kudz Ze Kayah, except for June, which had a 142 mm total due to a significant

storm early in the month. Over the period of full operation, the low elevation station recorded 181 mm of precipitation, compared with 258 mm at the higher station. The average of the two is approximately 220 mm, compared with 235 mm derived from regional analysis.

Precipitation records at Wolverine also indicate that the spring months are generally drier than summer months. Minimum monthly total precipitation at Wolverine was 5.8 mm during June of 1996. Maximum monthly precipitation occurred during July of 1997 (96.2 mm). The 1997 season was wetter than 1996. Total precipitation during the common period of record (June through August) was 196.6 mm in 1997 compared to 138.7 mm in 1996. Average monthly precipitation during this period was 46.2 mm in 1996 and 53.9 mm in 1997. Maximum daily precipitation was 20.8 mm, occurring on August 8th of 1996.

A comparison of the two locations shows during June and July of 1996, Wolverine received slightly less rainfall than Kudz Ze Kayah (Table 3.2).

Evaporation

An evaporation pan was established at the Low Elevation Station at Kudz Ze Kayah. The IEE indicates that pan evaporation daily averages at Kudz Ze Kayah varied between 2.1 and 5.3 mm in 1995 the period of record. The highest average occurred in late May, and the lowest in early August. A maximum daily value of 6 mm was recorded in late May and mid-August. The weather station database indicates that the evaporation pan was malfunctioning for most of the 1996 field season and that the data collected during this period is not reliable.

No evaporation data has been collected at Wolverine.

Snow Course

At Kudz Ze Kayah, snow courses were monitored in March and April (1995) at three locations at different elevations. The lowest location was adjacent to the low elevation climate station. The other two locations were upslope. Snow depths were consistently greater with elevation, as expected. Snow depth at the lowest location was at its thickest (75 cm) for the period of monitoring when measurements started on April 7. Therefore, the peak snow depth at this location could have occurred earlier. The peak at the highest location was 92 cm on April 23. The snow cover had completely melted at the lower two locations by May 16, while 10 cm remained at the highest location on May 23, when measurements ceased.

Snow depths were considerably lower than normal in 1995. The Snow Survey Bulletin published by DIAND shows that snow depths measured at the five closest stations to Kudz Ze Kayah were 66-92% of normal, with an average of 75%.

Water equivalents measured on site at the three locations peaked at 156 mm at the lowest station on April 18, and at 220 mm at the highest station on April 23. Water equivalents as a percentage of snow depth varied from 18% at the lowest location on April 23 (24% at the highest location) to 54% at the highest station on May 23.

At Wolverine, snow course measurements were conducted at two locations on March 18th, 1997. Snow depth at the higher elevation station (airstrip, elev. 1340 masl) were 71

cm with a water equivalent of 128 mm. At the lower elevation station (camp, elev. 1145 masl) snow depths were 46 cm with a water equivalent of 70 mm.

Temperature

Temperature data is summarized in Table 3.3. At Kudz Ze Kayah, average monthly air temperatures at the low elevation climate station ranged from 1.6 °C in May, 1996 to 10.5°C in July, 1996. Extreme temperatures over the period of record varied from –17.4°C in May, 1996 to 23.8°C in July, 1996. Monthly average air temperatures at the high elevation climate station ranged from –3.3°C in April, 1996 to 8.7°C in July, 1995. Extreme temperatures at this station exhibited a slightly narrower range than the lower station with a low of -15.3°C in May, 1996 and a high of 17.4°C in June, 1996.

Temperatures at Wolverine ranged from –23°C in April, 1996 to 30°C in July, 1996. Average monthly temperatures ranged from –7.4°C in April, 1996 to 13.5°C in July, 1997.

A comparison of the two locations indicates that Wolverine may be subject to a larger variation in temperatures.

Humidity

Humidity data was collected at both Kudz Ze Kayah weather stations during 1995 and 1996 and at the Wolverine Station during 1996 and 1997 (Table 3.4). Average monthly humidity at the Kudz Ze Kayah low elevation stations ranged from 55% in June, 1996 to 78% in July and August of 1995. Minimum humidity of 16% was measured in June 1996.

Monthly average humidity at Wolverine ranged from 49% in June 1996 to 80% in August of 1997. Minimum humidity of 17% was measured in June 1997.

Wind Speed/Direction

Wind speed and direction data are summarized in Table 3.5 and Figures 3.4 and 3.5. Winds at the Low Elevation station were predominantly from the north and north-west. The strongest winds are from the north, with an average velocity of 39.8 km/h. Although winds from the east are not common, they are strong when they occur. Average wind speed from north-eastern, eastern, and south-eastern winds exceed 26 km/hr on average. Winds are almost constant at the low elevation station. Calm periods comprised less than 1% of the total wind measurements.

Winds at the high elevation station are primarily from the north and north-east. Winds are strongest from the north, with an average velocity of 58.6 km/hr. Wind speeds correlate well with predominant wind direction, with the strongest winds coming from the most frequent wind directions. Winds at the high elevation station are stronger but less frequent than the low elevation station. Calm periods comprised approximately 4% of the total wind measurements.

Solar Radiation

Solar radiation was only monitored at the low elevation station. This data is presented in Appendix 3A. Average monthly radiation was highest in June, 1996 at 353.6 W/m². The lowest monthly average of 272.6 W/m² was recorded in August, 1995. Maximum solar radiation values occurred in June, 1996 (948.6 W/m²).

3.1.2 Geology

3.1.2.1 Regional Geology

The Finlayson Project is situated within the Finlayson Lake District of the southeastern Yukon, an elongate composite geological terrane bounded on the southwest by the Tintina Fault Zone and on the northeast by the Finlayson Lake Fault Zone (Figure 3.6). The Tintina Fault Zone is a major transcurrent structure along which approximately 450 kilometers of dextral offset occurred in Late Cretaceous and/or early Tertiary time (Tempelman-Kluit et al., 1976). The Finlayson Lake Fault Zone is described by Mortensen (1996, personal communication) as a complex structure which may in part represent a transgressive dextral paleosuture.

Rocks grouped with the Yukon Tanana Terrane (YTT) by Mortensen and Jilson (1985) underlie much of the Finlayson Lake District. The YTT underlies a large area of western to southeastern Yukon and east central Alaska. Mortensen (1992) has divided the YTT in the Yukon into 3 main structural assemblages:

- 1) The Nisling assemblage, a lower quartzite and marble package of possible Proterozoic and/or Cambrian age;
- 2) The middle Nasina assemblage, a package of Late Devonian to mid Mississippian carbonaceous metasedimentary and mafic to felsic metavolcanic rocks; and
- 3) An upper package of mid-Permian felsic metavolcanics (Klondike Schist) and metaplutonic rocks.

Recent interpretations conclude that the YTT represents a mid-Paleozoic volcanic-plutonic arc assemblage built on continental crust (Nokleberg and Aleinikoff, 1985; Mortensen and Jilson, 1985; Foster et al., 1987; and Mortensen, 1992). Although the andesitic volcanics one would expect to be voluminous in a continental margin arc setting are seemingly not present in the Finlayson Lake District, Mortensen (1996, personal communication) suggests that large K-feldspar megacrystic granitoids which form part of the core of the belt are intermediate in composition and therefore, together with the volcanics, represent a differentiated igneous suite.

Regional metamorphism throughout the YTT ranges from very low grade to amphibolite facies. Radiometric dating suggests that metamorphic events may have occurred at different times in different subterrane. Mortensen and Jilson (1985) have subdivided the YTT in the Finlayson Lake District into six major lithologic packages:

- 1) A sequence of layered metasediments and metamorphic rocks,
- 2) Paleozoic metaplutonic rocks,
- 3) Middle to late Paleozoic mafic and ultramafic igneous rocks and chert,
- 4) Early Mesozoic clastic rocks,
- 5) Mesozoic plutonic rocks,
- 6) Late Cretaceous and/or early Tertiary volcanic rocks (Figure 3.7).

3.1.2.2 Kudz Ze Kayah Geology

The resource in the Kudz Ze Kayah area is called the ABM deposit. The ABM is a volcanic hosted massive sulphide deposit hosted within a thick felsic tuff and sill/flow complex with minor mafic sills/flows and interbedded sediments. It occurs roughly 200 metres stratigraphically below the base of an overlying carbonaceous, locally calcareous

phyllite metasedimentary sequence. The property geology is shown on Figures 3.8 and Figure 3.9.

Bedding strikes generally east-north-east with dips of 15 to 35 degrees to the north. The bedding parallels a shallow north to north-east dipping. Evidence includes base and precious metal and barium zonation within the deposit itself.

The host felsic volcanic sequence underlies the extreme upper reaches of Geona Creek and Geona Lakes, and South Lakes and extends east and west along strike. North of Geona Lakes the property is underlain by units of the overlying metasedimentary sequence. These units occur along ridges east and west of Geona Creek.

3.1.2.3 Wolverine Geology

The Wolverine Deposit and its host stratigraphy belong to the middle unit of the LMP. The host stratigraphy can be traced along the northeastern side of Wolverine Lake to the southeast for more than 20 kilometres. It comprises an upright east-facing volcano-sedimentary sequence locally intruded by feldspar porphyritic subvolcanic intrusions.

In the vicinity of Wolverine Lake, the middle unit is comprised of a complex sequence of carbonaceous and tuffaceous sedimentary rocks, rhyolitic flow, volcanoclastic and hypabyssal intrusive rocks and magnetite iron formation. Andesitic to basaltic rocks structurally overlying the felsic-sedimentary rock package is of uncertain affinity. On a more regional scale monzonitic orthogneiss outcrops to the south, and Carboniferous-Permian serpentinized (magnetite-bearing) ultramafic rocks are exposed to the north.

The Wolverine ore sequence comprises the volcano-sedimentary sequence above the footwall phyllite and below the overlying andesite. The ore sequence is a complex interval made up of carbonaceous sedimentary units, felsic volcanoclastics, argillaceous volcanoclastics, rhyolite flows, and feldspar-quartz phyric rhyolite, subvolcanic intrusions and associated rhyolite volcanoclastic rocks. The massive sulphide horizon lies in the lower portion of the ore sequence. Situated above the massive sulphides are both calcite-pyrite exhalites and two or more intervals of banded magnetite iron formation (Figure 3.10).

The Wolverine Deposit consists of two stratabound lenses of massive sulphide, the Wolverine and the Lynx Zones, having a combined strike length of 800 metres and a dip length of up to 500 metres (Figure 3.11). The main massive sulphide lens in the Wolverine and Lynx zones are thought to form a contiguous tabular body referred to as the Main Lens. The Main Lens in each of the zones has a thicker core flanked by thinner massive sulphide material. In approximately 14 drill holes there is an upper lens referred to as the Upper West Lens. The Main and Upper lenses have an average true thickness of 5.1 metres, with a maximum thickness of 12.98 metres.

The deposit dips moderately to the northeast at a dip of 25 to 45 degrees. Trenching in the early 1980's in this location identified chlorite-sericite schists with narrow veinlets of copper and zinc mineralization.

The massive sulphides are comprised mainly of pyrite, sphalerite, chalcopyrite, galena, pyrrhotite and tetrahedrite with minor amounts of other sulphosalt minerals and minor free gold. The massive sulphides may contain up to 75% sulphides with quartz and carbonate gangue; although sulphides are generally about 50% in massive sulphides.

The detailed stratigraphic succession of the Wolverine Zone is very similar throughout the deposit to both the east and west,

3.1.3 Physiography

3.1.3.1 Geomorphology

The topography around the Finlayson Project is typical of historically glaciated areas. Mountains are rounded and valleys are broad and U-shaped. Elevations in the project area range from 1450 masl at Kudz Ze Kayah to 1123 masl at Wolverine.

Glacial, periglacial and fluvial processes are the main process which have been involved in the creation of landforms, and are the origin of surficial deposits. The Yukon has been glaciated four times over the last two million years, which has significantly modified the landscapes of southern and central Yukon. The Wolverine Lake area lies within the limits of the McConnell glaciation and most of the geomorphic features are related to the McConnell glaciation. McConnell glacial ice covered this area between 14,000 and 35,000 years ago.

As the McDonnell ice retreated and down-wasted, a complex network of ice tongues developed in valley bottoms. Morainal deposits are found at lower to mid-elevation areas and larger valley floors may contain more complex assemblage of glaciofluvial, glaciolacustrine and fluvial sediments. In this area, the upper steep slopes are covered by rock, often weathered and frost shattered, colluvial veneers with morainal blankets and colluviated moraine and rock covering the mid to lower slopes. Depressions and small valleys are often covered with morainal deposits with a narrow belt of fluvial deposits.

Permafrost is present almost everywhere. At high elevations, it is expressed by mud and stone circles (frost boils), stripes and pushed up stones. On many slopes, solifluction and soil creep are slowly modifying the surface. In the valley floors and depressions, poor drainage and thick organics are often present. Peat palsas up to three meters thick are present just east of Wolverine Lake.

3.1.3.2 Terrain Hazards

Slope failures in steep bedrock represent the highest risk hazard in the area. Failure in unconsolidated deposits are also a concern, due to the presence of permafrost. These failures can be rapid and involve large volumes of material, or they can occur slowly on small surfaces.

Landslides have occurred in a variety of surficial geological units in the Finlayson Lake area (Jackson, 1994). Large rock avalanches (rock falls) are still taking place, as indicated by the large number of talus cones and aprons throughout the mountainous portions of the map. Snow avalanches are common and evidence indicates that they often entrain large volumes of boulders and debris.

Dry permafrost (frozen ground with very little to no moisture) is often present in colluvial and morainal blankets at high elevations and is often detected by the presence of thick organic mats in poorly drained sites, solifluction lobes and stripes and sorted stone polygons. Thermokarst collapse and thaw slides are possible hazards in fine-grained, glaciolacustrine and fluvial sediments.

Floods related to ice-jams, snowmelt and summer rainstorms are possible hazards in lower reaches of most streams in the area. The steep portion of alluvial fans, in addition to the flooding risk, are also exposed to the additional possibility of mud flows and debris flows associated with rapid discharge increase.

3.1.4 Soils and Surficial Geology

3.1.4.1 Kudz Ze Kayah

A terrain assessment was conducted for the Kudz Ze Kayah Project based on airphotos which were taken on September 5, 1995. Investigation of the surficial geology was conducted around the tailings dams, pit area and proposed locations of waste rock dumps.

The surficial geology and terrain features in the Geona Valley area are shown on Figure 3.12. There are three main surficial deposit types; alluvial, glaciofluvial and morainal. Alluvial deposits are geologically recent and result from water processes reworking the sediments deposited during the last ice age. Glaciofluvial deposits are the result of water processes from the melting of glaciers and ice sheets. Moraine deposits are the result of direct glacial action.

In general, valley bottoms are infilled with sand and gravel deposits from alluvial and glaciofluvial processes, to depths of up to 20 m. There are some glaciofluvial deposits on the west side of Geona Creek near the confluence with Finlayson Creek where a deposit in excess of 40 m thick has been left. Silty sand and gravel till deposits overlie much of the area, ranging in thickness from less than 1 m to up to 10 m. The thickness of these deposits generally decreases with increasing elevation. Above about 1500 m elevation, the surficial deposits consists of a layer of organic material less than 0.5 m thick, overlying colluvium. The latter originates from frost loosening of bedrock.

Bedrock faulting observed on the ridges shows as well developed sets of faults with an orientation of about 080 degrees. No faults were observed with an orientation parallel to Geona Valley.

Permafrost is present on north and west facing slopes, especially above 1400 m elevation, although permafrost has been observed as low as 1250 m elevation. Permafrost related ground movement or solifluction is present on slopes steeper than about 4H:1V.

One land form, located at the top of Fault Creek, may be the remnant of a landslide. This feature is shown on Figure 3.12.

The gullies which contain Fault Creek, the creek to the north of Fault Creek (Pit Creek) and the gully on the east side of Geona Valley, which is a continuation of Fault Creek, have been identified as potential avalanche courses by Snow Safety Services. Due to the limited snow accumulations (approximately 1 m) and the relatively flat slopes compared to typical avalanche hazard terrain, the hazard posed by avalanches is thought to be very small in the project area.

Detailed geological assessments, supported by cross-sections, logs and laboratory testing, have been undertaken at the proposed dam, pit, mill and rock dump sites.

These assessments are discussed in the Kudz Zed Kayah Water Licence Application (Cominco 1997). A seismic risk evaluation is also presented in this document.

3.1.4.2 *Wolverine*

A surficial geology study for the Wolverine area and potential access corridors was completed in 1996 (Mougeot Geoanalysis). It is comprised of the following components:

- The soil survey was performed in conjunction with the surficial geology survey since the surficial geology units are strongly related to the soil parent material.
- Air photos at 1:40,000 scale, were used to construct a preliminary map of surface geology and terrain hazards, such as frequently flooded areas, avalanche chutes, landslide scars, areas prone to permafrost and permafrost related processes, as well as areas sensitive to surface disturbance, such as sand dunes, etc. This map was used as a base and checked in the field along the areas of main interest, including the campsite, exploration targets, and potential access road corridor.
- Ground truthing was completed in the summer of 1996 to provide both a description and a distribution map of soil subgroups, including organic soil, using the Canadian Soil Classification System. Data collected in the field included descriptions of major pedological horizons, pH, textural and structural classification, moisture holding capacity and drainage and topographical classes.
- Information on grain-size distribution, basic lithology, variability, and stratigraphy of Quaternary geology units was collected.
- Presence of permafrost and depth to permafrost were indicated whenever possible, particularly along the potential road corridor.
- A soil and surficial geology map was developed indicating potential aggregate source locations and possible terrain hazards. Boundaries were transferred from airphotos to the basemap and were digitally stored allowing the interaction with maps generated from other study components of the Baseline Biophysical Survey.

In the Wolverine area surficial geology units include morainal blankets, slopes of mixed colluvium and morainic sediments and fluvial deposits. The units are shown on the surficial geology map, Figure 3.13, produced as a result of a terrain analysis. The geologic units are based on deposit genesis, general texture (grain size), landform description, expected soil types, as well as possible terrain hazards, and/or active modifying processes.

Terrain Hazards - Wolverine Lake Area

The most severe hazards in the area are related to exfoliation of steep rock faces (shown on Figure 3.13, map symbol R), as is the case for the north and east facing walls of the cirque located directly east of the airstrip. The base of this cirque-like gully is well vegetated and appears stable, although poorly drained to wet. Several other steep rocky walls have bouldery colluvial fans at their base. Avalanches are probably a hazard at these sites as well. The areas where the possibility of both rock fall and avalanche hazards were observed include the northeastern shoreline of Wolverine Lake and south and east of the present exploration camp. These areas are denoted by the slide scarp (AR) symbol on Figure 3.13.

Most other slopes have either slow soil creep or solifluction processes (S on Figure 3.13), or frost shattered rock colluvium. These slopes do not present a hazard to human life, as the processes are slow and involve a low volume of material. However the cost

of road and facility maintenance can rise considerably if these surfaces are not considered during road design.

High water table or very poor drainage conditions (W on Figure 3.13) are usually associated with low relief, low elevations with organic (O on Figure 3.13) and ice-rich deposits (X or Z on Figure 3.13). The water table is usually higher in mid summer to late summer, as the permafrost melts.

3.1.5 Water Resources

3.1.5.1 Surface Hydrology

Kudz Ze Kayah

Site Data - Hydrometric Station Installations

Evaluation of the runoff characteristics for Kudz Ze Kayah included the collection and analysis of site specific hydrologic data. Installation of hydrometric stations was conducted by Via-Sat Data Systems in 1995. The following equipment was installed:

- Two automated stage recorders: pressure transducers and data loggers were employed to collect a continuous record of stage. Stage was recorded every 15 minutes; and upon completion of a stage-discharge curve, a continuous record of discharge was produced. The locations of these stations were Geona Creek and Lower Finlayson Creek.
- Four staff gauge sites: staff gauges were installed at Fault Creek, South Creek, East Creek and Upper Finlayson Creek. Stage was read manually from the staff gauge on a regular basis, and upon completion of a stage-discharge curve, a discharge value was calculated for each stage reading collected.

The locations of these data collection sites are shown on Figure 3.14. Sites were chosen on the basis of preliminary information with respect to the location of potential tailings storage areas. Drainage areas are listed below for each hydrometric station shown on the above figure.

Catchment	Drainage Area km ²
South Creek	9.82
Fault Creek	1.94
Geona Creek	26.2
East Creek	73.4
Upper Finlayson Creek	153
Lower Finlayson Creek	191

Installation of the hydrologic monitoring equipment was initiated in early April, 1995 however, some sites were still frozen. Some of the staff gauges were installed between April 10 and 12. Reliable data was collected a few weeks later when the water surface had thawed sufficiently. In early April, the only creek that had thawed enough to allow discharge measurements to be made was Geona Creek. All other discharge measurements for the hydrologic monitoring stations were collected between May 3 and 10, on June 28, between July 1 and 18, between August 4 and 7, on August 20, and between August 28 and September 3. Each station had between 5 and 7 simultaneous

stage and discharge measurements. The stage-discharge relationship was re-evaluated to produce a revised rating curve for each station following each set of additional flow measurements. The best fit was obtained for the staff gauge on East Creek which had an R^2 of 0.999 corresponding to a coefficient of variation of 8.2%. The poorest fit was determined for the rating curve on South Creek which had an R^2 of 0.943.

The rating curve initially developed for Fault Creek was not considered reliable due to the bouldery channel bed, however, data collected subsequent to May 7 has resulted in an acceptable stage-discharge curve which provides a reasonable fit to the data. Stage-discharge rating curves for all six sites are presented in Appendix 3.2a of the Kudz Ze Kayah Water Licence Application.

Automated Sites

For the two automated sites, data collection began in late April. On Geona Creek, ice break-up was observed to begin on approximately April 27. An initial maximum of 0.72 m^3/s was recorded on April 28, after which flows fluctuated for a few weeks. A second, higher peak flow of 0.98 m^3/s then occurred on May 14. Maximum discharges in Geona Creek following the rainstorm of June 4-6 were just slightly less than those recorded during ice break-up and snowmelt: a discharge of 0.96 m^3/s was recorded on June 6 at 01:30. Following recession of the stormflow, discharge remained below 0.6 m^3/s until September 2. As a comparison, the minimum flow recorded on Geona Creek during the period of observation was 0.14 m^3/s .

The ice break-up on Lower Finlayson Creek began in early May. The associated peak discharges occurred between May 12 and 14: there was a small peak on May 12 of 4.88 m^3/s , and a slightly larger maximum of 5.15 m^3/s on May 14. These snowmelt maxima were exceeded by the discharges produced by the rainstorm of June 4-6. The stage began to rise on June 5, and the peak discharge of 11.9 m^3/s occurred at 18:00 on June 6. Following recession of the stormflow, discharge remained below 2.0 m^3/s until September 2. As a comparison, the minimum flow recorded at this station during the period of observation was 0.63 m^3/s .

Manual Stations

For the manually read staff gauge stations, installations were completed in early May, and daily stage readings were initiated on May 3 for South and Fault Creeks, and May 6 for Upper Finlayson and East Creeks. On all four creeks, the peak flows associated with snowmelt and ice break-up occurred between May 11 and 13. Measurement of the discharge on East Creek is complicated by the presence of some large boulders. A discharge estimate for East Creek was obtained by subtracting the measured discharge on Finlayson Creek, upstream of the East Creek confluence, from the measured discharge on Finlayson Creek, downstream of the confluence. This discharge estimate was then compared to the East Creek staff gauge reading to obtain the rating curve.

Peak flow (freshet) measurements at the various gauge locations are as follows:

- Fault Creek = 0.35 m^3/s on May 13
- South Creek = 0.86 m^3/s on May 13
- East Creek = 1.77 m^3/s on May 12
- Upper Finlayson Creek = 2.60 m^3/s on May 11

The peak discharges associated with the storm event of June 4-6 exceeded the freshet discharges for both Upper Finlayson and East Creek and almost equalled the freshet discharge for South and Fault Creeks:

- Fault Creek = 0.38 m³/s
- South Creek = 0.75 m³/s
- East Creek = 2.18 m³/s
- Upper Finlayson Creek = 3.93 m³/s

The above peak discharges occurred on June 5 and 6. Following recession of the storm flows, discharges remained relatively low for the remainder of the summer. Maximum and minimum flows during this latter period were as follows:

- Fault Creek = 0.06 to 0.013 m³/s
- South Creek = 0.17 to 0.053 m³/s
- East Creek = 0.49 to 0.18 m³/s
- Upper Finlayson Creek = 1.33 to 0.29 m³/s

The lowest flows recorded on each creek during the data collection period occurred in late July.

Discharge measurements for each of the gauges are presented in Appendix 3.2a of the Kudz Ze Kayah Water Licence Application. An examination of the snowpack at regional snow course stations (Appendix 3.1, Kudz Ze Kayah Water Licence Application) revealed the April 1, 1995 snowpack to be significantly below normal. Streamflow in the Kudz Ze Kayah area would therefore be expected to be below average for the 1995 freshet.

Regional Stations Analysis

The surface hydrology of the Kudz Ze Kayah project area was characterized by using data from six monitoring stations installed on area drainages, and by regional analysis using data from Water Survey of Canada (WSC) and DIAND hydrometric stations in the region. The locations of regional stations are shown on Figure 3.2. Regional data were assembled and analyzed for general trends, including the magnitude and timing of annual runoff.

Mean annual runoff (MAR) for the project area was estimated at 414 mm. The derived value for evapotranspiration in the area, determined by subtracting runoff from precipitation (655 mm), is therefore 241 mm per year. The estimated runoff is approximately 63% of precipitation. This agrees with data obtained from the Hydrological Atlas of Canada.

The estimated average monthly distribution of runoff is given below.

Average Monthly Runoff Depths (mm)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
7.3	5.5	5.3	6.1	68.9	129	66.2	40.2	35.6	25.3	14.1	10.4	414

Based on regional data, maximum monthly runoff usually occurs in June, with the peak in the hydrograph occurring in late May or early June, due to snowmelt. Site records have also shown significant peaks during summer months due to rainfall events. The minimum runoff usually occurs in March or April just prior to the snowmelt freshet.

The above monthly runoff distribution is based on stream-flow records from regional stations, the majority of which have catchments with considerably more drainage area at elevations lower than Kudz Ze Kayah. The regionally derived runoff distribution will over-estimate the proportion of runoff that occurs in the winter, and describe a freshet occurring too early at the project site. To accurately characterize winter and the timing of the freshet, the monthly runoff distribution from regional analysis was adjusted. Data from other catchments in the region at similar elevations were used. The adjusted runoff distribution is given below.

Adjusted (Higher Elevation) Average Monthly Runoff Depths (mm)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
3.7	2.7	2.7	3.1	74.7	140	71.8	43.6	38.6	16.9	9.4	6.9	414

The analysis of regional data is presented in Appendix 3.2a of the Kudz Ze Kayah Water Licence Application. An analysis of floods for the region of Kudz Ze Kayah is included in Appendix 3.2b of the Kudz Ze Kayah Water Licence Application. Both maximum daily and maximum instantaneous floods were analyzed. Appendix 3.2c of the Kudz Ze Kayah Water Licence Application describes the derivation of the probable maximum precipitation (PMP) for the project area. The HEC-1 computer program was then used to translate the PMP estimate into a probable maximum flood (PMF) for mine facility design.

Wolverine

Monitoring Program

Figure 3.15 shows the locations of hydrology monitoring network developed for the Wolverine baseline studies in 1996. The 24 sites monitored during the baseline studies period can be put into three categories:

- 3 stations - Automatic stations (i.e., sites equipped with a datalogger and pressure transducer, and also a staff gauge);
- 3 stations - Manual stations (i.e., sites equipped with a staff gauge only); and,
- 18 stations - Direct measurement stations (i.e., sites with no water level measuring)

Automatic Stations

The automatic stations were established in late May 1996 on Go Creek above Pup Creek (Station W-12) and on Nougha Creek above the Robert Campbell Highway (Station W-21). A third station was established at Wolverine Creek (W9) on May 29, 1997. The equipment installed at each station comprised a datalogger (Lakewood Chartpac with 32K memory), a PS-9000 pressure transducer, communication cables, battery power set up, and a staff gauge. Sturdy steel shelters were constructed to house each datalogger from the elements. Data was recorded at 15 minute to one hour

intervals throughout the day. Measurements were averaged to calculate daily mean flow.

W12 - Go Creek

Station W12 on Go Creek was monitoring continuously from May 29 to November 26 in 1996 and from March 18 to September 12 in 1997. During that time, 12 stage discharge measurements were taken, eight in 1996 and four in 1997 (Table 3.6). The rating curve developed from these measurements (Figure 3.15a) was used to estimate streamflows over the period of record (Figure 3.16). The information presented in this figure has been processed and several anomalous measurements were removed. All of these measurements occurred near the end of the season and were presumed to be the result of ice formation in the stream. Ice has two effects on automated instrumentation. Firstly it changes the dimensions of the stream cross-section which disrupts the established stage-discharge relationship. Secondly, if ice develops directly over the automated sensor, the pressure registered by the sensor will increase. Since the instrumentation relies on pressure as a surrogate measurement for stage, the recorded stage will be incorrect.

Flows in 1996 and 1997 were similar. Peaks occurred during the freshet in late May and early June and then declined. Intermittent peaks occurred between June and early September. Flow patterns were typical of a small drainage with low attenuation capacity; characterized by sharp peaks in the hydrograph indicating rapid changes in flow volume in response to precipitation events. Flows declined steadily throughout September and into later months

Maximum flows occurred on March 24, 1997 (1.81 m³/s). The maximum daily average flow was approximately 1.3 m³/s (May 23, 1997). Over the period of record, flows averaged approximately 0.4 m³/s.

W21 - Nougha Creek

Valid data was collected from Station W21 between May 28 and October 14 in 1996 and between May 13 and September 13 in 1997. Although the station was monitored outside these times, the data collected was discarded. Ice formation in the stream resulted in anomalous measurements.

Six stage-discharge calibrations were collected over this time (Table 3.7), four in 1996 and two in 1997. The stage-discharge relationship developed from this data is presented in Figure 3.17. This relationship was used to convert the collected stage data into a continuous record of streamflow (Figure 3.18). The more frequent (15 minute to one hour) recordings were converted to estimates of daily average flow.

Stream discharge at W21 varied between approximately 9 and 1.2 m³/s. The average flow over the period of record was approximately 5 m³/s. Stream flows were highest in late May and early June. Intermittent peaks occurred throughout the summer and fall, likely in response to rainfall events. Flows were generally higher and more dynamic in 1997 as compared to 1996.

W9 - Wolverine Creek

Data was collected from W9 between May 29 and September 11 of 1997. This station included V-notch weir of known dimension and which was used to calculate the stage-

discharge relationship. As with the other stations, the more frequent daily measurements (every 15 minutes to ½ hour) were used to estimate daily average flows.

The daily estimates are presented in Figure 3.19. Peak flows (approximately 0.058 m³/s) at this station occurred in mid-July, much later than other streams. Average flows over the period of record were 0.019 m³/s and minimum flow was estimated at 0.003 m³/s. The flows in Wolverine Creek are less dynamic than Go and Nougha Creeks, both in terms of daily and seasonal variation, indicating a predominantly groundwater fed stream.

Manual Stations

Manual stations were installed at Campbell Creek near the mouth (Station W-8), Money Creek below Go Creek (Station W-14), and Hawkowl Creek near the mouth (Station W-15). The datum of each staff gauge was surveyed relative to the elevation of a local benchmark. This was done as a precautionary measure so that correction factors could be readily computed in the event that the staff gauges either shift under the weight of winter ice or are washed away during an extreme flood.

Figure 3.20 contains the stage-discharge calibrations that were collected at these three stations during 1996 and 1997. This figure also shows the rating curves developed from these measurements. Stage measurements were not collected from these stations on a regular basis, consequently no hydrograph can be developed for these sites. Based on the brief record of data, the seasonal distribution of flows at these stations is similar to that seen at the automated stations. Flows peak in late May and early June and then decline steadily throughout the year.

Direct Measurement Stations

Stream flow data was also collected at various stations throughout the Wolverine project area during water quality and fisheries study campaigns. This data is summarized in Table 3.8. This information will assist in examining how streamflow characteristics vary amongst the various streams in the immediate vicinity of the Wolverine Lake orebody. This will be of particular importance in assessing the low-flow characteristics of these streams, which can not be accurately predicted without the availability of at least some site-specific flow measurements. In combination with water quality data, this flow information will assist in analyzing how the chemical quality of the local streams varies as a function of discharge rate.

Runoff Characteristics

Table 3.9 shows the watershed characteristics of the areas monitored by the automated hydrology stations. The hydrograph from each of the automated stations was translated into surface runoff conditions using the watershed area. This analysis is presented in Figure 3.21.

Runoff in Go Creek varied between approximately 35 and 0.2 L/s/km². The average runoff was approximately 11 L/s/km² for the period of record. Nougha Creek runoff varied between approximately 31 and 4 L/s/km² and averaged 17 L/s/km² for the period of record. Wolverine Creek varied between 17.0 and 1.1 L/s/km² and averaged 5.8 L/s/km² over the period of record.

Runoff patterns in Go Creek and Nougha Creek show excellent correlation. Hydrograph peaks occur almost simultaneously. Runoff in Nougha Creek appears to increase in 1997 as compared to 1996. Go Creek delivered a higher runoff rate than Nougha Creek in 1996 but was lower in 1997. The runoff attenuation capacity of the larger watershed (Nougha Creek) is apparent from the more relaxed rate of the falling arm of the high runoff events. Wolverine Creek shows a much lower runoff capacity that delivers its freshet much later in the year. Flows in Wolverine Creek are likely dominated by groundwater contributions whereas flows in Go and Nougha Creek have a relatively higher proportion of surface runoff contribution. This could explain the apparent differences in runoff characteristics of these streams.

3.1.5.2 Limnology

Bathymetric surveys of Little Jimmy, Little Wolverine, Wolverine and Wind Lakes were conducted in July of 1996. Lake profiles were collected at Little Jimmy, Little Wolverine, and Wolverine Lakes during this period. These profiles included measurements of temperature, dissolved oxygen, specific conductance and total dissolved solids (calculated from specific conductance) at regular depth intervals in several different locations at each lake.

Wolverine Lake

Wolverine and Little Wolverine Lakes have a combined area of 8.4 km². The shoreline perimeter is 30.4 km. The maximum depth recorded during bathymetric surveys was 77.9 m in Wolverine Lake and 18 m in Little Wolverine Lake. Water in Little Wolverine Lake is soft and low in dissolved solids. Nutrients are detectable, particularly ammonia and phosphate species. The water quality in Wolverine Lake is soft and low in dissolved solids. The water is very clear (turbidity less than 0.4 NTU) and neutral in pH. Ammonia is occasionally detectable at the surface and nitrate is occasionally detectable at depth. Phosphates are detectable throughout the water column and appear higher near the lake bottom.

Between July 19th and 20th of 1996, four lake profiles were done at separate locations in Wolverine Lake, roughly following the center axis of the lake. Depths ranged between 20 m and roughly 73 m. These profiles indicate that the limnological conditions of Wolverine Lake are different for the main part of the lake than they are for the northern end. The northern portion of the lake is shallower and almost separated from the main body of the lake by an island.

Surface temperatures at the time of the survey were roughly 13°C at all locations in the lake. The temperature profile (Figure 3.22) shows the very clear development of the thermocline, starting at approximately 5 m depth. This is consistent at all locations measured. For the main body of the lake, temperatures fall below 4 °C at about 25 m depth and are consistent through the underlying hypolimnion. In the shallower northern end of the lake, temperatures drop more quickly with depth and are generally lower than the main body of the lake. This may suggest that this portion of the lake is not as well mixed as the main body. This theory is consistent with the more sheltered characteristics of the northern end.

The oxygen profile (Figure 3.23) shows consistent dissolved oxygen levels throughout the water column at all locations in the main body of the lake. Dissolved oxygen levels are roughly 9 ppm throughout this area. Oxygen levels start to decline at approximately 55 m depth, reaching 7 ppm in the deepest portions of the lake. It should be noted that

this decline in oxygen levels is related to absolute depth. Locations less than 55 m in depth show consistent dissolved oxygen levels throughout the water column. This decline is likely the result of aerobic processes consuming oxygen during the natural decomposition of lake sediments.

The northern end of the lake shows a different pattern, with oxygen levels rapidly declining starting at approximately 10 m depth to about 6 ppm at the lake bottom (20 m). Again, this decline is likely the result of natural decomposition of lake sediments. From the bathymetric profiles of the lake, it is apparent that the northern end is separated from the main body of the lake by a height of land and that the main body is relatively consistent in its bottom profile. This suggests that sediment build-up (and subsequent decomposition and oxygen consumption) would occur primarily at the deepest locations in these two separated basins. The dissolved oxygen profiles support this theory. The decline in oxygen levels, in both cases, occurs in the water column roughly 10 meters above the deepest portion of the basin.

Little Wolverine Lake

Little Wolverine Lake was profiled at one location on July 19, 1996. Surface temperatures were roughly 13°C at that time. The thermal profile (Figure 3.24) shows the development of the thermocline at about 4 m depth. This is slightly shallower than seen in Wolverine Lake. Water temperatures at the lake bottom were approximately 4.6 °C and appeared to stabilize over the last meter of the water column.

The dissolved oxygen profile of Little Wolverine Lake is very erratic (Figure 3.25). The readings indicate a sharp decline in oxygen levels approximately one meter below the surface. Oxygen levels recover over the interval from 2 m to 4 m depth and then decline irregularly to the lake bottom. The trend in dissolved oxygen below the 4 m depth is generally consistent with the oxygen consumption related to sediment decomposition. However, several sharp increases of 1 or 2 ppm in this segment of the water column are indicated by the data. This irregularity may be a result of equipment malfunction although there are no notes to that effect.

Little Jimmy Lake

Little Jimmy Lake has a total area of approximately 0.8 km² and a shoreline perimeter of 6.2 km. The maximum depth recorded during bathymetric surveys was 14.2 m.

The thermal profile (Figure 3.25) of Little Jimmy Lake indicates surface temperatures of approximately 13°C and the development of the thermocline starting at about 5 m depth. This is consistent with the pattern seen in other lakes. Water temperatures stabilize at roughly 7°C below 10 m depth. This is warmer than water temperatures in the hypolimnion of the other lakes.

The dissolved oxygen profile of Little Jimmy Lake (Figure 3.26) is slightly different than the other lakes surveyed. Oxygen levels decline abruptly and in two phases. The first decline occurs between 5 and 6 m depth where dissolved oxygen drops from 9 to 6.5 ppm. The second decline occurs between 8.5 and 9.5 meters, where concentrations drop from 6.5 to 3.2 ppm. From 6 to 8.5 m depth, dissolved oxygen concentrations are consistent at 6.5 ppm.

The low dissolved oxygen levels at the lake bottom indicate substantial oxygen consumption as a result of natural decomposition processes. The higher rate of

decomposition may be related to the higher water temperatures in this lake. The low levels of oxygen may make the depths of this lake uninhabitable for some species of fish. Some anaerobic decomposition may also be occurring and would be noticeable from the smell of sulphur gas in sediment samples.

Wind Lake

Wind Lake has a total area of 1.1 km² and a shoreline perimeter of 7.1 km. The maximum depth recorded during bathymetric surveys was greater than 9 m. No profiles were conducted in Wind Lake.

3.1.5.3 Hydrogeology

Kudz Ze Kayah

Groundwater flows and elevations have been described based on data collected from piezometers and boreholes in 1995. Descriptions and data for the various mine facilities are given in Golder Associates geotechnical reports, presented as Appendices 2.3 and 2.5b of the Kudz Ze Kayah Water Licence Application.

The groundwater table is characterized as a subdued replica of topography, with shallow depths to groundwater in the valleys and much deeper depths below slopes. The Geona Creek valley bottom is a discharge area for groundwater from upslope. Hence, the artesian conditions observed in many boreholes drilled.

In between periods of high runoff induced by either spring snowmelt or summer rain storms, the contribution of base-flow to creeks from groundwater may be a significant proportion of the total creek flow. Alpine snowmelt and melting permafrost would also contribute to streamflows. The valley overburden deposits likely act as a sponge, soaking up water during periods of infiltration, and then releasing it at a declining rate after the infiltration period has passed. In late winter, and during dry summer spells, creek flow may be almost entirely groundwater discharge, mostly from the overburden deposits.

Wolverine

No groundwater information has been collected for the Wolverine Operations Area. Terrain mapping provides some indication of hydrogeological conditions. As seen at Kudz Ze Kayah, the groundwater is likely a subdued replica of the topography. The phreatic level is closer to surface in the valley bottoms and is likely much deeper as slopes increase. This is supported by terrain conditions which show poorly drained areas on valley bottoms and little or no evidence of groundwater springs on the steeper slope in the area.

3.1.5.4 Surface Water Quality

Kudz Ze Kayah

Sampling Program

Cominco initiated a baseline water quality monitoring program in July, 1994. The program was expanded in December, 1994, continuing through to September, 1995. During that 14 month period, samples were collected from 23 stream locations and 6 lakes/ponds (Figure 3.27). Table 3.10 summarizes the sampling locations and sampling frequency at each site.

Water temperature, dissolved oxygen, specific conductance and pH were measured in the field during each sampling trip. Samples for metals analysis were preserved with acid in the field. Filtration for dissolved metals analysis was also performed in the field. Samples were shipped to Zenon Environmental Laboratories in Vancouver, B.C. Table 3.11 contains a list of the parameters analyzed and their respective detection limits. Detection limits for metals were one-tenth of the Canadian Water Quality Guidelines (CCREM, 1987). A field quality control program including field blanks, filtration blanks, and field duplicate was incorporated to the water quality sampling program. The QC samples were submitted "blind" to the analytical laboratory (labelled so that duplicates and blanks were not immediately apparent). Appendices 3.3a, 3.3b, and 3.3c of the Kudz Ze Kayah IEE present the complete water quality database for the project, including analytical certificates, QA/QC results, and analysis of water quality by site.

Results

Geona Creek

Geona Creek water quality on the mainstem varies with the influence of tributaries. The water quality of the ponds is similar to that of the stream, with upstream-downstream differences among ponds being similar to upstream-downstream differences among stream sampling sites.

The pH of Geona Creek is slightly alkaline, with an average of about 7.5 in the upper reaches, increasing to 7.7 to 7.8 near the mouth. The increase in pH apparently results from the tributary inputs. The two west-side tributaries (sites 2 and 3) near the headwaters are less alkaline, with measured pH as low as 6.9 and 6.8, respectively. The east-side tributaries (sites 6 and 18), which enter Geona Creek farther downstream, are more alkaline, with average pH's of 8.1 and 8.0, respectively.

Alkalinity, hardness and specific conductance show patterns similar to that of pH. The water is well-buffered (relatively insensitive to acidic inputs). Most sites have average alkalinities greater than 50 mg/L (Figure 3.28). Alkalinity increases downstream as a result of the high alkalinities contributed by side tributaries (mean alkalinities 130 mg/L at site 6 and 168 mg/L at site 18). The water is moderately soft (average hardness near 100 mg/L) in the upstream reaches, becoming moderately hard to very hard downstream (average hardness 142 mg/L at site 7, increasing to 195 mg/L at site 17 near the mouth) (Figure 3.29). This pattern is consistent with inputs from the tributaries. The site 3 tributary near the headwaters is very soft (average hardness 44 mg/L), while the east-side tributaries downstream are increasingly hard (average hardness 153 mg/L at site 6, 195 mg/L at site 18). Similarly, specific conductance increases downstream, reflecting higher concentrations of the dissolved ions that contribute to alkalinity and hardness (Figure 3.30). Alkalinity, hardness and specific conductance all vary seasonally with maximum levels occurring during base flow conditions (December, April) and minimum levels occurring during freshet (May, June).

Concentrations of algal nutrients, particularly phosphorus are relatively low. Average total phosphorus concentrations are less than 10 µg/L at all mainstem sites, and maximum concentrations are less than 20 µg/L (Figure 3.31). Phosphorus concentrations in the tributaries are similarly low. The Site 18 tributary is anomalously high with an average total phosphorus concentration of 40 µg/L (range 25 to 63 µg/L).

Nitrate concentrations are generally low near the Geona Creek headwaters, including the headwater ponds, while farther downstream the nitrate concentrations appear more variable (Figure 3.32). The highest nitrate concentrations were recorded in December, 1994, and April, 1995, when there was snow cover and groundwater discharge provided a major proportion of streamflow. In the summer when headwater flows were available, nitrate was generally undetectable or near the detection limit (20 µg/L), even at the downstream sites.

Sulphate concentrations are elevated throughout Geona Creek with average concentrations usually in the 20 - 30 mg/L range. Concentrations are more variable near the headwaters (in the ore zone). The highest sulphate concentrations occurred in the winter low flow samples. This seasonal pattern likely is caused by the higher proportion of groundwater that has been mineralized by contacts with sulphides in the orebody. There is also a significant sulphate contribution from Fault Creek (site 2), but the other west-side tributary (site 3) apparently carries less sulphate than mainstem Geona Creek (Figure 3.33).

Iron and zinc concentrations are generally elevated in Geona Creek, particularly in the headwaters (ore zone). Average concentrations of both total iron and total zinc exceed the Canadian Council of Resource and Environment Ministers (CCREM) guidelines (1987) for protection of aquatic life (300 µg/l and 30 µg/L, respectively) (Figures 3.34 and 3.35). High concentrations of total iron and zinc occurred in May, 1995, during a period of relatively high flows. The maximum concentrations of dissolved iron and zinc occurred during winter low flows. Thus, groundwater, which leaches the orebody, appears to be a significant contributor of these metals, at least in the winter.

The iron and zinc concentrations in the tributaries differ from the mainstem creek and/or from each other. Both the west-side and east-side tributaries are low in iron (Figure 3.24), confirming that the orebody and/or the bedrock of the valley bottom is the primary source of iron in Geona Creek. By contrast, the two west-side tributaries near the headwaters (sites 2 and 3) carry high concentrations of zinc, while the east-side tributaries farther downstream have considerably lower concentrations (Figure 3.35).

Copper concentrations are variable. Total copper concentrations sporadically exceeded the applicable CCREM guidelines, which vary with hardness. These periodic exceedances occurred throughout most of Geona Creek but did not occur in any of the tributaries (Figure 3.36).

Total selenium concentrations in mainstem Geona Creek, Fault Creek and the east side tributaries periodically exceeded the 1 µg/L CCREM guideline (Figure 3.37). The highest selenium concentration measured was 2.4 µg/L in the headwater pond (site 11). Maximum selenium concentrations at all other sites were less than 2 µg/L. Most guideline exceedances occurred during base flow conditions (December, 1994, and April, 1995). Maximum dissolved selenium concentrations also occurred during base flow, suggesting that selenium, like iron and zinc, leaches from the orebody.

Other environmentally significant metals/metalloids (arsenic, cadmium, chromium, mercury, nickel, lead) are far below the applicable CCREM guidelines, with a few exceptions. Mercury never exceeded detection limits ranging from 0.01 to 0.05 µg/L in any stream but was detected once (0.02 µg/L) in the headwater pond (site 25). Cadmium levels were well below 1 µg/L at most sites, exceeding the CCREM guideline

only in the site 3 tributary, where the maximum concentration was 2.1 µg/L. Lead, at a concentration of 5.9 µg/L, exceeded the applicable guideline (2 µg/L) once in the site 25 pond. Chromium concentrations at sites 2, 6, 7, 11 and 17 occasionally exceeded the 2 µg/L guideline for protection of phytoplankton and zooplankton but never exceeded the 20 µg/L guideline for the protection of fish. Arsenic, mercury and nickel concentrations were below the CCREM guidelines at all sites.

Finlayson Creek

The water quality of Finlayson Creek continues the pattern of Geona Creek water quality. The pH, alkalinity, hardness and specific conductance immediately upstream and downstream of the Geona Creek confluence are similar to or slightly lower than those of Geona Creek (Figures 3.28 to 3.30). Levels of all four parameters are higher near the mouth of Finlayson Creek. The average pH of Finlayson Creek varies from 7.7 upstream of Geona Creek to 8.0 near the mouth. Over the same stretch, the average alkalinity varies from 121 to 176 mg/L, while the average hardness increases from 142 to 208 mg/L. Similarly, specific conductance increases from 254 to 367 µS/cm. Geona Creek appears to have little effect on the levels of these parameters in Finlayson Creek. The seasonal water quality pattern is similar to that in Geona Creek with maximum alkalinity, hardness and specific conductance occurring during base flows and minima occurring during freshet.

Nutrient levels in Finlayson Creek are similar to those in Geona Creek, although somewhat more variable (Figures 3.31 and 3.32). The average phosphorus concentration at site 26 near the mouth of Finlayson Creek (11 µg/L) is double the average concentration at the two upstream sites. This increase probably indicates an accumulation of phosphorus from upstream sources. One such phosphorus source may be in the lower reaches of East Creek. Nitrate levels in Finlayson Creek, as in Geona Creek, were high during winter low flows, but undetectable during the summer.

Sulphate levels in Finlayson Creek increase in a pattern similar to that of other dissolved ions (as indicated by alkalinity, hardness and specific conductance). Although Geona Creek contributes some of the sulphate to Finlayson Creek, the highest average sulphate concentration (28.7 mg/L) was recorded near the mouth (Figure 3.33), suggesting other sulphate sources in the watershed.

The spatial pattern of iron in Finlayson Creek is somewhat similar to that of sulphate. Upstream of the Geona Creek confluence iron concentrations were always below the CCREM guideline (300 µg/L). The average concentration increases below Geona Creek, with an even greater increase near the mouth of Finlayson Creek (Figure 3.34). At the latter two sites (sites 15 and 26, respectively), iron concentrations sometimes exceeded the CCREM guideline. Maximum total and dissolved iron concentrations occurred in May and/or June during the high flow period.

Average total zinc concentrations were similar at all three Finlayson Creek sites, and also similar to the downstream Geona Creek sites (Figure 3.35). However, concentrations were seasonally variable, occasionally exceeding the CCREM guideline of 30 µg/L. Total zinc concentrations peaked during the freshet (May), while dissolved zinc concentrations peaked during winter low flows (December or April). This seasonal and spatial pattern of zinc concentrations suggests that there may be both groundwater and surficial zinc sources throughout the Finlayson Creek watershed.

The range of variability in copper concentrations was similar at all three Finlayson Creek sampling sites, although the average concentration was slightly higher at the downstream site (1.3 µg/L) compared with the two upstream sites (0.8 µg/L). Copper concentrations did not exceed the CCREM guideline (3-4 µg/L, based on the range of hardness recorded in Finlayson Creek).

Selenium concentrations in Finlayson Creek are in the same range as levels in Geona Creek. During the winter low flow period (December, 1994, and April, 1995), total selenium concentrations both upstream and downstream of the Geona Creek confluence (sites 16 and 15) exceeded the CCREM guideline of 1 µg/L (Figure 3.37). At the mouth of Finlayson Creek (site 26), selenium did not exceed 1 µg/L, but in April, 1995, the selenium concentration was 0.92 µg/L. Dissolved selenium levels were highest during the winter low flows, suggesting groundwater as the major source of selenium in Finlayson Creek, upstream as well as downstream of Geona Creek.

Concentrations of other metals/metalloids in Finlayson Creek are generally low. Chromium concentrations at all three sites occasionally exceeded the 2 µg/L guideline for protection of phytoplankton and zooplankton but never exceeded the 20 µg/L guideline for the protection of fish. Arsenic, cadmium, mercury, nickel, and lead met the applicable CCREM guidelines at all times. Mercury was detected at concentrations ranging from 0.02 to 0.05 µg/L at all sites, but these values are below the 0.1 µg/L CCREM guideline.

East Creek

The water quality of East Creek is generally similar to that of lower Geona and Finlayson Creeks, and shows a similar pattern of increasing concentrations of dissolved ions from headwaters to mouth (Figures 3.28 to 3.37). However, the site near the mouth of East Creek (site 21) has the greatest range of variability for many parameters compared with any of the monitoring locations. For example, measured hardness ranged from 107 to 378 mg/L (Figure 3.29), while total phosphorus concentrations varied from 5 to 94 µg/L (Figure 3.31).

Sulphate, iron and zinc concentrations also increase from headwaters to mouth. Sulphate concentrations in the headwaters (site 19) and mid-reach (site 20) of East Creek were lower than those in Geona and Finlayson Creeks, but near the mouth of East Creek, sulphate concentrations were within the range of values recorded in upper Geona Creek (mean 34.6 mg/L) (Figure 3.33). Total iron concentrations in upper and middle East Creek are comparable to those in lower Geona and Finlayson Creek. Near the mouth of East Creek, iron concentrations were similar to those within upper Geona Creek, with all samples containing concentrations above the CCREM guideline of 300 µg/L (Figure 3.34). Total zinc concentrations were somewhat higher at the downstream site compared with the two upstream sites. The average zinc concentration (8 µg/L) was considerably less than that in upper Geona Creek (Figure 3.35). This spatial pattern of sulphates and metals suggests that there is iron sulphide mineralization in the lower East Creek watershed, but, unlike the orebody in Geona Creek, this mineralization does not contain a significant amount of zinc. The small amount of zinc present appears to be contributed by groundwater, as indicated by the maximum dissolved zinc concentrations being measured during the April, 1995 (low flows). Peak concentrations of dissolved iron did not show a consistent seasonal pattern.

Concentrations of other metals are low throughout East Creek. For example, copper concentrations never exceeded 1 µg/L at the upper and mid-reach sites, or 2 µg/L at the downstream site (Figure 3.36). The maximum selenium concentration in East Creek was 0.38 µg/L. In middle and lower East Creek (sites 20 and 21) chromium occasionally exceeded the 2 µg/L CCREM guideline for the protection of phytoplankton and zooplankton, reaching a maximum concentration of 4.8 µg/L at site 20. Other metals and metalloids (arsenic, cadmium, mercury nickel and lead) met the CCREM guidelines at all sites and times with the exception of an anomalous lead value measured in lower East Creek (site 21). This anomaly consisted of a total lead concentration of 32 µg/L and a dissolved lead concentration of 2 µg/L. The maximum total lead concentration measured at any other time was 0.7 µg/L.

South Creek and North Lakes

The water quality of the South Creek/North Lakes drainage is significantly different from that of the Finlayson Creek drainage (including Geona and East Creeks). The water is less alkaline and softer. Average pH at the South Creek/North Lakes sampling sites varied from 7.2 to 7.7. Average alkalinity ranged from 39 to 60 mg/L (Figure 3.28), while average hardness varied from 30 to 79 mg/L (Figure 3.29). Specific conductance was also lower than at most sites in the Finlayson Creek drainage, reflecting the lower concentrations of dissolved ions.

Nutrient (nitrogen and phosphorus) concentrations varied spatially, being low in the North Lakes (sites 22 and 23), in the outlet stream (site 27), and at the headwaters of South Creek (sites 1 and 12), but periodically higher downstream on South Creek (site 13) and in North Lakes Creek downstream of the confluence with South Creek (site 14). The nutrient levels in the South Creek/North Lakes drainage did not differ significantly from those in the Finlayson Creek drainage (Figures 3.31 and 3.32).

Sulphate concentrations are lower in the South Creek/North Lakes drainage compared with most sites in the Finlayson Creek drainage (Figure 3.33). The highest concentrations of sulphate occurred at the headwaters of South Creek (sites 12 and 1), near the drainage divide with Geona Creek.

Metal concentrations in the South Creek/North Lakes drainage are generally similar to those in the Finlayson Creek drainage, although slightly lower values occur in the North Lakes drainage upstream of the South Creek confluence. Average total iron concentrations ranged from 91 to 231 µg/L. Maximum iron concentrations exceeded the 300 µg/L CCREM guideline in the streams, but not in most of the lakes (Figure 3.34). Average zinc concentrations were 4 to 15 µg/L in South Creek and in North Lakes Creek below the South Creek confluence, but 2 to 3 µg/L in the North Lakes and their outlet stream. Total zinc concentrations measured in the South Creek/North Lakes drainage never exceeded the CCREM guideline of 30 µg/L (Figure 3.35). Similarly, copper concentrations were slightly higher in South Creek compared with the North Lakes. The maximum total copper concentration in the creek, exceeded 2 µg/L (the applicable CCREM guideline for the range of hardness in South Creek) (Figure 3.36).

Selenium concentrations are lower in the entire South Creek/North Lakes drainage compared with the Geona/Finlayson drainage. Selenium concentrations never exceeded the 1 µg/L CCREM guideline.

Concentrations of other metals/metalloids in the South Creek/North Lakes drainage are low. In the headwater lake (site 12) chromium occasionally exceeded the 2 µg/L CCREM guideline for the protection of phytoplankton and zooplankton. No other metals exceeded CCREM guidelines at any site, and chromium met the guideline at all sites except the lake. Mercury was detected occasionally at sites 13, 14 and 24, with a maximum concentration of 0.02 µg/L (compared with a CCREM guideline of 0.1 µg/L).

The distribution pattern of metals and sulphates in the North Lakes/South Creek drainage suggests some groundwater originating from the mineralization near the Geona Creek/South Creek drainage divide discharges to the drainage. However, dissolved metals show no clear seasonal pattern that would suggest groundwater as the major source of metals.

Wolverine

Sampling Program

Westmin Resources conducted a water quality sampling programs in 1995, 1996, and 1997 for the Wolverine Project. The locations of the water quality sampling stations, along with the frequencies of visits, are provided on Table 3.12. Samples were collected from 35 sites, including 28 stream locations and 7 lake locations. The water quality monitoring stations are shown on Figure 3.38. In 1995, one round of samples was collected during October 2-4. There were 22 sample stations identified during this initial sampling effort. In 1996 and 1997 the program was expanded and sampling stations were designated as "routine" stations or "comprehensive" stations. During both years, routine stations were sampled in late March and samples were collected on a monthly basis until June. Samples were collected on a roughly biweekly basis, starting with the June samples, for five (1997) or six (1996) consecutive sampling rounds. Comprehensive stations were sampled twice during the summer exploration program, during mid-July and late August or early September. Expatriate Resources conducted one round of water sampling in 2000 but results were not available at the time of this report. Station by station summaries of the water quality sampling are available in Appendix 3B. During July 19-20, 1996 Westmin Resources conducted limnology studies for the lakes in the project area. Water quality samples were collected at various depths in Little Wolverine Lake, the inflow to Wolverine Lake, and at several locations in Wolverine Lake.

In-situ parameters of temperature, pH, specific conductance, and dissolved oxygen were measured with each water sample taken. Samples collected in 1995 were sent to Quanta Trace Laboratories in Burnaby, B.C. for analysis. Samples collected in 1996 and 1997 were sent to ASL Labs in Vancouver, B.C. The parameters analyzed and their respective detection limits and methodology are presented in Table 3.13.

QA/QC protocols included submission of duplicate samples and field-filtered blanks. In addition, 10% of all samples sent to ASL were subject to duplicate analysis.

Results

Wolverine Drainage

The Wolverine Drainage contains a wide range of water body types, from small streams to the very large Wolverine Lake. Water quality is dependent on the type of water body. The smaller catchments that feed Wolverine Lake have a different characteristics than

the lake itself. The water quality downstream of Wolverine Lake (Nougha Creek) is similar to the lake. The lake is the major contributor to flows in this creek and the similarities in water quality are not surprising.

The pH throughout the watershed is consistently slightly alkaline (Figure 3.39). Average pH values range between 7.6 and 7.8 at almost all sample stations. Station W1 (Nougha Creek downstream of Wolverine Lake) showed a high range of values for pH, between 8.6 and 7.3.

Total dissolved solids, hardness, and sulphate concentrations show an identical pattern throughout the drainage, indicating the correlation between these variables (Figures 3.40 to 3.42). Concentrations of these parameters are elevated in the small streams that drain into the lake from the north side. Average hardness and TDS values in these streams ranged between 75 mg/L and 250 mg/L with a maximum of 400 mg/L TDS in Wolf Creek (W2). Conditions are similar in Wind Lake and Wind Creek, which enter the lake from the extreme northwestern end. Concentrations in Wolverine Lake itself are lower than in these streams and show very little variation. Total dissolved solids were consistently measured at around 75 mg/L. The outflow of Wolverine Lake (Nougha Creek) has average values similar to the lake but more variation. Maximum total dissolved solids were measured at 135 mg/L. At the Robert Cambell Highway crossing, average concentrations and range of variation for these parameters has increased.

Nutrient concentrations are lower in the lakes (Wolverine and Wind) than in the contributing creeks (Figure 3.43). Total nitrogen species (nitrate, nitrite, ammonia) in the lakes averaged between approximately 0.04 mg/L and 0.08 mg/L. In the creeks, these values ranged between 0.09 mg/L and 0.18 mg/L.

Concentrations of zinc, copper, arsenic, iron, aluminium and nickel were consistently detected throughout the watershed (Figure 3.44). Detections of silver, cadmium, selenium and lead, were less consistent and were never detected in several of the stations. In three stations (W9, W4 and W2) consistent detections of cadmium, selenium, zinc, and iron indicate correlation in for these parameters in these streams. These streams drain the Wolverine and the Fisher exploration targets. An association of detectable lead, nickel, and zinc is also apparent in the W2, W4 and W29 (Wind Lake) stations.

Maximum and average values of copper naturally exceeded the CCME water quality guidelines for the protection of aquatic life at most of the stations throughout the watershed (Figure 3.45). Concentrations of zinc, iron, aluminium, selenium, cadmium, and silver occasionally exceed these guidelines under natural conditions (Figures 3.46 to 3.51). Many of these exceedances can be attributed to those streams which drain mineralised areas, namely Viking Creek (W4), Wolf Creek (W2), and Wolverine Creek (W9). Arsenic, Nickel and lead did not exceed the guidelines at any of the stations in the watershed (Figures 3.52 to 3.54). Some values for lead are seen to exceed the guideline but this is an artefact of high detection limits.

Little Wolverine Lake

Water in Little Wolverine Lake is soft and low in dissolved solids (Table 3.14). Nutrients are detectable, particularly ammonia and phosphate species. Both of these are important for algal growth. Metals concentrations are below CCME criteria for the protection of aquatic life.

In profile, there is a slight increase in dissolved solids with depth. Phosphate concentrations increase with depth, as does chlorophyll, indicating primary productivity occurs at depth. The water is clear (turbidity of 1.7 NTU at 8 m depth) and light penetration is sufficient to sustain primary productivity at the lake bottom.

Inflow to Wolverine Lake

The inflow channel to Wolverine Lake has very soft water with low levels of dissolved solids (Table 3.15). Ammonia and phosphate are detectable throughout the water column. Concentrations of metals are below CCME guidelines for the protection of aquatic life.

In profile, there is a slight decrease in pH, increase in alkalinity and increase in total calcium with depth. Phosphates increase with depth, as does chlorophyll, indicating increasing primary productivity with depth. The water column is clear (turbidity of 1.6 NTU at 12 m depth) and light penetration sufficient to maintain measurable levels of primary productivity. There is a sharp increase in manganese near the lake bottom.

Wolverine Lake

The water quality in Wolverine Lake is soft and low in dissolved solids (Table 3.16). The water is very clear (turbidity less than 0.4 NTU) and neutral in pH. Ammonia is occasionally detectable at the surface and nitrate is occasionally detectable at depth. Phosphates are detectable throughout the water column and appear higher near the lake bottom. Metals are below CCME guidelines for the protection of aquatic life. Notably, selenium and zinc are below the method detection limits.

Spatially, water quality is consistent throughout the lake. There is a slight increase in dissolved solids with depth. This is accompanied by a slight decrease in pH and increases in hardness and total calcium, magnesium, and sulphates. These trends are very slight but generally consistent. Phosphate concentrations seem to increase sharply at the lake bottom. Primary productivity, as measured by chlorophyll, is lower than the smaller lakes and shows no consistent trends with depth or spatial variation. Distribution is relatively uniform, compared to the smaller water bodies.

Go / Money Creek Drainage

There are no large lakes in this drainage basin and water quality between sample sites is relatively consistent. pH values in this drainage may be slightly less alkaline than the Wolverine drainage (Figure 3.39). Average values ranged between approximately 7.5 and 7.8. Minimum pH values were below 7.3 for half the stations in this drainage.

As with the Wolverine drainage, total dissolved solids, hardness, and sulfate concentrations showed similar patterns, indicating the correlation between these parameters. Go Creek has softer water and there is less variability in these parameters than in Money Creek. Average TDS in Go Creek ranged around 75 mg/L with a maximum around 110 mg/L. In the larger Money Creek, average TDS values ranged between 60 and 110 mg/L with maximum around 190 mg/L at the Robert Campbell Highway crossing.

Nutrient concentrations are relatively consistent throughout the mainstem of Money Creek. Average total concentrations of nitrogen species (nitrate, nitrite, and ammonia) ranged between 0.11 and 0.12 mg/L from the headwaters to the Robert Campbell Highway crossing. Nitrogen concentrations tended to be lower in the smaller,

contributing creeks with the exception of Pup Creek, which had average concentrations above 0.12 mg/L.

As with the Wolverine Drainage, concentrations of zinc, copper, arsenic, iron, aluminium and nickel were detected at all sampling stations throughout the drainage (Figure 3.55). Lead, selenium, cadmium, and silver were rarely detected in the watershed.

Similar to Wolverine, copper concentrations exceeded the CCME guidelines for protection of aquatic life at almost every station in the watershed (Figure 3.45). Zinc, iron, and selenium very rarely exceeded their guidelines. Aluminium, arsenic, lead and nickel never exceeded their respective guidelines. Selenium, cadmium, and silver show infrequent exceedances of their guidelines. These are likely an artefact of high detection limits.

3.1.5.5 Groundwater Quality

Kudz Ze Kayah

During the summer of 1995, geotechnical properties of soil and rock were evaluated in the vicinity of the proposed dam, dump and pit sites. Boreholes were drilled and piezometers installed. Selected piezometers and exploration boreholes in the area of the open pit were sampled on September 4, 1995 (see Figure 3.56). One piezometer below the proposed tailings dam (95G-13D), and one either side of the pit (95G-26 and 29) were sampled, and analyzed for a range of non-metal "general parameters" and total and dissolved metals. The general parameters included pH, conductivity, suspended solids, dissolved solids, hardness, alkalinity, nitrogen species, phosphorous and sulphate. Three other piezometers, located on the north and south sides of the pit (95G-21 and 23), and approximately 0.5 km north of the pit at the toe of a proposed waste rock dump (95G-31) were sampled. These samples were analyzed for total and dissolved metals only.

To supplement the database, a number of flowing exploration boreholes were also sampled. One each on the north and south sides of the pit were sampled (T94-23 and 49) and analyzed for general parameters and total and dissolved metals. Three other borehole samples (T94-14, 26 and 30) were analyzed for total and dissolved metals only. All of the exploration boreholes were cased through the overburden, and are open for the remaining length of the borehole in bedrock.

At the time of sampling, readings of pH, conductivity, dissolved oxygen and temperature were collected. These, together with piezometer and borehole completion details, are given in Table 3.17. Results are given in Table 3.18. Analytical certificates can be found in Appendix 3.3a of the Kudz Ze Kayah IEE.

In many respects the groundwater quality does not differ greatly from that of the surface water. The groundwater pH is similar to that of surface water. Alkalinity, total dissolved solids and hardness are slightly higher in groundwater than in surface water, reflecting the higher concentrations of dissolved ions that are typical of groundwater. Sulphate concentrations are variable, with two wells (one shallow, one deep) having sulphate concentrations more than double the concentrations in surface water and the remaining three having concentrations more similar to surface water.

Groundwater does not appear to be a major source of algal nutrients, except that the shallow groundwater provides phosphorus. Concentrations of nitrate, nitrite and ammonia were generally low except for a moderate level of nitrate (0.13 mg N/L) in shallow well 95G-26. The two shallow wells (<10 m deep in the overburden) had phosphorus concentrations an order of magnitude or more above those measured in surface water.

For the most part metal levels in both shallow and deep groundwater are low. In particular, copper and lead concentrations in all groundwater samples were equal to or lower than the concentrations in surface water. Exceptions to the pattern of low metals were elevated levels of arsenic and iron in the three deep (bedrock) wells in the orebody (T94-49, T94-30 and T94-13) and elevated arsenic, iron, cadmium and zinc in one well from the overburden (95G-26).

The deep well with the highest arsenic and iron concentrations (170 µg/L and 4300 µg/L, respectively) also had elevated sulphate (71.4 mg/L) and the lowest pH and alkalinities of any of the wells measured. Zinc was also somewhat elevated 160 µg/L. Sulphate, pH and alkalinity were not measured in the shallow well that had elevated arsenic, iron, cadmium and zinc (95G-26).

3.1.5.6 Sediments

Kudz Ze Kayah

Sample Program

Two sets of streambed sediment samples were collected. Sediment samples were collected from eight water quality sites in July, 1994. The sampling sites were concentrated in the area of the orebody and included sites in the Geona Creek main stem, its tributaries and South Creek (Table 3.19). In September, 1995, sediment samples were collected from six water quality sites, including three sites in Geona Creek, two in South Creek and one in East Creek. The 1995 samples were collected in triplicate. Analytical certificates are included in Appendix 3.3a of the Kudz Ze Kayah Water Licence Application.

The Cominco Exploration laboratory analyzed the 1994 samples for metals. The 1995 samples were screened (by sieving), and the fraction less than 53 µm was analyzed by Zenon for metals, total organic carbon and acid volatile sulphide. The particle size distributions were also reported.

Results

Sediment metals concentrations are elevated in the headwaters of Geona and South Creeks (Tables 3.20 and 3.21). At one or more sites in 1994 and/or 1995 the concentrations of arsenic, cadmium, copper, iron, manganese, lead and zinc exceeded the 95th percentile of the metal concentrations measured in sediments across the south-eastern Yukon by the Geological Survey of Canada (Hornbrook *et al.* 1989). The elevated metal concentrations reflect the mineralized nature of the project area.

The highest concentrations of most metals occur in the vicinity of the orebody. Metal concentrations at site 4 (the ore zone) are particularly elevated (Figures 3.57 to 3.60). Metal concentrations are also elevated at site 1, the headwaters of South Creek, which

may receive some groundwater seepage from the orebody. Cadmium, lead and zinc concentrations are lower, downstream in South Creek (site 13) and in East Creek (site 20), compared with Geona Creek or the South Creek headwaters.

Some differences in metal concentrations occurred between the 1994 and 1995 samples. Concentrations of many metals were higher in 1994 than in 1995, particularly at sites 4 and 7. Several factors may account for these differences. In 1994, Cominco Exploration personnel noted extensive iron hydroxide precipitates at many sites. Metals such as arsenic, cadmium and zinc may have precipitated with the iron hydroxide, resulting in anomalously high sediment concentrations. In 1995, Norecol Dames & Moore personnel noted minimal evidence of iron hydroxide precipitates, and did not sample from any area where iron staining was observed.

However, correlations between pairs of metals in both the 1994 and 1995 samples suggest that co-precipitation with iron is not responsible for elevated levels of cadmium, lead and zinc. The distribution of these three metals did not show any significant correlation with the distribution of iron in either year (Table 3.22). In 1994, all metals except chromium were positively correlated with manganese (high concentrations of metals occurred where manganese was high), whereas in 1995, there was a slight (but not significant) negative correlation of cadmium, copper, lead and zinc with manganese (low concentrations of the metals occurred where manganese was high). It is possible that scavenging of metals (co-precipitation) by manganese hydroxide precipitates was responsible for the higher metals levels measured in 1994, and that similar manganese precipitates were not encountered in 1995.

Other differences in sediment composition may have contributed to the differences in metals concentrations. For example, the concentration of total organic carbon was lowest at site 7 (Figure 3.61). This site also had the lowest metal concentrations in Geona Creek. Metals may adsorb onto organic particles, and thus metals concentrations often increase simultaneously with those of total organic carbon. The higher 1994 metals levels at sites 4 and 7 may have been associated with localized deposits of organic material.

Acid volatile sulphide (AVS) concentrations were measured as an indicator of the biological availability of metals in the sediments. Increasing concentrations of AVS correlate with increasing availability of metals to biota. The highest concentrations of AVS occurred at sites 1 and 4 (Figure 3.62), which also had the highest concentrations of metals.

Sample Variability

Statistical analysis was used on the 1995 (replicated) sediment data to determine the number of samples required to detect a 50% change in average metals concentrations 80% of the time. Results indicate that triplicate samples should be sufficient for any future sediment monitoring.

Selenium in Sediments

A specific program of sediment and water sampling was carried out in 1997 to develop a site specific selenium criterion. The average sediment selenium concentration in Finlayson Creek between Geona Creek and East Creek (based on five sampling sites) was about 1.3 µg/g (range over the three sampling periods: 1.2 to 1.4 µg/g). The standard deviation ranged from 0.24 to 0.56. The variability of selenium concentrations

within sites in Finlayson Creek is lower than the variability among sites. The seasonal variability (comparing May, July and August values) is similar to the within-site variability and less than the variability among sites.

Wolverine

Sampling Program

Stream sediment sampling was first initiated in October 1995. This program sampled fine sediments from 18 stream sites. In July of 1996 a second sediment sampling program was conducted and consisted of the following:

- Stream sediments were collected from each of the twenty-four water quality stream monitoring sites; and
- Lake sediments were collected from the deepest sections of Little Jimmy and Little Wolverine Lake and from four deep areas in Wolverine Lake.

In these programs a single sample was collected from an exposed area of the stream bank, generally characterized by the finest grain size evident at each site. All samples were of recently transported streambed load and were collected using a teflon trowel. Lake sediments were collected from the deepest areas in each of the lakes with an Ekman dredge. The material within the dredge was sub-sampled with a teflon trowel to ensure that the sample was not in contact with the metal walls of the dredge. The stream and lake sediment samples were collected and placed in labeled ziplock bags and packed with ice for transport to the laboratory. The samples collected in 1995 were analyzed by Quanta Trace Laboratories of Burnaby, B.C. The samples collected in 1996 were analyzed by Chemex Laboratories Limited in Vancouver, B.C.

The laboratory analysis consisted of determining ICP metals concentrations for two particle sizes:

- less than 0.070 mm; and,
- between 0.070 to 2 mm.

Dissolved organic carbon was also analyzed on both of these portions. Particle size analyses were not performed on the samples. Two separate particle size fractions were analyzed as recommended by Environment Canada.

The location of the stream and lake sediment sample sites are shown on Figure 3.63. The stream sample location and coordinates are shown on Table 3.12 within the water quality section.

Results - Stream Sediments

Concentrations of metals in sediment are presented in Appendix 3C. Levels of dissolved organic carbon and metals are higher in the smaller size fraction (<0.070 mm) in most samples. Concentrations of copper and chromium exceed the CCME Interim Sediment Quality Guidelines (CCME, 1999) in most samples. Concentrations of zinc and cadmium are highest in Wolverine Creek. Copper levels are highest in Viking Creek. Wolf Creek also shows high levels of zinc, cadmium, cobalt, and nickel. These three streams drain the mineralized areas of the Wolverine and Fisher Zones. Station W-18 (upper tributary to Go Creek) reported the highest iron concentrations, although the levels were only slightly higher than those reported from downstream stations W-17 and W-19.

Metals concentrations appear consistent with sediment quality across the south eastern Yukon. Concentrations seem to range around the 50th percentile of concentrations for the region.

Correlation analysis indicates an association between iron, cobalt, and chromium in sediment, possibly due to co-precipitation reactions (Table 3.23). There is also a possible relationship between manganese and molybdenum and between molybdenum and dissolved organic carbon.

Results - Lake Sediments

Concentrations of metals in sediments is presented in Appendix 3C. Unlike stream sediments, most metals concentrations appeared higher in the larger size fraction (between 0.07 mm and 2 mm). The exception was lead which appears to accumulate preferentially in the smaller size fraction (<0.7 mm). The highest concentrations of copper, cadmium, and zinc are found in the sediments of Little Wolverine Lake. Little Jimmy Lake had the lowest concentrations of metals in sediment, with exception of molybdenum which was highest in this lake. Concentrations of cadmium, iron, manganese, molybdenum, and zinc, are generally higher in these lake sediment than average values from regional stream sediments. Concentrations of cobalt, copper, nickel and lead seem relatively consistent with regional stream sediment values. Concentrations of cadmium, chromium, copper, and zinc exceed the CCME Interim Sediment Quality Guidelines (CCME, 1999) in Little Wolverine and Wolverine Lakes.

Correlation analysis (Table 3.23) indicates several potential relationships between metals in sediment. Cadmium correlates very well with zinc and copper and moderately with dissolved organic carbon and lead. Cobalt correlates well with copper and moderately with zinc. Chromium shows a similar pattern. Copper correlates very strongly with zinc. Lead and zinc show a possible correlation to dissolved organic carbon. Molybdenum shows a consistent negative relationship with all other metals. This negative correlation is strongest with cadmium, cobalt, copper, and zinc. This may be due to differences in sediment contribution quality on a watershed level or to possible replacement reactions between these metals at binding sites on sediment particles.

3.2 Biological Environment

3.2.1 Aquatic Environment and Fisheries Resources

3.2.1.1 Kudz Ze Kayah

The fisheries studies included primarily fish sampling and aquatic habitat surveys. Water quality, benthic invertebrate and zooplankton sampling were also completed during the fisheries field program. A detailed description of study methodology is presented in the Kudz Ze Kayah IEE. Table 3.24 provides a chronological summary of the fisheries fieldwork undertaken in 1995. Fish, water quality, benthic invertebrate and zooplankton sampling sites are shown on Figure 3.64. Fish sampling sites only are shown on Figure 3.65 for ease of reference. Analytical certificates relating to fish studies are included in Appendix 3.3a Of the Kudz Ze Kayah Water Licence Application.

Stream Benthos

The results of the stream benthic sampling are summarized in Table 3.25. Appendix 3.5 of the Kudz Ze Kayah Water Licence Application provides the percentage abundance (by numbers) of each taxonomic group (taxon) of benthic invertebrates in each sampling

area. The total numbers and percentage contribution of each taxon, the totals and mean numbers of organisms per sample and per square metre (m²), and diversity indices are also given in Appendix 3.5 of the Kudz Ze Kayah Water Licence Application.

Geona Creek

Station 9 in Geona Creek had approximately 34 different invertebrate groups (families or genera) and almost 163,000 organisms per square metre. The diversity index was moderately high at this site indicating a healthy mix of taxa. Of that total number, 76% were dipterans, including over 37% of the total as either *Cricotopus* or *Orthocladius* species of the dipteran family Orthoclaadiinae. The next largest group was also dipteran, with over 25% of the total number of benthic organisms in the genus *Micropsectra* of the family Chironominae (midges). The third highest number of benthic invertebrates at Station 9 in Geona Creek were mayflies (Ephemeroptera).

Finlayson Creek

Station 16 is also in Finlayson Creek just upstream of Geona Creek. The total number of benthic organisms at that site in September, 1995, was approximately 30,000/m². The diversity index was 0.98 indicating a relatively high diversity of invertebrate taxa in the benthic community. Almost 59% of these were dipterans, including 32% (of the total benthos) as *Micropsectra*, followed by *Tvetenia*. Over 21% of the total invertebrates at Station 16 were mayflies (Ephemeroptera). Stoneflies (Plecoptera) accounted for 13%.

Station 15 is in Finlayson Creek just below the confluence with Geona Creek. Approximately 35 taxa were represented in the benthic community at that site in September, 1995, and the diversity was high. The total number of organisms/m² of substrate was 53,251. Over 43% of these were dipterans, particularly *Micropsectra* and *Cricotopus*, while the mayflies were also strongly represented at almost 30% of the total number of invertebrates at the site.

East Creek

Station 19 in upper East Creek showed a total number of organisms/m² of only 9,620, including 27 different taxa (families or genera). When one of the samples (#5) which had unusually low numbers is taken out of the calculation, the total number of organisms/m² at this site was approximately 12,000. This station showed a relatively high diversity of benthic taxa. Almost 63% of the total was diptera, especially *Micropsectra* and *Cricotopus*, while stonefly (Plecoptera) nymphs made up almost 15% of the total. Worms, particularly naids and tubificids accounted for 11.6% of the total. Sediments at this site had relatively high proportions of fine-grained material.

Station 20 is located in East Creek, above the natural lake in the mid-reaches. This site produced over 245,800 invertebrate animals/m² of substrate and included almost 33 different taxa in total. The diversity index was moderate indicating relatively less diversity of different taxa compared with Station 19 upstream, and similar to those in upper Geona Creek (Station 9) and lower South Creek (Station 13). Eighty-three percent of the total was two-winged fly larvae/pupae (dipterans), especially *Cricotopus* (37.9% of total) and *Micropsectra* (29.1%) of the total. Mayflies comprised almost 10% of the total, and most of these were of the genus *Baetis*.

Station 21 is in the lowermost reach of East Creek just above the confluence with Finlayson Creek. Approximately 75,000 benthic invertebrates occupied each square metre at this site, and over 76% of those were dipterans, primarily species of the genera

Rheotangtarsus, Cricotopus and Eukiefferiella. Almost 8% (each) of the total organisms were worms and crustacean forms. The diversity index was moderately high, similar to Station 19 in upper East Creek.

South Creek

Station 13 in South Creek had over 35 genera/families represented in the benthic community in September, 1995, and also showed a moderately high diversity index similar to Station 9 samples. The total number of organisms/m² averaged over 78,000, of which 80% were dipterans (two-winged flies). The mayfly (ephemeropteran) *Baetis* was also well represented as in Geona Creek.

North River

Station 27 is in the North River above the confluence with South Creek and just below the eastern-most North Lake. There were over 31 taxa (families or genera, usually) and over 118,000 invertebrates/m² of bottom surface. Taxonomic diversity was also moderately high. Diptera formed almost 72% of the total numbers, with mainly *Tvetenia*, *Cricotopus* (and/or *Orthocladius*) and *Micropsectra* species. There was also a relatively high number of worms, particularly naidids and nematodes (round worms), and an unusually high number of the cnidarian (jelly fish) *Hydra* sp. The hydra were likely due to the lake, which is shallow and has abundant aquatic vegetation and plankton, and several fish species.

Station 14 is in the North River below the confluence with South Creek and between the North Lakes. This site showed almost 110,000 invertebrate organisms/m² of substrate in the early September, 1995, sampling period. The diversity index was also relatively high at 1.16, with almost 35 taxa per sample on average. Over 85% of the fauna were dipterans, distantly followed by oligochaete worms and ostracod crustaceans.

Lake Benthos

The lake benthic samples were taken from the two upper ponds in Geona Creek (Stations 11 and 25) and the uppermost lake in South Creek (Station 12).

Station 11, the uppermost headwater pond in Geona Creek, showed relatively high numbers of total organisms (over 225,000/m² of bottom area) and of crustacean benthos (70% of all organisms sampled). Overall taxonomic diversity was considerably lower than at the stream benthic stations. The crustaceans included primarily ostracods (seed shrimp) and harpacticoid copepods (opossum shrimp, sow bugs, sideswimmers), followed by cyclopoid copepods, and are of the same taxonomic families as the planktonic crustaceans (see Section 3.6) in the pond. The diptera, especially the chironomids *Tanytarsus* and *Stictochironomus*, as well as *Procladius* of the *Tanypodinae* family, form only about 25% of the total benthic community by numbers. Worms, especially tubificid (tube-dwelling) oligochaetes (segmented worms) formed a higher proportion (3.3%) of the benthic community compared with the stream samples (typically 0.8%).

The second pond (Station 25) had a considerably higher proportion of worms (31.5%), particularly tubificids in the benthic community, but considerably lower density at just under 9,000 m². There was also a slightly higher proportion of molluscs, including small clams (pelecypods) and snails (gastropods), in the ponds than in the streams. The diversity index was also lower than in the streams, but higher than in the uppermost pond. Crustacean forms, particularly ostracods, formed almost 40% of the benthic

community in the second pond. The diptera again accounted for only about 25% of the benthic invertebrates, considerably less (proportionately) than in the stream samples (see above). Among the dipterans, the dominant forms were as in the upstream pond (Station 11).

Station 12, the uppermost headwater lake (large pond) in South Creek, showed moderate total numbers of organisms per unit area (approx. 35,500) and a high proportion of crustaceans, including copepods, cladocerans and ostracods. Species diversity was moderate. The molluscs again formed approximately 3% of the total benthic community, proportionately higher than in the streams. The larval forms of the dipterans (two-winged flies) comprised approximately 24% of the benthos by numbers, with high proportions of Procladius and Tanytarsus.

Zooplankton

Planktonic invertebrates were sampled in the lakes and ponds of the project area, including the headwater ponds in Geona Creek and the large ponds/lakes in upper South Creek, the natural lake in mid East Creek and in two of the North Lakes (Figure 3.66) to establish the background range of species in the drainage systems. Table 3.26 describes the zooplankton sampling sites in terms of lake/pond sizes, depths, substrate types and *in situ* water quality.

The results of the zooplankton sampling and analysis are summarized in Table 3.27. Details are presented in detail in Appendix 3.6 of the Kudz Ze Kayah Water Licence Application.

Geona Creek Ponds

The zooplankton community in the uppermost pond in Geona Creek (Station 11) was dominated by crustacean copepods and ostracods, numbering over 120,000 and 150,000 per cubic metre, respectively (Table 3-22). There were also large numbers of chironomid larvae, numerous clumps of green single-celled algae (diatomaceous chlorophyta) and, in the near-bottom layer, molluscs (snails). The true zooplankters (copepods and ostracods) are detritivores (feed on detritus), while the chironomids are predators on smaller zooplankters.

The second pond in upper Geona Creek (Station 25) showed a similar zooplankton assemblage as in the uppermost pond, with high numbers of ostracods and copepods, as well as chironomids and, from aquatic vegetation, molluscs. Over 400,000 ostracods (genus *Cypris*) per cubic metre occupied the second pond in September, 1995.

South Creek Lakes

Plankton hauls were completed on both of the lakes/ponds in upper South Creek.

The results for the uppermost lake in South Creek (Station 12) indicate that crustaceans dominate the plankton community, the largest group being the cladoceran *Bosmina*, followed by the copepod *Cyclops*. The total number of true zooplankton taxa was 6 and the total number of zooplankters/m³ was approximately 82,000.

The results for the second lake (Station 24) showed high numbers per cubic metre for the ostracod crustacean *Cypris*, with over 500,000 individuals per cubic metre in the water column. These were followed distantly by the cladoceran crustacean *Moina*, the

cyclopoid copepod crustacean *Cyclops*, the small molluscan snail *Lymnaea* and several chironomid species, including *Paratanytarsus*, *Zalutschia* and *Corynone*.

North Lakes

Plankton hauls were completed on the eastern and southern North Lakes on September 17, 1995. The results indicated that in both lakes the predominant zooplankton groups were crustaceans, including the calanoid copepods *Diaptomus* sp. and *Heterocope* sp., the cyclopoid copepod *Cyclops* sp. and the cladoceran crustacean *Chydorus* sp. (a "water flea"). Small numbers of rotifers (Rotatoria), represented by *Kellicottia* sp. were also present. There may also have been a few other invertebrates captured in the plankton net, including insect larvae, but these did not show in the subsampling and analysis.

East Creek Lake

The East Creek Lake zooplankton samples showed a similar assemblage of taxonomic groups, including (in descending order of abundance): the rotifer *Kellicottia* sp., *Cyclops* sp. and *Diaptomus* sp., *Daphnia* sp. and *Heterocope*.

Cirque Lake

Cirque Lake, the primary target lake for transplanted fish from upper Geona Creek, was also sampled for zooplankton and showed a similar species assemblage to the other lakes sampled. The dominant taxa were the cyclopoid copepod *Eucyclops agilis* at 30,200/m³, followed by various chironomid larvae with up to 27,000 individuals per cubic metre. Other microorganisms in the plankton of Cirque Lake included oligochaete worms (9,000/m³), ostracods and copepod egg masses. The plankton community appeared to be relatively dense during a dive survey of the lake in September 1995. It is not currently utilized by fish.

Fisheries Resources

Spring Program

The results of the spring 1995 fish sampling program are shown in Table 3.28. The spring fish sampling program in the project area indicated that:

- there are Arctic grayling in the headwater ponds of Geona, East and South Creeks, as well as in the Geona/Finlayson Creek system downstream and in the North Lakes area. Only small (2-3 year-old) grayling were caught in Geona Creek and the beaver ponds. Adult grayling were captured in the large ponds in upper South Creek. Many arctic grayling (595 by August 31, 1995) were live-captured in the weir trap at the outlet of the lake in mid-East Creek (Figure 3.65). They appeared to be moving into the lake from the creek, perhaps to oversummer in the deeper and colder lake water. They may also have been returning to their overwintering habitat, although none were caught exiting the lake at break-up or during the freshet;
- slimy sculpins were caught in Finlayson Creek, lower East Creek, upper Geona creek and in the North Lakes area;
- round whitefish (*Prosopium cylindraceum*) were captured only in the North Lakes area. Positive identifications were confirmed on frozen specimens in late 1995 using gill raker counts;

- burbot were caught in the headwater lakes/ponds of South Creek and in the North Lakes area;
- after extensive fishing effort, no fish were caught in upper East Creek (above beaver dams), or in South Creek below the ponds (i.e. between several beaver dams at the lake outlet and a large beaver dam at the creek outlet into the North Lakes system). No fish were caught in mid-lower Geona Creek in the vicinity of the beaver dams in that creek. Large beaver dams likely create effective fish migration barriers at most water levels. Fish production may also be low due to severe winter conditions and low summer flows. Several juvenile Arctic grayling were sighted in lower South Creek in the fall program; and
- the only trout or char species found in the study area was lake trout (*Salvelinus namaycush*) in the North Lakes system. No trout or char were found in the Finlayson Creek system. However, they are known to inhabit the Finlayson River/Lake system.

Summer Program

The primary fisheries work in the summer of 1995 included fish sampling at the three (3) weir traps. The results included the following:

- no fish were captured in the weir trap in upper Geona Creek or in upper South Creek. Small (80-160 mm) Arctic grayling were captured and/or observed in these creeks during the spring and fall field programs, but none were captured in either the weir traps or the minnow traps, all of which had mesh sizes too small for the grayling to pass through. This suggests that there were few fish in those areas during the open water period;
- many Arctic grayling were captured in the weir trap in East Creek at the outlet of the natural lake in the mid-creek area (Figure 3.65). Almost 600 grayling were captured in the trap from late July to late August, 1995. Most were moving into the lake from the creek downstream. These fish may oversummer and overwinter in the lake, or may move upstream through the lake into the creek and lake system above; and
- mid-summer water level and quality conditions in upper Geona Creek and the beaver ponds were suitable for fish presence. Arctic grayling juveniles and sub-adults were captured by angling and/or observed in the uppermost beaver ponds in Geona and South Creeks during the summer months.

Fall Program

The fall fieldwork in the fisheries program resulted in the following observations:

- few fish inhabited the uppermost ponds in Geona Creek in the fall. Only 1 arctic grayling was sighted during dive surveys in the ponds. Fish may have moved downstream in response to decreasing water temperatures from summer to fall;
- both Arctic grayling and lake trout were caught in the uppermost (eastern) North Lake. These species could be observed in the shallow (4-5 m) lake from a boat and helicopter. Arctic grayling, lake trout and slimy sculpin were also caught in

the North River between the lakes, as in the spring field program. The river between the lakes appears to be a productive area for several of the key species in the study area;

- juvenile Arctic grayling were observed in South Creek at the hydrology/water quality station (Station 13). These fish may have moved downstream from the headwater lakes, or upstream from the North River, although the latter route is more obstructed by beaver dams. The South Creek system is considered to contain salmonid fish (grayling) in low numbers throughout its length, although none were captured in the weir trap. The lakes contain adult grayling, burbot and probably sculpins;
- upper East Creek appears to be devoid of fish. This correlates based on instream diver surveys with the results of spring electrofishing. The large uppermost beaver pond has some good habitat characteristics (better than in the Geona Creek ponds), but is inaccessible to fish due to the numerous beaver dams downstream; and
- lower Finlayson Creek supports relatively large Arctic grayling which are either from the Finlayson River/Lake system, or are resident in the lower creek. Habitat conditions in Finlayson Creek are excellent for salmonid fish as there are extensive areas of riffle, pool and cover.

The fall fish catches are summarized in Table 3.28 along with the spring data.

Population Characteristics

Size and Condition

Table 3.28 shows the lengths and weights of the fish measured in the field. Also shown are the relationships between length and weight, also called condition factors, which indicate the relative health of the fish. The calculated condition factors for the Arctic grayling sampled in the vicinity of the project indicate body shapes similar to (normal) cutthroat and/or rainbow trout, and to Arctic grayling from the Flat River, NWT, another Liard River tributary. The data indicate that most of the grayling from the study area were relatively healthy, with the exception of the spring South Creek and fall Finlayson Creek samples, which showed below average values (slightly thin fish). For the South Creek samples, this is likely because the fish were partially spawned or spawned out at the time of sampling (i.e. were mostly in immediate post-spawning condition), and were thus relatively thin.

Growth Rates

The results of age analysis on fish scales and inner ear bones (otoliths) are included in Table 3.28. The ages of fish are indicated by the number of full years of post-hatch growth, plus a few weeks or months (depending on life cycle timing and capture dates; e.g. 4+). The data from the fish samples indicate that the arctic grayling and round whitefish from the study area have similar growth rates to those species from other northern latitudes. The age analysis also showed that:

- all of the grayling caught and observed in the upper Geona Creek ponds were likely 2+ years in age that were hatched from the spring 1993 spawn. Hatching may have occurred within the headwater area;

- the larger grayling from South Creek and North Lakes ranged to 10+ years in age, and showed a typical growth rate for the species in northern waters; and
- the round whitefish sample from the North River between the North Lakes also showed typical growth rates for the species in northern areas. The adult fish captured ranged from 3+ to 5+ years in age, and would have been derived primarily from the 1990 broodstock, as well as the 1991 and 1992 spawning events.

Diets

The results of the diet (fish stomach content) analyses are summarized in Table 3.29, which shows the sizes, feeding habits and habitat preferences of the primary invertebrate taxa ingested by fish in the study area. Details of the fish diet analysis, including laboratory methods and results, are included in Appendix 3.4 of the Kudz Ze Kayah Water Licence Application.

The arctic grayling sampled in the study area showed a range of food items indicating a degree of opportunism typical of many animal species. They likely ingested the food items that were the largest and/or most numerous and available at the time of sampling. The type of food item also depended on whether they last fed in a pond or stream. The full range of the diet would require knowledge of both kinds of habitat and the food types consumed by the invertebrates (e.g. periphyton - algae/slime on rocks that is eaten by "grazers").

Arctic grayling from Geona Creek had recently taken mayflies (Ephemeroptera) which are bottom-feeders that graze on periphyton (attached, often unicellular, algae) and stoneflies (Plecoptera), which made up approximately 51% of the diet items in the fish sampled. The plecopterans eaten included both plant eaters and predators. Dipterans (two-winged flies) formed approximately 20% of the diet items in grayling from upper Geona Creek, while other food groups included worms and crustacean zooplankters.

Sex Ratio and Maturity

The fish catch data included information on fish genders wherever possible. Fish that were dissected for metals and/or stomach content analysis were also inspected for gender and state of reproductive maturity. The results are shown in Table 3.28. In Geona Creek, almost all of the arctic grayling observed and caught were immature. Only one of 51 sampled from the creek in 1995 was judged to be a male. No adult and/or spawning grayling were found in Geona Creek during the fisheries studies.

Larger Arctic grayling were captured in the North Lakes, East Creek, South Creek and Finlayson Creek systems. Arctic grayling captured in the spring of 1995 showed different degrees of reproductive ripeness in the different drainage areas sampled. Large grayling in lower Finlayson Creek had completed spawning in early June 1995 when water temperatures were 6-8 °C, approximately 2-3 weeks before those in upper South Creek. The East Creek Arctic grayling population that was sampled at the weir trap just below the lake in the mid-reaches of the creek were also selectively sampled for sex and state of maturity.

Tissue Chemistry

The results of chemical analyses of fish tissues are summarized in Table 3.30 including concentrations of arsenic, cadmium, copper, lead, selenium, tin and zinc. The concentrations shown are in micrograms per gram ($\mu\text{g/g}$) wet weight, which is equivalent to parts per million (ppm). Except for mercury, there are no Canadian guidelines on the maximum metal levels in fish for human consumption.

Background arsenic levels in fish near the site are almost all equal to or under $0.2 \mu\text{g/g}$, the only exceptions being $0.5 \mu\text{g/g}$ in slimy sculpin whole bodies from Finlayson Creek and $0.3 \mu\text{g/g}$ in burbot from the North Lakes area. For comparison, the mean and maximum arsenic levels in whole fish from over 100 stations across the United States in 1984-85, as determined by the U.S. Fish & Wildlife Service, were $0.14 \mu\text{g/g}$ and $1.5 \mu\text{g/g}$, respectively (Schmitt and Brumbaugh, 1990).

Background cadmium levels were also generally low ($<0.1\text{-}0.2 \mu\text{g/g}$) with the exceptions of Arctic grayling livers in Geona Creek ($3.6 \mu\text{g/g}$), Finlayson Creek ($1.9 \mu\text{g/g}$) and South Creek ($8.7 \mu\text{g/g}$) as shown in Table 3.30. Cadmium levels in whole fish from 109 stations across the U.S. averaged $0.03 \mu\text{g/g}$, with a maximum of $0.22 \mu\text{g/g}$ (Schmitt and Brumbaugh, 1990).

Background copper levels in fish tissues ranged from $1.4 \mu\text{g/g}$ in lake trout muscle from eastern North Lake to $47.2 \mu\text{g/g}$ in the liver of the same fish. The range for the other species was $1.6 \mu\text{g/g}$ in Finlayson Creek grayling muscle to $15.1 \mu\text{g/g}$ in South Creek grayling liver. The slimy sculpins tested for whole body metals content had concentrations of $3.2\text{-}4.4 \mu\text{g/g}$ copper. In the Flat River, NWT, upstream of a tungsten mine/mill, copper concentrations in grayling flesh ranged from 0.3 to $0.8 \mu\text{g/g}$ (Moore *et al.*, 1976). Copper levels in Flat River grayling livers ranged from 2.76 to $5.0 \mu\text{g/g}$. The U.S. survey of over 300 composite whole body fish samples from 109 stations found a mean of $0.65 \mu\text{g/g}$ and a maximum of $23.1 \mu\text{g/g}$ (Schmitt and Brumbaugh, 1990).

Lead concentrations in fish near the property were generally below $0.002 \mu\text{g/g}$ (the detection limit for lead). Exceptions included whole body grayling from upper Geona Creek ($0.004 \mu\text{g/g}$), Finlayson Creek sculpin whole bodies ($0.003 \mu\text{g/g}$), North Lake grayling liver ($0.006 \mu\text{g/g}$) and North Lakes slimy sculpin ($0.004 \mu\text{g/g}$). Lead levels in whole freshwater fish from across the United States averaged $0.11 \mu\text{g/g}$ and showed a maximum value of $4.88 \mu\text{g/g}$ (Schmitt and Brumbaugh, 1990).

Mercury levels in fish from the study area were generally less than $0.05 \mu\text{g/g}$ (Table 3.30) and the highest value found was $0.2 \mu\text{g/g}$ wet weight in whole sculpins from the North Lakes area. The highest level in fish muscle tissue was $0.1 \mu\text{g/g}$ in North Lakes grayling and lake trout muscle. Unlike most of the other metals analyzed for this study, mercury is known to bioaccumulate in animal tissues such that older individuals and species higher on the food chain tend to accumulate more mercury than other groups. The maximum acceptable level of total mercury in fish muscle for human consumption is $0.5 \mu\text{g/g}$. For people who eat fish frequently, the level is $0.2 \mu\text{g/g}$, as determined by the Health Protection Branch of Health Canada. The levels are based on the maximum concentrations for safe weekly consumption of fish equivalent to 0.42 Kg of fish at $0.5 \mu\text{g/g}$ mercury and 1.05 Kg at $0.2 \mu\text{g/g}$ mercury (Grey *et al.*, 1995). Mercury levels in fish

from across the United States averaged 0.10 µg/g and ranged up to 0.37 µg/g (Schmitt and Brumbaugh, 1990).

Selenium content in fish near the site were determined to be generally <10 µg/g with some exceptions, including: Geona Creek grayling liver (26 µg/g); Finlayson Creek grayling liver (21 µg/g) and gonad (16 µg/g); South Creek grayling liver (25 µg/g) and gonad (14 µg/g); North Lakes grayling liver (13 µg/g) and gonad (16 µg/g); and North Lakes lake trout liver (11 µg/g). Selenium levels in whole fish from across the United States in 1984-85 averaged 0.42 µg/g, with a maximum of 2.30 µg/g (Schmitt and Brumbaugh, 1990).

Tin concentrations in fish tissues were consistently below the detection limit of 2 µg/g.

Zinc concentrations in fish tissues near the site ranged from 20.5 µg/g in South Creek grayling muscle to 280 µg/g in North Lake grayling gonad tissue. Levels of >200 µg/g were also found in Geona Creek juvenile grayling whole bodies (202 µg/g) and gonads (211 µg/g). For comparison, a study by Moore *et al.* (1976) in the Flat River, NWT, showed zinc concentrations in Arctic grayling flesh (muscle) ranging from 4.1 to 10.1 µg/g upstream of an operating tungsten mine/mill. Zinc levels in the livers of Flat River Arctic grayling were approximately 48 µg/g (Moore *et al.*, 1976). Zinc levels in whole fish samples from across the continental United States showed a mean of 21.7 µg/g and a maximum of 118.4 µg/g in 1984-85 (Schmitt and Brumbaugh, 1990).

The British Columbia Ministry of Environment, Lands and Parks (BC Environment) recently completed a survey of metal concentrations in fish tissues from 54 BC lakes (Rieberger, 1992). The fish species included Arctic grayling, mountain whitefish, lake trout, rainbow trout and others. Mercury was the only metal to show evidence of bioaccumulation. The highest mercury level in fish muscle was 0.29 µg/g in cutthroat trout, and compares with the federal standard of 0.5 µg/g in fish for human consumption. The highest lead level in muscle tissue was found in mountain whitefish (0.46 µg/g), which is below the BC Environment guideline of 0.8 µg/g. Arctic grayling had the highest mean concentrations of copper (0.45 µg/g), lead (0.46 µg/g) and zinc (6.05 µg/g) of any fish species sampled in that survey (Rieberger, 1992). Some of the background concentrations in fish muscle in the study area were above those from uncontaminated lakes in British Columbia.

Fish Production

The potential fish yield in each of the study ponds and lakes was estimated using a morphoedaphic index, which relates fish yield in a north temperate lake to the mean depth of the lake and the total dissolved solids (TDS) in the lake water. The results are shown in Table 3.31. A morphoedaphic index of approximately 2.0 distinguishes oligotrophic (low nutrient, <2) from eutrophic (high nutrient, >2) lakes (Ryder, 1964).

Northcote and Larkin (1956) had previously studied the application of morphoedaphic indices to lake productivity in British Columbia. They found a positive correlation between mean depth, total dissolved solids and fish yield in 100 B.C. lakes. They found that TDS is especially important in predicting overall lake productivity, while depth was only weakly correlated (i.e. depth is not as important as TDS in determining lake productivity).

Both the Ryder and Northcote & Larkin predicted "yield" formulae are used in Table 3.31, and are in reasonable agreement for most of the lakes and ponds listed. The (instantaneous) yields are expressed in the "index" columns as pounds per acre-foot, while the final "yields" are in pounds of fish (all species) from each whole lake or pond. The indices predict that several hundred pounds of fish could be taken from each of the upper Geona Creek ponds at any given time, while the larger lakes could produce several thousand pounds. The values shown are likely somewhat high for all of the ponds and small lakes, as the indices were designed for larger lakes in north temperate areas, whereas the subject lakes and ponds are smaller, colder and contain slower-growing fish.

3.2.1.2 *Wolverine*

Benthos

Sample Program - 1996

Artificial substrate samplers were used to collect benthic invertebrates from six stream locations. These samplers were chosen as the appropriate method since the water depth, high velocities and larger substrate types encountered at the sites, prevented the successful use of a stream-net sampler (i.e. Hess, Surber, Knapp). These cylindrical wire baskets measuring 26 cm long with a diameter of 17 cm, were filled with washed indigenous gravels collected from the streambed or bank at each site.

Three rock filled samplers were submerged in riffle areas at W-12 (Go Creek), W-14 (Money Creek downstream of Go Creek) and W-23 (Money Creek upstream of Dollar Creek) on the Money Creek drainage; and at W-26 (Wind Creek), W-1 (Nougha Creek at the Wolverine Lake outlet) and W-21 (Nougha Creek near the Robert Campbell Highway) on the Nougha Creek drainage. The samplers were placed in-situ July 15th and 16th, 1996, and left allow the colonization of invertebrates for five weeks. Figures 3.67 and 3.68 provide the locations for benthic invertebrate monitoring stations.

On August 21st and 22nd, 1996, the artificial substrate samplers were retrieved by placing a screened bucket with a 300 micron mesh downstream and under the basket. On shore the basket was opened and the rocks were emptied into the bucket. Individual rocks were then carefully washed in the screened bucket to remove and collect all invertebrates from that sample. The detritus and benthic organisms remaining in the bucket were placed in a one litre nalgene bottle and preserved with 10% formalin.

An Ekman dredge (6 inches x 6 inches x 6 inches) was used to collect bottom fauna from five lake locations; three in Wolverine Lake (B-3 to B-7), one in Little Wolverine Lake (B-10) and one in Little Jimmy Lake (B-1). Triplicate samples were collected at various depths at each site. The sediment contained in the dredge was emptied into the screened bucket to drain off all water. This material was then placed into a one litre nalgene bottle and preserved with 10% formalin.

All benthos samples were sent to Dr. Charles Low, Ph.D., an entomologist in Victoria, B.C. for enumeration and identification. At the lab, all samples were washed through two screens with mesh sizes 1 mm and 180 µm. All of the organisms retained by the coarse screen were counted and identified, whereas the organisms on the 180 µm screen were sub-sampled as necessary. A Folsom plankton splitter was used for the sub-sampling. The majority of the benthos were identified to the genus level.

Sample Program – 1997

Triplicate samples were collected with a surber sampler from Wolverine Creek (W-9) during the intensive sampling program in May, July and September, 1997. These samples were preserved with 10% Formalin and sent to Dr. Charles Low, Ph.D. in Victoria B.C. for identification and enumeration.

Analysis Method

Population indices were used to analyse the benthic data, allowing direct comparison of sample sites and an overall evaluation of community health. A summary and explanation of these indices is included below.

Tolerance Categories (Beak, 1965) determine the relative abundance of benthic organisms at each station classified as sensitive, facultative or tolerant fauna. Various groups of benthic invertebrates display different degrees of sensitivity to degradation in habitat quality.

In most cases, sensitive species include Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) which are found primarily in "clean" water conditions containing little contamination or little organic matter. These species have a low tolerance range due to their physiology, which makes them susceptible to disturbance and, therefore, are a good indicator of environmental change.

Facultative species have a moderate tolerance range for temperature, water quality and substrate types. These include Diptera (true flies), Homoptera (aphids), Coleoptera (beetles), Collembola (springtails) and non-insect benthic families. Species in this category make use of a wide variety of habitats from poor to good water quality conditions.

Tolerant species consist mainly of the Oligochaetae (freshwater segmented worms and earthworms) which can survive under conditions adverse to most species.

Various indices were applied to the data to produce quantitative values for community structure. The **Equitability Index** (Pielou, 1966) measures the degree of evenness with which sampled individuals are distributed in the taxa represented in the community. If one species is dominant in the sample, a low index value will represent this population skew. This index has a maximum value of 1.

$$J = \frac{\bar{d}}{K \log s}$$

J = Equitability Index

\bar{d} = Shannon - Wiener diversity index (see below)

K = 3.321928 (constant)

s = number of taxa in the sample

The **Richness Index** (Margalef, 1958) is the measure of the "taxonomic wealth" in a benthic community. Species richness indicates the number of taxa represented relative to the population size. The higher the richness in a community, the more organisms (taxonomically) exist, which in turn reflects habitat complexity (i.e., the greater the number of habitat niches that are available for biological use, the greater variety of invertebrate fauna able to colonize, survive and reproduce in a given area).

$$R = \frac{s-1}{\ln N}$$

R = Richness Index

s = number of taxa in the sample

N = number of individuals in the sample

The **Shannon-Wiener Diversity Index** (Shannon and Wiener, 1949) is a single measure of the complexity of a community and is determined by the summation of the relative proportions of individuals of one species in the whole sample population. As sample size decreases, the diversity index becomes less reliable. In addition, other qualifiers exist; for example, diversity indices do not consider the taxonomic category of fauna used in the calculation. Studies have shown that a reduction in actual diversity value may be recorded only in the most severe cases of habitat degradation.

$$\bar{d} = -\sum_{i=1}^s \left[\frac{N_i}{N} K \log \left(\frac{N_i}{N} \right) \right]$$

\bar{d} = Shannon - Wiener Diversity Index

s = number of taxa

N_i = number of individuals in the i^{th} taxum

N = number of individuals in the sample

K = 3.321928 (constant)

The **Keefe-Bergersen TU Diversity Index** (Keefe and Bergersen, 1977), which is a variation of the Shannon-Weiner Diversity Index, is determined from the proportion of taxa represented in the sample in relation to the number of individuals in the sample.

$$TU = 1 - \left(\frac{N}{N-1} \right) \left[\sum_{i=1}^s P_i^2 - \frac{1}{N} \right]$$

TU = Keefe - Bergersen diversity index

N = number of individuals in the sample

s = number of taxa in the sample

P_i = proportion of individuals in the i^{th} taxum

The **Dominance Index** (Simpson, 1949) implies the extent to which one or a few species dominate the species composition of the sample. This is determined by the proportion of population found in any one taxa in relation to the whole population. A high index number represents high density of one species and a low index shows a more even distribution of individuals among taxa.

$$C = \sum_{i=1}^s \left[\frac{N_i}{N} \right]^2$$

C = Dominance Index

s = number of taxa in the sample

N_i = number of individuals in the i^{th} taxum

N = number of individuals in the sample

Stream Benthos

Enumeration and taxonomic identification data for stream benthic samples are presented in Appendix 3D.

1996

A summary of benthic community characteristics and indices for the 1996 sampling program is provided in Table 3.32. The sample sites on Money Creek appear to be very similar in terms of overall productivity and diversity. The upstream station (W23) has a slightly lower proportion of individuals from sensitive taxa. The overall number of taxa is identical at these stations. All community indices are very similar for these two stations.

The station at Wind Creek (W26) showed the highest productivity and the lowest diversity, as measured by the Shannon Wiener Diversity Index. The population at this site is dominated by facultative species. Unidentified juvenile Chironomids were the most numerous taxonomic group, followed by Simuliids and two species of Chironomini. There were more taxa identified at this station than at any other, indicating higher habitat complexity. This station also had the highest in-situ conductivity and water temperature. Water depth and velocity were among the lowest of the six sample stations. The higher temperatures may contribute to higher levels of productivity. The high conductivity indicate lower overall water quality which would result in the dominance of a few taxa which are able to tolerate the water quality conditions.

Nougha Creek at the outlet (W1) from Wolverine Lake also had relatively high overall productivity. The proportion of sensitive species is higher than at Wind Creek. Populations of individual taxa were more evenly distributed than at W26, contributing to a higher diversity index value. This station had the lowest number of overall taxa and a low richness index, indicating lower habitat complexity. Water temperature at this station was high compared to other stations, possibly contributing to the high productivity.

Productivity was similar at stations W12 (Go Creek) and W21 (Nougha Creek at the Robert Campbell Highway) and lower than other stations. Higher proportions of sensitive taxa and even population distribution among taxa contribute to higher diversity values. The combination of low taxa count and low overall population contribute to a higher Richness index and indicates higher habitat complexity. Station W21 has the highest richness index of the six sample stations and the second highest taxa count. It also had the highest diversity index and lowest variance, indicating even distribution of the population across the identified taxa.

1997

The sample program in 1997 was designed to monitor changes in the benthic community through time. Total population numbers and diversity increase over the course of the summer. The population proportion of sensitive taxa increases through the

year and is highest in September. There is a noticeable decrease in indices for diversity, richness, and equitability in July. Indices for dominance and variance are the highest during this month. The trend indicated by these indices is an increase in overall population density led by increases in the number of a few taxa. This is combined with no significant change in the number of taxa in the sample. This may be the result of seasonal differences in growth rates for benthic invertebrate species. Some species may mature earlier in the summer and reach sufficient size to be captured in samplers and identified. This could explain the higher number of individuals in only a few of the taxonomic categories.

This tends to be the general trend in freshwater ecosystems. Although there is not a thorough understanding of the life cycles of invertebrates in northern climates such as the Yukon, it is understood that most aquatic insects have one generation per year and often the eggs overwinter in a diapause state (Meritt and Cummins, 1984). If the eggs hatch prior to winter, little growth occurs until spring. When benthos samples are collected in spring, a good portion of the instars are too small to be captured by conventional benthos sampling techniques (mesh size is usually 300 microns). Any incidental instars captured would be too small (microscopic) for macro identification. Growth increases throughout the summer with increased temperatures, sunlight and food availability, so that by late summer, the standing biomass is pretty much at its peak. This was observed in the September sample. Diversity was substantially greater in September with more species within Plecoptera and Diptera present.

The life cycle summary described above is highly generalized, the life cycles of aquatic invertebrates are varied even within the same family.

The data was further analyzed by determining the composition of the community for each month. Each community was broken into major taxonomic groups and the percentage of each determined (Table 3.33). Based on this, taxa were classified with respect to their dominance within the community for each month. Diptera was the dominant order on all three occasions, forming over 70% of the communities. Most of the other orders were common although Plecoptera was subdominant in September. Generally, the distribution was similar throughout the summer.

When the background water and sediment quality at Wolverine Creek, W-9, is considered, it was very unexpected that there was such a diverse community. In addition, there was representation from the orders Ephemeroptera, Plecoptera and Trichoptera, which are generally recognized as pollution sensitive taxa (Lehmkuhl, 1979 and Winner et al, 1977).

The majority of the zinc water was in the dissolved form allowing it to be more readily available than that bound up to suspended sediment particles. The zinc concentrations found at W-9 were four to five times greater than the guideline of 0.03 mg/L of total zinc for the protection of freshwater aquatic life (CCREM, 1987).

Natural levels of zinc in the stream sediments at W-9 were also very high. The metals appear to be concentrated in the smaller sized fraction of the sediment. As benthic invertebrates, by definition of their name, dwell in intimate contact with the stream sediments, it is probable that they assimilate metals. For example, the Trichoptera *Imania sp* that was found in May and July, ingest mineral particles by scraping the upper surfaces of rocks (Wiggins, 1977). Tissue analysis of invertebrates from this location would likely reveal high metals in tissue concentrations.

Several species of insects who have a low tolerance to metals (Lehmkuhl, 1977), were present at this site. Specifically they were *Paraleptophlebia* sp of Ephemeroptera and *Despazia* sp, *Sweltsa* sp, *Zapada* sp and *Perlomyia* sp of Plecoptera. The Plecopterans were present in significant numbers during the September investigation. The naturally high levels of metals in the aquatic environment of Wolverine Creek have likely led to adaptation of the local community to these conditions.

Lake Benthos

Enumeration and taxonomic identification data for lake benthic samples are presented in Appendix 3D. A summary of community indices and population characteristics is presented in Table 3.34. Taxonomic diversity in lake samples was similar to that found in creek samples although community composition was quite different. Lake samples had much higher proportions of tolerant organisms and lower populations of sensitive organisms than the stream communities. Community indices showed a similar range of values compared to stream samples.

Little Wolverine Lake showed the highest overall community richness and the highest number of identified taxa indicating a higher degree of habitat diversity. This sample station had the lowest sample depth (0.5 m). The highest diversity index value was measured in Wolverine Lake west of the island. This station had the lowest overall productivity and most even population distribution. The higher numbers of identified taxa and high richness indicates higher habitat complexity at this station. This sample station was the deepest of the lake samples (3.0 m). Diversity indices are similar at all lake stations, indicating a similar degree of population distribution across taxonomic categories. Little Jimmy Lake had the lowest number of identified taxa and the highest proportion of tolerant species compared to the other lake samples. This is interesting considering that the sediments of Little Jimmy Lake had the lowest concentrations of metals. This indicates that other habitat parameters play a more important role in regulating benthic communities.

Zooplankton

Sampling Program

In August 1996, a Wisconsin tow-net with a truncated cone (to improve filtration efficiency), mesh size 76 microns, was hauled horizontally through the water at a depth of one to two metres behind an inflatable boat. Five replicate samples were collected from each of the three lakes (Little Jimmy, Little Wolverine and Wolverine Lakes) The location of the plankton hauls on the lakes is presented in Figure 3.69. The zooplankton were anaesthetized prior to preserving with 10% formalin, then shipped to Linmotek Research and Development Inc. in Vancouver, B.C. for identification and enumeration of species.

In the laboratory, zooplankton samples were split using a Folsom plankton splitter to a volume which contained not less than one hundred post naupliar stages of the most abundant taxa of crustaceans. For each random sub-sample comprising a known proportion of the samples, species were enumerated, and size (to the nearest 0.01 mm), sex, stage of maturity, and reproductive condition was determined at 5-100x magnification under a GSZ-Zeiss stereo microscope. The number of eggs were counted and size of female was measured for the first ten adult females of the dominant species. Rotifers and nauplii were counted as encountered. Rotifers were identified to the genus level. Cladoceran sizing is included with regular lab procedures. Copepod sizing was added because of the relative abundance of copepods.

Results

Table 3.35 presents a summary of plankton sample data. The locations of the haul sites is shown on Figure 3.69 and the tabulated data for each lake is contained within Appendix 3D. The tables presented in Appendix 3D display zooplankton analysis, measurements of adult copepoda, and measurements and reproductive condition of plankton at Wolverine Lake and Little Wolverine Lake. Measurements and reproductive condition were not determined at Little Jimmy Lake.

Little Jimmy Lake showed the highest overall productivity with over 16,000 organisms per cubic meter. The vast majority of these organisms were copepods. Wolverine Lake had the lowest overall productivity approximately 4,600 organisms per cubic meter. Wolverine Lake had the highest diversity of species. Two species (*Daphnia pulex* and *Diaptomus ashlandi*) were well represented in the Wolverine Lake population and not present in the other lakes.

Fisheries Resources

Study Program

1996

Investigations into the fisheries resources in the Wolverine Lake and Money Creek drainages were completed in the summer of 1996. Three investigations were conducted during the open water season. These surveys were designed to provide background fisheries data on streams and lakes in the Wolverine Lake project area. These initial investigations were developed to determine the extent of fish habitat and utilization in project areas streams, to gain understanding of fisheries resources in the area, and to identify potentially sensitive habitats and species occurring in the project area.

The spring, summer and fall fisheries resources investigations consisted of the following:

- Conducting small mesh (non-destructive) gillnet surveys on Little Jimmy, Little Wolverine, Wolverine and Wind lakes;
- Collection of fish tissue (flesh and liver) samples for chemical analysis of heavy metal content;
- Investigation of thirty creeks within the study area for potential to support fish. This included assessing general habitat conditions and cursory utilization assessments of Nougha and Money Creek and their tributaries;
- Investigation of the inlet and outlet of Wolverine lake for spawning activity;
- Investigation of the lower reaches of Money and Nougha creeks for spawning activity and general habitat evaluations;
- Investigating the extent of Dolly Varden trout utilization of Money and Nougha creeks;
- An aerial survey of Money Creek to detect any congregations of spawning dolly varden or any signs of dolly spawning such as redds. Ground surveys were conducted at the outlet of Go Creek;
- Investigations into lake trout spawning locations on Wolverine, Little Wolverine, Little Jimmy House and Francis lakes;

- Ground investigations of Nougha Creek at the confluence with the Finlayson River, including angling in the Finlayson River downstream of Nougha Creek to detect presence or absence of dolly varden;
- Investigations into fish utilization of Francis Lake near the outlet of Money Creek, including determination of key fish habitats such as lake trout spawning; and

1997

Field investigations were conducted during the 1997 open water season focused on assessment of fish habitat characteristics and utilization in streams along proposed access road alternatives and assessment of habitat potential for bull trout in Money Creek.

Access routes under consideration at that time included a direct connection to the Robert Campbell Highway and a connection to the Kudz Ze Kayah access road along the north shore of Wolverine Lake. This route is still an alternative access to the Wolverine operations area but the direct connection to the Robert Campbell Highway is no longer under consideration. Potential stream crossing locations and stream outlets were assessed three times during the open water season to determine seasonal use patterns.

A total of fifteen creeks were studied during the proposed access road crossing investigation. The creeks investigated consisted of the following:

- A tributary to East Lake;
- Two tributaries to Wind Lake;
- Seven tributaries of Nougha Creek;
- Nougha Creek;
- Three tributaries to Wolverine Lake, and
- A small headwater feeder creek of Van Bibber Creek.

Habitat characteristics evaluated at each site included; creek depths and widths, water velocities, pool to riffle ratios, substrates, overhanging and adjacent vegetation and potential fish cover. Methods used to determine fish presence were electro-fishing, seining (where possible), angling and visual observations.

Money Creek and two of its tributaries; Go Creek and an unnamed tributary that enters Money Creek from the north approximately 19 km upstream of Francis Lake, were investigated to determine potential spawning and overwintering areas for bull trout. The assessments were conducted between September 15 and 18, 1997 and consisted of:

- aerial assessments conducted by helicopter to observe any aggregations of fish and map deep pools suitable for overwintering;
- ground surveys using minnow traps, electro-fisher, seine net, angling and visual observations; and
- Float surveys conducted with dry suits, mask and snorkel to investigate micro-habitats and determine presence of adult fish.

The sample sites investigated during 1996 and 1997 are listed below.

Site	Description
M1	Mouth of Money Creek at Francis Lake
M2	Money Creek - Mouth at Robert Campbell Highway
M3	Money Creek Approximately 3.5 km Upstream of the Outlet to Francis Lake
M4	Money Creek - Mouth Area of Major Tributary to Money Creek Approximately 18 km upstream of the Outlet to Francis Lake
M5	Money Creek Approximately 36 km Upstream of the Outlet to Francis Lake
M6	Money Creek 1 km Downstream of its Junction with Go Creek
M7G	Money Creek at its Junction with Go Creek
M8	Money Creek Downstream of Little Jimmy Valley Tributary
M9	Money Creek at Downstream End of Wide Gravel Area
G1	Go Creek at Junction Area with Money Creek
G2	Go Creek Approximately 2.5 km Upstream of the Mouth of Go Creek
G3	Go Creek Approximately 5.6 km Upstream of the Mouth of Go Creek
G4	Go Creek Approximately 5.9 km Upstream of the Mouth of Go Creek
G5	Go Creek Approximately 7.5 km Upstream of the Mouth of Go Creek
P1	Pup Creek, a Tributary of Go Creek
HO	Hawk Owl Creek, a Tributary of Go Creek

A temperature data logger was installed at Station W-14 (Money Creek, approximately 100 m downstream of Go Creek) and operated from May 28 to September 12 to assist the fisheries personnel in determining the timing of bull trout (Dolly Varden) spawning.

A general aerial habitat assessments of both Money Creek and Nougha Creeks was conducted in July in order to provide a habitat evaluation of the creeks and their potential to support fish.

Results

1996

This section provides a summary of the data collected during the three investigations in 1996. For complete results refer to the data provided in Appendix 3E. In order to simplify the conclusions from the fisheries resource investigation the results have been summarized by location.

Wolverine Lake

Gillnetting results in Wolverine Lake showed fish populations consisted of 47.5% lake trout and 52.5% Arctic grayling by number, however lake trout comprised 65% of the fish by weight (see Figure 3.70 and Tables 3.36 and 3.37). The locations of small mesh, non-destructive gillnet sets is shown on Figure 3.71. Length frequency data for Arctic grayling for Wolverine Lake is presented on Figure 3.72.

Longnose suckers did not appear in the catch from Wolverine Lake, however subsequent surveys in Wolverine Lake indicated that suckers were a component of the fish population. The lack of sucker from the gillnet sample record is likely due to the fact that suckers were spawning at the time of the survey (several ripe and exuding suckers

were captured in Little Wolverine Lake). Evidence of rearing suckers captured at TWV4 (Figure 3.73) indicates that the creek is likely a spawning area for them. Suckers move into creek areas to spawn, thus they were not utilizing the lake proper during the gillnet surveys. The locations of lake tributaries and lake sample sites is shown on Figure 3.73.

Juvenile burbot were found utilizing the mouths of small tributary creeks entering Wolverine Lake. No adults were recorded during field investigations, although it is assumed that a small population of adults live in the lake.

Little Wolverine Lake

Length frequency data for Arctic grayling for Little Wolverine and is presented on Figure 3.72.

Gillnet results from Little Wolverine Lake showed that lake trout comprised 29% of the catch by number but 55% of the catch by weight, Arctic grayling were 66% by number but only 37% by weight. Longnose suckers comprised 5% of the catch by number and 8% by weight from Little Wolverine Lake (Figure 3.70).

During fall spawning surveys very few lake trout were recorded in Little Wolverine Lake. The trout that were captured were in a resting state and would not have been involved in the 1996 spawn. Lake trout who utilize Little Wolverine Lake (see Figure 3.74) are likely part of the same population as those utilizing Wolverine Lake. Combined length frequency calculations for lake trout taken in Little Wolverine and Wolverine Lakes are shown on Table 3.38 and Figure 3.75.

Wolverine and Little Wolverine Lakes

Based on the fisheries data collected, the creek joining Wolverine and Little Wolverine Lakes (Site W-11), and the outlet of Wolverine Lake seems to provide important fish habitat for both Arctic grayling and rearing lake trout (see Tables 3.36, 3.38 and 3.39).

The condition factors (K) for lake trout taken from both Wolverine and Little Wolverine Lakes are identical (1.18), adding support to the theory that there is a single population of trout for both lakes. In comparison to other undeveloped lake trout lakes in the Yukon, Wolverine Lake is a highly productive Lake (N. DeGraff, pers. Comm, YTG Fisheries).

Tributaries to Wolverine Lake

A total of eight tributaries flowing into Wolverine Lake were investigated for utilization by fish. Of these tributaries two (TWV 7 and TWV 8) were dry at the time of sampling. Two other tributaries (TWV 1 and TWV 2), did not provide adequate fish passage from the lake and were determined to not provide fish habitat (refer to Figure 3.73).

TWV 3 (Wolf Creek) is 0.2 to 0.4 m deep and 1 to 2 m wide with a silt bottom, interspersed with woody debris from recent beaver activities. Eight slimy sculpin, four juvenile burbot and one juvenile Arctic grayling were recorded in the lower 15 m of the creek. No fish were recorded more than 15 m from the lake.

TWV 4 (Wind Creek) drains from Wind Lake. This creek enters Wolverine Lake in the shallow bay at the north end of the lake. The creek shows significant evidence of both recent and historic beaver activities. The creek consists of a series of beaver dams and ponds within 10 m of its outlet into the lake. Thousands of longnose sucker fry and post

fry were observed in the lower reaches of the creek. Thousands of Arctic grayling fry were also observed in the creek outlet, immediately adjacent to the lake. Based on the observations, this site appears to be an important spawning location for suckers as well as a rearing site for grayling.

TWV 5 is a high velocity creek with a predominantly cobble substrate. The mouth area (up to 80 m from the lake) slows and flows through a wide area with riffles and pools. No fish were found more than 80 m from the Lake outlet. Fish recorded in the lower 80 m included: many slimy sculpin, ten lake trout fry, three juvenile burbot and several adult Arctic grayling.

TWV 6 has a variety of substrates, consisting of an even mix of cobbles, gravel and sand, with silting in low velocity areas. Fish recorded in this creek were as follows: twenty one lake trout fry, one lake trout post fry, seventy slimy sculpin and six burbot. Very few fish were captured more than 30 m from the lake and those that were found were sculpins.

Tributaries to Little Wolverine Lake

Four tributary creeks entering Little Wolverine Lake were sampled for the presence of fish.

TLW 1 (Campbell Creek) has a 1 to 3 m wide channel with a depth of 0.6 m. Substrates were silted. Fish captured included thirteen slimy sculpins and one juvenile burbot.

TLW 2 (Wolverine Creek) is dammed along the lakes edge by a 0.5 m high beaver dam, which creates a pond 10 m x 30 m adjacent to the lake. Five slimy sculpin were captured between the beach and the beaver dam; no fish were encountered above the dam.

TLW 3 (Burne Creek), also known as Burn Creek, enters the lake as a braided channel cut through moss covered boulders with a gravel bottom. No fish were encountered in this creek.

TLW 4 (Inflow to Little Wolverine Lake) enters the lake in a grassy bog area, the creek forks 15 m from the lake and enters the lake as two channels. The two lower channels provided good fish habitat consisting of silt covered sand and fine gravel in a 2 m to 3 m wide channel, with depths of up to 1 m. Two hundred Arctic grayling fry, thirty seven slimy sculpins and six lake trout fry were recorded.

Little Jimmy Lake

Arctic grayling comprised 96 % of the catch by number and represented 77% of the catch by weight. Lake trout comprised only 4% of the catch by number but represented 23% of the catch by weight (refer to Figure 3.74). No other species of fish were recorded in the lake itself, however juvenile burbot were captured in the mouth area of the tributary creek. Length frequencies for Arctic grayling are shown on Figure 3.72.

Tributaries to Little Jimmy Lake

One tributary to Little Jimmy Lake (TLJ 1) was flowing during the summer of 1996; the other tributary (TLJ 2) was dry.

TLJ 1 sampling resulted in the observation of six sculpins, one burbot juvenile and one lake trout post fry were recorded within 8 meters of the lake. No fish were recorded above this point.

Money and Nougha Creeks and Wind Lake

Money Creek was surveyed to determine fish species composition and potential barriers to fish passage. Dolly varden, Arctic grayling, and slimy sculpin were all observed, unfortunately cursory surveys to document dolly varden spawning were unsuccessful. A potential barrier to fish passage was noted midway between sites M 4 and M 5 (see Appendix 3E). This obstruction was the result of a log jam combined with beaver activities and was not considered to be permanent.

Two tributaries to Money Creek were investigated and sampled for the presence of fish. These were Go Creek and an unnamed tributary adjacent to site M 4. Both of these tributaries supported juvenile dolly varden and slimy sculpin. Arctic grayling, at all life stages, were observed on Go Creek.

Nougha Creek

Arctic grayling and slimy sculpin were observed utilizing Nougha Creek. Lake trout fry were recorded in the headwater area near the outlet of Wolverine Lake.

Wind Lake Fish Species Composition

Gillnet results from Wind Lake showed that species composition indicated 64% Arctic grayling, 27% longnose sucker and 9% lake trout. Weights for fish captured could not be recorded due to equipment failure at the time of the survey.

Proposed Access Road Creeks

Investigations into the extent and type of fish habitats were conducted on four small creeks that may be crossed by one of the potential access roads should development proceed past the advanced exploration stage. Two of these creeks drain into Wind Lake and the other two drain into Nougha Creek, a short distance downstream of the creeks origin at Wolverine Lake. No fish were found to be utilizing these creeks during these investigations, which were conducted on July 15, 1996. The locations of creek sample sites are shown on Figure 3.73. The creeks draining into Wind Lake have been labeled AR 1 and AR 2, while the creeks draining into Nougha creek have been labeled AR 3 and AR 4.

Creek AR 1 forks into two branches at it's upper reaches. Both of these branches flow through a heavy tangle of willow and alder brush. The channels are narrow (5 to 3 m) and are shallow (0.1 to 0.5 m), but flow in well defined channels. Substrates vary from silted sands in the wider areas to cobble gravel in the narrower reaches. This creek may provide fish habitat in the area near Wind Lake, however this area was not surveyed.

Creek AR 2 is a willow choked draw that does not have a defined channel. The point where the creek enters the lake is an indistinct channel with water flowing into the lake in small rivulets. This creek was not considered to provide fish habitat.

Creek AR 3 drains into Nougha Creek approximately 1 km downstream of Nougha Creeks origin at Wolverine Lake. This creek flows in a small defined channel 0.2 m deep by 0.5 m wide for a distance of 10 m upstream of Nougha Creek, above this point the creek narrows to 0.3 meters and has increased velocities. No fish were found

utilizing this creek during our investigations on July 16, 1996. However the creek does have the potential to support fish.

Creek AR 4 flows into Nougha Creek approximately 75 m downstream of AR 3. The creek flows through existing vegetation and drops off of a 0.5 m bank to enter Nougha Creek. No place to sample for fish was found in this creek; however, it was not considered to provide fish habitat.

Nougha Creek, near the outlet of Wolverine Lake, is an area where Arctic grayling spawn, rear and overwinter as adults, and where lake trout rear. Based on these observations, the area appears to be an important fish habitat.

1997

Fisheries Investigations of Proposed Access Corridors

With the exception of Nougha Creek, all potential crossing sites investigated occur in areas where the creek flows in a small draw with dense willow cover over and adjacent to the creeks. These creeks flow through dense tangles of willow in incised channels which are typically deeper than they are wide. These creeks rarely exceed a width of greater than 0.3 m, and have velocities averaging >1 m/sec. This type of creek, generally, does not provide good fish habitat. Auries noted during spring investigations implies the creeks bottom freeze, a factor that severely limits ability to support overwintering by fish. Rare and occasional ground water feeds may provide habitats suitable for slimy sculpin over wintering, and Arctic grayling may move into the creeks during summer months. During our investigations no fish were found in any of the creeks above the point where streamflow flowed through dense willows.

TE: The tributary to East Lake, as marked on the map sheet, does not at this time represent an above ground flow. This creek has been denoted as non-fish bearing and as such requires no further fisheries investigations.

TW-1: Tributary to Wind Lake #1 has two distinct reaches, the first being from the outlet to Wind Lake upstream for 400 m through a large wetland area, the second reach is above the first and extends up its valley, as a willow tangled draw, to the headwater area. The lower reach provides critical spawning, rearing and feeding habitat for Arctic grayling, particularly where it is closer to the lake. Long nose sucker and slimy sculpin also utilize this reach. Arctic grayling fry were the only species utilizing this reach during fall investigations. The upper reach is of little value as fish habitat.

TW-2: Tributary to Wind Lake #2 consists of a small creek flowing through a willow draw. This creek does not provide fish habitat in its upper reaches. The only reach of this creek to provide fish habitat is the lowest 35 m, which forms a small bay of the lake. This area has significant influence from the lakes warmer water.

WO and N: Nougha Creek near the outlet from Wolverine Lake represents important fish habitat. Utilization of the reach adjacent to the lake was documented as supporting Arctic grayling spawning and rearing, lake trout rearing and adult feeding and long nose sucker, slimy sculpin, and burbot were also present. Large numbers of adult Arctic grayling observed during fall surveys may indicate this is an overwintering site for grayling. Fish habitats vary seasonally with water levels and velocities.

TN-1: Tributary to Nougha Creek #1 is a small creek (0.35 m wide x 0.05 m depth). The lowest 10 m of the creek consists of a gravel boulder bottomed riffle with velocities >1m/sec. Above this reach, the creek flows through tangled willows alternating between being a narrow incised channel with velocities >1m/sec to areas with little or no defined channel with flows flooding out through the adjacent willows and sedges. Limited fish habitats exist in the creek in the form of eddies and pools below boulders. Two trails cross this creek 35 and 50 m upstream of Nougha Creek. Small pools with gravel substrates have been created by the trails crossing the creek. No fish were found in this creek.

TN-2: Tributary to Nougha Creek #2 does not have a defined channel outlet into Nougha Creek, rather it spills over the bank along a 10 m reach. Above this the creek flows through a tangle of willow and the channel is not well defined in most places. The most defined channel area occurs where the creek has been crossed by two winter trails, 30 and 40 m upstream of Nougha Creek. This creek does not represent fish habitat.

TN-3: Tributary to Nougha Creek #3 has flow and size sufficient to support fish. The outlet into Nougha Creek creates two important eddy pools in Nougha, one upstream and one downstream of the outlet. The first 10 m of the creek upstream of Nougha consist of a shallow glide at the mouth then a fast riffle before narrowing and entering into heavy willow tangles. Substrates in the creek are consistently heavily silted with clay and sand in the lower reach, gravel and cobbles occur occasionally at distances greater than 20 m upstream of Nougha Creek.

This creek is crossed by two winter trails 40 and 50 m upstream of Nougha Creek. Significant ice buildups were observed at the crossing sites during our spring investigations. The creek flows in a gully at the site of crossing with banks rising as much as 2.5 m above the actual flow. Arctic grayling juveniles were recorded in the first 20 m of the creek upstream of Nougha Creek during fall investigations and in the zone of influence during both summer and fall investigations.

TN-7: Tributary to Nougha Creek #7 does not have a discernible flow above ground at the outlet to Nougha Creek. The creek does have a large ponded area adjacent to Nougha Creek but flows from the creek enter this pond as seepage from the surrounding area. The distinct above ground channel that flows into a small alluvial area 50 m up from Nougha quickly dissipates into the wetland area leaving no above ground flow. Flows within the ponded area occur as seepage. The creek proper drains a willow tangled and spruce filled draw. Vegetation adjacent to the channel is alpine shrub.

The creek does not provide fish habitat, nor access to Nougha Creek, however the outlet bay formed by the creeks historic flows does offer a zero velocity area adjacent to Nougha Creek and as such provides some fish habitat.

TN-8: Tributary to Nougha Creek #8 is a small creek (depth was 0.2 m and width was 0.8 m), narrowing to < 0.25 m) which flows as stepped 0.3 m waterfalls interspersed by riffle/rapids (velocity > 2 m/sec) through a dense tangle of willow. The tributary flows directly into Nougha Creek in a narrow, confined and incised channel. There is very little in terms of a zone of influence where the tributary enters Nougha Creek, since it enters on a deep side into velocities >2m/sec. The tributary provides very limited fish habitat, primarily due to steep gradient and high velocities. This creek does not merit further fisheries investigations.

TN-9: Tributary to Nougha Creek #9 enters Nougha Creek as a waterfall approximately 3 m high. A second waterfall occurs within 20 m. The waterfalls cascade over bedrock with boulders. Above the waterfall area the creek channel is narrow and confined with velocities >2 m/sec over predominantly boulder/cobble substrates. The creek is heavily covered with willow and spruce.

The potential for fish utilization of this tributary is extremely limited due to high water velocities. The first 20 m of the creek forms a permanent barrier to fish passage. The creek enters Nougha directly with very little zone of influence. Nougha Creeks flows are fast (>2 m/sec) in this reach with a narrow and confined channel that provides very little low velocity habitats. This tributary creek does not provide fish habitat.

TN-10: Tributary to Nougha Creek #10. The upper reach starts 15 m u/s of Nougha Creek and is narrow and confined in an incised channel. The upper reach is 0.3 m wide and 0.5 m deep, on average, with surface velocities >1 m/sec.

The lower 15 m reach consists of mostly boulder substrates with a wetted width of 2 m, or greater. The lower reach of the creek has potential to support fish. The boulder substrates are clear of any silts or fines, a situation that may indicate ground welling.

This creek enters Nougha Creek where the flows are mostly <1 m/sec and some channel braiding occurs. The zone of influence to Nougha consists of an upstream pool of 2 m by 3 m and a downstream mix trail of approximately 2 m by 8 m, both of these areas have depths >0.5 m. Fish were captured in Nougha Creek adjacent to the tributary, however no fish were captured in the tributary itself. Sculpins and Arctic grayling juveniles were recorded in the zone of influence during summer and fall investigations.

TWV-1 Tributary to Wolverine Lake #1, also known as Jasper Creek, provides very little fish habitat and shows very low utilization. The creek is small with a depth of 0.3 m and a width of 0.6 m and has a high flow (<2 m/sec) through a heavy tangle of willow. The creek does provide an important mix zone as it enters Wolverine Lake. Several slimy sculpin and a single Arctic grayling juvenile were recorded in the creek. Large numbers of lake trout fry and grayling fry were recorded in the mix area of Wolverine Lake. Seines pulled in adjacent areas of Wolverine Lake had very low catches relative to those pulled in area influenced by TWV-1.

TWV-2 Tributary to Wolverine Lake #2 is a very small creek with depths of <0.01 m and width that does not exceed 0.3 m. The Creek does not provide any fish habitat.

TWV-3 Tributary to Wolverine Lake #3 drains a wetland area adjacent to Wolverine Lake. The creek is has a low gradient in its lower reaches and in several locations throughout its length. Numerous species of fish, in limited numbers, were recorded in the creek near the outlet during all seasonal investigations. Available fish habitat occurs predominantly within 150 m of the lake, however small pockets of good habitat occur 500 m upstream of the lake near the confluence of two feeder creeks.

TVB & TVB-1 Tributary to van Bibber Creek, and tributary to this tributary. The site of investigation consisted of the headwater reaches at the confluence of two feeder creeks. The northern most of the feeder creek intersects the proposed access route just upstream of its confluence with the second feeder creek. The creeks both consist of wide, flat, stepped riffles with available structural habitats with very low conductivity (i.e.

very pure water) and cold water temperatures. The reaches investigated are above a long reach consisting of high velocity water and a narrow channel with limited fish migration potential. Fish were not recorded in any of the channels of this creek.

Investigations into the outlet areas of these creeks revealed several to have significant fish values. The tributary to Wind Lake, TW-1, has an extended outlet area flowing through small bluffs of willow mixed with dwarf birch. The area is extensively worked by beavers and extends over 300 m from the lake. This area provides spawning and rearing habitat for Arctic grayling. Juvenile long nose sucker and juvenile Arctic grayling utilize the ponds associated with the creek near the lakeshore.

Tributary TWV3, at its outlet to Wolverine Lake, provides rearing habitats for juvenile Arctic grayling, juvenile lake trout, juvenile long nose sucker and juvenile burbot, resident slimy sculpin also utilize this creek. Suitable habitats are located upstream of the lake for a distance of 150 m, aerial assessments showed potential for fish habitat in scattered pockets up to the point of the confluence of two feeder creeks 500 m from the lake.

Most of the tributaries entering Nougha Creek are colder than Nougha throughout the year. Tributaries TN1 and TN3 provide limited fish habitats near the outlets, however utilization was restricted to within 20 m of Nougha Creek. Several of the tributaries create eddying in Nougha Creek at their point of entry creating important habitats in an otherwise fast flowing Nougha Creek.

Although most of the creeks investigated did not provide fish habitat, the outlet areas often enhanced fish habitats by introducing oxygen and nutrient rich waters to the lake and receiver creek. This was especially evident in the lakes where utilization of the waters at the creek outlet was significantly higher than in similar adjacent areas.

Bull Trout Habitat Evaluation

Bull trout are a sub-species of the genus *Salvelinus*, which includes Arctic char, lake trout and dolly varden. The species is wide spread throughout western North America and eastern Asia. Within the dolly varden / bull trout complex numerous forms exist, including northern and southern, anadromous and non-anadromous, stream resident and lake resident populations (Armstrong and Morrow, 1980). The different forms have developed varying life history strategies that make it difficult to confidently describe the Money Creek population based on existing models from other areas.

Although a great deal of information has been compiled on the species understanding, references in this specific type of habitat are limited. The similarities between land locked and anadromous individuals are subtle but distinct enough that the species complex has often been subjected to sub-species classifications, (e.g. bull trout/ dolly varden). The life history and habits of the various forms varies greatly depend on the surrounding environment. The fish in Money Creek correspond most closely with the stream resident form of dolly varden/ bulltrout, typically confined to clear water tributaries of major rivers. However, there are similarities with a form described as a stream-lake resident (Morrow and Armstrong, 1980).

Genetic analysis, conducted by the Yukon Territorial Government Fisheries Department, in conjunction with the University of British Columbia, on specimens taken from the Liard River drainage in the Yukon has shown all specimens analyzed to be bull trout. Three specimens taken from the Money Creek watershed during the field assessment were genetically tested at the University of British Columbia by Eric Taylor, Assistant

Professor, Department of Zoology. Growth hormone diagnostic testing was conducted and resulted in a positive identification of the specimens as bull trout *Salvelinus confluentus*.

Timing of field investigations was coordinated after assessing several reference sources. The closest (proximity) bull trout population to have existing information is at Shiltsky Lake, Yukon, where spawning occurred between September 16 and 21, consistently over a five year period. Water temperatures at spawning vary with the reference; the 1995 spawn at Shiltsky Lake was recorded at 12°C, in contradiction to other recorded references which suggests spawning occurs between 5 and 7°C (Blackett, 1968) or near 8°C (Scott and Crossman, 1974).

Water temperatures in Money Creek were monitored with a data logger located 500 m downstream of the outlet of Go Creek (site W-14). Temperature data was recorded 20 times per day from August 20 to September 12. During this time period daily temperatures rose to highs of between 9 and 12°C, while night time lows fell as low as 5.7°C. Daily temperatures typically fluctuated between 3 to 5°C.

Thermographic records taken at site W-14 on Money Creek indicate that temperatures were approaching a high of 5 to 7°C on September 12 when the recorder was removed. Temperatures remained at that level until our investigations were conducted. Blackett (1960) reported that anadromous dolly varden in Alaska spawned at temperatures between 5 and 6°C but spawning ceased abruptly after a further 2°C drop in temperature. Temperatures at the time of our field investigations were near 6°C. In light of this, the lack of spawning individuals observed during the surveys may indicate that spawning occurred prior to the investigations.

Spawning did not appear to occur in large aggregations, as few suitable locations were recorded and those investigated showed no signs of a recent spawn. One potential area that large numbers may have spawned in is the gravel shoals located immediately upstream of the outlet of Money Creek to Francis Lake. Alternatively, small pockets of sorted, clean washed gravels were observed under undercut banks during the float surveys. These potential micro-spawning sites were small, usually oblong in shape and less than 0.5 x 0.3 m. Fish of this species complex have been recorded utilizing similar habitats (Armstrong and Morrow, 1980, and Blackett 1968).

Money Creek may be used as a spawning and rearing creek for bull trout, with adults utilizing Francis Lake and only entering the creek for spawning. Unpublished data from YTG (Thompson Per. Com, 1997) shows that eleven adult dolly varden / bull trout were captured during index gillnetting surveys of Francis Lake conducted in 1990. Of the eleven fish captured, one was taken in the East arm, one was taken in the small lake at the north end of the West arm, and nine were captured just to the south of the Money Creek outlet. This data suggested that the creek is used for spawning and rearing while the lake is used by adults. This model would explain why extensive effort to capture bull trout produced only randomly scattered immature specimens. Considering this model it seems likely that the spawning locations would be located in the lower reaches of the creek. The steep canyon areas and rapids would present a barrier to adult fish migration during spawning in September when water levels are low. These same rapids become more passable to the fry during high water in the spring, allowing the upstream

movement of fry that would rear in the creek for as much as several years, or until they reach sexual maturity.

Given the extended effort into locating bull trout in Money Creek and the low numbers of fish captured or observed, it seems likely that the population density and extent of utilization is quite low. Results of fish sampling from this investigation are provided in Appendix 3E (Appendix 2 of the Proposed Access Road Creek Crossings – Fish Habitat Evaluation and Utilization Assessment, 1997 report). The locations of the sample sites are shown on Figure 3.75.

Potential over wintering sites exist in an area only accessible by helicopter. A very tight canyon starting approximately 8 km upstream of Francis Lake extends for a distance of approximately 2.5 km. The canyon has abrupt valley walls, is 100% confined and flows in a narrow channel interspersed with deep pools below abrupt rapids and steep riffles. This canyon area represents a unique habitat on Money Creek. Pools of the same depth occur rarely elsewhere on the creek and definitely do not occur in such a concentrated cluster. The series of pools starts at a small waterfall at coordinates 61°09'17"N / 129°46'45"W. Float surveys were conducted in the uppermost pool of the reach and Arctic grayling, in an aggregation of 24 adults and sub adults, were observed. One juvenile bull trout was observed below the pool.

Money Creek – Aerial Habitat Survey

Aerial assessments of Money Creek were conducted on July 14, 1997 in order to provide an evaluation of the creek and it's potential to support fish. The July survey was a continuation of the 1996 investigation that focused on species utilization along specific sections of Money Creek.

Twenty-four separate reaches were identified, defined by changes in habitat conditions. The first 23 reaches were identified in the 50 km stretch between the creek outlet to Francis Lake and the confluence with Go Creek. The area above Go Creek was defined as one reach.

Overall, Money Creek flows as a high velocity creek with predominantly cobble substrates interspersed with boulders and sorted gravel. Fish habitats are limited and typically small. Concentrated pockets of key habitats exist along the creek, the most notable being the potential over wintering sites near Reach #7. The creek flows clear and shallow with high velocities that provide poor cover and few resting areas for fish.

The lower 1.5 (Reaches 1 and 2) km of the Creek is relatively flat and dominated by glide and riffle/glide type habitats with cobble and gravel substrates. Finer sediments are found in deposits nearer the outlet to the lake.

For roughly 16 km above that point (reaches 3 to 10), the stream is confined to a continuous canyon with fast flows, large boulders, rapids and cascades, and deep pools. For the next 32.5 km (Reaches 11 to 17), it enters a broad valley which presents meanders, broad channels, mixed substrate conditions, wetlands and beaver habitat complexes, and abandoned/side channels.

The area above Go Creek is defined as one reach of undescribed length. This area flows through broad alpine and sub-alpine valleys. The stream is braided and has meanders. Substrate is variable and contains a higher proportion of angular fragments than lower reaches.

Habitat descriptions by reach are provided in Appendix 3E.

Nougha Creek – Aerial Habitat Survey

Aerial assessments of Nougha Creek were conducted on July 16, 1997. A total of 14 separate reaches were identified along the 18 km of stream surveyed.

In general, Nougha Creek provides many good fish habitat areas but fish passage is blocked to upstream movements by waterfalls in Reach # 4. The creek provides many habitats for Arctic grayling.

The first 3 reaches extend for 6.5 km above the stream outlet to Finlayson Lake. Through this area, the stream transitions from a broad, smooth, slow channel with fine substrate to a more confined channel with boulders and larger substrate and faster flows. Reach 4 is 1 km long and includes steep gradients, waterfalls and deep pools. It is noted to contain potential barriers to fish migration. Reach 5 (2 km long) is a broad flat valley with gradient that combine to result in meandering of the stream channel, fast flows including riffle complexes and larger substrate materials. Above this (Reach 6) is a 0.8 km stretch of stepped rapids that may also provide a barrier for fish migration.

The remain stream length (roughly 8 km encompassing Reaches 7 to 10) transitions from a moderate gradient with riffle and pool habitats to broad channels with sluggish flows, silty substrate, oxbow lakes, and beaver habitat complexes.

Habitat descriptions by reach are provided in Appendix 3E.

Metals Concentrations in Fish Tissue

A total of 10 slimy sculpin samples (consisting of 3 to 7 individual fish each) and 4 Arctic grayling samples were taken for heavy metal analysis. The slimy sculpin samples were taken from two tributaries to Little Wolverine Lake, three tributaries to Wolverine Lake, the outlet of Wolverine Lake, and three sites on Money Creek. The Arctic grayling samples were taken from the inlet and outlet of Wolverine Lake (two fish from each site). Arctic grayling samples consisted of both flesh and liver samples. A total of 6 lake trout were taken for heavy metal contaminant analysis. A set of three samples from each fish was obtained, a back flesh sample, a stomach flesh sample, and the liver.

The results of the analysis are shown in Figure 3.76. Zinc showed the highest potential for tissue accumulation and was highest in the liver tissues and the sculpins. Selenium showed the second highest accumulation and was high in the liver tissues but not the sculpins. Sculpins showed a higher propensity to accumulate arsenic. Lake Trout accumulated lower levels of cadmium in their muscle tissues but higher levels in their livers as compared to other fish.

3.2.2 Vegetation

3.2.2.1 Kudz Ze Kayah

The proposed Kudz Ze Kayah mine site and the southern portion of the project tote road lie within the Pelly Mountain Ecoregion as described by Oswald and Senyk (1977). The majority of the tote road (ie. north of Finlayson Creek) lies within the Pelly River Ecoregion (Oswald and Senyk, 1977). More recently, Geomatics International (May, 1995) completed a document called "Ecosystem Classification for the South-east

Yukon". This study classified vegetation and soil types for the Liard River, Beaver River and Logan Mountain areas in the south-east corner of the territory. The Kudz Ze Kayah study area lies immediately adjacent to the geographical area classified by Geomatics.

Vegetation surveys were completed on site during August 7 - 10, 1995. Sampling was conducted at plots using a truncated format adapted from Luttmerding et al. (1990) and Geomatics International (1995). A complete description of the study methodology is presented in the Kudz Ze Kayah IEE. Figure 3.77 shows plot and transect locations. Vegetation types in the vicinity of the proposed mine site are shown on Figure 3.78, while vegetation types along the tote road from of the proposed tailings dam north to the Robert Campbell Highway are shown on Figure 3.79. A detailed description of each habitat type, including scientific names of plant species, is provided in Appendix 3.8 of the Kudz Ze Kayah Water Licence Application.

From a vegetation perspective, the Kudz Ze Kayah project area can be subdivided into two areas; Finlayson Creek north of the Geona Creek confluence (access road corridor) and Geona and South creeks (mine development area). The access road corridor is generally predominated by boreal forest, grading into shrub vegetation types. The mine development area is comprised of shrub and herb vegetation types.

The primary forest types along the access road corridor are open canopy black spruce on mineral soils and open canopy sub-alpine fir. Dwarf birch tall shrub and willow dwarf birch tall shrub vegetation types predominate at higher elevations on the uplands above Finlayson Creek.

The mine development area is at a higher elevation and forest cover is generally sparse. The smaller shrub vegetation types which predominate are willow dwarf and alpine dwarf and herb vegetation types such as woodrush and mesic mixed.

The individual vegetation types and their relative abundance and significance in terms of wildlife habitat are summarized below.

Forested Types

Closed-Canopy Trembling Aspen Forest

This vegetation type resembles the Closed-Canopy Trembling Aspen Forest (V2) type described in Geomatics (1995). These forests are dominated by trembling aspen, with sub-alpine fir. The shrub layer is poorly developed, and composed of dwarf birch and willows. In the herb layer only kinnikinnick, fescues, and Arctic lupine are abundant. The moss and lichen cover is typically very low. These forests develop on rapidly to well drained, dry (subxeric) sites on glaciofluvial material. This type is found on a few scattered sites north of the Finlayson Creek crossing. It is relatively rare and accounts for less than one percent of the study area.

This habitat type provides limited food resources for ungulates and carnivores.

Open-Canopy Sub-alpine Fir Forest

These sub-alpine fir dominated stands resemble the Open Canopy Sub-alpine fir Forest (V15) type described by Geomatics (1995). The sub-alpine fir canopy is discontinuous, on average 10 to 15 m high. The shrub layer is generally well developed, particularly in openings between trees. The main species include dwarf birch, willows, crowberry, and

lingonberry. Sub-alpine fir regeneration is also present. The herb component is variable, from poor to moderately rich, with bunchberry, alтай fescue, Arctic lupine and twinflower. The ground is covered by a thick feathermoss carpet, with lichen (mostly reindeer lichens) patches in more open and dry areas. Soil texture is variable, usually fine to medium-textured. This type is commonly found along Geona and Finlayson Creeks above the valley floors. It forms a reverse tree line in a complex with the sub-alpine fir tall shrub type on sections of the mid to lower slopes of Geona and South Creek valleys. It is relatively common and accounts for about 6 to 10% of the study area.

This habitat type provides cover for moose and caribou in summer and fall, and possibly into the early winter. Limited use by upland furbearers is expected.

Open-Canopy Black Spruce Forest (on mineral soil)

This type resembles the Open-Canopy Black Spruce Forest (V17) type described in Geomatics (1995). This forest type, which develops on mineral soils in upland areas, is dominated by black spruce, with lesser amounts of other coniferous species such as sub-alpine fir. Trees are usually short (10 to 12 m), and have small diameters. Shrub layer development is good, with taller stature willows, Labrador tea, bog blueberry, and dwarf birch, and dwarf shrubs such as lingonberry and crowberry. Herb layer cover is typically low, with few species present. Feathermosses and reindeer lichens are abundant. This forest type is typical of upland sites on medium textured mineral soil occurring from the tote road crossing at Finlayson Creek north to the Robert Campbell Highway. This type is one of the most abundant and covers approximately 15% of the study area.

This habitat type provides early-summer range for moose and is utilized by caribou during spring and fall migrations; it provides good habitat for black bears, smaller carnivores, upland furbearers, and small bird species. North of the Kudz Ze Kayah project area, this habitat type provides winter range for caribou.

Open-Canopy Black Spruce Forest (on organic soil)

This type resembles the Open-Canopy Black Spruce Forest (V18) type which develops on organic soils, as described in Geomatics (1995). These stands are dominated by black spruce. Trees are poorly stocked, reaching only 8 to 12 m in height and are of small diameter. The shrub layer is moderately well developed, the leading species being Labrador tea, willows and dwarf birch. Black spruce reproduction is also common. Herb cover is low to moderate. Feathermosses and sphagnum form a thick carpet on the ground. This forest type typically occurs in topographical lows (depressions or swales associated with small streams) in complex with open-canopy black spruce forest that occurs on mineral soils. Soils consist of veneers or blankets of organic material. It occurs from the tote road crossing at Finlayson Creek north to the Robert Campbell Highway. This type is uncommon and accounts for about 2 to 5 percent of the study area.

This habitat type provides some winter range for caribou to the north of the Kudz Ze Kayah project area and receives some use during spring and fall caribou migrations. It is not as well developed as the similar type on mineral soil (see above) and has less thermal cover and food resources for caribou. Use by carnivores, furbearers and birds is also expected to be less than the similar type on mineral soil.

Open Canopy White Spruce Forest

This vegetation type was not sampled at the Kudz Ze Kayah project site, but is expected to occur along Finlayson Creek below its confluence with Geona Creek. This type resembles the Open Canopy Black Spruce Forest (V16) as described by Geomatics (1995). This forest type occurs on alluvial sites along rivers and lakes at elevations up to about 1030 m asl. (Geomatics, 1995). White spruce is the dominant tree, however black spruce and sub-alpine fir may also be present in this area. The shrub and herb layers are expected to be well developed and rich. Horsetails are often abundant in the herb layer on these alluvial sites. A maximum of one to two percent of the area is covered by this vegetation type.

This forest habitat represents the most productive forest type in the Kudz Ze Kayah project area and provides cover and food for moose in spring and summer. It is used during winter by moose travelling along adjacent riparian areas. Caribou utilize this forest habitat during spring and fall migrations. This type provides good habitat for black bears, carnivores, upland furbearers, and a wide variety of bird species.

Shrub Types

Dwarf Birch Tall Shrub: Herb poor - moss rich

This tall shrub type resembles the Dwarf Birch Tall Shrub (V101) type described in Geomatics (1995). These tall shrub thickets are dominated by dwarf birch with a minor component of willows. Crowberry and other dwarf shrubs are found in the secondary shrub layer. The shrub canopy varies from about 50 cm to 2 metres in height, but may be overtopped by single short trees. Herbs are usually poorly represented, but mosses and lichens are abundant. Sedges and grasses are common on moist sites (ie. toe slope positions). This shrub type is common and forms extensive wide bands on the moderately sloping topography above Geona and Finlayson Creek valleys and comprises approximately 10 % of the study area. It is occasionally located on steeper slopes. It is often located on exposed knolls which have poorly developed or nutrient poor soils.

This habitat type provides cover and limited food for moose during summer, fall and early winter; it provides cover and limited food for caribou in summer. This type would receive limited use by carnivores, furbearers and small birds. Ptarmigan utilize this type for cover and food in winter.

Willow Tall Shrub

These tall shrub thickets, dominated by various species of willow, resemble the Willow Tall Shrub (V104) type described by Geomatics (1995). The canopy height, cover and continuity are extremely variable. Dwarf birch is usually present in the main shrub layer. The herb layer is generally well developed and moderate to very rich in species. Common species may include common horsetail, tall bluebell, fireweed, alai fescue, bluegrass, arrow-leaved groundsel, monkshood, dwarf scouring rush, sagewort, tall Jacob's-ladder, and tall larkspur. The moss layer is generally poorly developed, with feathermosses and lichens on upland sites. This type is found on moderate to steep slopes in the upper Geona and South Creek valleys. It is relatively uncommon and accounts for about two to five percent of the study area.

This shrub habitat provides cover and an abundant food source for moose during late spring, summer and fall. Depending on snow depth, use during winter is also expected,

as willows are abundant. This habitat type provides cover and food for caribou during their movements through the Kudz Ze Kayah project area. Willows and the rich herb layer provide an abundant food supply for bears during the spring and summer. Ptarmigan use this habitat type for cover during winter and during the breeding season.

Willow Tall Shrub: wet, riparian

This vegetation type, dominated by various species of willow, represents a wetter phase of the Willow Tall Shrub (V104) type described by Geomatics (1995). The canopy is typically 1 to 2 m in height, however, the percent cover and continuity are extremely variable. Dwarf birch and shrubby cinquefoil may also be present in the shrub layer. The herb layer is generally well developed, but not very species rich. Sedges, bluejoint and horsetails are common. Sphagnum mosses are found on these lowland sites. This type is found on organic veneers over fluvial deposits and/or fluvial mineral soils along Geona and Finlayson Creek and their tributaries. It is relatively uncommon in the study area and accounts for approximately two to five percent of the study area.

This habitat type has similar wildlife values to the willow tall shrub type, but is expected to receive less use by caribou and ptarmigan.

Willow-Dwarf Birch Tall Shrub: herb rich

These tall shrub thickets resemble the Willow-Dwarf Birch Tall Shrub (V105) type described by Geomatics (1995). Willows and dwarf birch are co-dominant and form the main canopy in this type. Stands vary considerably in their composition, structure and site/soil characteristics. Shrubs present in the lower canopy may include bog blueberry, lingonberry, and crowberry. The herb layer is generally well developed and moderately species rich with arctic lupine, alai fescue, tall bluebells and sagewort. Moss and lichen cover varies from moderate to abundant. Feathermosses are typical of mesic sites, lichens increase in abundance on dry sites. This vegetation type is common on the mountain slopes above Geona Creek and Finlayson Creek and on the rolling uplands along the road corridor. It is relatively common and comprises 6 to 10 percent of the study area.

This habitat type provides cover and food for moose during summer and fall and cover for caribou during fall and early winter. It provides some food for bears during summer. Ptarmigan utilize this habitat type for much of the year.

Willow-Dwarf Birch Tall Shrub: herb poor

This type is a variation of the Willow-Dwarf Birch Tall Shrub (V105) type described by Geomatics (1995). Dwarf birch and different willow species are dominant in the main canopy. Bog blueberry, Labrador tea, lingonberry, crowberry, and bearberry may be present in the lower shrub layer. The herb layer is typically poorly developed and species poor with Arctic lupine, alai fescue, and woodrushes. Moss and lichen cover varies from poor to abundant. Lichens are more abundant than in the herb rich type. This type is typically found on medium to coarse textured, nutrient poor soils (often on knolls). It is relatively common and occupies approximately 6 to 10 percent of the study area, occurring on rolling uplands from the Finlayson Creek area north to the highway.

This habitat type has similar values to the herb rich type (above) but provides less food for bears.

Dwarf Birch Dwarf Shrub

This dwarf shrub type, dominated by dwarf birch, resembles the Dwarf Birch Dwarf Shrub (V110) type described in Geomatics (1995). These shrubby stands are typically less than 50 cm in height. Other dwarf shrub species such as bog blueberry, lingonberry, crowberry and alpine willows may be present. The herb layer may be well developed on wet sites, but is generally poorly developed on drier sites. The moss layer is moderate to well developed. The significance of lichens increases on drier sites, especially on exposed soil and rock/boulder outcrops. This type is relatively uncommon and occupies 2 to 5 percent of the study area. It is found in complex with other dwarf shrub and herbaceous vegetation types in the alpine areas above Geona and South Creeks.

This habitat type provides food for caribou during summer and fall, and depending on local conditions, into the early winter. It provides some cover and food for ptarmigan.

Willow Dwarf Shrub

This type resembles the Willow Dwarf Shrub (V113) described by Geomatics (1995). Various dwarf willow species may be dominant in this type. The willows are usually only a few centimetres in height. The herb stratum varies from poorly developed and species poor to moderately rich. The moss layer is poorly to moderately well developed. This type is also relatively uncommon, occupying 2 to 5 percent of the study area. It is found in complex with other alpine vegetation types in alpine areas above Geona and South Creeks.

This habitat type has similar values to the dwarf birch dwarf shrub type.

Sub-alpine Fir Tall Shrub

These tall shrub stands resemble the Sub-alpine Fir Tall Shrub (V120) type described by Geomatics (1995). Sub-alpine fir is dominant in the main canopy, while willows, dwarf birch, Labrador tea, crowberry, bog blueberry and lingonberry may be present in the lower canopies. Fir height and growth form are extremely variable, from prostrate and twisted krummholz to low-stature upright individuals. The herb stratum is generally poorly to moderately well developed and rich, the main species being bunchberry, fireweed, twinflower and wood horsetail (moist sites). Herb cover increases in open patches. Mosses form a thick carpet beneath the fir canopy. This type is relatively uncommon and is typically found in a relatively narrow band on the lower mountain slopes above Geona and South Creeks. It occupies 2 to 5 percent of the study area and is often complexed with the open canopy sub-alpine fir, dwarf birch tall shrub and willow dwarf birch tall shrub types.

This habitat type provides some cover for moose and for caribou during summer and fall migrations. It provides habitat for carnivores, furbearers and small birds.

Alpine Dwarf Shrub

This unit approximates the Miscellaneous Alpine Dwarf Shrub (V172) and Mountain Avens Dwarf Shrub (V111) types described by Geomatics (1995). This type may be composed of various dwarf shrubs such as willows, dwarf birch, mountain avens, four angled mountain-heather, crowberry and bog blueberry. The herb layer is poorly to moderately well developed. Common species may include anemone, woodrushes, Arctic lupine, altai fescue, and bistort. Lichens are common on some sites. These communities occur on subxeric to mesic sites in the alpine zone above Geona and

South Creeks in complex with other alpine dwarf shrub and herbaceous vegetation types. It is relatively common and accounts for approximately 6 to 10 percent of the study area.

This alpine shrub habitat provides food for caribou during summer and fall, and depending on snow conditions into early winter. It provides cover and food for ptarmigan.

Herb Types

Woodrush Herb

This alpine meadow type resembles the Dry Wood Rush Herb (V200) type described by Geomatics (1995). Woodrushes are the dominant herbs; other herbaceous plants occur sparingly. Dwarf shrubs, such as lingonberry and four angled mountain-heather may be locally abundant. Lichens are generally abundant, while the cover of mosses is sparse. This community is found on exposed slopes and ridges in the alpine zone above Geona and South Creeks. Soil development is weak. It is relatively uncommon and accounts for about 2 to 5 percent of the study area.

This herb type provides food for caribou during the summer and fall.

Wet Sedge Herb: riparian wetland

This wet meadow type resembles the Wet Sedge Herb (V208) type described by Geomatics (1995). Sedges are dominant in the herb layer. The cover and diversity of other herbaceous and shrub species is typically low. Substrate is typically a veneer (or blanket) of organic material, over fluvial deposits. They develop in a variety of topographic situations, most frequently on the shores of small lakes, on floodplains (riparian sites), and in depressions in the Geona and Finlayson Creek valleys. Soils are typically organic. This type is relatively rare and occupies only about one percent of the study area.

This habitat type provides some food (sedges) for bears in summer as it is often part of a riparian habitat complex.

Mesic Mixed Herb

This meadow community resembles the Mesic Mixed Herb (V401) type described by Geomatics (1995). It is composed of approximately equal proportions of graminoid and forb herb species. Species richness and abundance are usually high. Common species include polargrass, spike trisetum, altai fescue, fireweed, tall bluebells, mountain monkshood, tall larkspur, arrow-leaved groundsel, and roseroot. Dwarf alpine willows are also commonly present. It is typically found on mesic to subhygic sites in areas with better soil development. This meadow type was found on a variety of topographic positions on mountain slopes and alpine areas in the Geona and South Creek areas. It is relatively uncommon and comprises 2 to 5 percent of the study area. It is found in complex with dwarf shrub and tall shrub types.

This alpine meadow habitat type provides food for caribou during summer and fall and food for ptarmigan.

3.2.2.2 Wolverine

The Wolverine Lake study area falls within the Pelly Mountains Ecoregion as defined by Oswald and Senyk (1977) and the Ecoregions Working Group (1995). The terrain within the study area is generally over 1200 meters with widespread discontinuous permafrost. Much of the area is treeless with treeline occurring at 1350 to 1500 meters. The southern part of the study area was burned by a forest fire in 1994 and is now in the early stage of regenerative growth.

In 1994, vegetation communities and soil types were classified for the Liard Basin and Logan Mountains by the Yukon Department of Renewable Resources (Zoldeski and Cowell, 1996). The proposed Wolverine Lake mine site lies immediately to the west of this area.

Methodology

Aerial photographs (1:40,000 scale taken in August, 1992) were used to delineate the major vegetation communities in the study area on NTS topographic maps. A ground-truthing of the airphotos was carried out during a vegetation/habitat survey in mid-July, 1996. The vegetation sampling method was adapted from the format developed during the Southeast Yukon Ecosystem Classification (Zoldeski and Cowell, 1996).

Sampling plots were selected to represent the vegetation communities identified from the airphotos. Plots were accessed by boat, helicopter and on foot. All sampling plots were 10 m x 10 m (100 m²). The plant species and their cover-abundance were described for each vegetative layer. Tree species 5 m or more in height constituted the overstorey, while the understorey consisted of three shrub layers (<0.5 m, 0.5-2 m and 2-5 m). The relative abundance of herbaceous plant species, bryophytes and lichens were recorded. Notes on elevation, aspect, slope and moisture regime were also taken. Additional observations of plant communities were taken during the walking transects between sampling plots and during other biophysical surveys in the study area. Locations of sampling plots and transects are shown in Figure 3.80.

Vegetation communities were compared to the vegetation types identified by Geomatics International in the southeast Yukon (Zoldeski and Cowell, 1996). The vegetation type classification key provided in the Field Guide to Ecosystem Classification for the Southeast Yukon (Zoldeski and Cowell, 1996) was also used in the identification and naming of plant communities.

Plant specimens were identified in the field where possible. Some specimens were preserved for later identification. Floras used in the identification of vascular plants included Hulten (1968) and Porsild and Cody (1980). Vitt *et al.* (1988) and MacKinnon *et al.* (1992) were used in the identification of bryophytes and lichens. Herbariums located at Forest Resources (DIAND), Fish and Wildlife Branch (Govt. of Yukon) and Agriculture Branch (Govt. of Yukon) were also used in specimen identification.

Vegetation Communities and Habitat Potential

Vegetation in the Wolverine Lake study area includes bog forests and upland forests, as well as alluvial plain shrub, sub-alpine transition and alpine tundra zones. A map showing vegetation types is presented in Figure 3.81. Polygons representing vegetation zones have been delineated. Several vegetation types may be shown within each polygon. It should be noted that the boundaries between polygons are not always distinct in some vegetation transition zones.

A complete list of plant species observed is given in Appendix 3F. This is not intended to be an exhaustive list of plant species in the study area. A description of individual vegetation types and their extent within the study area is summarized within this section. A description of the strata composition in each vegetation type is presented in Appendix 3F.

Closed Trembling Aspen Forest

A closed canopy of trembling aspen (*Populus tremuloides*) with minor occurrences of willow (*Salix* sp.) make up the tree layer. The low shrub layer consists mainly of soapberry (*Shepherdia canadensis*). Kinnikinnick (*Arctostaphylos uva-ursi*), twinflower (*Linnaea borealis*) and common juniper (*Juniperus communis*) form the groundcover. The herb layer, not well developed, is dominated by fireweed (*Epilobium angustifolium*). Bryophytes and lichens are uncommon.

The Closed Trembling Aspen Forest vegetation type (V2) of the 1996 Southeast Yukon Ecosystem Classification best describes these aspen stands.

Closed aspen forests are found on well drained sandy sites on south or west facing slopes. This vegetation type is uncommon in the Wolverine Lake area. A few scattered stands occur in the upland vegetation zone, particularly on the southwest facing slopes above Wolverine and Little Wolverine Lakes.

Closed Balsam Poplar Forest

The closed tree canopy and tall shrub layer consist primarily of balsam poplar (*Populus balsamifera*), with occurrences of willow (*Salix* spp.). Soapberry (*Shepherdia canadensis*) and shrubby cinquefoil (*Potentilla fruticosa*) dominate the low shrub layer. Dwarf shrubs include kinnikinnick (*Arctostaphylos uva-ursi*), prickly rose (*Rosa acicularis*) and twinflower (*Linnaea borealis*). The herb cover is not extensive, but includes a variety of species. The moss and lichen layer is not well developed.

This vegetation type resembles the Closed Balsam Poplar Forest (V3) of the 1996 Southeast Yukon Ecosystem Classification.

Closed balsam poplar forests, normally found on active alluvial sites, are uncommon in the Wolverine Lake area. A few scattered upland stands occur on the lower slopes northeast of Wolverine Lake.

Open Alpine Fir Forest

The open canopy overstorey in this vegetation type is dominated by alpine fir (*Abies lasiocarpa*). The dwarf shrub layer is particularly well developed and consists mainly of crowberry (*Empetrum nigrum*) and white mountain heather (*Cassiope tetragona*). Herbs are uncommon in this vegetation type. The non-vascular plant layer is comprised primarily of *Cladina* spp.

This vegetation type is similar to the Open Alpine Fir Forest (V16) of the 1996 Southeast Yukon Ecosystem Classification.

Open alpine fir forests are common throughout the sub-alpine transition zone in the Wolverine Lake area. Alpine fir forests on the upper slopes may transform into krummholtz. The lower extent of these alpine fir stands typically border on white or black spruce forests. On the slopes southwest of Wolverine Lake, alpine fir forests extend almost to the lakeshore.

Open White Spruce Forest

White spruce (*Picea glauca*) dominates the open canopy overstorey. The low and dwarf shrub layer is well developed and consists primarily of shrub birch (*Betula glandulosa*), willow (*Salix* sp.), Labrador tea (*Ledum groenlandicum*) and crowberry (*Empetrum nigrum*). Herbs are poorly represented in this vegetation type. The non-vascular plant layer is dominated by *Pleurozium shreberi* and *Cladina* sp.

This vegetation type resembles the Open White Spruce Forest (V17) of the 1996 Southeast Yukon Ecosystem Classification.

Open white spruce forests are fairly common in the upland vegetation zone, particularly on the slopes northeast of Wolverine and Little Wolverine Lakes. They are typically bordered by black spruce stands in the lower bog forests and extend upslope to open alpine fir forests in the sub-alpine transition zone.

Open Black Spruce Forest - Lowland

An open canopy of black spruce (*Picea mariana*) makes up the overstorey and tall shrub layers. Low shrubs include black spruce and willows (*Salix* spp.). The dwarf shrub consists of a variety of mainly ericaceous shrubs, predominately Labrador tea (*Ledum groenlandicum*). Herbs, not abundant, include graminoids (*Arctagrostis latifolia*). Sphagnum moss (*Sphagnum* spp.) and lichen (*Cladina* spp.) complete the groundcover.

This vegetation type is best described by the Open Black Spruce Forest (Organic Soil) (V19) of the 1996 Southeast Yukon Ecosystem Classification.

A narrow zone of open black spruce forests on organic soils is found on the lowland bog areas around much of Wolverine and Little Wolverine Lakes. It typically borders on the white spruce forest, alpine fir forest or black spruce forest (mineral soil) of the upland forest zone.

Shrub Birch Low Shrub

Shrub birch (*Betula glandulosa*) thickets, less than 2 m in height, form the dominant vegetative cover. A sparsely developed dwarf shrub layer is formed primarily of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). Herbs are uncommon in this vegetative type. The groundcover consists mostly of lichens (principally *Cladina* spp.).

This vegetation type resembles the Shrub Birch Medium/Tall Shrub (V101) of the 1996 Southeast Yukon Ecosystem Classification.

Low shrub birch thickets are common in the upper sub-alpine transition zone on the mountains around Wolverine Lake. It is also common in the alluvial plain shrub zone. Shrub birch is a major regeneration species following the 1994 forest fire in the southern portion of the study area.

Willow Low Shrub

A low shrub layer of willows (*Salix* spp.) dominates this vegetation type. The tree layer, mostly white spruce (*Picea glauca*), and tall willow (*Salix* spp.) shrub layer are sparsely developed. Dwarf shrubs consist mainly of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). The herb layer is poorly developed. Non-vascular plants are represented by feather moss (*Hylocomium splendens*), sphagnum moss (*Sphagnum girgensohnii*), and foliose lichens (*Peltigera scabrosa*).

The Willow Medium/Tall Shrub (V104) of the 1996 Southeast Yukon Ecosystem Classification is most similar to this vegetation type.

Stands of low willows are found along the upper tributaries to several of the drainages in the Wolverine Lake area. It also occurs as regeneration following the 1994 forest fire in the southern part of the study area.

Shrub Birch - Labrador Tea Low / Dwarf Shrub

The low and dwarf shrub layers are dominated by shrub birch (*Betula glandulosa*) and Labrador tea (*Ledum groenlandicum*). The sparse tall shrub layer consists of willow (*Salix* sp.) and paper birch (*Betula papyrifera*). Herbs, not abundant, are mostly graminoids, particularly *Festuca altaica*. Non-vascular plants are represented primarily by *Cladina mitis* and *Hylocomium splendens*.

The Shrub Birch-Labrador Tea Medium/Tall Shrub type (V102) of the 1996 Southeast Yukon Ecosystem Classification best resembles these vegetation stands.

This shrub vegetation is found in scattered stands throughout lower slopes of the upland forests around Wolverine Lake. It does not constitute a large portion of the vegetative cover in the area.

Labrador Tea Dwarf Shrub

A dwarf shrub layer of Labrador tea (*Ledum groenlandicum*) and a groundcover of lichen (predominately *Cladina stellaris* and *Cladina rangiferina*) characterize this vegetation type. Herbs are uncommon.

This vegetation type does not correspond to any of those described in the 1996 Southeast Yukon Ecosystem Classification.

This dwarf shrub type covers much of the mid elevation hillside southwest of Wolverine Lake. On slopes with north/northeast aspect, this vegetation extends down to the alpine fir krummholtz of the sub-alpine transition zone.

Mountain Avens Dwarf Shrub

A dwarf shrub layer of mountain avens (*Dryas integrifolia*) characterizes this alpine vegetation type. Other dwarf shrubs, including net-veined willow (*Salix reticulata*) and cranberry (*Vaccinium vitis-idaea*), also occur as groundcover. A sparse herb layer

includes alтай fescue (*Festuca altaica*). Lichens include *Dactylina arctica* and *Cetraria* spp.

The Mountain Aven Dwarf Shrub (V107) of the 1996 Southeast Yukon Ecosystem Classification resembles this vegetation type.

Mountain avens are one of a complex of very low shrub types in the alpine tundra zone. They occur in scattered patches on the well drained upper alpine ridges in the Campbell Range north and east of Wolverine Lake.

Willow Dwarf Shrub

Dwarf shrubs, primarily net-veined willow (*Salix reticulata*) and other dwarf willow species (*Salix* spp.) form the most extensive layer in this vegetation type. The herb layer, although not well developed, includes a variety of species and is dominated by alтай fescue (*Festuca altaica*) in the mesic zones and water sedge (*Carex aquatilis*) in the wetter sites. Bryophytes and lichens are sparse in the mesic areas, while feather moss (*Tomenthypnum nitens*) forms extensive mats in the wet areas.

This vegetation type resembles the Willow Dwarf Shrub (V108) of the 1996 Southeast Yukon Ecosystem Classification.

Dwarf willow is a common shrub in the alpine tundra zone. In the Wolverine Lake study area, it occurs on the upper slopes of the Campbell Range.

Alpine Bearberry Dwarf Shrub

This dwarf shrub vegetation type is dominated by alpine bearberry (*Arctostaphylos alpina*). Crowberry (*Empetrum nigrum*) and shrub birch (*Betula glandulosa*) are also common. Herbs and mosses are uncommon. Lichens, primarily *Cladina stellaris* and *Alectoria ochroleuca*, form much of the groundcover.

This vegetation type resembles the Alpine Bearberry Dwarf Shrub (V118) of the 1996 Southeast Yukon Ecosystem Classification.

A dwarf shrub type that is relatively uncommon in the Wolverine Lake area, it occurs on alpine ridges such as the one west of Little Wolverine Lake.

Low-Bush Cranberry Dwarf Shrub

Low-bush cranberry (*Vaccinium vitis-idaea*) and net-veined willow (*Salix reticulata*) form the dwarf shrub layer. Other significant groundcover includes fruticose lichens (primarily *Alectoria ochroleuca* and *Cladonia* spp.). The herb layer, not extensive, consists mostly of graminoids, usually alтай fescue (*Festuca altaica*).

This vegetation type is similar to the Mountain Cranberry Dwarf Shrub (V121) described in the 1996 Southeast Yukon Ecosystem Classification.

Low-bush cranberry is another component of the dwarf shrub vegetation in the alpine tundra zone. It is found on exposed alpine ridges in the Campbell Range.

Grass Herb

Dense stands of alтай fescue (*Festuca altaica*) are the characterizing feature of this vegetation type. A variety of other herb species occur in low abundance. Shrubs are uncommon. The groundcover also includes lichens (predominately *Cladina rangiferina*).

The Mesic Grass Herb (V202) of the 1996 Southeast Yukon Ecosystem Classification is the vegetation type that best corresponds to the these graminoid meadows.

Mesic grass meadows make up only a small component of the vegetation in the Wolverine Lake study area. They occur in moderately well drained depressions in the low alluvial shrub zone.

Sedge Herb

These wet sedge meadows are dominated by the water sedge, *Carex aquatilis*. Shrubs and forb species are uncommon. Extensive layers of brown moss, *Tomenthypnum nitens*, are formed in some areas.

This vegetation type resembles the Wet Sedge Herb type (V206) described in the 1996 Southeast Yukon Ecosystem Classification.

Sedge meadows, although not extensive in the Wolverine Lake area, occur in poorly drained areas in the alluvial shrub zone.

Wet Mixed Herb

Sedges (*Carex aquatilis*) form the dominant cover in this vegetation type. Other herb species, particularly tall Jacob's ladder (*Polemonium acutiflorum*) and swamp cinquefoil (*Potentilla palustris*) are also prevalent. Bryophytes and lichens are uncommon.

The Wet Mixed Herb (V214) of the 1996 Southeast Yukon Ecosystem Classification best describes this vegetation type.

Accounting for a very small component of the vegetative cover in the Wolverine Lake area, mixed herb meadows are found on the better drained lowland sites in the alluvial shrub zone. The open meadows near the creek draining Muskrat House Lake is one such example.

Cetraria - Alectoria Fruticose Lichen

This vegetation type is characterized by a groundcover dominated by fruticose lichens (primarily *Alectoria ochroleuca* and *Cetraria nivalis*). Dwarf shrubs include net-veined willow (*Salix reticulata*), arctic willow (*Salix arctica*) and other willow species (*Salix* spp.). The most prominent herb is alpine holy grass (*Heiurochloe alpina*).

This vegetation type is similar to the *Cetraria-Alectoria ochroleuca* Fruticose Lichen (V300) of the 1996 Southeast Yukon Ecosystem Classification.

This high alpine vegetation type occurs on the high windswept ridges of the Campbell Range. It does not comprise a large part of the Wolverine Lake study area's vegetation.

Crustose - Fruticose Lichen

Boulder fields covered with fruticose (*Cetraria* spp.) and crustose (unidentified) lichens characterize this vegetation type. Shrubs are absent and herbs, including mainly alтай fescue (*Festuca altaica*), are scarce.

The *Rhizocarpon-Umbilicaria* Crustose Lichen vegetation type (V301) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine boulder fields.

Relatively uncommon in the Wolverine Lake area, these boulder fields are found on the steeper alpine slopes of the Campbell Range.

Cladina Fruticose Lichen

Extensive mats of the lichen *Cladina stellaris* characterize this vegetation type. The herb layer is thin and dominated by arctic blue grass (*Poa arctica*). Shrubs and mosses are uncommon.

The *Cladina* Fruticose Lichen vegetation type (V302) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine lichen dominated zones.

Although normally an alpine vegetation type, a few isolated *Cladina* dominated communities occur within the alluvial shrub zone, such as in the Go Creek valley.

Other vegetation types observed but not sampled include:

Open Black Spruce Forest - Upland (V18 of the 1996 Southeast Yukon Ecosystem Classification) occurring on mineral soil on the fringes of the lowland bog forest and occasionally at higher elevations in the upland forest.

Willow -Shrub Birch Low/Tall Shrub (V105 of the 1996 Southeast Yukon Ecosystem Classification) occurring intermittently in the sub-alpine transition zone.

White Heather Dwarf Shrub (V115 of the 1996 Southeast Yukon Ecosystem Classification) occurring on exposed ridges in the alpine tundra zone.

Mesic Mixed Herb (V213 of the 1996 Southeast Yukon Ecosystem Classification) occurring infrequently in the sub-alpine transition zone.

It should be noted that **Open Tamarack-Spruce Forests** (V23 of the 1996 Southeast Yukon Ecosystem Classification) occur just north of the Wolverine Lake study area in the Noug Creek valley, but was not observed in the study area.

Metal Concentrations in Vegetation

Vegetation samples were collected from five sites in the study area in order to determine background levels of metal enrichment. The locations of these sampling stations are shown in Figure 3.80. Elevations and UTM coordinates are given below.

Station	Elevation (m)	Location (UTM)	
1	1150	436850 E	6813350 N
2	1320	441400 E	6808800 N
3	1140	431000 E	6816500 N
4	1770	440550 E	6812100 N
5	1710	435050 E	6816500 N

Samples of lichens (*Cladina* spp.) and the leaves and twigs from willow shrubs (*Salix* spp.) were collected in mid-July, 1996. These species are common within the study area. The entire above ground portion of lichens and the leaves and twigs from the current year's growth of willows were collected. Samples were shipped to a laboratory for ashing and ICP analysis for metals.

The results of the metals in vegetation survey are presented in Table 3.40. Willows (both twigs and leaves) appear to accumulate more zinc than lichens. Willow twigs seem to accumulate more copper than willow leaves or lichens.

Sensitivity of Vegetation to Disturbance

The sensitivity of vegetation in the Wolverine Lake area to human disturbance depends on factors such as elevation, site moisture, slope and soil texture. Lower elevation vegetation communities generally revegetate more easily, particularly aspen forests and willow and alder thickets which reproduce vegetatively (suckering). Alpine areas revegetate much more slowly because of the slower rate of succession due to climatic conditions and because the thin soil horizons are easily destroyed. The soil erosion hazard increases with the slope and with the silt content in the upper soil horizons. In areas with saturated soils and deep layers of organic materials, the removal of surface vegetation can lead to the melting of permafrost.

The vegetation types most vulnerable to disturbance by human activity in the Wolverine Lake study area include all those in the alpine tundra zone (alpine dwarf shrub and alpine lichen dominated vegetation types). Although soil erosion hazards and terrain constraints in the alpine tundra zone may be minimized by avoiding steep slopes and areas of cryoturbation, reclamation/revegetation of disturbed sites in this zone is difficult.

Removal of the surface vegetation and organic layers (primarily sphagnum peat) from lowland black spruce forests, such as those adjacent to the Wolverine and Little Wolverine Lakes may result in the melting of permafrost.

High water tables and deep organic layers typical of the wet sedge and wet mixed herb meadows that occur in lowlands, such as those along the creek draining Little Jimmy Lake, and in poorly drained areas in the alluvial shrub zone, such as along Go Creek near the airstrip may make these communities sensitive to development as well.

3.2.3 Ecosystems and Wildlife

The Finlayson District is an important area for sport hunting and traditional First Nations land use. Potential effects to wildlife have been a historic concern associated with

mining projects in the Finlayson area. Wildlife studies and mitigation plans developed for past projects focused on identification of critical species and habitat in the project area. The objective of these programs was to mitigate direct effects to wildlife populations through overhunting and to avoid disruption to key habitat areas. These studies, in combination with data collected by government agencies, were successful in identifying key wildlife habitats and important species and mitigating potential effects.

Due to lack of regional information and limited project scopes, historic study efforts for wildlife resources did not consider overall habitat requirements for the species in the area. Overall habitat requirements include consideration of forage availability, cover, travel corridors, territory size and boundaries, etc. in addition to the critical components (rutting and calving grounds, nesting sites etc.) that were evaluated in previous studies. Potential effects to wildlife resulting from the Finlayson Project can be more accurately assessed by understanding the regional availability of these general habitat requirements.

Habitat requirements are species dependent and can be described in terms of the general ecosystem components. The term “ecosystem” refers to all physical and chemical components and their interactions in a natural environment. Wildlife are most influenced by the more large-scale considerations of climate, vegetations cover, topography and landscape, drainage conditions, etc. In combination, these are the factors that most influence wildlife populations, both in terms of distribution and abundance, in their natural habitat.

Although climate, vegetation, landscape conditions, and drainage patterns were considered individually for both the Wolverine and Kudz Ze Kayah Projects, no attempt was made to interpret these attributes from an ecosystem perspective. Such an interpretation will be made for the Finlayson Project Environmental Assessment Report in order to accurately characterize potential cumulative effects to wildlife populations resulting from project development.

The following section is a broad interpretation of ecosystems occurring in the Finlayson Project Area and a brief summary of the wildlife values that occur in the area.

3.2.3.1 Ecosystems

Regional Ecosystems

The Finlayson project area occurs at the southern extent of the Tintina Trench at the intersection of three ecoregions, the Pelly Mountains, Liard Basin and Yukon Plateau North ecoregions (ESWG 1995), and includes boreal, sub-alpine and alpine environments. General physiographic conditions within the project area range from the low lying, rolling topography near Finlayson Lake to the high elevation, rugged terrain of the Pelly Ranges. Elevation ranges between approximately 1000 – 2000 m within the general project vicinity. Discontinuous permafrost underlies much of the area. Forested areas are contained to valley bottoms and lower slopes with treeline occurring between 1300 - 1500 meters. Similar to most areas of Yukon, wildfire exerts an important control over the distribution and seral stage of vegetation communities in the area.

In Yukon, the most commonly used for the description of regional ecosystems is the National Ecological Framework (ESWG 1995). The National Ecological Framework provides a context for the description and comparison of regional ecosystems (i.e. ecoregions) at a scale of 1:1,000,000. While useful for the comparison of broad regions

at the national scale, this classification is of limited utility for the assessment of smaller geographic areas such as the Finlayson Project; it does not provide enough resolution to capture the ecological variation that occurs within diverse ecological settings. Figure 3.82 shows the regional setting of the project area.

Within a single Yukon ecoregion, environmental gradients created by elevation perhaps exert the strongest control over the distribution of vegetation communities. The description of this elevation gradient requires such terminology as boreal, sub-alpine and alpine zones. In the Finlayson project area the definition of boreal refers to the forested, low elevation valley bottoms and low-lying terrain surrounding Finlayson and Wolverine Lakes. Most waterbodies and wetlands are associated with this zone. Sub-alpine refers to the zone between the relatively closed-canopy forests in the boreal zone and the dwarf shrub, herb and non-vegetated rock areas in the alpine zone. It should be recognized that the sub-alpine zone represents a broad gradient between these low and high elevation conditions; the sub-alpine zone is dominated by tall shrub vegetation with scattered spruce and fir forests at its lower limits, grading into lower stature shrub and herb communities at upper elevations. The alpine zone is defined by treeless conditions with rock, low shrub and herb communities being characteristic features. The Finlayson Lake project area spans a range of vegetated and non-vegetated boreal, sub-alpine and alpine settings within the Pelly Mountains, Yukon Plateau North and Liard Basin ecoregions. The delineation of these different elevation zones and the different ecosystems within each does not currently exist for the project area.

Local Ecosystems

Previous vegetation mapping programs for the Kudz Ze Kayah and Wolverine Lake projects focused on localized conditions immediately surrounding the access road and actual/proposed mine sites (Figure 83). Both projects used the framework of the Southeast Yukon Ecosystem Classification (Geomatix 1995 and Zoladeski et al. 1996), specifically vegetation types, or “V-Types”, for the description of local vegetation conditions. While this is a useful approach for describing vegetation, the Southeast Yukon Ecosystem Classification has several short-comings:

- The classification was never intended to be map-based. The ecosystem classification was intended to be used as a field classification guide for site-specific applications and is therefore very difficult to use directly for map-based applications.
- The classification system does not incorporate hierarchical concepts (i.e. there is no differentiation between boreal, sub-alpine and alpine ecosystems, nor is there differentiation between ecological conditions between different ecoregions).
- The classification does not contain seral/structural stages. Many of the V-Types described in the classification are simply different seral or structural stages of the same ecosystem type;
- While many of the “V-Types” may represent minor floristic differences, it is questionable whether many of the different V-Types represent meaningful ecological communities;
- The classification is not based on physiographic (soil/terrain) information. The primary parameters used to classify V-Types are leading tree or shrub species, canopy closure and vegetation stature. Ecologically-based classifications should begin at the site level (slope, aspect, elevation, surficial material, landscape position, etc.) and then consider vegetation conditions.

It should be noted that while the Kudz Ze Kayah and Wolverine Lake vegetation mapping programs both used the Southeast Yukon Ecosystem Classification framework of Zoladeski et al. (1996), the Kudz Ze Kayah project used an earlier version of the classification (Geomatics 1995). Upon review of previous reports, it also appears that different interpretations were made for some V-Type definitions. Many V-Type description and classification discrepancies therefore occur between the two previous projects. Table 3.41 has been provided to summarize the variety of V-Types described in the area and to illustrate where potential classification problems exist.

3.2.3.2 *Wildlife Values*

The Finlayson region contains very high wildlife values. Wildlife resources in the immediate project area and surrounding region include the Finlayson Caribou Herd, moose, black bear, grizzly bear, wolf, fox, coyote, wolverine, marten, mink, river otter, beaver, several raptors, ptarmigan, various waterfowl, and a variety of other forest birds. The lakes and small ponds/wetlands provide breeding and migratory habitats for waterfowl and other aquatic birds. The Finlayson Lake/River area and the east slope of the Pelly Mountains are part of the Tintina Trench migration corridor and are used extensively by waterfowl and other waterbirds, including trumpeter swans and sandhill cranes, on their north-south migrations.

One of the most significant wildlife resources in the area is the Finlayson Caribou Herd. This woodland caribou herd has been the subject of a significant management effort by the YTG Renewable Resources since the early 1980s. Their studies have included detailed population surveys and radio collaring. Annual rut surveys are flown by YTG Renewable Resources to monitor the caribou population. The Finlayson region was also the site of an extensive wolf control program carried out during the late 1980s – early 1990s, and has contributed to much additional information on ungulate - wolf interactions. The Finlayson herd is highly valued as a subsistence base for the Ross River Dena, by resident sport hunters, the Yukon guiding industry and for their own intrinsic value.

Finlayson region moose are also an important resource for the same user groups, including the Ross River Dena. The Finlayson region contains some of the highest recorded moose densities in Yukon.

Development of the Kudz Ze Kayah and Wolverine wildlife programs recognized that the major species of concern were woodland caribou (Finlayson Caribou Herd) and moose. The study program was developed in consultation with YTG Renewable Resources biologists and the Ross River Dena, and reflects concerns identified during previous consultation processes. Several additional caribou surveys (peak calving survey and post-calving aggregation survey) were added to the study program to provide specific data (peak calving date and cow:calf ratio, respectively) that would be useful in assessing potential impacts following mine development and for future caribou population monitoring. The study area was also significantly expanded for the additional caribou surveys in order to provide population-wide data for the part of the Finlayson herd utilizing the area around the project.

As stated in the original project reports, the Wolverine and Kudz Ze Kayah wildlife programs were developed to provide necessary information to assess wildlife resources and habitat values in the study area, and to provide the basis for an assessment of the impact of mine development, operation and decommissioning. The intent of the programs was not to provide a complete inventory of all wildlife in the project area, but rather to

identify critical species and their habitats and to provide or supplement existing information sources. Baseline work was necessary to formulate management strategies for dealing with potential impacts related to mine development, mining activities and to provide a baseline for future monitoring activities. The primary wildlife concerns associated with increased human activity in the project area are:

- Increased hunting pressure facilitated by new access roads;
- Disruption of critical wildlife functions such as breeding and migration;
- Alteration or alienation of habitats such as winter ranges and nesting areas.

Previous Wildlife Studies

In conjunction with specific information collected during the baseline wildlife programs, a number of additional YTG Renewable Resources resources were also utilized. These included caribou studies (Farnell and McDonald 1987; Farnell and Hayes 1992), wolf studies (Hayes and Harestad 1994), and moose surveys (Jingfors 1988; Larsen and Ward 1991). YTG information sources included published and unpublished (draft manuscript) reports, preliminary maps of caribou survey data and population distribution and radio-tracking results. General information on wildlife in the Finlayson region and specifically the Kudz Ze Kayah and Wolverine project areas was also gained through telephone discussions and meetings with Fish and Wildlife Branch staff.

Detailed wildlife survey results of the Kudz Ze Kayah and Wolverine baseline programs are contained in the previous project reports. The following summaries have been prepared based on a synthesis of the previously collected information.

Woodland Caribou (Finlayson Caribou Herd)

In co-operation with YTG Renewable Resources, both the Kudz Ze Kayah and Wolverine projects conducted baseline ungulate surveys in the immediate project area. Aerial surveys were flown at key times in 1995 and 1996 to document caribou distribution and numbers at key periods of the year, corresponding to late winter, calving, post-calving aggregation, and rutting activity. Additional information on caribou was also obtained during a 1995 moose survey. The survey data provided key population characteristics (such as peak calving date, post-calving calf:cow ratio, and numbers on rutting range). Most upper sub-alpine and alpine areas surrounding Wolverine Lake and the Kudz Ze Kayah mine site are considered Key Habitats by YTG Renewable Resources for the Finlayson Caribou Herd during the fall rut. However, survey data indicates that limited calving and post-calving aggregation activity occurs in or immediately adjacent to the Finlayson project area.

The impetus for the Finlayson caribou studies was the declining state of the herd during the early 1980s. YTG Renewable Resources implemented a wolf control program in 1982/83 and again in 1989/90 out of concern for the declining caribou population. The wolf population was substantially reduced in the area occupied by the Finlayson Caribou Herd. In conjunction with wolf control, sport hunting was limited to bull caribou, and First Nations hunters were encouraged to select male over female caribou. Annual monitoring of the caribou herd by YTG is ongoing. Results of the 1994 survey indicate that the Finlayson herd has rebounded from a low of approximately 2,000 in the early 1980s to an estimated 8,000 caribou by the mid-1990s. Of the estimated 8,000 in the herd, approximately 1,000 to 2,000 inhabit the general region around the project area. Woodland caribou use of the Kudz Ze Kayah and Wolverine Lake area shows a large amount of variability, between 66

and 552 caribou were counted in the general project areas during annual rut surveys during the 1990s.

Seasonal Movements and Habitat Use

Caribou calve on ridges and upper slopes of basins in late May and by mid-June form aggregations in the uplands. They remain dispersed in small bands in the uplands and upper forests through summer. During late spring through summer, caribou utilize many of the shrub and herb vegetation types that were identified in the vegetation study as well as the open-canopy sub-alpine fir forest on valley slopes.

Caribou form rutting aggregations in early October and occupy the uplands (ridges and plateaus), including the upper elevations of the project area. At this time, caribou may utilize any of the alpine shrub and herb vegetation types. After the rut, caribou disperse throughout the area and occupy the alpine, sub-alpine and upper forests until late fall (mid-November). At this time, they utilize a wide range of vegetation types. By mid-November, caribou start to move down into the boreal forest which includes the open-canopy black spruce forest vegetation types.

By December-January, caribou have moved down to their traditional winter range in the Pelly River lowlands. Their winter range includes the boreal forest along the Robert Campbell Highway, to the north of the project area. By early to mid-May, caribou once again move to higher elevations, following the receding snow to the uplands on their way to calving areas.

Moose

Data on moose distribution and numbers were obtained through aerial surveys flown in March and November 1995, to document late-winter and post-rut distribution. Additional data on moose were obtained during the course of caribou surveys. Moose may occur on the Kudz Ze Kayah and Wolverine properties throughout the year. Moose are well dispersed in the project area during summer and early fall and congregate in post-rut groups in the upper elevations around the project area. The information indicates that moose spend early winter in the project area and may remain into late winter during some years. In 1991, moose densities in the Frances Lake survey area were 383 moose/1000 km², which was among the highest recorded in the Yukon (Larsen and Ward, 1991).

Seasonal Distribution and Habitat Use

Moose utilize the forested vegetation types during much of the year, although primarily in the winter when they inhabit the lowlands along Finlayson Creek down to the Robert Campbell Highway. Riparian forests and closed conifer stands provide important browse and thermal cover during this time. The tall shrub vegetation types are also utilized into the winter period when moose occur in the upper Geona Creek valley. During spring to fall, moose are widely distributed throughout the area and can occur in any of the vegetation types. Alpine areas, due to their poor cover and food availability, are probably not utilized however. During the rut and post-rut, moose occupy upper sub-alpine basins and utilize the tall shrub vegetation types and the open-canopy sub-alpine fir forests. Some calving is known to occur in the upper Geona Creek valley.

Thinhorn Sheep

Key habitats for sheep include winter ranges, lambing areas, rutting grounds, mineral licks and migration corridors. These habitats are critical because they are limited in extent, and they are used repeatedly by the sheep. Thinhorn sheep inventories were not

carried out in either the Kudz Ze Kayah or Wolverine Lake baseline programs, but incidental sightings were recorded. YTG sheep surveys flown in 1986, 1988 and 1995 suggest that sheep utilize portions of the Campbell Range to the east of Wolverine Lake as late winter range and lambing areas. Between 41 and 72 individual sheep were surveyed during these flights but all occurred outside of the Wolverine project area. The mountains southwest of Wolverine Lake and north of Money Creek are also believed to be used by sheep as a lambing area and a summer range for nursery bands. A small portion of the mountain range has been designated as a Key Habitat for sheep. Baseline vegetation mapping for the Wolverine project does not indicate that this Key Sheep Habitat contains high sheep values.

Bears

Grizzly bear (*Ursus arctos*) and black bear (*Ursus americanus*) can be found throughout the entire Finlayson area and were occasionally observed near the Kudz Ze Kayah and Wolverine properties during baseline wildlife data collection programs. In north Yukon, grizzly bear home ranges are generally very large and it is likely that one or two grizzlies include the project area as part of their home ranges. No bear den sites were observed during previous wildlife surveys. Grizzlies range throughout the open valleys, sub-alpine and alpine environments of the region, and may occur in any portion of the project area. Grizzlies utilize a variety of habitats throughout the area, focusing primarily on low elevation meadows and wetlands in spring for early green-up vegetation. Sub-alpine and alpine habitats are probably most important during late summer and fall for the variety of berries that can be found throughout these environments.

Black bears are more abundant in the lower forests toward Finlayson Lake and the Robert Campbell Highway. Black bear are not expected to be common in the project area because of the predominance of high elevation sub-alpine and alpine habitats.

Wolves

Wolves (*Canis lupus*) and their predation effects on the Finlayson Caribou Herd have been the subject of intensive study by YTG Renewable Resources. The wolf control program between 1983 and 1989 reduced the wolf population by approximately 85% (Farnell and Hayes 1992). Following the control program, the wolf population was monitored to examine recovery rates and it appears that numbers have recovered to near the pre-control populations. Similar to most areas of Yukon, wolves play an important role in the Finlayson region and are considered to be the primary predator of caribou and moose.

During previous wildlife studies, wolves or their sign were observed infrequently around the Kudz Ze Kayah and Wolverine properties. Any wolf sightings were scattered throughout the uplands of the area. It was acknowledged that mineral exploration related activities concurrent with the 1995 baseline fieldwork programs may have discouraged wolves from fully utilizing some portions of the Finlayson project area.

Furbearers

Beavers (*Castor canadensis*) are moderately abundant in small lakes and ponds of the area. Beavers can be expected throughout the lower and mid-elevation streams and ponds of the area.

Other furbearers which were not recorded during previous wildlife programs but which are known to occur in the region and expected to occur in at least parts of the project area

include coyote (*Canis latrans*), lynx (*Lynx canadensis*), marten (*Martes americana*), ermine (*Martes erminea*), mink (*Mustela vison*), and river otter (*Lontra canadensis*).

Small Carnivores

Small carnivores in the region include fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), and the least weasel (*Mustela nivalis*).

Small Mammals

No direct information was collected for small mammals in the project area. Similar to most areas of Yukon, snowshoe hares (*Lepus americanus*) occur throughout the region and inhabit most forested and shrub habitats throughout the boreal and sub-alpine of the project area. No information is available on mice and voles.

Ground squirrels (*Spermophilus parryii*) occur on sub-alpine slopes in the area. One observation of a grizzly bear foraging for ground squirrels was recorded in the Kudz Ze Kayah project area. Both snowshoe hares and ground squirrels represent an important food base for avian and mammalian predators.

Birds

Waterfowl/Waterbirds

Waterfowl use of the immediate project area is limited to the few scattered ponds and larger water bodies. Suitable wetlands are restricted to the small lakes and ponds at the top end of Geona Creek and South Creek; these habitats are utilized during spring and fall migrations. Trumpeter swans are known to breed in the lakes and potholes throughout the Pelly lowlands and to migrate through the Finlayson River valley. Whitefronted geese migrate through the Pelly River and Finlayson River valleys in significant numbers from late August until mid September. Common loons are also known to occur on Wolverine Lake. Migrating northern phalaropes were observed in small numbers on ponds near Wolverine Lake.

Sandhill Crane

Approximately 200,000 Alaskan and Siberian breeding Sandhill Cranes migrate northward through the study area in May and June and return southward between late August and late September. Large numbers of these birds are particularly evident in the general Kudz Ze Kayah area during the fall migration along the Tintina Trench.

Raptors

Golden eagles were observed on numerous occasions during the baseline wildlife programs. Bald eagles and gyrfalcons have also been observed in the Kudz Ze Kayah – Wolverine Lake area as well. No raptor nest sites or family groups were observed in the immediate project footprints during previous studies.

Ptarmigan

Ptarmigan are common in the project area. All three species of ptarmigan (willow, rock, and white-tailed) may occur in the region. The various willow, willow/birch, and sub-alpine fir shrub habitats provide abundant cover and food for willow ptarmigan during the breeding season and into the fall. Shrub communities are utilized in the winter for food and cover by all three species.

Critical/Sensitive Habitats

With the current limited extent of vegetation mapping and the lack of a regional framework in which to evaluate the project, it is very difficult to assess habitat rarity and sensitivity.

Within the immediate project area, the most sensitive and potentially important habitats for a range of species include wetlands, open waterbodies and riparian shrub and forest communities. These habitat types are also of limited spatial extent in the Finlayson area; it is not currently possible to quantify their regional distribution. Most upland forest, shrub and alpine habitat types that occur within the direct project area are expected to be common throughout the region.

3.3 Heritage Resources

3.3.1 Background

Little is known about the archaeological and historic site resources in the study area, and generally speaking, the surrounding southeast Yukon country. The lack of site data can probably be best attributed to the little archaeological and historic sites research conducted in this part of the Territory. The fact that the Finlayson Project area is an important habitat for the Finlayson caribou herd, and given the traditional subsistence importance of this herd to the Ross River Dena, suggested that the project area should yield evidence of past human use and occupation.

Sites have been identified in the nearby Ross River/North Canal Road (Gotthardt 1981) and MacMillan Pass (Greer 1982) areas, at Pelly Banks (Gotthardt personal communication 1996), around Frances Lake (Gotthardt 1986, 1993) and the upper Liard and Frances Rivers (Gotthardt 1989a). Although none of these studies has investigated any sites in detail, they nonetheless provide information on what types of sites might be anticipated from the Finlayson Project area.

A study of sites in the Frances Lake area (Gotthardt 1993) recorded both precontact archaeological sites, grave sites, cabins, caches, historic period campsites, as well as the Hudson's Bay Company's 1842-1851 trading post. Sometimes, many of these features occur at one site or locale, such as around the narrows on Frances Lake, or the caribou crossing on the east arm of Frances Lake.

3.3.1.1 Precontact

A chronology of precontact or prehistoric occupations for the southeast Yukon has yet to be developed. The following summation of south Yukon culture history is based largely on syntheses of culture history for the southwest part of the Territory (Gotthardt 1989b; Workman 1978). Four broad cultural phases are recognized in the south Yukon prehistoric sequence; these phases are defined primarily on the basis of changes in stone tool technology.

The oldest cultural phase, Northern Plano/Northern Cordilleran (8,000 to 5,000 B.C.) is characterized by artifacts such as large round-based lanceolate point forms and lithic technology which includes the production of large blades, as well as flakes, as blanks for tool manufacture. Transverse notched burins were also made by these early residents.

The following Little Arm Phase (5,000/6,000 B.C. to 2,500/3,000 B.C.) featured stone tool technology emphasizing the production of composite tools using small blades or microblades. The microblades are believed to have been hafted with a mastic into the

lateral edges of bone or antler points and used as knives or projectile points. The ultimate origin of this distinctive technology is believed to be extreme northeast Asia. Some researchers consider the appearance of microblade technology in the western subarctic as marking the arrival in Alaska-Yukon of the distant ancestors of the Na-Dene, that is, speakers of Athapaskan languages such as Kaska, Tutchone, Gwich'in, etc. (Aigner et al. 1986; Meltzer 1989). Others (e.g., Clark 1981) consider the relationship between microlithic materials and succeeding occupations of the southern Yukon as uncertain.

The Taye Lake Phase (2,500/3,000 B.C. to A.D. 750) follows Little Arm. Sites or site components of this phase feature a new stone tool technology that is characterized by the production of large side-notched as well as stemmed spear and arrow points. This has led one researcher to propose that an actual migration of new people had taken place (Workman 1978). Continuity or gradual change in tool types from the time of the appearance of the Taye Lake materials to the historic period is evident, however, which suggests that Taye Lake may represent the arrival in the region of the distant ancestors of the Na-Dene, including the Kaska (Workman 1978). Whether the Taye Lake people displaced or assimilated with the resident population was not known.

The Aishihik Phase (A.D. 750 to A.D. 1800+) follows the Taye Lake phase. There is considerable continuity in tool types between the two phases; they are separated on stratigraphic grounds, with Aishihik materials being those found stratigraphically above the White River volcanic ash layer (dated to ca. A.D. 750), while the former is found stratigraphically beneath the ash layer. Some new technological elements do appear in the Aishihik phase, including native copper tools; barbed bone and antler points, and small stemmed or notched projectile points, those small enough to have been used as arrow rather than spear points. Large ground-stone adzes, used to fell trees, were also now being made.

The economy of Aishihik Phase in the southwest Yukon has been suggested to be predominantly small, mobile groups of people pursuing their seasonal round over large stretches of territory (Workman 1978). A similar pattern has been proposed for the Carcross-Tagish area (Greer 1984), and the Macmillan Pass area (Greer 1982). The Macmillan Pass study for example, reported that precontact archaeological sites in that area tended to be small in size, covering an area of less than 100 square metres. These sites were often located in well-drained settings, around lakes (Greer 1982). The collections recovered from precontact sites in the Macmillan Pass area tended to be dominated by flakes, the detritus from the manufacture of stone tools, and bone preservation was rare.

In the southern Yukon, the appearance of European trade goods in the archaeological record marks the beginning of the Bennett Lake Phase, dated ca. A.D. 1800+ to A.D. 1900-. Sites assigned to the Bennett Lake Phase in the southwest Yukon were produced by the direct ancestors of the Southern Tutchone Champagne-Aishihik people, in the Carcross area, by the direct ancestors of the Carcross-Tagish First Nation. In some cases historic personages are known to be associated with particular sites.

There is technological continuity in many elements with the preceding Aishihik Phase, as tools like bone points and scrapers, women's stone scrapers continued to be made. Gradual replacement of certain tools with items of European manufacture, particularly metals, is evident; for example, metal tipped rather than stone, arrow points, were made. Gun shot, beads, buttons, are found in these sites. Sometime during the Bennett Lake

Phase, people began constructing cabin villages which were occupied at least seasonally. A somewhat greater emphasis on trapping fur bearers also characterizes the subsistence orientation of this period.

While these same researchers have considered their past, an adequate history of the Ross River people has yet to be assembled and little information has been compiled on the Ross River Dena perspective of their past. That which is available on the Kaska in general suggests that they have lived in their traditional territory for a long time, since the creator made or restored the earth to its current form (McClellan 1991; Honigmann 1981). While conflicts with neighbouring peoples as recent as the 19th century are reported (Field 1913, 1939) Kaska history has no stories of migrations or of distant homelands.

3.3.1.2 Traditional Land Use and Lifestyle

Prior to contact with non-native outsiders, the economic life of the Ross River Dena is thought to have been similar to that of most aboriginal groups of the subarctic cordillera. It would have included big and small game hunting, fishing and some gathering. Their seasonal round would have involved considerable mobility, with travel mostly by foot, and many different camps would have been used in the course of a year (McClellan and Denniston 1981). This precontact land use pattern is believed to have continued well into the 20th century, as evidenced in first hand accounts of the traditional lifestyles observed in 1913 by the trader Poole Field:

The Indian generally tries to get into a good game country about the end of August when all game is fat, to put up a cache of dried meat for the winter months. If in the mountains the women catch groundhogs and gophers; they dry them for the winter. (Field 1957:54).

The Elders interviewed by the anthropologist R. McDonnell in the late 1960s reported that hunting occurred primarily during the fall and winter seasons, except for intercepting game at a salt lick, which could be done year round (McDonnell 1975:162). Gathering was pursued intermittently close to their camps. This activity required considerably technical skill and a detailed knowledge of the resources on the land, in order to predict their occurrence (Ibid.: 163-64).

Snares, made of twisted sinew or babiche tied to stick, were an important component of the traditional technology. They were set on game paths, for example where animals came to a lake to feed or to a lick for salt, and were used to catch moose, sheep, black bear, wolves and wolverine (Field 1957). The local people told the trader Field that traditionally

...they used bows and arrows to hunt with, spears, snares and dead falls also. They would make long fences when the caribou and sheep came below timberline, sometimes packing poles to make their fences with up on top of the mountains. They would leave spaces big enough for a caribou or sheep to go through in their fences and set snares in them. Whenever a herd was sighted they would try to surround them and drive them through their fences. (Field 1957:53)

Traditionally, the usual domestic or residential unit was the extended family. Each local group had to at least have a core of able-bodied and knowledgeable "providers" (McDonnell 1975). The size of local groups likely varied greatly in size, as families came together or dispersed for various seasonal activities.

Details on traditional housing styles are limited, though the trader Field was told of traditional lifestyles during the years he operated trading posts at Ross River and Pelly Banks. He reported that “Years ago they lived in open camps sheltered on three sides by throwing up logs and brush and had a fire in front using a skin covering of caribou skins for a roof.” (Field 1957: 52). Many such sites would have been established over the course of a year, as the families travelled around within to harvest the required resources. McDonnell (1975:102), who interviewed Ross River people in the 1970s, estimated that traditionally, the people living in this area may have established 23 different camps over the course of a single year. He adds, however, that more than two-thirds of these campsites would have been established in the short spring season.

It is not known precisely when the Pelly Banks people started building cabins and more permanent residences. Likely these buildings were not constructed until after axes became regularly available from the local trading posts (Pelly Banks, Frances Lake or Ross River) around the turn of the century. It is believed that cabins were first built at these trading posts settlements.

3.3.1.3 Post-contact

Most of the history information available on the Ross River Dena concerns their early involvement with outsiders through the fur trade. While they are understood to have always taken some animals for furs, it was through middlemen that they first became involved in the European first trade at the beginning of the 19th century. Western trade goods may have made their way to the Ross River Dena from European trading ships in the Gulf of Alaska to the west, or from various Hudson’s Bay Company trading posts in the Mackenzie basin (Fort Liard, Fort Simpson, and Fort Norman established on the Mackenzie River in 1804, 1804 and 1810, respectively, or Fort Halkett established on the Liard in 1821). Given that long distance travel was common for people at the time, the Ross River Dena may even have visited some of these trading posts themselves.

Historical Chronology of the Finlayson Area	
Precontact	Kaska speakers living in the headwaters country of Liard and Pelly Rivers, including the Wolverine Lake area
1820s	Fort Halkett established on the Liard River (1821)
1830s	Dease Lake Post in operation (1838-1841)
1840s	HBC's Robert Campbell explores Frances Lake, travels overland to the Pelly, and explores it to its mouth (1840). Campbell establishes Fort Frances (1842) and Pelly Banks Post (1846), and Fort Selkirk, at the mouth of the Pelly (1848). Pelly Banks post burnt and not rebuilt (1849).
1850s	HBC closes Fort Frances (1851); Fort Selkirk destroyed (1852).
1880s	George Dawson, geologist travels overland from Frances Lake to the Pelly, reopening the area (1887). Frances Lake trading post reopened briefly (1880). Lower Post established on the Liard River (1887).
1890s	A few Klondike stampeders pass through the area (1897-98)
1900s	J. Lewis and P. Field open post at mouth of Ross River (1900); HBC reopens small post near their old site of Pelly Banks (ca.1901); Taylor and Drury buy Ross River and Pelly Banks posts (1905); white men trapping extensively in the area in this decade, then move out of area.
1910s-1930s	Pelly Banks and Ross River trading posts generally in operation (some periods of closure). Frances Lake post opened by HBC in 1939. First missionary (Anglican) based at Ross River (late 1930s). Devastating measles epidemic in area (1938).
1940s	Construction of the Canol Road and Pipeline (1942-44), influx of outsiders. Pelly Banks post open (ca.1944-1949). Frances Lake post closes (1947).
1950s	Ross River trading post moved across river to present location (1952); Pelly Banks post closes for last time (1950). Frances Lake post open briefly (1953-54).
1960s	Campbell Highway built (1964), Ross River undergoes boom associated with Faro mine development; day school for Indian children established at Ross River, Indian families forcibly moved across river to present location (1965-66)
1990s	Comprehensive Land Claim, Umbrella Final Agreement signed (1990)

The first direct contact between the Ross River people and non-native outsiders in their homeland came in the 1840s, when the Hudson's Bay Company trader Robert Campbell travelled through their lands (Wright 1976, Wilson 1970). Campbell arrived from the south, his route taking him up the Frances River to Frances and Finlayson Lakes, and then overland to the Pelly River, which he explored to its mouth, before returning south. In 1842 Campbell returned to the area and established the trading post he named Glenlyon House, later Fort Frances, on Frances Lake. Only a few years later, in 1846, Campbell established the trading post known as Pelly Banks, in the upper Pelly River basin.

The Finlayson Project is situated between these two early trading posts, and no doubt the families who used this area visited one or both of these posts (see HBC 1842-44, 1850-51 as cited in Gotthardt 1993:11, for the names of Kaska men trading at the

Frances Lake Post). Ready access to these new trade goods was short-lived, however. The Pelly Banks post was destroyed by fire in 1849 and not rebuilt (McDonnell 1975; Denniston 1966). In 1851, difficulties in obtaining trade goods as well as food supplies, plus limited trade results, and trading conflicts lead the company to close Fort Frances (see Gotthardt 1993:10).

In the period 1850-1899, there was little contact between the Ross River people and white men. A trading post was opened by an independent on Frances Lake in 1880, but it lasted only a short time (Gotthardt 1993:12). Some of the Ross River people are known to have made occasional trading trips to posts located farther afield, including the post on the Liard River. In the late 1890s, a few stampeders heading to the Klondike to search for gold passed through the area.

After the turn of the century, however, things changed quickly. In 1900 a pair of independent traders opened a post at the mouth of the Ross River, across the Pelly River from the current settlement. Around 1901, the Hudson's Bay Company reopened a post near the old site of Pelly Banks (McDonnell 1975; Denniston 1966). Both these posts were purchased by the Taylor and Drury firm in 1905. While a store has been open at Ross River settlement more or less continuously since that time, the trading posts at Frances Lake and Pelly Banks were somewhat less reliable. They were operated intermittently up until 1947 and 1954, respectively, when they closed for the last time (see above).

The presence of trading posts is only one measure of outside influence on the life of the Ross River people. With time, slowly other changes came, but it was not until the 1930s that missionaries and the Christian church had a regular presence in the area. They encouraged the people, among other things, to send their children to school, with the only option available being residential schools located in Whitehorse and Carcross, outside their territory.

Major changes came with the construction of the Canol Road and Pipeline in the 1940s, as outsiders entered the area in large numbers. By 1944, this project was terminated, however, and the pipe was salvaged and much equipment was abandoned. While the North Canol Road section was no longer maintained, the South Canol Road opened up the area to mineral exploration. This culminated in the 1960s with the Faro mine discovery and development, a boom economy with the influx of non-native entrepreneurs, and in 1964, the construction of the Campbell Highway from Watson Lake to Ross River. Soon after the road was put through to Carmacks.

The 1960s saw a major increase in direct government influence over the lives of the Ross River Dena. One of the principal means of influence was via the establishment of a day school in Ross River. While reuniting families, this event significantly altered the lifestyle of the Ross River Dena (McDonnell 1975:7). Previously, almost all families had spent the winter in the bush trapping, and in the summer months they may have been involved in some wage labour. Now those families with school aged children had to stay in the village to look after the children. They went from life in the bush, which has been described as an intimate, at times, a vigorous existence (McDonnell 1975:7), to a sedentary one with limited employment opportunities.

The Yukon Comprehensive Land Claim Umbrella Agreement, signed in 1990, gave the fourteen Yukon First Nations, including the Ross River Dena Council, title to some of the lands they have traditionally occupied as well as greater control over other aspects of

their lives. The Claim also formally recognizes First Nations' interest in the subject of the present report, the region's archaeological and historic sites. Under the terms of the Yukon Land Claim agreement, First Nations own all archaeological and historic sites on Settlement Lands, as well as all sites that have a direct connection to their history.

A range of site types dating to the historic period have been recognized in the southern Yukon. These include cabins, caches (various types), stores and fur trade posts, road houses, churches, trading sites, campsites, and grave sites.

3.3.2 Kudz Ze Kayah Mine Site and Access Road

A heritage resource survey was undertaken between May 4 to 24, 1995 as part of the Environmental Assessment of the Advanced Exploration Project. The study was completed in two phases: Phase 1 was the resource assessment of the tote road from the Robert Campbell Highway to the project site; and Phase 2 was an assessment of the proposed mine development area. The survey, undertaken by Doug Rutherford and a field assistant from the Ross River Band, consisted of an archaeological reconnaissance of the proposed road alignment and the mine development areas to assess the potential and test for the presence of archaeological resources. Concurrently, an oral history was conducted to determine traditional land use within the project area by an elder of the Ross River Dena Council. Seven elders were interviewed during the project. A final report was prepared by Rutherford and submitted to the Heritage Branch, Government of Yukon in early July of 1995 (Rutherford, D.E., June 1995, Archaeological Reconnaissance of the Kudz Ze Kayah Project, Central Yukon, Phases 1 and 2) (see Appendix 4.3 of the Kudz Ze Kayah IEE).

Survey Findings

The original assumption of the presence of significant heritage resources was not substantiated. No cultural material was observed in the surface survey during the Phase 1 and 2 assessments. A total of 15 areas were tested along the tote road route prior to construction and an additional 6 in the mine development area. Sites tested were selected as having the greatest potential for cultural material based upon maps, airphotos, helicopter and foot surveys of the study area. Sampling sites selected also considered geographical factors such as proximity to water (including consideration of landscape change over time), drainage, and level surfaces for comfortable living or camping conditions.

No evidence of cultural material or features were observed during the archaeological assessment within the area of the mine project. If any cultural materials are found during development, measures will be taken to mitigate the potential for impacts. These measures might include either modifying the site layout or salvaging the resources prior to construction. All potential mitigation measures would be done in consultation with the Ross River Kaska Dena and the Yukon Territorial Government (YTG) Heritage Branch.

Airstrip

Subsequent to the heritage resource survey, an airstrip has been proposed for a site near the proposed access road and the Robert Campbell Highway. While this area is adjacent to the surveyed area that was found to have a low potential, additional survey work will be required to ensure that no heritage resources will be impacted with construction of the airstrip. This work was completed in the spring of 1996 following break-up, and prior to any construction of the airstrip.

3.3.3 Wolverine and Ore Haul Route

Heritage resource investigations in the Wolverine area were carried out under permit # 96-11ASR (Greer, 1996). These studies were conducted in two phases, June 24-26th and September 11-13th 1996. The June work included both interview work and an overview flight of the general Wolverine Lake area.

Interviews were conducted with Chief and Council and community Elders at Ross River on June 24th, 1996. The following day, Elders Mary Charlie and her son Franklin Charlie and Jim Dick traveled to Wolverine and participated in an aerial reconnaissance of the area. A helicopter was used to survey the area around Wolverine Lake, the upper Money Creek basin, "Sheep Mountain", North Lakes, and the area north of Wolverine Lake (between Wolverine Lake and the Campbell Highway). A cabin site was relocated and a precontact archaeological site was identified during this trip.

On June 26th, back in Ross River, further interviews were conducted with Elders, in groupings as follows: Jim Dick, Mary Dick (husband and wife) and Amos Dick (brother to Jim); Mary Charlie and Franklin Charlie (mother and son); and Tom Smith and Tilley Smith (husband and wife).

During September additional fieldwork was completed. Harry Atkinson of Ross River acted as a guide and field assistant. Mr. Atkinson had previously worked on the drilling crews for the Wolverine Project, and was familiar with the area, although he had not hunted in the immediate area. Elders Jim Dick and Amos Dick spent one day with the field crew at the Wolverine. During helicopter aerial reconnaissance, they pinpointed the location of their family's cabin and graves at the north end of the lake, the graves at "Nougha Creek", and a cabin at "Van Bibber Creek". They also related more specific information on traditional land use patterns in the study area.

During the September fieldwork potential mine site access routes were flown to look for evidence of old sites and to assess their potential for buried archaeological sites. Ground truthing investigations were conducted in places recognized as being of archaeological and historic site potential, as known from existing Yukon archaeological site location patterns. Specific locales checked include the inlet and outlet of Wolverine Lake, the north shore of Wolverine Lake opposite the island, the area of the tailings area.

All reported camp sightings in the immediate vicinity of Wolverine Lake and the mine development area were checked. In addition to the information noted during the June interview sessions, and the September 11th visit with Jim and Amos Dick, data on potential site locations was made available via a set of working maps compiled by Lorraine Sterriah, Westmin Resources Limited Ross River liaison (Sterriah 1996 maps). The Sterriah maps showed traditional land use data, including place names, cabin and camp locations. These maps are understood to have been compiled primarily from information shared by Grady Tom.

A member of Westmin's crew also shared information on the location on two historic hunting campsites she had seen in the course of her work.

Standard Yukon archaeological site survey and assessment procedures were followed to identify and evaluate sites. At all locales investigated, the objective was to determine if there are any archaeological or historic remains including artifacts or structures or features on the surface or in buried context. As there were no eroding bank faces in any

of the areas checked, sub-surfacing testing was necessary to detect buried archaeological deposits. All locales investigated were recorded on topographic maps; more specific details on the areas surveyed are provided in the project Field Report and field notes.

3.3.3.1 Traditional Land Use Areas

Within the traditional lands of the Ross River Dena, certain areas were well known as habitual winter grazing routes for caribou. Year after year families returned to these places where they could snare, or in more recent times, shoot, caribou (McDonnell 1975:75). The available evidence suggests that the Wolverine Lake area, strategically located within the Pelly Mountains, but a short distance from the Pelly Plateau country, was one of these favoured traditional land use areas. Long term familiarity with the landscape of the Wolverine Lake area is implied in a 1995 interview with Doris Bob (Rutherford, 1995).

It appears that people came here both for the resources available within and directly around the lake itself, as well as those food sources such as caribou that were available in the surrounding high country. Shorter-term hunting camps were established in latter. Many hunting camp locations have been reported above 4,500 feet elevation (Greer field notes 1996; Sterriah 1996 maps). Camps are reported to have been established (1) up the creek which drains into “Jack Mackay Point” (on the south shore of Wolverine Lake); (2) in the upper reaches of “Van Bibber Creek”; and (3) the high country above or north of the mine site development area (these basins are referred to as “Hawkowl Creek” and “Campbell Creek”. (Access Mining Resources 1996). Other high elevation camp locations may well have been used as well. The edge of the tree line (Plate 14) seems to have been a preferred area for camp establishment in higher elevation settings.

Closer to the lakeshore, fish camps, staging camps and cabins are reported (Greer field notes 1996). Many of the old sites around the lake are situated near traditionally used fish net set locations (Greer field notes June 1996 and September 1996). These include: the point at the north end of the lake, at the island in the lake (between the island and both the north and south lake shores), and at the lake inlet at the south end. Amos Dick reported that there were big ling cod, lots of trout, as well as whitefish in Wolverine Lake.

The locale known as “Jack Mackay Point”, a broad point on the south shore of the lake, opposite the island, is another important historic land use area. Besides a camping area, used when nets were put in the lake, this is a staging area for trails leading up to the high country to the south, where hunting camps were established. Just north of the point, is where the Jack Mackay cabin was recorded (see below).

The inlet of Wolverine Lake, at the south end is another key land use area around the lake. While a gravesite understood to be located near the lake outlet was not found, an archaeological site was identified in this area. Evidence of recent but traditional style camps (cuttings, stumps, campfire signs) was also seen in this area, including on the point of land where the exploration base camp is situated on the east shore of Wolverine Lake, just north of the inlet. The lake outlet, or more specifically the general north end of the lake, appears to be the most important land use area around the lake proper.

Four lick locations were pointed out by Elders Mary and Franklin Charlie and Jim Dick. The four lick areas are situated west of the Wolverine Lake mine development area; two

of the four licks are situated around “Sheep Mountain”, a third by North Lakes, and the fourth, in the Money Creek basin.¹

The Kaska name for Money Creek, *Elés Tué’* which translates as lick creek, appears to take its name from the lick feature situated there. This lick is actually a cluster of three licks situated in close proximity together. The fact that the creek takes its Kaska name from these licks indicates the importance of these features to the traditional economy.

Further recognition of their significance to the Ross River Dena is indicated in the story Mrs. Charlie shared about these licks. According to Mrs. Charlie, the animals have been coming to the three licks from the beginning of time. Moreover, there is a man-made fence structure leading down to these licks, and it too has been there long time. The feature Mrs. Charlie described is an esker ridge, which has been around since the time of deglaciation. The fence feature along which snares were traditionally set is clearly recognizable from the air. This story therefore suggests that this natural “fence” has likely been used by the Ross River people for catching game for thousands of years.

The three other waterbodies in the Wolverine Lake valley have also seen considerably traditional use. The lake north of Wolverine Lake is known as “Wind Lake” (or Wind Lake #1). A camp used by Robinson Dick is situated along its east shore (Sterriah 1996 maps; location noted in Greer field notes September 1996). Traditional use trails also run along both the west (Sterriah 1996 maps) and east shores of this same lake (Greer field notes September 1996).

A snare set location is understood to have been situated along the west side of “Wind Lake #2”, which is situated south of Wolverine Lake (Sterriah 1996 maps). This feature location was not ground checked during the present project. The inlet of this same lake is also understood to be a net set location (Greer field notes June 1996).

A cabin belonging to Little Jimmy is reported to have been situated along the west side of the lake which is south of “Wind Lake #2” and referred to as Little Jimmy Lake (Sterriah 1996 maps).

The project field notes contain references to other traditional use sites mentioned by the Ross River Elders that are outside the Wolverine Lake study area (Greer field notes 1996), including grave sites at McEvoy and Finlayson Lakes, and hunting camps in the North Lakes area.

¹ The locations of these important resource areas is confidential, as requested by the Ross River Dena Council. The Council has also requested that all lick areas receive protection from disturbance and mining development.

3.3.3.2 Archaeological Sites

Eight archaeology sites have been officially registered as a result of the Wolverine investigations. These are referred to by their respective registration numbers, e.g. JiTn-1². In some cases, a site name has been suggested. A brief description of each of the registered sites follows. The site locations are shown in Figure 3.84.

JiTn-1 (unnamed site). Precontact archaeological site, at the inlet or south end of Wolverine Lake. The site is situated on a low bench feature (but not the lowest) on the east side of the outlet. A high bench feature immediately behind the site provides a good view down the lake, and is the reported general location of an historic grave which has not been relocated. Stone flakes, the byproducts of stone tool manufacturing and maintenance, were found at this site. These were situated both above and below the volcanic ash layer, which is dated to ca. 1250 years ago. The archaeological site is not large; its horizontal extent is estimated at less than 100 square metres. Limited archaeological testing was completed at the site, just sufficient to recognize that there are buried archaeological deposits.

JiTn-2 Jack Mackay cabin (suggested name). This cabin is located towards the north end of Wolverine Lake, on the south side, west and north of the island in the lake. The cabin has been seen from the air only, and was not visited on the ground. (Note that Grady Tom, Sterriah 1996 maps, had marked this cabin as being on the north shore of Wolverine Lake; the cabin location on the south side of the lake was pinpointed by F. Charlie during a flight on June 25/96. Franklin also provided the identity of the cabin's owner). Cabin location should be visited to verify its condition and associated features.

JiTn-3 (unnamed site). This is an historic hunting campsite that is situated in the mountains north of Wolverine Lake, in the upper "Van Bibber Creek" drainage basin, east of "Nougha Creek", at an elevation of ca. 1450 metres. The site is located in a stand of alpine fir, around the treeline. At one end of the stand of trees a meat drying and smoking area was seen, recognizable by the cross-pole for hanging the meat, with charcoal from the curing fire visible underneath. The campsite area was at the other end of the stand of trees. Here remains of a fireplace (charcoal and charred poles), a windbreak (piled brush), and cut poles that once held the fly that provided shelter were seen. The age of this site is uncertain, though it is not likely particularly old, based on the artifacts (bottle, tobacco tin) seen on the site surface. No items were collected at this site.

JjTn-1 (unnamed site). This site is an historic brush camp, that is located at the north end of Wolverine Lake, northwest of the lake outlet. The structure, which was a short-term use shelter, is situated a couple hundred metres north of (back in the bush from) Franklin Charlie's new cabin. It was probably used by one or two individuals when out hunting or on travelling on the trap-line. The poles from which it was constructed had all been cut with an ax, and the structure did not appear to be particularly old, perhaps, about 50 years. It is also likely that there are other similar structures located elsewhere in the study area. No items were collected at the JjTn-1 site.

²Archaeological sites are referred to by their respective Borden number, e.g., JiTo-1, following the standardized system of site registration used in Canada, which assigns letter codes to sites based on their geographic location (latitude and longitude). The Wolverine Lake development area falls within the JiTm, JiTn, JiTo, JiTp, JjTm, JjTn, JjTo and JjTp Borden blocks. Note that although sites are not required to have a name, some suggestions have been offered.

JjTo-1 George and Maudie Dick and Johnson and Louise Jules Cabins, plus Graves (suggested name). These cabins are located at the north end of Wolverine Lake, west of the lake outlet and north of the creek that drains into Wolverine Lake from "Wind Lake" to the north. The cabins are situated several hundred metres above and back in from the lakeshore, at an elevation of ca. 3,900 feet in a open stand of spruce trees. One of Westmin's exploration survey lines lies less than 100 metres south of the cabins.

The cabin locations were pinpointed by Amos and Jim Dick during the September fieldwork. The brothers had lived at this site as young children, and provided the information on the cabins and their owners' family relationships. George Dick and Louise Jules were brother and sister (Greer field notes, Jim Dick interview 26/6/96, also Amos Dick 11/9/96). The cabins are thought to have been built in 1924, but the brothers did not know when they were last used.

The two cabins are positioned about 30-45 feet apart, with the larger (ca. 18 by 12 feet), Dick family cabin being west of the Jules family cabin. The Dick cabin has a peaked roof, which is now collapsed. Its door is on the south side, and it has windows on the both the east and west walls. All window and door frames of both cabins are hand hewn. While the stove had been removed from the Dick family cabin, remains of the stove pipe ring (made from a blazo can) were recognizable inside the structure, as was part of a home-made bed positioned in one corner. The smaller (ca. 10 by 14 feet) Jules family cabin has its door on the west wall, with windows on the east and south walls. It has a single pitch flat sod roof, which is now collapsed.

The graves were recognizable as depressions behind the Dick family cabin. One of the depressions is marked by an upright stake (Plate 20). Two children of George and Louise Dick are reported by Jim and Amos Dick to have been buried here.

In addition to the graves, various other related camp structures and features were recognizable around the two cabins. These included a collapsed elevated cache in front of the Jules cabin, and a possible in-the-ground refrigerator storage pit, behind the same dwelling. In front of the Dick family cabin was a carved stump used by women for wringing out hides as part of the tanning process. Amos reported that his grandfather also stayed for a while in a tent at this site; the likely location of the tent site was recognized northwest of the Dick family cabin. In this same area the upright poles from a second elevated cache was seen.

No items were collected at this site.

JiTo-1 Johnny Caesar Camp (suggested name). This site is an historic campsite; precontact archaeological deposits, including a possible house pit or storage pit feature are also present at the site. It is located at the north end of Wolverine Lake, west side, south of the creek that drains into Wolverine Lake from "Wind Lake" to the west. The site is situated on high bench feature on the south side of the creek, and provides a good view east over the north end pond area of Wolverine Lake. A trail that goes from the north end of Wolverine Lake west to the North Lakes runs through the site.

The site was located by Amos Dick during the September fieldwork; Amos also provided the name of the former camp's occupants. The Caesar camp was recognizable by poles which marked the outline of small (ca. 6 by 8 feet) wall tent. A milk can was seen on the

site surface, but was not collected, nor was any subsurface testing of the tent area conducted.

Sub-surface testing elsewhere at the site revealed buried archaeological deposits (Plate 23). Two tiny lithic chips, the byproducts of stone tool manufacture and maintenance, that are made of grey chert, were found below the volcanic ash layer dated ca. 1250 years ago. A depression, measuring less than 2 metres by 2 metres by 1 metre deep, was also recognized at the site. It is uncertain if this feature is a storage pit, the remains of a dwelling structure, or a natural feature. This site is not large; its horizontal extent is estimated at less than 200 square metres.

JjTm-1 Van Bibber Creek Cabin (suggested name). This cabin is situated north of Wolverine Lake, on the east side of a creek which drains into the Finlayson River and that is locally known as "Van Bibber Creek". The cabin is located just a couple hundred metres south of the Campbell Highway, though it was built long before the highway. According to Amos Dick, the cabin belonged to Little Jimmy. Grady Tom (Sterriah 1996 maps) thought the house may have belonged to Old Bob. This same owner identification may possibly have been implied by Mary Charlie in interview with Doris Bob (see Rutherford 1995, Appendix p 43). The cabin seen from the air only, and was not visited on the ground. This cabin location should be visited to verify the condition of the structure and associated features.

JjTm-2 Nougha Creek Graves (suggested name). This site records two historic graves that are situated in the lower part of the "Nougha Creek" basin, east of the creek, just south of the Campbell Highway, but well south of the Finlayson River. The two graves, marked by fences were seen from the air only, and were not visited on the ground. Elder Mary Charlie reported that these graves were those of Fred Magan's children, who died when Mary was a child (Greer field notes, 1996). These graves should be visited to verify their condition and vulnerability.

Other signs of traditional land use (cuttings, stumps, etc.) were recognized in the following places, but have not been registered as sites. Recent camps and cabins, have similarly not been registered as sites because they were not old enough (greater than 50 years).

3.3.3.3 Sites Not Yet Documented/Relocated

The **grave** of Peter Mackay, brother of Mrs. Mary Charlie, is reported as being located somewhere in high country between Wolverine Lake and Campbell Highway. It was reported by Mrs. Charlie (Greer field notes, 1996), and Greer, Mrs. Charlie and others searched for it from air in June/96, with no success. Greer and Harry Atkinson looked for this grave in September/96, also from the air, but again with no success.

The **grave** of Jacob Dick, brother of Jim, Amos, and Robertson Dick is reported as being located on high bench on east side of inlet of Wolverine Lake. It was reported by G. Tom (Sterriah 1996 maps). Greer and Harry Atkinson examined this bench in September/96, but saw no above ground structures or features that might represent a grave marker. The landscape feature itself has an irregular ground surface, so a grave depression would not be easily seen.

In June 24th project interviews, Mrs. Mary Charlie mentioned the graves of three people who were killed by a snowslide. Of the three, the Chief who died was buried at Finlayson Lake; the chief's brother was buried on the mountain somewhere between Wolverine

Lake and the Campbell Highway. The third person killed by the slide, a child, was buried somewhere upstream from the mouth of "Nougha Creek".

Another grave was mentioned by Franklin Charlie during the June 24th project interviews. It was reported as being on the south side of the creek between "Wind" and Wolverine Lake. The area mentioned is where the Johnny Caesar camp was identified during the September fieldwork, and while lots of old cuttings signs were seen in this area, a possible grave structure was not observed.

A cabin used by Little Jimmy is reported to have been located on the west side of "Little Jimmy Lake", the small lake located south and upstream from "Wind Lake #2", south of Wolverine Lake, around 61°21'N, 130°10'W. This cabin location was reported by G. Tom (Sterriah 1996 maps). The west side of this lake was examined from the air in September, but no cabin remains were seen. Ground examination of the area is needed. Jim Dick (Greer field notes, 1996), also referred to a house belonging to Little Jimmy as being somewhere on "Nougha Creek".

A man-made moose lick area was reported on the west side of "Wind Lake #2", the small lake located south end of Wolverine Lake, around 61°19'N, 130°10'W (G. Tom, Sterriah 1996 maps). The area was examined from the air in September, but no obvious signs of a lick area were seen. Ground examination of the area is needed. The man-made feature being referred may be the one reported by Mrs. Mary Charlie, that is the fence structure which leads to the licks by Lick Lake; this feature is situated in the next valley west.

Many other campsite locations were reported (Greer field notes, 1996; Sterriah maps 1996). Most of these are understood to be located in the high country and neighbouring higher valleys of the study area. The reported locations are marked on Maps 3. Only one high elevation hunting camp has been relocated, that being the JiTn-3 site.

3.4 Socioeconomic Conditions

3.4.1 Overview of Yukon Land Claims

All Yukon First Nations were involved through the Council for Yukon Indians (CYI) in an extensive set of negotiations on land rights, participation on land use management boards and self government from 1973 to 1993. In May, 1993, an Umbrella Final Agreement (UFA) was signed between the Government of Canada, the YTG and the Council of Yukon Indians. The UFA established the framework for final negotiations on individual, comprehensive land claim agreements with each of the 14 Yukon First Nations. The UFA also required self-government agreements with each Yukon First Nation. Legislation authorizing implementation of the UFA was subsequently proclaimed in February, 1995. The CYI was established to negotiate the UFA. With that mandate accomplished, the CYI has now evolved into the Council for Yukon First Nations but only represents 11 of 14 Yukon First Nations.

Concurrent with the signing of the UFA, four First Nation Final Agreements and Self Government Agreements were signed. At the present time, there are seven Final Agreements that are in effect and seven that are still being negotiated.

The Finlayson Project is in Kaska Traditional Territory. The Ross River Dena Council and the Liard First Nation are the 2 principal aboriginal groups in Ross River and Watson

Lake that will be involved in the development and approval of the Finlayson Project. Both the Ross River Dena Council and the Liard First Nation have joined forces with the Kaska Dena Council in British Columbia to deal with land claims negotiations and the approval of development projects such as mining.

3.4.2 Yukon Statistics

The Yukon's population as of June 2000 was 30,896 (Bureau of Statistics, Yukon Monthly Statistical Review, September, 2000). This represents a 1.3 % decrease in population from June 1999 to June 2000. The June 2000 population was 50.7 % males and 49.3 % females and persons under the age of 15 accounted for 21.2 % of the population and 5.6 % of the population were aged 65 and over (Bureau of Statistics, Yukon Monthly Statistical Review, September, 2000).

The largest communities in the Yukon are Whitehorse with a population of 22,810, Dawson City 1,947 and Watson Lake 1,665 (Bureau of Statistics, September 2000). About 73% of the Yukon's population live in Whitehorse.

The official unemployment rate for Yukon Territory in August, 2000 was 10.1 % which is 2.9 percentage rates higher than the rest of Canada (7.2 %). During August, 1999 Yukon's rate of unemployment stood at 9.8 % (Source: Yukon Bureau of Statistics).

The economic health of Yukon Territory is closely tied to the health of the Canadian exploration and mining industry. There has been a steady decline in the Yukon economy over the past 3 years, which roughly corresponds to the decline of the Canadian minerals industry.

The total GDP for Yukon Territory in 1998 was \$ 947,400,000 of which Mining, Quarrying and Oil Wells contributed up to 7.5 % of the GDP. The following is a summary of the Real Gross Domestic Product by Industry from 1988 to 1998 for Mining, Quarrying, and Oil Wells in 1992 Canadian dollars (Source: Yukon Bureau of Statistics):

- 1988- \$ 231.6 million
- 1989- \$ 220.1 million
- 1990- \$ 238.5 million
- 1991- \$ 198.5 million
- 1992- \$ 308.9 million
- 1993- \$ 80.7 million
- 1994- \$ 47.8 million
- 1995- \$ 86.3 million
- 1996- \$ 178.0 million
- 1997- \$ 78.4 million
- 1998- \$ 71.0 million

These figures clearly show the decline in the GDP for the mining industry in Yukon Territory from 1996 to 1998 and an overall decline throughout the 1990's.

The value of mining related exploration activities in Yukon Territory has been declining for the past 5 years. The following summarizes exploration expenditures from 1995 to 2000 in Canadian dollars (Yukon Mining Industry- A Background Paper):

- 1995- \$ 39.3 million
- 1996- \$ 46.4 million

- 1997- \$ 40.6 million
- 1998- \$ 15.5 million
- 1999- \$ 12.6 million
- 2000 (forecast by the Yukon Chamber of Mines)- \$ 7.4 million

Clearly the Yukon exploration industry has been significantly negatively impacted with the downturn in the Canadian minerals industry.

3.4.3 Yukon Communities

The Yukon communities that would probably directly benefit from the Finlayson Project includes Ross River, Watson Lake and Whitehorse. These communities can provide the vast majority of services required for a major mining project as well as a trained labor force that would be available to support the Finlayson Project.

3.4.3.1 Ross River

The history of Ross River goes back to about 1900 when a trading post was built at the confluence of the Ross River with the Pelly River. The post became an important trading centre, as it was the navigational limit of steamboats on the Pelly and served aboriginal people in the Pelly, Ross River and Macmillan River areas. The construction of the Canol Pipeline and Road in 1942-44 between Norman Wells, NWT and Whitehorse, created the first road transportation link for Ross River with the Alaska Highway. With the closing of the Canol Road in the 50's, many residents moved to Watson Lake, Whitehorse and Carmacks. Between 1955 and 1964, approximately five extended Indian families, two white families, and a priest lived in the settlement of Ross River (Sharp, 1977).

The old Indian village, located around the original trading post, was moved between 1960 and 1963 to the present village site on the south side of the Pelly River.

Major population growth occurred between 1962 and 1968 with the discovery of lead, zinc and silver deposits near Faro. The Canol Road was reopened in 1962 and by 1966 the Anvil orebody was scheduled to become a mine. To facilitate mine development, a road was built from Watson Lake to Faro, by-passing Ross River. An airstrip was built in Ross River. Secondary development occurred along with the mining exploration and mine development, including a motel, bar and beer parlour, department store, a police station, health clinic, water system and other facilities.

The population of Ross River was 376 in June 2000 and 375 in June 1999 (Yukon Monthly Statistical Review, September, 2000). Of the current population in Ross River, approximately 325, or 86%, are Ross River Kaska Dena (information from Ross River Dena Development Corporation, November, 1995).

Ross River is unincorporated. The Ross River Dena Council is recognized as the local First Nations government. Facilities in Ross River include a new school which opened in November 2000 which includes Kindergarten to Grade 10. Students generally go to Whitehorse for Grades 11 and 12. In addition there is a Yukon College community campus for adult education; a highways maintenance facility; a RCMP post; a medical facility (but the nearest doctor is in Faro); a hotel; gas station; restaurant and pub. The Ross River Dena Council also operates a store. The ice rink is presently closed. Water supply is delivered by truck to the households. Sewage is by pump outs and septic

fields. Housing supply is very limited (reported only 2 or 3 houses available) and the land base for residential development is quite limited.

3.4.3.2 Watson Lake

The Municipality of Watson Lake is located in southeastern Yukon. It is situated on the Alaska Highway at the junction with the Robert Campbell Highway. The town of Watson Lake grew from the construction of the military airport constructed in 1942 and the construction of the Alaska Highway (the Alcan project), completed in 1942.

The population of Watson Lake in June 2000 was 1,665 (Yukon Monthly Statistical Review, September, 2000). The population growth rate of Watson Lake is significantly affected by the level of mining and forest harvesting activities. For example, the unemployment rate in Watson Lake for 1996 was 11.3 % (Source: Yukon Bureau of Statistics). Recently, South Yukon Forest Corporation (SYFC) shut down their mill near Watson Lake and laid off the majority of their workforce. Up to this point, SYFC was the largest private sector employer in Yukon Territory with a workforce of some 70 people near Watson Lake. This recent closure of this industrial facility has driven the unemployment rate in Watson Lake to higher levels than the official rate of unemployment.

Major economic activities include government services, tourism, transportation, forest harvesting, and mining. Tourism has shown steady growth from an annual summer tourist flow along the Alaska Highway. Watson Lake being a transportation hub has benefited from the steady growth Watson Lake has served primarily as a transportation, housing and communication centre of the mining industry. Major mining projects include Sä Dena Hes, which is presently closed but may re-open.

Watson Lake was incorporated as a town in 1984. It is governed by an elected municipal council consisting of a mayor and four councillors, each elected for three-year terms. Watson Lake has a well developed infrastructure of paved roads, adequate water supply from wells, domestic sewage collection and treatment and is served by diesel electric generated power supply. The housing supply had been increased in expectation of mine development and presently the estimated vacancy rate is 14.3% (Bureau of Statistics, October 1995). Other services include a local detachment of the Royal Canadian Mounted Police, court facilities, fire protection, a regional hospital and health centre and a campus of the Yukon College. Watson Lake also has 2 public schools which go from Kindergarten to Grade 7 (Johnson Elementary) and from Grade 8 to Grade 12 (Watson Lake Secondary School).

3.4.3.3 Whitehorse

Whitehorse is the capital and largest city in the Yukon, with a population of 22,810 (Yukon Monthly Statistical Review, September, 2000) or about 73% of the Yukon population. It is the major centre for transportation, retail and commercial and government services. With such a large percentage of the Yukon's population, it is reflective of much of the statistics for the Yukon as a whole.

The history of Whitehorse dates back to about 1898. Located at the head of navigation on the Yukon River, Whitehorse started as a transshipment site for prospectors during the Klondike gold rush. In 1900, it became a permanent settlement as the Whitepass and Yukon Railway was completed running from Skagway Alaska to Whitehorse. From 1900

to 1941, Whitehorse was a transportation hub with the railroad, river boats to Dawson and for air freight and mail. It also had supporting services for tourism and mining. The population was about 750 people until 1941 when construction started on the Alcan Highway. Major growth occurred in Whitehorse in 1941 when the Alcan Highway, the Canol Pipeline and northern airfields were constructed for supporting the war effort. Whitehorse became the major staging point for the effort which brought in over 30,000 American and Canadian servicemen and civilians during the construction period. With the completion of the Alaska Highway, Whitehorse became the major transportation center in the Yukon. In 1953, the Territorial government was moved from Dawson to Whitehorse.

Whitehorse is a modern city with essentially all the amenities of any similar size Canadian city.

The housing vacancy rate for Whitehorse in June 2000 was 15.1 %. This is a decrease from 18.7 % in June 1999 (Yukon Monthly Statistical Review, September, 2000). Whitehorse has adequate municipal land that can be used to increase the supply of housing.

3.4.3.4 Faro

Faro is located in south central Yukon and is accessed by the Robert Campbell Highway. Faro is approximately 70 km by road west of Ross River, and 120 km by road east of Carmacks.

The town of Faro was developed in 1966 as a housing and service centre for the Anvil mine. The Robert Campbell Highway was constructed in 1966 from Watson Lake to facilitate the Anvil mine development. Accommodation was constructed for the mainly single 500-person construction work force and then housing was constructed for the operating workforce of approximately 400 people with their families. On June 13, 1969, there was a fire that destroyed the original Faro townsite. The town was rebuilt within several months and expanded services included a hotel, bar, shopping centre and recreational facilities.

The population of Faro has had wide fluctuations, depending on the levels of operation of the Anvil mine. The population in 1966 was approximately 500, increasing to 1,517 in 1991. When the mine shut down in 1992, the population in Faro declined, and was only 515 in 1994 (Bureau of Statistics, 1994). The population in June, 2000 was 438 which is a decrease from June 1999 which stood at 597 (Yukon Monthly Statistical Review, September, 2000).

The available housing in Faro is very limited. There are some rental apartments available but single family housing is virtually non existent. There is serviced land available to build additional housing but no plans for additional construction have been made.

Faro was originally constructed to support the Anvil mine. Government services in Faro include a school for Kindergarten to Grade 12, a 4-member RCMP detachment, a nursing station, a campus of the Yukon College, restaurants, liquor sales, hotel and service stations. There is an airstrip but no regular scheduled flights.

3.4.4 Transportation

There are two transportation systems in the Yukon, air and road. Both will be used to service the Finlayson project.

3.4.4.1 Air Transport

The air transport system has been well developed, being a major factor in opening up the Yukon. There are excellent airport facilities at Whitehorse, which is served daily by a national airline and is also the base for a number of charter companies. The Watson Lake airport has paved runways and a terminal which is staffed part time. Air connection from Watson Lake to Whitehorse is via charter as there are no scheduled air flights between these 2 centres.

Ross River and Faro have good quality gravel strips and small terminals. There is little air traffic except for occasional charters and local airline connections to Whitehorse in the summer. None of the airports operate at anywhere near full capacity.

There is a small airstrip adjacent to the Robert Campbell Highway, near Finlayson Lake, about 14 km north of the Kudz Ze Kayah access road junction. This gravel strip is only about 500 metres long and is unsuitable for upgrading to handle twin engine commuter airplanes. There is also a gravel airstrip at the Wolverine exploration camp that is suitable for handling twin engine freight aircraft.

3.4.4.2 Road Transport

There are two major highways in southern Yukon: the Alaska Highway which runs from the B.C. border, through Watson Lake to Whitehorse, then on to Alaska; and the Klondike Highway which runs from Skagway to Dawson City via Whitehorse and Carmacks (Figure 4.1). There is also the Robert Campbell Highway which connects Watson Lake and Carmacks via Ross River and Faro (both a few kilometres off the highway).

Much of the Alaska Highway has been upgraded in the last few years. The highway is covered with pavement and "chip seal". Highway traffic is minimal during the winter months and, although it increases in the summer with the tourist traffic, it is still not yet up to design capacity (YTG). The Klondike Highway is covered with "chip seal" and pavement from Skagway to Carmacks and operates below design capacity all year (YTG).

The Robert Campbell Highway is a secondary gravel highway. Upgrading has been carried out at the north end of the highway from Faro to Carmacks, in order to handle the concentrate trucks from Faro. There has also been some upgrading at the south end between Watson Lake and the Sa Dena Hes mine turn off (42 km). The upgrading on this section should be completed when this mine re-opens. Traffic counts by the YTG Transportation Services have shown that only between 8 and 12 vehicles per day travel between Ross River and Watson Lake in the winter months, October to April. During the 1995 summer months this traffic increased to an average of about 60 vehicles per day, with a peak of 86 in July. This is an increase from the 1993/4 average of 44 vehicles per day.

3.5 Valuable Ecological and Cultural Components (VECC)

Those issues that are considered important to local ecology and culture have been largely identified through the public consultation process carried out by Cominco for the Kudz Ze Kayah Project. Based on the CEAA screening report for the project, these include:

- Air quality
- Water quality
- Fisheries resources
- Wildlife resources
- Moose populations
- Finlayson Caribou herd
- Wilderness setting
- Recreational fishing and hunting
- First Nations grave sites
- Caribou fence sites
- Ross River group trapline
- Ross River community issues (jobs, training)
- Cross cultural understanding of mine employees

The public consultation program for the EA will verify that this list of VECC's remains appropriate and comprehensive. The Finlayson Project will utilize similar mitigation measures and development plans to address the concerns surrounding these issues.

3.6 Additional Studies and Analysis

Based on the amount of baseline data available for the project area, very little additional study is anticipated for the Finlayson Project. The baseline investigation study areas largely cover the development footprint of the project. Some small gaps in the database developed by these studies have been identified. Those gaps are outlined below and study plans proposed to collect the additional data.

The only area not covered by the original baseline investigations is the Route B ore haul road corridor. Additional studies for this route are proposed below.

3.6.1 Climate

The regional analysis of climate conditions for the Kudz Ze Kayah Project did not consider the inclusion of the Wolverine area. Climatic conditions at Wolverine may differ slightly from Kudz Ze Kayah due to differences in landscape. However, the regional analyses for Kudz Ze Kayah utilized data from stations outside the general area of the Finlayson Project and as such, the conditions estimated for Kudz Ze Kayah should generally apply to Wolverine. Furthermore, the type of development proposed at Wolverine (underground) is not as dependent on climatic conditions as Kudz Ze Kayah.

For the Finlayson Project Environmental Assessment Report, the regional analysis of climatic conditions will be reviewed in the context of the additional regional and site-specific data that has been collected since the analysis was completed. If required, the regional analysis will be updated.

3.6.2 Soils, Surficial Geology and Terrain Hazards

The soils, surficial geology and terrain conditions for have been adequately characterized for the Finlayson Project operations areas at Kudz Ze Kayah and Wolverine. With the exception of the Route B ore haul route, road corridors have been adequately assessed. If the Route B corridor is selected as the preferred ore haul route, a field study of surficial geology and terrain conditions will be completed to a similar standard to those completed for other project areas.

3.6.3 Water Resources

In general, surface water conditions (hydrology, limnology, and water quality) have been adequately characterized for the Finlayson Project. The regional analysis of surface runoff and flood conditions for Kudz Ze Kayah is adequate for feasibility level design of mine facilities. The facilities proposed at Wolverine are not as dependent on surface runoff conditions. For the Finlayson Project Environmental Assessment Report, the regional analysis of average and 7-day low flow conditions will be extended to a selected location in the Go Creek basin. This data will be used in the analysis of water quality and hydrological effects related to discharge from the Wolverine operations water treatment plant.

For the Finlayson Project Environmental Assessment, water quality information collected from the Kudz Ze Kayah and Wolverine areas in 2000 will be included in the database and all water quality information compared to the most recent water quality guidelines published by CCME.

Hydrogeology and groundwater quality have been adequately characterized for the Kudz Ze Kayah operations area. At present, the only groundwater information available for the Wolverine operations is anecdotal data from exploration drilling. Groundwater conditions in the area of the Wolverine deposit will be characterized during the test mining proposed for 2001. This will include estimation of groundwater inflows to the underground operations and characterization of groundwater quality.

Sediment quality has been adequately characterized for all project areas and no further studies are anticipated.

3.6.4 Fisheries and Aquatic Resources

Studies of fisheries and aquatic resources for the Finlayson Project are extensive. For most aspects, aquatic resources have been adequately characterized. However, it is noted in the fisheries investigations for Wolverine, analysis of metals in fish tissue did not include selenium or mercury, two potentially important metals from an aquatic health perspective. Further analysis of metals in fish tissue in Go Creek and Wolverine Lake will be completed for the Finlayson Project Environmental Assessment Report.

Habitat assessments for potential road crossings did not consider the Route B ore haul corridor since this route was not considered at the time of investigations. If Route B is selected as the preferred ore haul route, fisheries assessments will be completed for stream crossing along its path.

3.6.5 Vegetation

Vegetation communities in the development footprint have been adequately characterized. The differences in classification systems used at Wolverine and Kudz Ze

Kayah will be rectified to the extent possible in the Finlayson Project Environmental Assessment. No vegetation studies have been completed for the ore haul road alternatives. Following final selection of the preferred corridor, vegetation communities will be assessed similarly to those studies already completed for other proposed development areas.

3.6.6 Wildlife and Ecosystems

The amount of baseline wildlife information collected for the Kudz Ze Kayah and Wolverine projects, in addition to YTG Department of Renewable Resources information, represents some of the most extensive ungulate baseline data collection performed in Yukon. Both wildlife programs were focused on species of regional concern, woodland caribou and moose.

A major gap for the Finlayson project is the absence of regional ecosystem information. Broad ecosystem mapping should be produced for a much larger area surrounding the project at a scale of 1:250,000. It is anticipated that much of this information will be produced through the use of satellite imagery and the synthesis of existing information sources.

For the development of local ecosystem information, classification discrepancies between the Kudz Ze Kayah and Wolverine vegetation mapping must be resolved. Vegetation communities identified in past projects (Zoladeski et al. 1996) will be synthesized and compiled to create meaningful ecosystem units. The mapping of local ecosystems must be expanded to cover the direct footprint of the entire project area. This will require expanded coverage for the proposed road corridor between the Kudz Ze Kayah and Wolverine properties.

Wildlife habitat values and a ranking of ecosystem sensitivity should be developed for each map polygon. When used in a GIS environment, this will allow direct and potential project impacts to be quantified.

3.6.7 Archaeology and Heritage Resources

Heritage resource investigations in the project area have located a number of sites and identified additional sites which are purported to be in the area. For the Kudz Ze Kayah area, concentrate haul road, and airstrip no areas of heritage or archaeological importance were identified. The area around Wolverine and the proposed ore haul routes have the potential to host areas of heritage importance. For the Finlayson Project Environmental Assessment Report, the areas specifically proposed for development will be re-examined and the project design adjusted to avoid disturbance of those areas. The findings of the additional investigations will be reported in the Environmental Assessment Report.

4 ENVIRONMENTAL EFFECTS ASSESSMENT

Environmental Effects Assessment is the principle project-planning tool of an Environmental Assessment Report. In its most basic form, environmental assessment is the comparison and analysis of environmental conditions and project description information. This allows the identification of project-environment interactions and prediction of effect characteristics using a variety of analysis tools. Based on the potential effects identified, mitigation measures can be developed to eliminate or minimize the environmental effect of the project as a whole.

The following section describes how the environmental effects of the Finlayson Project will be identified, analysed, and presented. It presents a preliminary identification of potential environmental effects and mitigation measures proposed to eliminate or minimize those effects.

4.1 Assessment Process

4.1.1 Assessment Scope

In the environmental effects analysis, the definition of the environment will be extended beyond biological and physical aspects of the project area. The definition of project environment will include consideration of the biological and physical environment, socioeconomic effects, effects on regional and aboriginal land use, effects on archaeological and heritage resources, and effects on human health.

The potential range of the project influence in the environmental component being considered will determine the geographic boundaries limiting the assessment of interactions. For example, the assessment of effects on the physical environment may be limited to areas within the footprint of mine development while assessment of socioeconomic effects will be extended to the communities surrounding the project.

The assessment of project-environment interactions through time will be achieved by breaking the project development down into four principle phases; construction, operations, and reclamation and decommissioning. The fourth temporal phase, final closure, will be analyzed to assess the final, permanent effects of the project.

The environmental effects analysis of the Finlayson Project will consider this project environment through the following components:

- Analysis of alternative means of carrying out the project and the potential environmental effects of those alternatives
- Identification of project-environment interactions
- Potential effects of project-environment interactions
- Measures taken to mitigate these effects
- Determination of significance of effects including:
 - Identification of adverse effects
 - Determination of effect significance
 - Likelihood of effect occurrence
- Analysis of cumulative effects resulting from project development in combination with other regional activities
- Identification of potential accidents and malfunctions associated with the project and analysis of their environmental effects

4.1.2 Assessment Approach

In the initial phase of the assessment, environmental attributes of the project area will be reviewed and a list of valuable ecological and cultural components (VECC's) will be developed. The VECC's will first be selected based on previous consultation carried out by Cominco during the Kudz Ze Kayah review and through consultation with government agencies and stakeholders. The environmental effects of the Finlayson Project on these VECC's will be analyzed through a four step process:

1. *Analysis of alternative means of carrying out the project.*

For each of the temporal phases identified, a matrix will be developed comparing project development alternatives and environment components. Alternatives to be considered in this process will include various, methods, means, and locations for project activities and facilities. Potential project alternative-environment interactions identified through this process will be qualitatively explored and the best alternative identified. A comparison of the project development plan and analysis of alternative means will identify the performance of the Finlayson Project in selecting alternatives with the least potential environmental effect.

2. *Identification of potential project-environment interactions and development of mitigation measures.*

The alternatives analysis matrix will be refined and reduced to include only those alternatives that are selected as part of the project development plan. The identified interactions will be qualitatively identified. Ecological/social relationship will be examined to identify potential secondary or indirect effects. Mitigation measures developed to eliminate or reduce the effect of adverse interactions. A summary table of the potential effects, corresponding mitigation measures, and residual environmental effects after implementation of mitigation will summarize this process.

3. *Determination of residual environmental effects*

Each of the residual environmental effects will be described to the extent possible using analysis techniques appropriate for the identified effect. Some examples of the analysis tools that could be used in this process include mathematical models, overlay maps, and consultation with experts.

4. *Determination of significance*

The determination of the significance of environmental effects in an extremely important aspect of an EA. The CEEA requires that the significance be determined for each environmental effect that is identified, including the cumulative effects of the project. The determination of significance is typically based on:

- Existing environmental conditions;
- Existing scientific, technical and other relevant information;
- Relevant regulatory criteria, standards/objectives, guidelines and thresholds;
- Public comments; and
- Professional judgement.

The significance of effects will be determined qualitatively by considering a number of different criteria, either implicitly or explicitly. There are many different criteria that can apply, however the ones to be used in this EA are:

- Magnitude (of the effect)
- Geographic Extent (of the effect)
- Duration (of the effect)
- Frequency (of conditions causing the effect)
- Ecological Importance (of resource or attribute)
- Societal Value (of resource or attribute)
- Permanence (of effect)

For the purposes of the EA the assessment of the significance of an environmental effect will be undertaken in two steps: (1) automatic designation of significance and (2) assessment of significance by criteria.

1) Automatic Designation of Significance:

As the first step, an environmental effect can be automatically designated to be a negligible effect, a significant adverse effect, a beneficial effect or an uncertain/unknown effect, according to the following definitions. Not all environmental effects will fit these definitions.

Negligible Effect (Not Significant) are those environmental effects, which after taking into consideration mitigation measures, are not likely to be measurable beyond the project site area and/or are temporary in duration, and completely reversible within a few days of an activity or disturbance.

Significant Adverse Effects are those environmental effects, which after taking into consideration mitigation measures, are anticipated to: exceed an applicable environmental legal standard, displace or endanger a designated or protected environmental feature or population, cause proven chronic effects on human health.

Beneficial Effects are those effects that result in improved environmental quality or socioeconomic conditions over baseline conditions.

Uncertain / Unknown Effects are those environmental effects for which there is insufficient information (i.e. either project description, environmental baseline or other) or documented scientific uncertainty or debate.

2) Assessment of Significance by Criteria

In the second step, the remaining environmental effects which could not be automatically designated will need to be assessed carefully by criteria. An environmental effect can be judged to be either a minor adverse effect (not significant) or as a significant adverse effect depending upon its characteristics. The following are suggestions for determining the significance of an affect using several criteria. These will need to be finalized with input from key stakeholders in the EA.

Minor Adverse / Mitigable Effects (Not Significant) are those environmental effects which, after taking into consideration mitigation measures, have magnitudes well below

legal regulatory limits, or are otherwise small or moderate in magnitude and exhibit any combination of the following:

- short or moderate in duration;
- occur rarely or sporadically;
- are localized in their geographic extent, and/or
- are quickly reversible.

Significant Adverse Effects are those environmental effects that, after taking into consideration mitigation measures, have a magnitude that is approaching a legal regulatory limit or exhibit any combination of the following:

- occur relatively frequently;
- are long term in duration or permanent effects;
- will affect a large geographic area either on-site or off the mine property; and/or
- will take a long time to recover once the effect ceases.

To better define these decision-rules for the assessment of significance, each criterion may need to be scaled and defined more precisely to allow for a more careful determination of significance and to develop a firm rationale for such determinations. Table 4.1 provides an example of the manner in which the criteria may need to be defined.

4.2 Cumulative Environmental Effects

In the absence of regional land use planning (e.g. Yukon Land Use Planning Council) cumulative environmental effects will be considered from two perspectives. The cumulative effects to all environmental components resulting from the Finlayson Project will be described in a summary section that concludes the findings of the environmental assessment. The cumulative environmental effects including consideration for other projects, activities and land use plans in the region will be considered in a separate analysis.

The analysis of cumulative environmental effects on a regional basis will be completed based on the findings of the environmental assessment. Other projects and land uses will be identified within a defined geographic area. The residual effects identified for each of the phases of project development will be compared to available information for potential effects of regional projects and land uses within the time frame of the particular project phase. Effects determined to be negligible will not be considered as part of the cumulative effects analysis. The potential cumulative effects resulting from multiple activities will be identified and qualitatively described. The post-closure effects of the Finlayson Project will be considered in relation to foreseeable projects and activities in the region for a period of 10 years following mine closure and completion of reclamation.

The significance of cumulative effects will be assessed using the same methodology as presented above.

Identified potential cumulative effects will be summarized along with active management plans which the company will use to minimize its contribution to cumulative adverse environmental effects in the region.

4.3 Environmental Health and Safety and Accidents and Malfunctions

The discussion of potential accidents and malfunctions will be approached in two parts. In the first part, the project mechanisms, systems, and administration procedures that will be established to respond to accidents and malfunctions will be outlined. This includes description of administrative structure and proposed resources of the environmental health and safety department of the Finlayson Project, the environmental health and safety procedures administered and to be developed by this department, and the Emergency Response and Spill Contingency Plan for the project. An environment and safety monitoring program will be proposed for the mining operations.

In the second part, potential accidents and malfunctions associated with the project will be identified. This will consider malfunction or failure of project components such as preventive engineering features (secondary containment facilities, liners, pumps, etc.), major facilities (tailings dam, waste rock storage facilities, pit walls, underground caving), and potential natural disasters (fire, flood, earthquake). It will consider potential accidents such as vehicle and airplane crashes and equipment accidents. The likelihood and potential environmental effects will be qualitatively described for each malfunction or accident identified. Emergency response procedures and protocols will be associated with identified potential accidents and malfunctions.

4.4 Follow-up Programs

Follow-up, within the context of environmental assessment, is defined in the CEAA as a program for:

- verifying the accuracy of the EA of a project; and
- determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project.

A follow-up program provides information about the current status of the project within its environmental setting. This feedback is essential to ensure that those who planned the development and those who manage the environmental affairs of the mine are supplied the information upon which to base their investment and other decisions.

A follow-up program will be developed for aspects of the project with one or more of the following characteristics:

- inadequate baseline environmental information;
- there exists a potential for cumulative environmental effects; and
- there is scientific disagreement over potential effects.

As part of the EA, a clear statement of the predicted environmental effects and a clear statement(s) of the commitments to mitigation as recommended in the EA document will be provided. A follow up program including environmental monitoring plans will then be tailored to the most important of these items.

Follow up programs and monitoring requirements have been established for the Kudz Ze Kayah operations as conditions to the Kudz Ze Kayah Project Water Licence. These

programs and monitoring requirements will be adopted for the Finlayson Project and modified to include the Wolverine operations.

4.5 Preliminary Environmental Assessment and Potential Mitigation Measures

Table 4.1a provides a preliminary overview of the direct project-environment interactions anticipated for the Finlayson Project. Indirect effects resulting from interaction between various environmental components are not outlined in this table. For many of these interactions, the effects have been assessed in detail as part of the Kudz Ze Kayah IEE and Water Licence Application. Mitigation measures for these effects were also developed as part of the Kudz Ze Kayah Project.

The following section is an integration of Kudz Ze Kayah environmental assessment and a preliminary assessment of potential effects resulting from addition of the Wolverine underground component to the project plan. Certain components of the Kudz Ze Kayah environmental assessment will need to be changed or expanded based on changes proposed for the Finlayson Project. This section indicates where such changes may occur.

4.5.1 Air Quality

Effects to air quality were not assessed as part of the Kudz Ze Kayah environmental assessment. The potential effects to air quality are increases in fugitive dust from disturbed areas, working areas, and roads and emissions from the power plants and incinerator facility.

Fugitive dust would only result during dry periods of the summer months and can be mitigated through watering of roads and some working areas and preventive engineering features on certain equipment (conveyor shrouds, bag houses). Winds in the project areas will quickly disperse any fugitive dust, providing natural mitigation of this potential effect. An additional issue to consider in the assessment of fugitive dust effects is the presence of receptors. In the remote area of the Finlayson Project, there are no human habitants (with the exception of the mine workers) who would be exposed to potential fugitive dust. The local climate, wind conditions, nature of the operation, and lack of human receptors should be considered in the assessment of the overall significance of this effect.

Emissions from the incinerator and power plants are also an issue of minor concern from an air quality perspective. Emissions from these facilities will be very low since modern standard operating procedures will be employed for these facilities including fuel efficiency considerations, regular maintenance, and emissions standards. Local wind conditions will quickly disperse the small amount of emissions that can be expected from such facilities. It is very unlikely that any changes in air quality will be detectable even in the immediate vicinity of these facilities.

The issue of greenhouse gas emissions resulting from project development will be considered as part of the Environmental Assessment Report.

4.5.2 Topography and Landscape Appearance

Changes to the landscape resulting from project development were not considered in the Kudz Ze Kayah environmental assessment. For the purposes of this assessment,

effects to topography and landscape appearance are defined as any changes in aspect, slope, or elevation of the landscape that would likely be visible from an aerial perspective. This definition is adopted as a means of isolating macro changes in the landscape resulting from major earthworks. Although these changes can be considered generally neutral in their direct environmental effect, the indirect effects of these changes to other environmental components needs to be considered as part of a comprehensive environmental assessment.

Changes to topography and landscape appearance will result primarily from development of major road corridors and associated borrow areas, the open pit, tailings facility and waste rock stockpiles. The extent of topographic change will be quantified in the Finlayson Project Environmental Assessment. Since many components of local ecology are dependent on these basic landscape characteristics, indirect effects can be expected to result in many different environmental compartments as a result of landscape change. The potential indirect effects will be qualitatively described in the Environmental Assessment.

4.5.3 Hydrogeology

For the purposes of the assessment, direct effects to hydrogeology are considered to be changes in phreatic levels and groundwater movement patterns as a result of contact between mine facilities and groundwater resources. For the Finlayson Project, effects to hydrogeology are expected to result from development of the underground and open pit mines and the tailings facility.

Development of the open pit at Kudz Ze Kayah will require dewatering to maintain pit wall stability and allow efficient operation of mining activities. The Kudz Ze Kayah Water Licence Application estimates that dewatering requirements for the open pit will range between 400 and 3,800 m³ per day. This dewatering is will result in a cone of depression in the phreatic surface surrounding the open pit. A head gradient will developed in this depression, directing groundwater flow towards the open pit.

The underground mine will also require dewatering for safety and efficiency of operation. As with the open pit, dewatering will result in a zone of phreatic depression surrounding the mine. Groundwater flow will be directed towards the operation as a result of the head gradient created by the dewatering activity.

The tailings facility will have the opposite effect to that seen from the open pit and underground mining operations. The deposition and storage of tailings in this containment facility will result in the development of a localized groundwater "mound" under this facility that will be the combination of natural groundwater and tailings solution captured in tailings mass. The pressure head resulting from the flooded facility will result in a localized zone of groundwater recharge as tailings water moves toward the natural groundwater resource under the facility. The potential mixing of tailings seepage and groundwater resources can be mitigated with a seepage collection system; either a series of collection wells or a seepage collection pond located down gradient from the tailings dam. The rate of seepage will decline to a steady state as tailings solids consolidate and transmissivity of the tailings mass is reduced.

In isolation, groundwater levels and movement do not constitute an important ecosystem component. However, groundwater does not behave in an isolated manner and has influence on surface water flow and quality characteristics. The potential indirect effects

on surface water resulting from changes to groundwater levels and movement will be identified and described in the Environmental Assessment

4.5.4 Groundwater Quality

During mine operations, effects to groundwater quality may result from operation of the tailings facility. The movement of tailings water into the natural groundwater could result in localized changes to the groundwater quality. These effects are unlikely to have broad geographic extent since groundwater naturally discharges to surface in Geona Creek, downstream of the facility. The mixing of tailings seepage groundwater resources can be mitigated with a seepage collection system. The models of surface water quality for the Kudz Ze Kayah Project (see below) include consideration for this seepage component.

Following closure, both the open pit and the underground mine will be flooded and groundwater movement will re-establish its natural pattern. The water in these flooded facilities will be in direct contact with the surrounding groundwater resource and will have some influence on the groundwater quality of the surrounding area. The water quality in the Kudz Ze Kayah pit at closure has been modelled and the details of that model are presented in the Kudz Ze Kayah Water Licence Application.

The quality of water in the open pit is expected to be acceptable and effects to the surrounding groundwater resource are not expected to be adverse.

Water quality in the flooded underground workings will be dependent on the wall rock and backfill characteristics. A more detailed investigation and model will be developed to estimate water quality in the flooded underground workings as part of the Environmental Assessment.

The secondary effects to other ecosystem components resulting from the connection between groundwater and surface water will be identified and described in the Environmental Assessment.

4.5.5 Surface Hydrology

For the purposes of this assessment, direct effects to surface hydrology are defined as changes to spatial and temporal aspects of streamflow volumes and distribution resulting from:

- placement of a facility in the path of an existing drainage corridor
- discharge of effluents to existing streams
- extension of a facility through a significant portion of a watershed resulting in potential alteration of surface runoff patterns

This definition applies to water treatment facilities at Wolverine and Kudz Ze Kayah, the open pit, waste rock stockpiles, and tailings facility at Kudz Ze Kayah, and major access corridors of the concentrate and ore haul routes.

The Kudz Ze Kayah IEE and Water Licence application did not include a specific assessment of effects on hydrologic regimes of site streams. Based on a preliminary evaluation of the project plan, operations at Kudz Ze Kayah can be expected to result in reductions in annual total discharge in Geona Creek and downstream drainages. Because water requirements of the operations will be relatively constant, streamflow reductions will likely be most noticeable during low flow periods in the fall and very early spring. Stream flows in the North Lakes drainage can be expected to increase due to

the diversion of the Fault Creek drainage into this system. This increase is expected to be largely unnoticeable due to the relative sizes of the Fault Creek and North Lakes catchments and the attenuation capacity of the many lakes in the system headwaters. In terms of measurable effect, there may be a slight increase in the lake levels of the uppermost lakes that will receive the Fault Creek flows. Measurable effects downstream of these lakes are very unlikely.

Direct hydrological effects related to the Wolverine operations will be limited to small increases in flows resulting from water treatment plant discharges. Dewatering operations in the underground mine are expected to provide enough water for infrastructure and mining operations. Excess water from the underground operations will be treated and released to Go Creek. Increases in Go Creek flows will likely be most noticeable during low flow periods since dewatering and water treatment plant discharge may occur at a relatively constant rate.

The hydrological effects of operations at Kudz Ze Kayah and Wolverine will be mathematically modelled as part of the Environmental Assessment.

The effects of the ore and concentrate haul roads on surface hydrology results from road ditching. Ditches on side hill portions of roads serve to intercept surface runoff and direct it to a concentration point, usually a natural drainage point that crosses the road corridor through a culvert. The end result is small, localized increases in surface flows at each culvert passage. Proper management of road ditching with regular culvert passages to direct surface runoff through the road corridor mitigates these effects. Surface runoff concentration is managed so as not to result in any secondary or indirect effects to other environmental compartments. Road construction and maintenance for the Finlayson Project will be properly managed and effects to surface hydrology will be mitigated.

The distribution and volume of the annual streamflow is a very important component in ecosystems. Effects on streamflow characteristics can be expected to have secondary effects on several different components of the local ecosystem. The potential secondary effects resulting from changes to the local surface hydrology will be identified and qualitatively described as part of the Environmental Assessment.

4.5.6 Surface Water Quality

The Kudz Ze Kayah IEE and Water Licence Applications contained a very detailed analysis of effects to downstream water quality. The effects to surface water quality from the Finlayson Project are not expected to be largely different than those predicted for Kudz Ze Kayah. However, the water quality models developed in the Kudz Ze Kayah Water Licence Application will have to be modified to account for small modifications to the Kudz Ze Kayah operating plans and for the addition of Wolverine ores to the process. Therefore, the results summarized below provide some indication of water quality effects but will be updated in the Finlayson Project Environmental Assessment.

The minimum and maximum predicted metals concentrations in Geona Creek at the mouth, in Finlayson Creek downstream of Geona Creek, and in Finlayson Creek downstream of East Creek are summarized in Table 4.2. The minimum concentrations correspond to monthly average concentrations in October after decant ceases while maximum concentrations generally correspond to monthly average concentrations in August (summer low flow during decant).

Sensitivity analysis of the water quality model was conducted using a series of extreme or worst case assumptions for various components of the model. The following worst case scenarios were modelled:

- higher seepage rates through the tailings dam;
- poorer tailings supernatant quality leaving the mill;
- poorer mine water treatment plant effluent quality;
- poorer WPAG dump runoff quality;
- unsuccessful tailings impoundment decant treatment; and
- poorer background water quality.

Table 4.3 presents a listing of the parameters that are exceeded in Geona Creek and Finlayson Creek downstream of Geona in response to different model assumptions. The copper and selenium concentrations in Geona Creek are the only metals that are predicted to exceed the CCREM guidelines under all scenarios modelled. Under certain worst case conditions, failure of polishing treatment and worst case tailing effluent, the zinc concentration could also exceed the CCREM guideline during certain periods. With the exception of selenium, these exceedances are intermittent and fairly minor.

4.5.7 Aquatic Resources

Effects on aquatic resources from the Finlayson Project will occur almost entirely as a result of the Kudz Ze Kayah Operation. The Wolverine underground operation will likely not require the disturbance of fish habitat. The infrastructure and facilities proposed for this operation are relatively small scale and their location is somewhat flexible. The only potential effects to aquatic resources will be secondary effects resulting from small changes in water quality and hydrologic regime due to discharge from the water treatment plant. The potential effects of these discharges will be qualitatively described in the Environmental Assessment of the Finlayson Project. The ore haul route has potential for minor effects to fish habitat as a result of stream crossings. These effects will be described in more detail in the Environmental Assessment of the Finlayson Project, when the exact location of the ore haul route is better understood.

The assessment of the effects of the Kudz Ze Kayah Project on aquatic resources is summarized below. A fish habitat compensation agreement was reached with the Department of Fisheries and Oceans (See Appendix 1A) to offset the effects to fisheries outlined below.

4.5.7.1 Habitat Alteration and Loss

The proposed mine development would displace a total of 4 km of upper Geona Creek, including 2-3 beaver ponds and the creek downstream to the location of the tailings impoundment structure. This unavoidable and unmitigable loss of fish production will be offset through a habitat compensation plan (see Appendix 1A) that will provide increased fish production in nearby water bodies. The expected increase in fish production from the proposed habitat compensation plan will more than offset the predicted losses of production in the project area.

The diversion of Fault Creek into South Creek may cause water levels in the headwater lakes and mainstem South Creek to increase. The diversion is expected to provide a net increase in habitat, especially for spawning, in lower Fault Creek and in the lakes and creek downstream.

After mine closure, some regeneration of the habitat lost in Geona Creek is expected to occur. The reach of Geona Creek below the tailings embankment is expected to recover to its pre-mine condition. The tailings embankment and spillway will present a impassable barrier thus preventing fish from moving to the upper reaches of Geona Creek. The fisheries compensation agreement has considered the opportunity to introduce fish into the tailings impoundment after closure but this can not occur until the water quality in the impoundment lake improves significantly. If a fish population is introduced, they will be essentially captive in the tailings area.

4.5.7.2 Potential Effects of Predicted Stream Water Quality

As mentioned in the section on water quality models, minor modifications in project development plans and the inclusion of the Wolverine ore in the process will require that the water quality models be updated for the Finlayson Project Environmental Assessment. The effects of water quality changes on aquatic life will also need to be re-evaluated based on the findings of the updated models.

There is some potential for water quality degradation in Geona Creek downstream of the operation that could affect aquatic resources. Although some parameters in Finlayson Creek may occasionally exceed the CCREM guideline for the protection of aquatic life, these conditions are unlikely to have any adverse effects on aquatic resources. The water entering the receiving environment from the tailings impoundment will be monitored over the life of the project and for a period of time after closure. The impoundment discharge will be managed to minimize metal levels in the receiving environment and to minimize the impacts on the aquatic resources.

Based on the water quality modelling, the concentrations of copper, selenium and zinc in the mainstem creeks below the project site were predicted to be near, or in exceedance of, the CCREM guidelines, which were developed to protect the most sensitive life stage(s) of the most sensitive aquatic species in Canada. The metal toxicities are affected by the water hardness with metal toxicity typically lower in harder water. The water in the project area is moderately hard to hard (100 to >300 mg/L CaCO₃) and therefore toxicity must be considered in this context. The only species that occur in Geona and Finlayson Creeks are Arctic grayling and Slimy sculpin. Arctic grayling is likely more sensitive to metals than the sculpin and is thus the focal point of the discussions.

Copper

The predicted normal range of copper concentrations during operations are 0.8 to 2.2 µg/L and the worst case is 5.7 µg/L. After closure, the normal range will be from 0.8 to 2.0 µg/L, and the worst case value will be 3.1 µg/L.

Copper concentrations below the project site will fluctuate slightly by season relative to the ratio of streamflow to the volume of tailings decant and/or seepage. The worst case predicted copper concentration of 5.7 µg/L in Finlayson Creek is at least an order of magnitude below copper concentrations that can be acutely lethal to salmonid fish in fresh water with a hardness equivalency of that creek.

Selenium

Threshold concentrations of selenium that can adversely affect the growth and long-term survival of early life stages of salmonid fish are reportedly within the range of 50 to 70 µg/L (Goettl and Davies, 1976; Hodson *et al.*, 1980; Hamilton *et al.*, 1987). The expected

maximum mean monthly concentrations in Finlayson Creek during operations and following closure are predicted to be appreciably lower than this threshold-effects range.

Based on a model developed by Van Derveer and Canton (1997), a site-specific water quality objective of 3.8 µg/L was assessed for Finlayson Creek. This objective is estimated to represent the longterm chronic toxicity level of selenium based on sediment conditions in the creek.

Since the normal range of selenium concentrations during operation is 0.5 to 2.3 µg/L, it is predicted that no chronic toxicity will occur. Although the worst case selenium concentration during operations is predicted to be 6.7 µg/L, chronic toxicity is not probable because of the relatively short time frame of such exceedances.

Zinc

The predicted normal range of zinc concentrations during operations are 10 to 17 µg/L, and the worst case is 36 µg/L. The predicted normal ranges of zinc concentrations in Finlayson Creek below Geona Creek are below the CCREM guideline (30 µg/L) both during operation and after closure. No chronic, sublethal toxicity effects are predicted as a result of zinc concentrations in Finlayson Creek.

Other Metals

Concentrations of other metals/metalloids (arsenic, cadmium and mercury) were not modelled as geochemical testing indicated that they would not leach significantly from waste rock and their concentrations in tailings supernatant would be negligible. Therefore, concentrations of these metals in receiving waters are not expected to increase due to mine activities, and they will not have any impacts on aquatic resources.

Combined Effects

The predicted maximum concentrations of copper, selenium and zinc will occur during low flows. Under these circumstances there is some potential for sublethal toxicity from the combined effects of copper and zinc. In mixtures of copper and zinc, the toxic effects of the individual components can be additive or, in some cases, more than additive (Taylor and DeMayo 1980).

However, in tests using Arctic grayling, Buhl and Hamilton (1990) demonstrated that the combined effects of copper, zinc, lead and arsenic were less than additive, and the toxicity of the mixture was similar to that of copper. Similarly, the combined toxicities of copper, zinc, and lead in the Kayah Ze Kayah effluent may, similarly, be less than additive. Thus, the potential for significant adverse effects from the combination of metals is small.

4.5.7.3 Effects on Fish Stocks

The primary environmental impact of the proposed project will be the direct loss of fish habitat in upper Geona Creek. This potential impact will be offset by the proposed compensation plan in which the fish in upper Geona Creek will be live-transported to other lakes that are now barren of fish. It is expected that the compensation plan will more than offset the direct losses of habitat area and fish production in upper Geona Creek.

The proposed compensation plan and the careful control of the sports fishery, will minimize any significant adverse impact on fisheries resources as a result of direct habitat loss or overfishing.

The alteration of the water quality in the creeks below the Kudz Ze Kayah project has some potential to impact the fisheries resources utilizing those waters. Geona Creek below the tailings impoundment was found to have limited fish habitat and no fish were found during extensive electrofishing and trapping in both the spring and the fall. Finlayson Creek, on the other hand, has numerous areas of potential habitat and contains some adult Arctic grayling. The individual metals concentrations indicate no long-term adverse impact on the fisheries resources in Finlayson Creek. However, the additive effect of a number of contaminants at sublethal concentrations might prove stressful to the more sensitive life stages of salmonid fish. No significant adverse impacts on the Finlayson River system below the confluence of Finlayson Creek are predicted. There would be no direct effect on water quality or fish in Finlayson Lake, as the lake is upstream of Finlayson Creek in the Finlayson River system.

Measures to detect the occurrence of an adverse effect on fish stocks downstream of the Kudz Ze Kayah project will be implemented as part of the monitoring program and will include:

- water quality sampling during and after mine life;
- fish presence/absence sampling in Finlayson Creek;
- benthic invertebrate sampling to establish numbers, taxa and distribution;
- fish health assessment using an accepted Health Assessment Index (Adams et al. 1993) to evaluate fish condition;
- habitat surveys, including benthic and/or drift sampling to determine relative productivity of fish food sources; and,
- fish tissue sampling using sculpins only.

If the above indicators show a potential impact on the aquatic habitat, additional studies would be implemented.

4.5.8 Vegetation

Direct effects to vegetation were not considered as part of the Kudz Ze Kayah Environmental Assessment process. The effects to vegetation were considered as part of the assessment on effects to wildlife and wildlife habitat. For the Finlayson Project Environmental Assessment, effects to vegetation will be quantified according to the various vegetation associations identified in the project area. Direct effects to vegetation are not likely to be serious since no rare or endangered plants have been identified and the extent of vegetation disturbance is very small. The secondary effects of vegetation disturbance on wildlife and wildlife habitat are described in the Kudz Ze Kayah Water Licence Application (see below).

Vegetation disturbance is largely temporary. Only the areas of the open pit and tailings facility will be permanently altered in terms of vegetation cover. Contemporaneous reclamation of disturbed areas throughout the operating life of the mine and a full reclamation of the site after mine closure will ensure that effects to vegetation are minimized to the extent possible.

4.5.9 Wildlife

Protection of wildlife has been identified as a primary concern in regard to the Finlayson Kayah project. Project facilities and activities have the potential to affect wildlife in several ways; increased hunting pressure, loss of habitat, and disturbances from operation and transportation activities.

Effects to wildlife were assessed in detail for the Kudz Ze Kayah Project. Many of the conclusions of this assessment and the proposed mitigations apply equally to the Wolverine operations and the Finlayson Project as a whole. The detailed assessment for the Kudz Ze Kayah operations is presented below. There are no changes in the development plan for the Kudz Ze Kayah operations that could potentially effect the findings of this assessment.

4.5.9.1 Kudz Ze Kayah

The loss and disruption of habitat resulting from the installation of mine facilities and access corridors is another concern. The amount of wildlife habitat affected by the facilities and infrastructure associated with the Kudz Ze Kayah operations are summarized in Table 4.4³. The total area of habitat directly affected by the mine site is approximately 300 ha. Most of the habitat affected at the mine site are shrub types (83%) which is potential caribou and moose summer/fall habitat. The access road will affect a total of 42.6 ha of forest (46%) and shrub (54%) habitat types; the forest habitat types (mostly black spruce and sub-alpine fir) are potential winter habitat for caribou and moose. The airstrip will be located in Open Canopy Black Spruce forest, which is also potential winter habitat for caribou and moose. No unique or especially important habitat types were identified during the vegetation survey. All of the habitat types encountered were typical of the region.

Animal disturbances due to noise and the presence of men and equipment has the potential to affect animal migration and movement between ranges.

The following sections deal with the potential impacts of the project on wildlife species in the area, with emphasis on caribou and moose. Mitigation measures, developed in consultation with YTG Renewable Resources' biologists and the Ross River Dena, will minimize potential impacts.

Caribou

Access Effects

Increased access to the traditional range of the Finlayson caribou herd, especially along their migration route to winter range, has been identified as the primary concern by YTG Renewable Resources and the Ross River Dena. Access control has already been implemented along the tote road by restricting access. A security station will be maintained near the junction with the Robert Campbell Highway and only authorized vehicles will be allowed on the road. Firearms will be strictly forbidden on site and on the road.

Restricted access along the road will minimize the potential for increased harvest of caribou.

Habitat Effects

Development of the project will remove approximately 300 ha of summer range at the mine site, of which approximately 210 ha of valley bottom habitat will be removed from productive caribou summer habitat in the long term, while the remaining 90 ha can be restored to useful habitat after decommissioning. This long term reduction of 210 ha of caribou summer range is less than 0.2% of the area of their range, and is therefore not

³ Wildlife habitat affected by the Wolverine operations and ore haul route will be similarly quantified as part of the Finlayson Project Environmental Assessment.

considered to be significant from a regional perspective. No unique or especially important habitat types were identified during the vegetation survey. All of the habitat types encountered are typical of the region. Since the habitat that will be impacted is typical and widely distributed in the region, a long-term reduction of the order proposed is not predicted to have an environmental effect.

Caribou depend on sub-alpine basins and ridges for calving and on high ridges and plateaus for rutting. Most calving activity occurs outside of the project area and habitat on rutting ranges adjacent to the development area will not be affected by the project. The project will, therefore, have little impact on habitats that are critical to caribou reproductive activities.

The 42.6 ha of boreal forest habitat along the access road and 22 ha at the airstrip represent a small area of winter range compared to the expanse of similar habitat in adjacent areas. Habitat removed by the road and airstrip during operation of the mine is not expected to result in any significant impact on the Finlayson caribou herd. After decommissioning, this habitat will return through natural succession to productive winter range.

Disturbance Effects

Disturbance to sensitive calving, post-calving, and rutting caribou has the potential to affect the welfare of the Finlayson caribou herd.

The project is not expected to interfere with movements of caribou between their winter range in the Pelly River lowlands and their calving, summer and rutting ranges. The mine site will be relatively compact and mining activity restricted to the upper Geona Creek valley. The mine site will not constitute a physical barrier to movements of caribou in the Geona Creek valley. Caribou may stay out of the immediate mine site area but it is unlikely that more than the immediate mine site area would be alienated for caribou during construction and operation of the mine.

Information from 1995 surveys and from previous YTG radio-collar location surveys suggests that relatively little calving takes place in the project area. The main calving and post-calving aggregation areas are to the south of the project area, therefore, interference with these activities from the project is not likely to be significant.

Movements to rutting ranges on adjacent uplands (mostly to the west of the mine site) start by early September and the rut is well underway by early October. Caribou disperse after the rut and inhabit the uplands and lower slopes into mid-November. During these times, caribou occur in varying numbers in the vicinity of the mine site.

Noise from blasting (which will occur on average three times per week during mining) may well travel a considerable distance and will be heard in the adjacent uplands. The actual effect of blasting on caribou during the rut is difficult to predict. The main shock of the blast will dissipate by the time it reaches the rutting areas, and only the diminished noise of the blast should reach caribou on the adjacent ridges and plateaus.

Mining activities other than blasting also have a potential to cause impacts on caribou rutting. Given the distance between the mine site and the rutting areas on the uplands nearby (approximately 2.5 km), the majority of development and mining related activity (truck traffic, machinery, heavy equipment operation, and camp/office operation) should not interfere with caribou movements or rutting activity.

Available data suggest that relatively little caribou calving takes place within this distance from the Kudz Ze Kayah project area.

Reaction of caribou on the calving and rutting areas will be monitored for the first few years of mining activity. Information from this program will provide on-site data that can be used to evaluate the impact.

In the area of the airstrip, there is a potential for disruption of movements of caribou which move from the north and cross Finlayson Lake to rutting grounds south of the Robert Campbell Highway. Normal aircraft flight paths for personnel movement would not be close to the caribou calving areas, thus no avoidance periods are considered necessary. However, the small aircraft involved (10-15 passenger size) should have enough manoeuvrability to avoid flying over caribou swimming the lake, thereby significantly reducing the potential for impact.

Road Traffic Effects

The potential for increased caribou mortality and disturbance to traditional range use have been identified as concerns by YTG and Ross River Dena. These aspects are discussed separately for the access road and Robert Campbell Highway.

Access Road

Vehicle and truck traffic along the access road have the potential to affect caribou through collisions and interference with movements of caribou between their seasonal ranges. Measures to reduce the potential for collisions will include:

- driver education;
- setting and enforcing speed restrictions during the migration periods;
- posting warning signs at locations with the greatest potential for animal collisions;
- reporting animal locations by radio to the security gate and other drivers; and,
- adjusting speed and frequency of traffic during particularly high risk periods.

A discussion of driver training and truck operating procedures is presented in the Kudz Ze Kayah Water Licence Application (Section 6.2).

Traffic along the access road has the potential to disrupt caribou migrations from their post-rutting range to their winter range. Monitoring of the access road during the mid-November/early January and April/May periods is the key to providing site specific data for managing this potential impact.

Robert Campbell Highway

Hauling concentrate along the Robert Campbell Highway during the winter has been identified as a concern by YTG Renewable Resources. The increase in heavy truck traffic has the potential to affect caribou on their winter range through direct mortality and through disturbance.

Hauling along the highway between the access road and the Ross River area will increase the risk of animal-vehicle collisions. Measures to reduce the potential impact related to traffic will be the same as those proposed for the mine access road.

Monitoring of the highway during the mid-November to mid-May period is the key to providing site specific data for managing this potential impact.

If concentrate is hauled south to Watson Lake, potential effects on caribou are expected to be minimal as historical information indicates that caribou are not common along this portion of the Robert Campbell Highway.

Moose

The mine site and mine road should have little impact on moose activities because of the very small areas of site disturbance involved (300 ha mine site and 42.6 ha access road), and control of traffic on the road. The noted key habitats will continue to be available and productive. No specific mitigation measures for moose habitat directly affected by the development are considered necessary.

Access Effects

Increased access has been identified by YTG as a concern for local and regional moose populations. This potential impact can be managed by controlling access, as outlined above for caribou.

Habitat Effects

Direct habitat loss is expected to have a minimal impact on moose. The area comprising the mine site provides spring, summer and fall habitat for moose. As with the caribou habitat, the removal of this small amount of moose range in the mine area is not expected to be significant.

The planned borrow areas are mainly within the footprint of the proposed development area. The wildlife habitat at this area is willow and birch shrub units on well drained soils. These habitat types are the most pervasive types in the general area and the effects on wildlife are therefore expected to be minimal. Furthermore, the borrow areas will be progressively re-contoured and re-vegetated during development and operation, thus returning the area to wildlife habitat in the short term.

The small amount of boreal forest habitat removed for the access road and airstrip during operation of the mine will not have a significant impact on the regional moose population. These habitats will readily return to suitable moose habitat after decommissioning. Reclamation activities will include re-grading and seeding/planting. Natural regeneration is expected to return these disturbed sites to productive moose habitat within 10 years after decommissioning.

Disturbance Effects

A potential exists for alienation of moose from habitat in the upper Geona Creek valley as a result of construction and mining activities. Moose may react by staying out of the mine site and immediately adjacent area, however, moose will still be able to travel through the Geona Creek valley to access the upper sub-alpine basins, which are used during the rut and post-rut. The lower portions of these sub-alpine basins and the lower valley slopes are used by moose for calving and will also still be accessible to moose travelling through or inhabiting the Geona Creek valley.

Moose movements are expected along the bottom and lower slopes of Geona Creek valley. The mine site however is not expected to create a complete barrier to migration either during or after mining. The mine site is relatively small and compact and large

mammals will be readily able to move around the mine site features. It has been shown that large mammals adapt very quickly to the presence of industrial activity and readily move through and around a mine site (e.g. Echo Bay's Lupin Mine, Cominco's Red Dog Mine).

Road Traffic Effects

Mortality from collisions with vehicles along the access road and the Robert Campbell Highway has a potential to impact the regional moose population. Measures to mitigate and manage this potential impact on moose are the same as those outlined above for caribou.

Wildlife logs will be kept throughout the operating period and will be reviewed annually by YTG Renewable Resources as requested. Although this is not considered a scientific monitoring program, the results can be used to indicate presence and therefore, to a certain extent, displacement and disturbance.

Bears

The reduction of habitat at the mine site, access road and airstrip should not significantly affect the regional grizzly bear population. Based on home range size in other parts of the Yukon (26 km² in south-western Yukon, Pearson 1975), the actual amount of habitat affected for the period of operation would not affect more than 12% of the home range of one or possibly two grizzlies, and likely a much smaller percentage. The habitat types affected by the project are common in the region.

Removal of a small amount of boreal forest along the access road and airstrip is not expected to have a significant impact on black bears.

Access control will minimize the potential for increased hunting pressure on both black bears and grizzly bears.

The potential for direct mortality of bears through encounters with construction and mine site workers will be reduced through implementation of the following practices:

- recording of all bear sightings;
- warning signs posted and information circulated for workers in the event that bears are regularly observed near the camp and mine site; and
- containment of food wastes in suitable, bear proof containers, daily incineration of food wastes and hauling of residue to a land fill.

Persistent bear problems will be reported to YTG Renewable Resources and any bear control will be dealt with by them.

Wolves

Wolves are a significant component of the wildlife resources of the region. Habitat reduction during life of the project is not significant to wolves, which travel large areas in pursuit of prey. Disturbance associated with the project is likely to keep wolves away from the immediate mine area and result in a loss of hunting terrain during the life of the project. Mitigation for this short term loss of habitat for wolves is not considered necessary. Reclamation and natural succession after decommissioning will return much of project related facilities to suitable hunting terrain for wolves. The long term reduction of habitat at the mine site in upper Geona Creek is not expected to have a significant impact on the regional wolf population.

The presence of the access road is likely to result in a minor positive impact for wolves that will take advantage of the road for movement, however, fatalities from collisions with vehicles could result.

Overall, impacts on the regional wolf population are not expected to be significant. Wolves will still be able to travel through the project area, between the boreal forest to the north and the uplands and valleys to the south.

Smaller Carnivores and Furbearers

Impacts on smaller carnivores and furbearers are related to reduction in available habitat. The access road and airstrip will remove a small amount of boreal forest habitat that is used by upland furbearers (e.g., foxes, marten, weasel). The areas involved will readily return to productive habitat once they are decommissioned and natural succession occurs.

The mine site area provides some habitat for beavers (small ponds on upper Geona Creek) and these particular habitats will be lost in the long term. Mitigation for this loss is not considered necessary, given that the present habitat is marginal for beaver.

Birds

The most significant bird species that rely on the mine site area for habitat is ptarmigan. In terms of direct habitat removal, the mine development will affect willow ptarmigan that breed in the willow, birch and mixed shrub units in the upper Geona Creek valley bottom. Densities of breeding willow ptarmigan can vary widely, ranging from 4-5 pairs/km² in low years to 25-30 pairs/km² in high years. Assuming the upper density figure (30 pairs/km²), the maximum number of willow ptarmigan potentially displaced during mine operation (covering an area of 3.0 km²) is estimated at 90 pairs. The amount of habitat lost in the long term, will result in a potential reduction in breeding habitat for a maximum of 60 pairs of willow ptarmigan.

Small numbers of migrating waterfowl (diving ducks) and shorebirds will be displaced from the small ponds that lie within the mine site. Displacement will be short term as the tailings impoundment and open pit will provide permanent water bodies that will replace existing small ponds. Some loss of habitat potential will still occur as the pit will not have a naturally vegetated, shallow shoreline.

Impacts to raptors (mostly golden eagles and gyr falcon) are not expected to be significant. The short term reduction of hunting terrain is not likely to impact local or regional populations of these two species. Breeding by either species has not been documented in the vicinity of the upper Geona Creek valley. No nest sites were observed during aerial surveys and no family groups were observed in the area during ground work or overflights.

The Tintina Trench is a major migration corridor of continental significance for very large numbers of migrating ducks, geese, swans and sandhill cranes. Increased traffic due to commuter flights to the airstrip will increase the risk of bird strikes. Bird strikes could have serious consequences for aircraft and occupants. This impact potential will be mitigated by restricting flights during periods of poor visibility during migration periods.

4.5.9.2 Wolverine Operations and Ore Haul Route

Effects to wildlife as a result of the underground operations at Wolverine are expected to be slight. The total footprint of the infrastructure associated with the operation is very small and the amount of surface activity will also be very low. Consequently, effects to habitat and effects related to animal avoidance and disturbance will be very low. The extent of habitat disturbance as a result of the Wolverine operations will be quantified in the Finlayson Project Environmental Assessment.

The potential effects associated with the ore haul route are the same as those mentioned for the access road and the Robert Campbell Highway, namely vehicle-wildlife collisions, disturbance and avoidance as a result of traffic, and increased access for hunters. The mitigations proposed will also apply to the Finlayson Project ore haul route including restricted access, regular monitoring, regulation of road traffic to minimize disturbance, road travel rules, driver training, and road decommissioning and reclamation on closure.

The habitat potential and wildlife values associated with the ore haul route alternatives will be considered during the assessment and selection of the final route. The Finlayson Project Environmental Assessment will include this assessment as part of the assessment of alternative means of carrying out the project.

4.5.10 Socioeconomic Conditions

The assessment of the Kudz Ze Kayah Project included a detailed analysis of the potential socioeconomic effects associated with the project. Effects to socioeconomic conditions cannot be considered to occur as a result of any particular project component. Socioeconomic effects result from the development and operation of the project as a whole. The socioeconomic effects of the Finlayson Project will be similar to those described for the Kudz Ze Kayah Project. The addition of the underground operations at Wolverine will not significantly change the assessment of socioeconomic effects.

The assessment of socioeconomic effects from the Kudz Ze Kayah Water Licence Application is presented below.

The potential for socioeconomic impacts are influenced by:

- the relatively remote location of the mine; and,
- commitments made to maximize local benefits and minimize impacts on communities and existing land uses.

The socioeconomic impacts that arise from potential environmental impacts have been identified in the Kudz Ze Kayah Water Licence Application and IEE. The socioeconomic objectives established in relation to these impacts are:

- Minimize the land area affected, thus minimizing the disturbance of wildlife habitat;

- Control the access to the area and implement a 'no-hunting' policy by employees to minimize the increased hunting pressure on the Finlayson caribou herd;
- Minimize the vehicle traffic thus minimizing the interference with wildlife migration paths;
- Implement a no fishing policy to prevent over-fishing;
- Work with the Ross River Kaska Dena and local outfitters to ensure the long-term conservation of the hunting, fishing, trapping and guiding base in the area;
- Utilize existing infrastructure compatible with current use and long term development plans; and,
- Employment of the mine workforce from local communities including Ross River, Watson Lake and Whitehorse thus maximizing local employment opportunities. Transportation will be provided to and from the planned airstrip.

Specific commitments made to minimize impacts include the following:

- The socioeconomic Participation Agreement between the Ross River Dena Development Corporation and Cominco Ltd. is intended to maximize local job and procurement benefits while minimizing the impact on the environment. Expatriate Resources has assumed this agreement and is negotiating a second agreement to cover the Wolverine operations.
- The mine workforce will be flown to an airstrip to be constructed near the Robert Campbell Highway, thus drawing on mainly local residents from Whitehorse, Watson Lake and Ross River.
- The mine access road from the Robert Campbell Highway will be a private, controlled road. Employees will not be allowed to drive their vehicles on the access road, and will travel to the mine site by bus from the airstrip. Personal use of vehicles for commuting will be discouraged.
- A policy of no guns in camp and no hunting by employees in the immediate project area will be implemented. The no hunting policy on the property will be in effect for all employees whether on duty or not. In addition, the access policy will control the access of vehicles, including off-duty employees, thus eliminating direct access to the area for hunting. In addition, personal use of all terrain vehicles (ATV's) for access around the mine area, that could disturb wildlife or lead to overfishing in North Lakes, will be prohibited.
- On completion of mining and mine closure, the access road will be removed and obstructions put in place to deter vehicle access.

The project has substantial potential to provide positive long term impacts on employment, income, training and education for local communities and throughout the Yukon.

Assessed impacts and mitigation measures, where appropriate, are discussed in the following sections for community issues, transportation, land use, and heritage resources.

4.5.10.1 Community Issues

Impacts on communities are expected to be mainly positive through increased employment income and through providing or receiving services. The potentially negative impacts include creating a shortage of housing, overcrowded schools, and a need for up-grading water and sewer systems. Indirect impacts may include community disruption by bringing in outsiders to a small community, or social problems such as alcohol or substance abuse.

The project is not expected to exert significant impacts on existing community infrastructures as employees will come from several communities. The indirect effects on

Ross River are addressed by Cominco's participation agreement with the Ross River Dena. At the request of the Ross River Dena, Expatriate hopes to extend the benefits of the Kudz Ze Kayah socioeconomic Participation Agreement and community relations policies to the Kaska Nation at large. Expatriate is in the process of negotiating a socioeconomic Agreement with the Kaska Nation to cover the operations at Wolverine.

Ross River

Ross River is the closest community and will receive benefits from mine development as set out in the socioeconomic Participation Agreement. Employment preference will be given to Ross River residents and members of the Kaska Nation. However, the need for highly skilled labour for many functions will require recruitment from outside the region. The agreement also provides for specific contracting opportunities to be made available to the Ross River Kaska Dena as well as training.

The population of Ross River is approximately 86% Ross River Kaska Dena. Through the socioeconomic Participation Agreement, the community will see significant economic benefits with project development.

Potential for negative impacts on Ross River could result from:

- an influx of new residents to Ross River;
- social-disruption from personnel during construction activities; and
- expansion of transportation and communications systems to support mine development.

The potential for an influx of new residents to Ross River for mine employment will be minimized by the limited availability of houses and land. The Ross River Dena Council will oppose efforts to increase community population. In addition, the fly-in/fly-out policy will not provide any incentives for the workforce to locate in Ross River in preference to Watson Lake or Whitehorse. The latter communities offer more services and will likely be favoured by most employees.

Some growth in services to support the Finlayson Project may occur, although the growth will likely not be significant. Existing services should see some economic benefits, but locating new service facilities in Ross River will not be promoted by mine operator without agreement with the Ross River Dena.

The potential for impacts on Ross River from construction crews, similar to that experienced during construction of the Anvil Mine, will be significantly reduced. The construction workforce will be flown in to the airstrip and housed in camp facilities on site. Private vehicles will be prohibited on the mine access road. The construction workforce will likely work a 7 day week. The 6 hour return drive to Ross River would deter visits, and will be discouraged by the mine operator.

It is not anticipated that the trucking will impact Ross River in a significant way as the trucks will not pass through the community. The northern truck route passes approximately 10 km from Ross River and it is not anticipated that it will become a service centre.

Whitehorse

Whitehorse will likely see the greatest positive impact. It is expected that the majority of the workforce will reside in Whitehorse, and many services will be procured from Whitehorse. It cannot be estimated very precisely what percent of the mine workforce

will reside in Whitehorse, but it will likely be more than 60%. This would constitute about 1.1% of the total Yukon workforce (the unemployed total in 1999 was 13.1%). Some of the employees will likely be new residents moving to the Yukon to fill certain skilled job requirements at the mine. The number of new residents is hard to estimate. Given the present level of mining activity in the Yukon, there should be an adequate workforce of trained personnel in the territory.

Watson Lake

Watson Lake will potentially benefit from mine development by employment at the mine and by transportation of concentrates. If the concentrates are hauled on the southern route past Watson Lake, the majority of the 50 person workforce for hauling and truck maintenance are expected to reside in the Watson Lake area.

Watson Lake, with a population of 1,665 as of September, 2000 and a housing vacancy rate of 14%, is expected to be able to absorb any new in-migration workforce.

4.5.10.2 Work Force

The mine operation will require about 252 people in direct employment. This does not consider contracting opportunities are the mine operations which will include:

- trucking and shipping;
- fuels and lubricant supplier;
- reagents supplier;
- gravel and borrow material contracts;
- catering;
- explosives;
- road maintenance; and
- communications and office equipment and supplies.

To account for these employment opportunities and the secondary jobs that will be generated as a result, a multiplier of 7 can be applied to the direct employment estimate. The estimated total number of jobs (direct and indirect) that would be generated by the Finlayson Project is 1,764.

4.5.10.3 Transportation

Air Transport

It is proposed to construct a new airstrip at the junction of the mine access road and the Robert Campbell Highway. This airstrip will be used by the twin engine commuter aeroplanes moving mine employees in and out of Whitehorse, Watson Lake and maybe Ross River. The operation of this airstrip is not expected to have a significant impact on wildlife. Flight paths will be selected to avoid wildlife calving and rutting areas during sensitive life cycle periods. These sensitive areas and time periods have been identified through field surveys and from YTG data. Flight paths and altitude, with appropriate avoidance windows, will be established.

It should be emphasized that during the mine operating period, most flying activity will be with fixed wing aircraft. Helicopters will likely only be used to carry out environmental sampling and wildlife surveys. Exploration activities carried out in the region will likely continue to use helicopter support but it is impossible to predict how much or when this might occur.

It should also be noted that aerial wildlife surveys themselves have the potential to result in disturbance to wildlife and therefore can result in an adverse impact. As such, additional annual surveys will be kept to the minimum necessary and prudent.

The airstrip is located on the eastern margin of the Tintina Trench which is a migration route for several varieties of large waterfowl. During the migration period, the charter airline would implement procedures to reduce collisions with birds, such as restricting flights in periods of poor visibility.

Transport of personnel by air will minimize road traffic on the Robert Campbell Highway. This airstrip will also provide a better alternative for emergency landings and for medivacs than the current Finlayson Lake strip.

Road Transport

Truck transportation of concentrates and supplies will result in increased traffic on Yukon highways. Impacts may include slowing traffic movement, increasing the potential for accidents, increased noise in communities along the highways and collisions with wildlife. However, these transportation requirements will also provide additional employment for the Yukon (estimated 50 jobs) and a need for additional services along the trucking route.

The project transportation requirements will result in a minimal percentage increase in load on the Alaska and Klondike Highways. The resulting traffic volume will remain within the design parameters for both these highways. The Robert Campbell Highway from the Faro junction to the Klondike highway junction, at Carmacks has previously been upgraded and will also remain well within the design parameters.

Concentrate Haul

Concentrate haulage constitutes the major proportion of the trucking requirements. The impacts of the increased truck transportation due to concentrate haulage may be mitigated by contracting with a qualified trucking firm that will:

- Use only experienced, professional drivers;
- Equip all trucks with two-way radio communications; and,
- Implement design, safety and operating procedures proven by similar trucking systems utilized in the Yukon.

The increase in traffic load on the Robert Campbell Highway between the site and either Ross River or Watson Lake will be more noticeable during the winter. Unless road upgrades on this section of the Robert Campbell Highway are completed, additional speed restrictions and/or more restrictive operating procedures will be considered. The above mitigation measures would also apply.

Road Upgrading

Truck transportation of concentrate and supplies on the Robert Campbell highway, either north or south from the site, could result in upgrading sections of the road. Potential land use impacts could result from this upgrading. Upgrading of the Robert Campbell Highway, while beneficial to the Finlayson Project is not an essential ancillary component of the project. This has been confirmed during review of the Kudz Ze Kayah Project through consultation with the YTG Department of Community and Transportation Services.

Consequently, potential affects associated with the upgrading are not within the scope of this review.

During the review process for the Kudz Ze Kayah Project, the YTG Department of Community and Transportation Services reviewed the requirements for road upgrading, including estimates of construction requirements and the schedule.

4.5.11 Heritage Resources

During assessment of the Kudz Ze Kayah project, traditional ecological knowledge (TEK) was incorporated by having the Ross River Dena involved with many aspects of the work. Meetings and discussions with the Ross River Dena began in 1994. These meetings and discussions, whether individually or in groups, often included elders, Chief and Council, various band members and members of the local environmental committee.

During the early stages of the project, elders and others participated at public meetings and identified their major concerns which included:

- The Finlayson Caribou Herd.
- Grave site locations.
- Caribou fence sites.
- Water Resources and water quality.
- The North Lakes area.
- Cross-cultural understanding of mine employees.
- The Group Trapline.
- Community issues, including lack of jobs, training, a future for their young people and the implementation of a community based drug/alcohol counselling/treatment program.

The project proponent at the time (Cominco) addressed the project related issues through measures including:

- A no gun and no hunting policy for mine employees.
- Archaeological assessment of the area to locate grave sites and caribou fence locations, along with other heritage resources. This assessment included oral interviews with elders. No heritage resources were found in the project area.
- The project has avoided use of the North Lakes area (potential tailings site) and Cominco proposed a no fishing policy for mine employees.
- A trial cross-cultural training program was developed and undertaken by the Ross River Dena in 1995.
- Any interruption to trapping in the area has been addressed in the socioeconomic agreement.

During the assessment period, the project provided a positive effect on community issues:

- There was increased employment, either directly through involvement with Cominco's exploration program or through contracting of work such as line cutting and road clearing.
- The exploration camp was operated as a "dry" camp.
- Enrolment at Yukon College courses increased dramatically during this period.

- Assistance was provided by Cominco to the “Community Treatment Program”

The protection of the Finlayson Caribou Herd was the main focus of the Ross River Dena throughout the project studies. Band members were involved in the design of wildlife monitoring programs with YTG Renewable Resources personnel and Cominco’s consultants. They also participated in the caribou and moose surveys.

As the current operator of the Kudz Ze Kayah Project, Expatriate Resources hopes to continue the beneficial relationship with the community established by Cominco in previous years. Expatriate will continue the policies established by Cominco in their relationship with the community. Furthermore, Expatriate hopes to extend the benefits of the Kudz Ze Kayah socioeconomic Participation Agreement and community relations policies to the Kaska Nation at large. Expatriate is in the process of negotiating a socioeconomic Agreement with the Kaska Nation to cover the operations at Wolverine.

Westmin commissioned a study of heritage and archaeological resources in the vicinity of the Wolverine operations during their time as operator of the project. The findings of this assessment are presented in this report. Further study and consultation may be required for the selected ore haul route.

4.5.12 Land Use

Subsistence hunting and trapping will be affected by project development. A group trapline managed by the Ross River Dena in the project area will be impacted. However, these impacts are mitigated by a land use interruption supplement as part of the socioeconomic Participation Agreement negotiated between Cominco and the Ross River Dena.

The displacement of wildlife habitat by the project will result in a minor reduction of available territory for subsistence hunting. The Ross River Kaska Dena are the people most likely to be affected. Their concerns, however, are not in regard to the loss of available hunting territory, but conversely, the added protection of wildlife through creation of no-hunt zones covering the project area. The question of establishing a no-hunt zone is the subject of a broader regional concern over wildlife management and hunting.

In regard to commercial guiding and hunting, the project is in the guiding territory of Doug Smarch of Teslin Outfitters. At the time of the Kudz Ze Kayah review, the degree of exploration activity in the area was having some adverse effect on those operations. Mr. Smarch was also concerned about greater numbers of people in his guiding area leading to greater hunting pressures. It is not expected that the project will lead to increased impacts on his guiding territory, as these impacts were related to exploration activities that have since subsided. The Finlayson Project will mitigate direct impacts by: (1) controlling road access; (2) enforcing a policy of no guns and no hunting along the access road and in the general mine area; (3) limiting employee access to North Lakes; (4) limiting use of helicopters during mine development and operation; and (5) maintaining good communication between Cominco and Teslin Outfitters to identify mining activities that could impact guiding use.

Impacts on fishing use are expected to be minor. At the time of the Kudz Ze Kayah review, there was fly-in use of the area by Warren LaFave’s operations at McEvoy Lake, but he was not using the project area to any significant extent. The potential for direct impacts from increased recreational fisheries use is considered minor due a strict “no fishing” policy set for mine employees.

The expansion of the project to include the Wolverine operation is not expected provide additional land use concerns than those identified for the Kudz Ze Kayah Project. Guide-outfitting, fishing and trapping activities in the project area will be re-examined and updated as necessary for the Finlayson Project Environmental Assessment.

4.5.13 Human Health

The definition of human health used by Health Canada is “a complete state of physical, mental and social well-being and not merely the absence of disease or infirmity” (Health Canada, 1999). This definition equates human health to general well being including lifestyles, traditions, spiritual and religious practices, as well as physical health and nutrition. In the perspective of the Finlayson Project, this definition applies most to potential disruption of First Nations traditional lifestyles and disruption of rural lifestyle choices of non-aboriginals living in the area.

The project development area itself (Wolverine and Kudz Ze Kayah) does fall within the Kaska Nation Traditional Territory and some areas are traditional land use areas. Expatriate intends to work with local First Nations in ensuring that disruption to these areas is minimized. There are no inhabitants in the immediate project area.

The communities and residents along the concentrate haul route will realize an increase in truck traffic along that route. For rural inhabitants, this may be an intrusion to their rural lifestyle choice. For the communities this may also be a disruption to their lifestyle. Expatriate intends to carry out consultation activities that will allow these persons to identify themselves and their concerns and develop mitigation strategies.

The only human health issue related to physical well-being associated with the project is the increased potential for vehicle accidents along the Robert Campbell Highway as a result of increased traffic from concentrate and supply trucks. The impacts of the increased truck transportation may be mitigated by contracting with a qualified trucking firm that will:

- Use only experienced, professional drivers;
- Equip all trucks with two-way radio communications; and,
- Implement design, safety and operating procedures proven by similar trucking systems utilized in the Yukon.

5 PUBLIC CONSULTATION

Public and stakeholder consultation is a very important component of the permitting process under CEEA. Consultation activities have been carried out for the Kudz Ze Kayah and Wolverine Projects during 1994-97 while the two projects were being developed independently. Recently, stakeholder consultation has been carried out by Expatriate Resources in regards to the Finlayson Project. The following is a summary of the historic consultation activities associated with the Kudz Ze Kayah and Wolverine Projects and more recent activities for the Finlayson Project.

5.1 Kudz Ze Kayah, 1994-98

Through the CEEA Environmental Screening and Water Licence Application process, the Kudz Ze Kayah Project was subject to extensive public and stakeholder review. The following is a list of the consultation activities that were carried by Cominco during this period. There is no attempt to document the details of these meetings as part of this report. The concerns and issues raised during consultation were considered in the development proposal submitted by Cominco as their Water Licence Application. Some of the consultation activities were clearly documented and are a matter of public record.

September 14, 1994	Cominco officials met with Liard River First Nation to discuss exploration work and canvass views and concerns on mine development.
September 15, 1994	Cominco officials met with Ross River Kaska Dena to discuss exploration work and canvass views and concerns on mine development.
November 25, 1994	RERC met with Cominco officials for a preliminary discussion of the Kudz Ze Kayah project.
January 11, 1995	Cominco officials met with Ross River Dena Council with respect to no-hunting zones, heritage review of winter trail and tote road security.
February 13, 1995	Cominco officials met with the Liard River First Nation to provide an overview of the advanced exploration program and environmental baseline studies.
February 14, 1995	Cominco officials provided an overview of the advanced exploration program and environmental baseline studies for the public in Watson Lake.
February 15, 1995	Cominco officials provided an overview of the advanced exploration program and environmental baseline studies for the public and Ross River Kaska Dena in Ross River.
February 16, 1995	Cominco officials provided an overview of the advanced exploration program and environmental baseline studies for the public in Whitehorse.

- June 16, 1995 Cominco officials presented an update on the project for the Liard River First Nation Chief and Council.
- August 2, 1995 Cominco presented the Project Overview document to RERC members and first nation representatives in Whitehorse.
- August 8, 1995 Cominco officials met with Yukon Renewable Resources and Ross River Kaska Dena to discuss wildlife studies.
- August 18, 1995 Cominco presented the results of the work on tailings site selection to DIAND staff.
- September 13, 1995 RERC members and first nation representatives visited the Kudz Ze Kayah site.
- September 14, 1995 A RERC meeting was held in Ross River to discuss the environmental assessment process, IEE guidelines, project overview and environmental studies, with Liard River First Nations, Ross River Kaska Dena and Cominco representatives in attendance.
- September 19, 1995 Cominco presented an update on work in progress on acid generation studies and cumulative effects to the RERC technical working group.
- September 20, 1995 Cominco presented further information in Ross River on baseline studies, the tailings impoundment and the proposed airstrip location.
- October 25, 1995 Cominco met with the RERC technical working group to report on work in progress with respect to waste, tailings and water management systems.
- November 28, 1995 Cominco presented information on the progress of water quality modelling studies to the RERC technical working group.
- March 8, 1996 The Cominco project team presented a summary of the IEE to the RERC and First Nation representatives.
- March 11–13, 1996 Cominco sponsored open house sessions in Whitehorse, Watson Lake and Ross River.
- March 27, 1996 Advertisements were placed in the *Yukon News* to inform the public about the Kudz Ze Kayah project and to invite public comments.
- March 29, 1996 Advertisements were placed in the *Whitehorse Star* to inform the public about the Kudz Ze Kayah project and to invite public comments.

- March 23, 1996 Members of the RERC technical working group met with representatives of the Ross River Dena Council in Ross River.
- June 19, 1996 DIAND's project manager met with members of the Liard River First Nations to discuss their input on the review of the IEE.
- September 13, 1996 The Cominco project team met with the RERC to present its response in relation to RERC's requests for additional information and to discuss technical issues pertaining to water management and water quality.
- April 9, 1997 Details and principal findings of the environmental assessment were presented to Liard River First Nation Chief and Council and elders.
- February 24, 1998 First public review session of the Kudz Ze Kayah Water Licence Application. Water Board, Cominco, DIAND, DFO, Yukon Conservation Society, Ross River Kaska Dena Council represented.
- March 3, 1998 Second public review session of the Kudz Ze Kayah Water Licence Application. Water Board, Cominco, DIAND, DFO, Yukon Conservation Society, Ross River Kaska Dena Council, and Liard First Nation represented.

5.2 Wolverine 1996-97

In July 1996, Westmin presented its proposed baseline studies programs to government technical personnel for review and comment. At each of these meetings, Westmin officials gave an overview of the project, the status and outline of the study plan and proposed work at each meeting. The following is a summary of those meetings. The issues raised at each of these meetings some correspondence relating to those meetings is presented in Appendix 5A.

- June 26, 1996 Westmin officials met with DIAND Land Resources representatives. Issues discussed included land use and project access issues and the CEAA review process.
- June 27, 1996 Westmin officials met with Department of Fisheries and Oceans. Issues discussed included fisheries management in Wolverine Lake, fisheries assessment programs, and benthic survey techniques.
- June 28, 1996 Westmin officials met with DIAND Environment representatives. Issues discussed included First Nations involvement and consultation, land use in the project area, and cumulative effects.
- June 28, 1996 Westmin officials met with DIAND Mineral Resources representatives. Issues discussed included Mining Land Use Regulations, project development timeline, First Nations involvement, wildlife, heritage resources, and acid rock characterization.

- June 28, 1996 Westmin officials met with DIAND Water Resources representatives. Issues discussed included climate and water quality monitoring and project development plans.
- June 28, 1996 Westmin officials met with YTG Renewable Resources. Issues discussed included wildlife, project activity and development plans, cumulative effects, and traditional ecological knowledge.

In February of 1997, Westmin Resources Limited and Atna Resources Limited held an open house in the community of Ross River. The following is a summary of the issues and concerns established in these meetings.

Issue	Predicted Impact	Potential Mitigation (Non-exclusive or Exhaustive)
Sheep	Localized	
Furbearers/Bears	Localized	Garbage management required. Incineration and electric fences.
Moose	<ul style="list-style-type: none"> • Mortality—Harvest • Mortality—Road Collision (when access road is developed) • Migration/Movement—Barrier Effect 	<ul style="list-style-type: none"> • Fish and Wildlife Management Plan (FWMP) for the area. YTG Renewable Resources committee to work with various stakeholders to assist Ross River Dena Council (RRDC). • Access control. • Continued study. • No hunting policy in camp. • Standard road mitigation, including speed reductions, signage, personnel education, knock down snow berms and other methods. • Westmin/Atna to monitor sightings and report collisions and mortality. • Use of convoys and reduced highway speed. • Baseline studies. • Provide passageway through high use/game trail areas.
Caribou	<ul style="list-style-type: none"> • Mortality—Harvest • Mortality—Road Collision • Disturbance—Calving • Migration/Movement—Barriers 	<ul style="list-style-type: none"> • YTG Renewable Resources committed to assist RRDC to develop FWMP for the area. • Access control. • Continued studying and monitoring. • Standard avoidance measures—road (see Moose for same mitigation). • Study haul/transportation corridor options and choose route of least impact. • Use convoys on highway and possibly reduce the speed of haul trucks. • Baseline studies to indicate key areas, avoidance during key times. • Westmin/Atna to monitor effects of cow/calf ratio in area. • Incidental observation. • Baseline studies. • Passageways and signage to be provided for access road.

Issue	Predicted Impact	Potential Mitigation (Non-exclusive or Exhaustive)
Fish	<ul style="list-style-type: none"> • Over-Fishing 	<ul style="list-style-type: none"> • YTG Renewable Resources committed to assist RRDC to develop FWMP. • Westmin/Atna committed to participate in development of the plan. • Baseline studies. • No fishing policy in camp.
Trapper	Economic impact possible due to disturbance and habitat loss/alteration	Westmin/Atna discussions with RRDC regarding First Nations compensation and other related concerns for the group trapping area.
Outfitter	Localized disturbance and Habitat loss/alteration	Westmin/Atna to discuss with outfitter regarding potential mitigation.

5.3 Finlayson, 2000

Expatriate Resources has carried out some preliminary consultation and information sessions with First Nations and government agencies. The following is a list of the meetings conducted and the issues discussed at each meeting. Full summaries of these meetings are presented in Appendix 5B.

July 19, 2000	Expatriate officials met with Kaska Nation representatives to provide a general overview of the company and a summary of the Finlayson Project and to discuss development of a socioeconomic Participation Agreement.
October 17, 2000	Expatriate officials met with YTG Renewable Resources to introduce the company and the project and provide a summary of the future activities anticipated for this project.
October 17, 2000	Expatriate officials met with DIAND representatives to introduce the company and project and discuss permitting requirements for the project.
October 18, 2000	Expatriate officials met with DFO, DOE, and DIAND Water Resources to introduce the company and the project and discuss future permitting activities for the project.
October 18, 2000	Expatriate officials met with Kaska Nation representatives to further discussions on the development of a socioeconomic Participation Agreement. A meeting and issues schedule was established and a resource funding plan developed.

5.4 Future Consultation

Expatriate intends to carry out a thorough consultation program throughout the regulatory and review process. The Company will hold open houses in Whitehorse, Ross River and Watson Lake at regular intervals as the project develops. Other potentially affected communities may be identified as the assessment process proceeds

and will be included in open house circuit. The open houses will be well publicized and open to all members of the public.

Each open house will present, in a clear and understandable format, up-to-date information on the project and the review process. Expatriate officials and their consultants will be available to answer questions during these open houses. Questionnaires will be distributed to attendees for voluntary completion and return to the Company.

Expatriate Resources will endeavour to identify potentially effected groups and address concerns raised by the public and reviewers. Working groups may be developed, including stakeholders and reviewers, to address specific technical and regulatory issues associated with the project.

The specific details of future consultation plans for the Finlayson Project will be developed in association with stakeholders.

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Table 2.16: ACID BASE ACCOUNTING RESULTS - Miscellaneous Discrete Samples

December 1996 Data - Westmin Resources Ltd. - Wolverine Project

Data reworked by MEM Inc. November 2000

Sample No.	Drill Hole	Interval (m)			Rock Type	% Total Sulfur	% Sulfate Sulfur	Paste pH	Acid Potential	Neutralization Potential (NP)		
		From	To	Total						Actual	Ratio	Net
Dilution Samples (3) - Immediate Foot or Hanging Wall Samples Combined with Massive Sulphide Samples												
105226+105213	WV96-39 (226)	393.3	395.2	1.9	Carbonaceous Argillite (Immediate Hanging Wall)	9.77	0.06	6.4	303.	29.4	0.10	-274.
	WV96-39 (213)	395.2	395.6	0.4	Massive Sulphides (Ore Zone)							
105829+105830	WV96-58 (829)	150	150.45	0.45	Massive Sulphides (Ore Zone)	12.8	0.03	7.7	399.	59.20	0.15	-340.
	WV96-58 (830)	150.45	151.9	1.45	Argillite (Immediate Footwall)							
105938+105939	WV96-63 (938)	130	130.3	0.3	Stringer sulphides (Ore Zone)	6.83	<0.01	7.6	213.	200.	0.94	-14.
	WV96-63 (939)	130.3	130.6	0.3	Argillite (Immediate Footwall)							
Miscellaneous Combined Sample** (1)												
105816+105817	WV96-58 (816)	104.2	105.6	1.4	RHDS	7.14	<0.01	8.1	223.	375.	1.68	152.
	WV96-58 (817)	139.1	141.5	2.4	Stringer sulphides							

** Stringer sulphides are not in an Ore Zone and are not near sample 105816 (a typical hanging wall Rhyolite)

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**Table 3.1
Estimated Mean Monthly Precipitation, Evaporation, and Temperature Values for the
Kudz Ze Kayah Operations Area**

Month	Rainfall (mm)	Snowfall (mm)*	Total Precipitation (mm)	Lake Evaporation (mm)	Temperature (°C)#
January	0	65	65	0	-12.6
February	0	50	50	0	-12.7
March	0	40	40	0	-7.2
April	5	25	30	0	-3.1 [0.4]
May	25	10	35	45	3.3 [6.7]
June	50	0	50	100	9.1 [10.5]
July	60	0	60	100	12.1 [10.0]
August	60	0	60	55	10.3 [7.1]
September	50	15	65	30	3.0
October	15	45	60	0	-4.5
November	0	75	75	0	-14.3
December	0	65	65	0	-12.5
Year	265	390	655	330	

* snowfall is expressed as water equivalent

based on Ketz River Mine which is at a similar elevation

[] 1995 records for the Kudz Ze Kayah low elevation station for comparison

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**Table 3.2
Summary of Precipitation Data from
Project Weather Stations (mm)**

		Kudz Ze Kayah		Wolverine
		Low	High	
1995	June	54	142*	
	July	59	52	
	Aug-Sept 4	47*	54*	
1996	April		2.4	
	May	37.5	21.8	
	June	18.5	14.8	5.8
	July	66.0	61	59.8
	August (1-28)			73.1
1997	May (10-30)			19.1
	June			51.2
	July			96.2
	August			49.2

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**Table 3.3
Comparison of Temperatures at Project Weather Stations (°C)**

	July		August	
	KZK Low Elev	KZK High Elev	KZK Low Elev	KZK High Elev
1995				
Ave	10.1	8.7	7.2	6.3
Max	19.2	17.0	16.9	14.7
Min	2.1	2.4	-1.2	-0.6

	April			May			June			July			August	
	KZK Low Elev	KZK High Elev	Wolverine	KZK Low Elev	KZK High Elev	Wolverine	KZK Low Elev	KZK High Elev	Wolverine	KZK Low Elev	KZK High Elev	Wolverine	KZK Low Elev	KZK High Elev
1996														
Ave		-3.3	-7.4	1.6	-0.4	0.7	8.2	6.9	-10.6	10.5	7.5	12.6		
Max		-2.5	3.5	14.2	11.5	8.0	20.2	17.4	28.0	23.8	16.6	30.0		
Min		-11.2	-23.0	-17.4	-15.3	-11.5	-3.1	-0.7	-4.0	1.5	-2.1	0.0		

	Wolverine			
	May	June	July	August
1997				
Ave	5.6	10.0	13.5	10.8
Max	20	27	27	28
Min	-7	-4.0	0	0

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**Table 3.4
Comparison of Humidity at Project Weather Stations (%)**

1995	KZK Low Elev	
	July	August
Ave	78	78
Max	100	100
Min	38	42

1996	May		June		July		August	
	KZK Low Elev	Wolverine	KZK Low Elev	Wolverine	KZK Low Elev	Wolverine	KZK Low Elev	Wolverine
Ave	63		55	49	75	73		77
Max	99		98	78	100	95		94
Min	27		16	28	29	29		49

1997	Wolverine			
	May	June	July	August
Ave	78	61	72	80
Max	95	98	98	99
Min	47	17	24	41

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Table 3.5
Wind Speed and Direction at Kudz Ze Kayah

	High Elevation Station		Low Elevation Station	
	Ave Speed (km/hr)	%	Ave Speed (km/hr)	%
N	58.6	23%	39.8	27%
NE	48.3	26%	27.4	10%
E	40.8	15%	26.3	9%
SE	43.8	13%	26.4	13%
S	31.3	3%	17.2	6%
SW	27.3	1%	8.7	2%
W	27.3	2%	11.0	6%
NW	35.4	12%	17.7	27%
C		4%		0%

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**Table 3.6
Stage - Discharge Measurements at Station W12
(Go Creek)**

Date	Discharge (m ³ /s)	Gauge Plate Reading (m)	Pressure Transducer Reading (m)
25-Mar-96	0.04	n/a	n/a
29-May-96	1.18	0.510	0.54
25-Jun-96	0.440	0.355	0.35
05-Jul-96	0.476	0.375	0.37
15-Jul-96	0.431	0.332	0.345
21-Jul-96	0.357	0.310	0.30
06-Aug-96	0.780	0.39	0.375
21-Aug-96	0.357	0.345	0.30
26-Nov-96	0.08		0.17
18-Mar-97	0.023		0.045
28-May-97	0.362	0.331	0.2704
12-Sep-97	0.317		0.2704
14-Jul-97	0.517	0.364	0.324

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Table 3.7
Stage - Discharge Measurements at Station W21
(Nougha Creek)

Date	Time	Discharge (m ³ /s)	Gauge Plate Reading (m)	Pressure Transducer Reading (m)
25-Mar-96		0.6	n/a	n/a
30-May-96	4:00 P.M.	6.160	0.405	0.41
16-Jul-96	10:00 A.M.	1.904	0.194	0.165
21-Jul-96	5:00 P.M.	1.789	0.172	0.15
22-Aug-96	2:30 P.M.	2.315	0.198	0.18
14-Jul-97	08:40	2.376	0.221	0.2
30-May-97	10:15	6.489	0.385	0.343

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Table 3.8
Spot Measurements of Stream Flows in the Wolverine Area

Station ID No.	Station Name	Date	Discharge (m ³ /s)
W1	Nougha Creek just below the outlet of Wolverine Lake	25-Mar-96	0.56
		30-May-96	5.16
		06-Jul-96	1.76
		07-Aug-96	1.25
		28-May-97	5.124
		13-Jul-97	2.079
W2	Wolf Creek near mouth	18-Jul-96	0.016
		23-Aug-96	0.015
		28-May-97	0.088
		13-Jul-97	0.027
		11-Sep-97	0.014
W4	Viking Creek near mouth	18-Jul-96	0.008
		23-Aug-96	0.011
		28-May-97	0.007
		13-Jul-97	0.005
		11-Sep-97	0.010
W6	Jasper Creek near mouth	12-Jul-96	0.028
		23-Aug-96	0.033
		30-May-97	0.098
		13-Jul-97	0.031
		11-Sep-97	0.027
W9	Wolverine Creek near the mouth	25-Mar-96	0.002
		29-May-96	0.09
		06-Jul-96	0.0104
		07-Aug-96	0.0227
		26-Nov-96	0.007
W11	Money Creek above Go Creek	25-Mar-96	0.28
		05-Jul-96	3.85
		06-Aug-96	2.77
		28-May-97	2.058
		14-Jul-97	3.549
W13	Pup Creek near mouth	12-Sep-97	2.536
		15-Jul-96	0.058
		21-Aug-96	0.089
		28-May-97	0.108
		14-Jul-97	0.057
W16	Go Creek upstream of Hawkowl Creek	12-Sep-97	0.059
		21-Jul-96	0.121
		27-May-97	0.111
		15-Jul-97	0.119
		12-Sep-97	0.259
W17	Headwaters of Go Creek	21-Jul-96	0.017
		22-Aug-96	0.033
		27-May-97	0.022
		14-Jul-97	0.027
		12-Sep-97	0.018

Station ID No.	Station Name	Date	Discharge (m ³ /s)
W18	Tributary upstream of Go Creek	21-Jul-96	0.014
		22-Aug-96	0.014
		27-May-97	0.012
		14-Jul-97	0.019
		12-Sep-97	0.006
W19	Upper Hawkowl Creek	21-Jul-96	0.047
		24-Aug-96	0.047
		27-May-97	0.024
		14-Jul-97	0.074
		12-Sep-97	0.039
W20	Burn Creek upstream of mouth	16-Jul-96	0.001
		20-Aug-96	0.013
		29-May-97	0.024
		15-Jul-97	0.011
		12-Sep-97	0.026
W22	Money Creek at Robert Campbell Highway	25-Mar-96	1.6
		20-Jul-96	4.106
		07-Aug-96	7.60
		28-May-97	4.912
		15-Jul-97	7.582
W23	Money Creek above Dollar Creek	25-Mar-96	0.2
		30-May-96	6.85
		15-Jul-96	0.143
		06-Aug-96	2.40
		28-May-97	2.273
		14-Jul-97	4.109
W25	Inflow to Little Wolverine Lake	12-Sep-97	2.984
		25-Mar-96	0.02
		20-Jun-96	0.262
		06-Jul-96	0.230
		06-Aug-96	0.133
		27-May-97	0.413
W26	Wind Creek	14-Jul-97	0.362
		12-Sep-97	0.232
		30-May-96	1.200
		20-Jun-96	0.0568
		06-Jul-96	0.0925
		07-Aug-96	0.428
W27	Dollar Creek	28-May-97	0.507
		14-Jul-97	0.075
		15-Jul-96	2.6
		21-Aug-96	0.109
W28	Light Creek at Robert Campbell Hwy	12-Sep-97	0.218
		25-Mar-96	0.15
		30-May-96	0.73
		20-Jul-96	0.274
		22-Aug-96	0.393
		28-May-97	0.490
		15-Jul-97	0.440

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**Table 3.9
Watershed Characteristics of Automated and Manual Hydrology Stations
in the Wolverine Area**

Station ID No.	Station Name	Catchment Area (km ²)	Catchment Median Elevation a (m)
W8	Campbell Creek near the mouth	7.2	1560
W9	Wolverine Creek	3.3	
W12	Go Creek above Pup Creek	36.4	1430
W14	Money Creek below Go Creek	238	1480
W15	Hawkowl Creek near the mouth	9.8	1630
W21	Nougha Creek at Robert Campbell Highway	287	1360

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**Table 3.10
Summary of Baseline Surface Water Quality Sampling Program for the Kudz Ze Kayah Area**

SITE #	DESCRIPTION	SAMPING DATES								
		Jul-94	Aug-94	Dec-94	Apr-95	May-95	Jun-95	Jul-95	Aug-95	Sep-95
1	headwaters of South Creek between 2 lakes	✓	✓	✓			✓		✓	✓
2	"Fault Creek" (west-side trib. to Wolf Lake)	✓	✓	✓	✓		✓		✓	✓
3	unnamed west-side trib. to upper lake in Geona Creek	✓	✓				✓		✓	✓
4	Geona Creek in ore zone (between 2 small lakes)	✓	✓	✓			✓		✓	✓
5	Geona Creek downstream of ore zone	✓	✓	✓		✓	✓	✓	✓	✓
6	unnamed east-side trib. of Geona Creek downstream of ore zone	✓	✓	✓	✓		✓		✓	✓
7	Geona Creek downstream of confluence with Site 6 trib.	✓	✓	✓	✓		✓		4	✓
8	Geona Creek 0.5 km downstream of Site 7	✓	✓							
9	lower Geona Creek 2 km downstream of Site 7	✓	✓	✓	✓		✓		✓	✓
10	lowermost small lake in upper Geona Creek	✓	✓				✓		✓	✓
11	uppermost headwater lake in Geona Creek	✓	✓		✓		✓		✓	✓
12	uppermost lake in South Creek	✓	✓		✓		✓		✓	✓
13	South Creek downstream of the headwater lakes			✓	✓	✓	✓	✓	4	✓
14	North River downstream of South Creek confluence			✓			✓		✓	✓
15	Finlayson Creek downstream of Geona Creek confluence			✓	✓	✓	✓	✓	4	✓
16	Finlayson Creek upstream of Geona Creek confluence				✓	✓	✓	✓	4	✓
17	lower Geona Creek upstream of Finlayson Creek confluence			✓	✓		✓		✓	✓
18	unnamed east-side trib. of Geona Creek				✓		✓		✓	✓
19	upper East Creek						✓		✓	✓
20	middle East Creek				✓		✓		✓	✓
21	lower East Creek				✓	✓	✓	✓	4	✓
22	upper (eastern) North Lake				✓		✓		✓	✓
23	lower (southern) North Lake						✓		✓	✓
24	second small lake in upper South Creek						✓		✓	✓
25	second small lake in upper Geona Creek						✓		✓	✓
26	lower Finlayson Creek at Robert Campbell Hwy.				✓	✓	✓	✓	4	✓
27	North Lakes Creek below eastern North Lake				✓		✓		✓	✓
28	small lake in mid-reach of East Creek						✓		✓	✓

✓ Collected

4 Sampled over four successive weeks

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**Table 3.11
Water Quality Analysis Method Detection Limits - Kudz Ze Kayah
Baseline Sampling Program**

PARAMETER	UNIT	DETECTION LIMIT
pH	pH units	0.1
Specific Conductance	uS/cm	1
Turbidity	NTU	0.1
Hardness (calculated)	mg/L	n/a
Alkalinity (to 8.3 and 4.5)	mg/L	0.5
Non-filterable Residue	mg/L	4
Filterable Residue	mg/L	4
Sulphate	mg/L	1.0
Nitrate	mg/L as N	0.02
Nitrite	mg/L as N	0.005
Ammonia	mg/L as N	0.005
Total Phosphorus	mg/L	0.003
Cyanide (total and WAD)	mg/L	0.001
Total and Dissolved Metals by ICP with special extractions/ analyses to meet the following detection limits:*		
Aluminum	mg/L	0.006
Arsenic	mg/L	0.00005
Cadmium	mg/L	0.00001
Chromium	mg/L	0.0002
Copper	mg/L	0.0002
Iron	mg/L	0.005
Lead	mg/L	0.0001
Mercury	mg/L	0.00001
Nickel	mg/L	0.001
Selenium	mg/L	0.00005
Silver	mg/L	0.00001
Zinc	mg/L	0.001

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Table 3.12
Sampling Schedule for Water Quality in the Wolverine Area

SITE DESCRIPTION	SITE #	1996										1997							
		Oct 2-4	Mar. 26-26	May 29-30	June 20-21	July 6-6	July 12-21	July 19-20	Aug. 6-7	Aug. 20-24	Nov. 26-27	Mar 18-19	May 27-30	Jun 14-15	Jul 1-2	July 13-16	Aug 2	Aug 15-16	Sept 11-14
Nougha Cr. 100 m d/s Wolverine Lake	W-1	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Wolf Cr. 50 m u/s mouth	W-2	X					X			X					X				X
Wolverine Lake mid-transect opposite W-2	W-3	X								X					X				X
Viking Cr. 50 m u/s mouth	W-4	X					X			X			X		X				X
Wolverine Lake mid-transect opposite W-4	W-5	X								X					X				X
Jasper Cr. 30 m u/s mouth	W-6	X					X			X			X ^D		X				X
Wolverine Lake mid-transect opposite W-6	W-7	X								X					X				X
Campbell Cr. 30 m u/s mouth	W-8	X					X			X				X					X
Wolverine Cr. 50 m u/s beaver dam at mouth	W-9	X	X	X	X	X	X		X	X	X		X ^{B, HDL}	X	X	X ^{BD}	X	X	X ^B
Little Wolverine Lake mid-transect opposite W-9	W-10	X								X					X				X
Money Cr. 60 m d/s Go Cr.	W-11	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
Go Cr. 20 m u/s Pup Cr.	W-12	X	X	X	X	X	X		X	X	X		X ^{HDL}	X	X	X	X	X	X
Pup Cr. 20 m u/s mouth	W-13	X					X			X				X					X
Money Cr. 100 m d/s Go Cr.	W-14	X	X	X	X	X	X		X	X	X		X	X ^{TDL}	X	X	X	X	X
Hawkowl Cr. 30 m u/s Go Cr.	W-15	X		X			X			X				X	X	X	X	X	X
Go Cr. 15 m u/s Hawkowl Cr.	W-16	X					X			X				X					X
Headwaters of Go Cr. (left tributary)	W-17	X					X			X				X					X
Headwaters of Go Cr. (right tributary)	W-18	X					X			X				X					X
Upper Hawkowl Cr.	W-19	X					X			X				X					X
Burn Cr. 20 m u/s mouth	W-20	X					X			X				X					X
Nougha Cr. 30 m u/s Robert Campbell Highway	W-21	X	X	X	X	X	X		X	X	X		X ^{D, HDL}	X	X	X	X	X	X
Money Cr. 50 m u/s Robert Campbell Highway	W-22	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
Money Cr. u/s Dollar Cr.	W-23		X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
East Cr.	W-24			X	X	X	X		X	X	X		X	X	X	X	X	X	X
Inflow to Little Wolverine Lake	W-25		X	X	X	X	X		X	X	X		X	X					X
Wind Creek	W-26		X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
Dollar Creek	W-27						X			X				X					X
Light Creek at Robert Campbell Highway	W-28		X	X	X	X	X		X	X	X		X	X	X	X	X	X	X
Wind Lake (centre or along shore)	W-29									X				X					X
Little Jimmy Lake	M-1								X										
Little Wolverine Lake (same as W-10)	L-1									X									
Wolverine Lake (1 mile north of island)	P-1									X									
Wolverine Lake (1/2 way between W2 & W4)	P-2									X									
Wolverine Lake (0.5 miles south of W5)	P-3									X									
Wolverine Lake (1 mile north of W7)	P-4									X									

- * X denotes that site was sampled
- HDL Hydrology data logger installed
- TDL Hobo temperature logger installed
- ^B Triplicate benthic samples collected
- ^D Duplicate sample collected
- ^{*} Creek frozen to bottom, no samples collected
- ^{**} Sample collected from along the shore

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**Table 3.13
Water Quality Analysis Methods and Detection Limits
- Wolverine Baseline Program**

PARAMETER		DETECTION LIMIT	METHOD
Total and dissolved metals:		(mg/l unless noted)	
Aluminum	Al	0.001	ICP / ICP MS
Antimony	Sb	0.00005	ICP / ICP MS
Arsenic	As	0.00005	ICP / ICP MS
Barium	Ba	0.00005	ICP / ICP MS
Beryllium	Be	0.0005	ICP / ICP MS
Bismuth	Bi	0.0005	ICP / ICP MS
Boron	B	0.001	ICP / ICP MS
Cadmium	Cd	0.00005	ICP / ICP MS
Calcium	Ca	0.05	ICP / ICP MS
Chromium	Cr	0.0001	ICP / ICP MS
Cobalt	Co	0.0001	ICP / ICP MS
Copper	Cu	0.0001	ICP / ICP MS
Iron	Fe	0.01	ICP / ICP MS
Lead	Pb	0.00005	ICP / ICP MS
Lithium	Li	0.001	ICP / ICP MS
Magnesium	Mg	0.05	ICP / ICP MS
Manganese	Mn	0.00005	ICP / ICP MS
Mercury (total)	Hg	0.00005	Cold Oxidation (CVAAS)
Molybdenum	Mo	0.00005	ICP / ICP MS
Nickel	Ni	0.0001	ICP / ICP MS
Phosphorus	P	0.05	ICP / ICP MS
Potassium	K	0.2	ICP / ICP MS
Selenium	Se	0.005	ICP / ICP MS
Silicon	Si	0.05	ICP / ICP MS
Silver	Ag	0.00001	ICP / ICP MS
Sodium	Na	2	ICP / ICP MS
Strontium	Sr	0.0001	ICP / ICP MS
Thallium	Tl	0.00005	ICP / ICP MS
Tin	Sn	0.0001	ICP / ICP MS
Titanium	Ti	0.01	ICP / ICP MS
Vanadium	V	0.001	ICP / ICP MS
Zinc	Zn	0.001	ICP / ICP MS
Total alkalinity	CaCO ₃	1	Titration to pH=4.5
Ammonia*	N	0.005	Colorimetry
Nitrate	N	0.005	Ion Exchange Chromatography
Nitrite	N	0.001	Colorimetry
Nitrite + nitrate	N	0.005	Ion Exchange Chromatography
Sulphate	SO ₄	0.03	Ion Exchange Chromatography
Total dissolved solids		1 to 5	Filtration/Gravimetric
Total suspended solids		1 to 5	Filtration/Gravimetric
Turbidity		1.0 (NTU)	Nephelometric
Conductivity		1:0 (µS)	Conductivity cell
pH (ReU)		0.1 (ReU)	Potentiometric
Cyanide (total)*	CN	0.005	Distillation/UV Detection
Fluoride	F	0.02	Colorimetry
Chloride	Cl	0.5	Colorimetry

Note * Indicates analysis only performed on samples collected on July 13-15

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Table 3.14
Water Quality of Little Wolverine Lake

Depth	(m)	1.0	8.1
General Parameters			
TDS	(mg/L)	64	81
Hardness	(CaCO3)	48.9	63.8
pH		7.53	7.06
NFR	(mg/L)	2	3
Turbidity (NTU)	(NTU)	0.5	1.7
Alkalinity Total	(CaCO3)	43.2	53
Major Anions			
Chloride	(mg/L)	0.5	0.7
Fluoride	(mg/L)	0.08	0.08
Sulphate	(mg/L)	10.2	12
Nutrients			
Ammonia Nitrogen	(mg/L)	0.021	0.02
Nitrate	(mg/L)	<0.005	<0.005
Nitrite	(mg/L)	0.001	0.001
Nitrite/Nitrate	(mg/L)	<0.005	<0.005
Dissolved ortho-Phosphate	ortho - PO4	0.007	0.019
Total Phosphate	PO4	0.016	0.043
Total Cyanide	(mg/L)	<0.005	<0.005
Total Metals			
Aluminum	(mg/L)	0.015	0.014
Antimony	(mg/L)	<0.2	<0.2
Arsenic	(mg/L)	0.00125	0.00252
Barium	(mg/L)	0.04	0.05
Beryllium	(mg/L)	<0.005	<0.005
Bismuth	(mg/L)	<0.1	<0.1
Boron	(mg/L)	<0.1	<0.1
Cadmium	(mg/L)	0.00007	<0.00005
Calcium	(mg/L)	15.2	18.6
Chromium	(mg/L)	<0.0005	<0.0005
Cobalt	(mg/L)	<0.01	<0.01
Copper	(mg/L)	0.0012	0.0008
Iron	(mg/L)	0.03	0.1
Lead	(mg/L)	0.00039	0.00031
Lithium	(mg/L)	<0.01	<0.01
Magnesium	(mg/L)	3.08	3.97
Manganese	(mg/L)	0.008	0.063
Mercury	(mg/L)	<0.00005	<0.00005
Molybdenum	(mg/L)	<0.03	<0.03
Nickel	(mg/L)	<0.02	<0.02
Phosphorus	(mg/L)	<0.3	<0.3
Potassium	(mg/L)	<2	<2
Selenium	(mg/L)	<0.001	<0.001
Silicon	(mg/L)	2.21	3.17
Silver	(mg/L)	<0.00001	<0.00001
Sodium	(mg/L)	<2	<2
Strontium	(mg/L)	0.043	0.054
Thallium	(mg/L)	<0.00005	<0.00005
Tin	(mg/L)	<0.03	<0.03
Titanium	(mg/L)	<0.01	<0.01
Uranium	(mg/L)	0.00035	0.00049
Vanadium	(mg/L)	<0.03	<0.03
Zinc	(mg/L)	0.011	0.006

Depth	(m)	1.0	8.1
Chlorophyll	mg/m3	0.77	1.19
DOC	(mg/L)	3.7	3.7
TOC	(mg/L)	4.0	4.1

Depth	(m)	1.0	8.1
Dissolved Metals			
Aluminum	(mg/L)	0.016	0.009
Antimony	(mg/L)	<0.2	<0.2
Arsenic	(mg/L)	0.00118	0.00203
Barium	(mg/L)	0.04	0.05
Beryllium	(mg/L)	<0.005	<0.005
Bismuth	(mg/L)	<0.1	<0.1
Boron	(mg/L)	<0.1	<0.1
Cadmium	(mg/L)	<0.00005	<0.00005
Calcium	(mg/L)	14.7	18.7
Chromium	(mg/L)	<0.0005	<0.0005
Cobalt	(mg/L)	<0.01	<0.01
Copper	(mg/L)	0.0009	0.0014
Iron	(mg/L)	<0.03	<0.03
Lead	(mg/L)	0.0001	<0.00005
Lithium	(mg/L)	<0.01	<0.01
Magnesium	(mg/L)	2.97	4.15
Manganese	(mg/L)	<0.005	<0.005
Mercury	(mg/L)	<0.00005	<0.00005
Molybdenum	(mg/L)	<0.03	<0.03
Nickel	(mg/L)	<0.02	<0.02
Phosphorus	(mg/L)	<0.3	<0.3
Potassium	(mg/L)	<2	<2
Selenium	(mg/L)	<0.001	<0.001
Silicon	(mg/L)	2.14	3.2
Silver	(mg/L)	<0.00001	<0.00001
Sodium	(mg/L)	<2	<2
Strontium	(mg/L)	0.043	0.054
Thallium	(mg/L)	<0.00005	<0.00005
Tin	(mg/L)	<0.03	<0.03
Titanium	(mg/L)	<0.01	<0.01
Uranium	(mg/L)	0.00037	0.00047
Vanadium	(mg/L)	<0.03	<0.03
Zinc	(mg/L)	0.006	0.006

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Table 3.15
Water Quality of inflow to Wolverine Lake

Depth (m)		1.0	5.0	12.0
General Parameters				
TDS	(mg/L)	56	53	60
Hardness	(CaCO ₃)	37.7	38.1	39.9
pH		7.36	7.24	6.81
NFR	(mg/L)	2	2	4
Turbidity (NTU)	(NTU)	0.5	0.8	1.6
Major Anions				
Alkalinity Total	(CaCO ₃)	34.9	35	37.2
Chloride	(mg/L)	0.5	0.5	0.6
Fluoride	(mg/L)	0.11	0.1	0.09
Sulphate	(mg/L)	7.2	7.7	6.9
Nutrients				
Ammonia Nitrogen	(mg/L)	0.021	0.031	0.029
Nitrate	(mg/L)	<0.005	<0.005	<0.005
Nitrite	(mg/L)	<0.001	<0.001	<0.001
Nitrite/Nitrate	(mg/L)	<0.005	<0.005	<0.005
Dissolved ortho Phosphate	ortho - PO ₄	0.009	0.013	0.037
Total Phosphate	PO ₄	0.02	0.026	0.068
Total Cyanide	(mg/L)	<0.005	<0.005	<0.005
Total Metals				
Aluminum	(mg/L)	0.007	0.01	<0.005
Antimony	(mg/L)	<0.2	<0.2	<0.2
Arsenic	(mg/L)	0.00087	0.00089	0.00125
Barium	(mg/L)	0.04	0.04	0.05
Beryllium	(mg/L)	<0.005	<0.005	<0.005
Bismuth	(mg/L)	<0.1	<0.1	<0.1
Boron	(mg/L)	<0.1	<0.1	<0.1
Cadmium	(mg/L)	<0.00005	<0.00005	<0.00005
Calcium	(mg/L)	11	11.1	11.4
Chromium	(mg/L)	<0.0005	<0.0005	<0.0005
Cobalt	(mg/L)	<0.01	<0.01	<0.01
Copper	(mg/L)	0.0003	0.0003	0.0004
Iron	(mg/L)	<0.03	<0.03	0.18
Lead	(mg/L)	0.00006	0.00014	0.00011
Lithium	(mg/L)	<0.01	<0.01	<0.01
Magnesium	(mg/L)	2.5	2.54	2.62
Manganese	(mg/L)	0.008	0.01	0.251
Mercury	(mg/L)	<0.00005	<0.00005	<0.00005
Molybdenum	(mg/L)	<0.03	<0.03	<0.03
Nickel	(mg/L)	<0.02	<0.02	<0.02
Phosphorus	(mg/L)	<0.3	<0.3	<0.3
Potassium	(mg/L)	<2	<2	<2
Selenium	(mg/L)	<0.001	<0.001	<0.001
Silicon	(mg/L)	2.38	2.41	3.1
Silver	(mg/L)	<0.00001	<0.00001	<0.00001
Sodium	(mg/L)	<2	<2	<2
Strontium	(mg/L)	0.033	0.033	0.033
Thallium	(mg/L)	<0.00005	<0.00005	<0.00005
Tin	(mg/L)	<0.03	<0.03	<0.03
Titanium	(mg/L)	<0.01	<0.01	<0.01
Uranium	(mg/L)	0.00033	0.00032	0.00031
Vanadium	(mg/L)	<0.03	<0.03	<0.03
Zinc	(mg/L)	<0.005	<0.005	0.01

Depth (m)		1.0	5.0	12.0
Chlorophyll	mg/m ³	0.73	0.91	2.18
DOC	(mg/L)	3.9	4.3	4.1
TOC	(mg/L)	4.4	5.3	4.1

Depth (m)		1.0	5.0	12.0
Dissolved Metals				
Aluminum	(mg/L)	0.008	0.007	<0.005
Antimony	(mg/L)	<0.2	<0.2	<0.2
Arsenic	(mg/L)	0.00082	0.00084	0.00099
Barium	(mg/L)	0.04	0.04	0.04
Beryllium	(mg/L)	<0.005	<0.005	<0.005
Bismuth	(mg/L)	<0.1	<0.1	<0.1
Boron	(mg/L)	<0.1	<0.1	<0.1
Cadmium	(mg/L)	<0.00005	<0.00005	<0.00005
Calcium	(mg/L)	10.8	10.9	11.4
Chromium	(mg/L)	<0.0005	<0.0005	<0.0005
Cobalt	(mg/L)	<0.01	<0.01	<0.01
Copper	(mg/L)	0.0014	0.001	0.0009
Iron	(mg/L)	<0.03	<0.03	<0.03
Lead	(mg/L)	<0.00005	<0.00005	<0.00005
Lithium	(mg/L)	<0.01	<0.01	<0.01
Magnesium	(mg/L)	2.64	2.66	2.78
Manganese	(mg/L)	<0.005	<0.005	0.111
Mercury	(mg/L)	<0.00005	<0.00005	<0.00005
Molybdenum	(mg/L)	<0.03	<0.03	<0.03
Nickel	(mg/L)	<0.02	<0.02	<0.02
Phosphorus	(mg/L)	<0.3	<0.3	<0.3
Potassium	(mg/L)	<2	<2	<2
Selenium	(mg/L)	<0.001	<0.001	<0.001
Silicon	(mg/L)	2.38	2.37	3.12
Silver	(mg/L)	0.00001	<0.00001	<0.00001
Sodium	(mg/L)	<2	<2	<2
Strontium	(mg/L)	0.035	0.035	0.036
Thallium	(mg/L)	<0.00005	<0.00005	<0.00005
Tin	(mg/L)	<0.03	<0.03	<0.03
Titanium	(mg/L)	<0.01	<0.01	<0.01
Uranium	(mg/L)	0.00036	0.00034	0.00024
Vanadium	(mg/L)	<0.03	<0.03	<0.03
Zinc	(mg/L)	<0.005	<0.005	<0.005

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Table 3.16
Water Quality in Wolverine Lake

Site #	Description	Depth (m)	General Parameters					Major Anions			
			TDS (mg/L)	Hardness (CaCO3)	pH	NFR (mg/L)	Turbidity (NTU)	Alkalinity Total (CaCO3)	Chloride (mg/L)	Fluoride (mg/L)	Sulphate (mg/L)
P-1	1 mile north of island	1.0	68	54.6	7.67	2	0.3	46.8	0.6	0.1	11.3
P-1	1 mile north of island	9.0	70	55.1	7.42	2	0.5	49.7	0.5	0.1	11.4
P-1	1 mile north of island	19.0	87	61.2	7.15	1	0.4	55.4	0.5	0.1	11.4
P-2	1/2 way between W2 & W4	1.0	73	54.9	7.57	2	0.3	45.8	0.6	0.08	10.9
P-2	1/2 way between W2 & W4	5.0	75	55.1	7.66	2	0.3	45.4	0.6	0.09	11.3
P-2	1/2 way between W2 & W4	34.2	79	57.7	7.39	1	0.2	47.5	0.5	0.09	11.4
P-3	0.5 miles south of W5	4.0	69	55.3	7.66	2	0.3	44.5	0.5	0.09	10.9
P-3	0.5 miles south of W5	30.0	72	56.5	7.41	<1	0.1	47.5	0.5	0.1	11.6
P-3	0.5 miles south of W5	68.0	79	57.9	7.25	1	0.2	49.5	0.6	0.1	11.7
P-4	1 mile north of W7	1.0	67	54.8	7.6	2	0.2	47.3	<0.5	0.08	11.5
P-4	1 mile north of W7	8.0	66	54.5	7.58	2	0.4	47.9	0.6	0.09	11.4
P-4	1 mile north of W7	30.0	69	56.5	7.44	1	0.1	49.5	0.5	0.09	11.7
P-4	1 mile north of W7	72.0	77	59.2	7.24	1	0.3	49.6	0.5	0.1	12.1

Site #	Description	Depth (m)	Nutrients						Organic Parameters			
			Ammonia Nitrogen (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrite/Nitr ate (mg/L)	Dissolved ortho - PO4	Total PO4	Total Cyanide (mg/L)	Chlorophyll mg/m3	DOC (mg/L)	TOC (mg/L)
P-1	1 mile north of island	1.0	0.006	<0.005	<0.001	<0.005	0.003	0.007	<0.005	0.4	3.9	4.8
P-1	1 mile north of island	9.0	<0.005	<0.005	0.001	<0.005	0.002	0.009	<0.005	0.53	4.4	4.4
P-1	1 mile north of island	19.0	<0.005	0.027	0.001	0.028	0.008	0.015	<0.005	0.62	4.3	4.5
P-2	1/2 way between W2 & W4	1.0	0.006	<0.005	<0.001	<0.005	0.002	0.007	<0.005	0.51	3.4	4.2
P-2	1/2 way between W2 & W4	5.0	<0.005	<0.005	<0.001	<0.005	0.002	0.007	<0.005	0.49	3.1	4.0
P-2	1/2 way between W2 & W4	34.2	<0.005	0.031	<0.001	0.031	0.006	0.008	<0.005	0.54	2.8	3.8
P-3	0.5 miles south of W5	4.0	<0.005	<0.005	<0.001	<0.005	0.003	0.008	<0.005	0.39	3.6	3.9
P-3	0.5 miles south of W5	30.0	<0.005	0.032	<0.001	0.032	0.006	0.009	<0.005	0.29	3.0	4.0
P-3	0.5 miles south of W5	68.0	<0.005	0.055	<0.001	0.055	0.012	0.016	<0.005	0.48	3.4	3.4
P-4	1 mile north of W7	1.0	0.009	<0.005	<0.001	<0.005	0.003	0.008	<0.005	0.51	4.3	4.8
P-4	1 mile north of W7	8.0	<0.005	<0.005	<0.001	<0.005	0.002	0.01	<0.005	0.76	4.3	4.6
P-4	1 mile north of W7	30.0	<0.005	0.031	0.001	0.032	0.005	0.009	<0.005	0.28	4.2	4.5
P-4	1 mile north of W7	72.0	<0.005	0.06	0.001	0.061	0.012	0.016	<0.005	0.22	3.1	3.7

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Table 3.16 (contd)
Water Quality in Wolverine Lake

Site #	Description	Depth (m)	Total Metals																
			Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Bismuth (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Calcium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lithium (mg/L)	Magnesium (mg/L)	Manganese (mg/L)
P-1	1 mile north of island	1.0	0.011	<0.2	0.00078	0.03	<0.005	<0.1	<0.1	<0.00005	15.1	<0.0005	<0.01	0.001	<0.03	0.00040	<0.01	4.15	<0.005
P-1	1 mile north of island	9.0	0.012	<0.2	0.00087	0.03	<0.005	<0.1	<0.1	<0.00005	15.1	<0.0005	<0.01	0.0008	<0.03	0.00027	<0.01	4.2	<0.005
P-1	1 mile north of island	19.0	0.011	<0.2	0.00118	0.03	<0.005	<0.1	<0.1	<0.00005	16.8	<0.0005	<0.01	0.0009	0.03	0.00080	<0.01	4.71	0.009
P-2	1/2 way between W2 & W4	1.0	0.01	<0.2	0.00088	0.04	<0.005	<0.1	<0.1	<0.00005	15.3	<0.0005	<0.01	0.0009	<0.03	0.00033	<0.01	4.15	<0.005
P-2	1/2 way between W2 & W4	5.0	0.01	<0.2	0.00085	0.04	<0.005	<0.1	<0.1	<0.00005	15.3	<0.0005	<0.01	0.0008	<0.03	0.00026	<0.01	4.13	<0.005
P-2	1/2 way between W2 & W4	34.2	0.01	<0.2	0.0009	0.04	<0.005	<0.1	<0.1	<0.00005	15.8	<0.0005	<0.01	0.0007	<0.03	0.00028	<0.01	4.33	<0.005
P-3	0.5 miles south of W5	4.0	0.011	<0.2	0.00086	0.04	<0.005	<0.1	<0.1	<0.00005	15.1	<0.0005	<0.01	0.0008	<0.03	0.00021	<0.01	4.1	<0.005
P-3	0.5 miles south of W5	30.0	0.029	<0.2	0.00092	0.04	<0.005	<0.1	<0.1	<0.00005	15.7	<0.0005	<0.01	0.0007	<0.03	0.00009	<0.01	4.27	<0.005
P-3	0.5 miles south of W5	68.0	0.006	<0.2	0.00106	0.04	<0.005	<0.1	<0.1	<0.00005	16.4	<0.0005	<0.01	0.0007	0.03	0.00010	<0.01	4.49	0.008
P-4	1 mile north of W7	1.0	0.01	<0.2	0.00084	0.03	<0.005	<0.1	<0.1	<0.00005	15	<0.0005	<0.01	0.0008	<0.03	0.00040	<0.01	4.23	<0.005
P-4	1 mile north of W7	8.0	0.011	<0.2	0.00085	0.03	<0.005	<0.1	<0.1	<0.00005	15.1	<0.0005	<0.01	0.0007	<0.03	0.00009	<0.01	4.26	<0.005
P-4	1 mile north of W7	30.0	0.008	<0.2	0.0009	0.03	<0.005	<0.1	<0.1	<0.00005	15.4	<0.0005	<0.01	0.0007	<0.03	0.00016	<0.01	4.36	<0.005
P-4	1 mile north of W7	72.0	<0.005	<0.2	0.00107	0.04	<0.005	<0.1	<0.1	<0.00005	16.5	<0.0005	<0.01	0.0007	0.04	0.00007	<0.01	4.54	0.013

Site #	Description	Depth (m)	Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silicon	Silver	Sodium	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
			(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
P-1	1 mile north of island	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.86	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00049	<0.03	0.006
P-1	1 mile north of island	9.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.18	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00051	<0.03	<0.005
P-1	1 mile north of island	19.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	3.21	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00061	<0.03	<0.005
P-2	1/2 way between W2 & W4	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.8	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00046	<0.03	<0.005
P-2	1/2 way between W2 & W4	5.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.72	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00047	<0.03	<0.005
P-2	1/2 way between W2 & W4	34.2	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.22	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00047	<0.03	0.006
P-3	0.5 miles south of W5	4.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.69	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00045	<0.03	<0.005
P-3	0.5 miles south of W5	30.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.26	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00047	<0.03	<0.005
P-3	0.5 miles south of W5	68.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.86	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00046	<0.03	<0.005
P-4	1 mile north of W7	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.85	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00046	<0.03	<0.005
P-4	1 mile north of W7	8.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.7	<0.00001	<2	0.052	<0.00005	<0.03	<0.01	0.00047	<0.03	<0.005
P-4	1 mile north of W7	30.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.15	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005
P-4	1 mile north of W7	72.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	3.11	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00044	<0.03	<0.005

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FINLAYSON PROJECT

Table 3.16 (contd)
Water Quality of Wolverine Lake

Site #	Description	Depth (m)	Dissolved Metals																
			Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Bismuth (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Calcium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Lithium (mg/L)	Magnesium (mg/L)	Manganese (mg/L)
P-1	1 mile north of island	1.0	0.007	<0.2	0.0008	0.03	<0.005	<0.1	<0.1	<0.00005	14.9	<0.0005	<0.01	0.0014	<0.03	0.00019	<0.01	4.23	<0.005
P-1	1 mile north of island	9.0	0.01	<0.2	0.00076	0.03	<0.005	<0.1	<0.1	<0.00005	15	<0.0005	<0.01	0.0012	<0.03	0.00012	<0.01	4.28	<0.005
P-1	1 mile north of island	19.0	0.013	<0.2	0.00109	0.03	<0.005	<0.1	<0.1	<0.00005	16.6	<0.0005	<0.01	0.0013	<0.03	0.00012	<0.01	4.78	<0.005
P-2	1/2 way between W2 & W4	1.0	0.007	<0.2	0.00086	0.03	<0.005	<0.1	<0.1	<0.00005	15	<0.0005	<0.01	0.0013	<0.03	0.00015	<0.01	4.21	<0.005
P-2	1/2 way between W2 & W4	5.0	0.011	<0.2	0.00082	0.03	<0.005	<0.1	<0.1	<0.00005	15.1	<0.0005	<0.01	0.0012	<0.03	0.00023	<0.01	4.21	<0.005
P-2	1/2 way between W2 & W4	34.2	0.011	<0.2	0.00091	0.03	<0.005	<0.1	<0.1	<0.00005	15.8	<0.0005	<0.01	0.0011	<0.03	0.0002	<0.01	4.44	<0.005
P-3	0.5 miles south of W5	4.0	0.018	<0.2	0.00086	0.03	<0.005	<0.1	<0.1	<0.00005	15.2	<0.0005	<0.01	0.0014	<0.03	0.00016	<0.01	4.22	<0.005
P-3	0.5 miles south of W5	30.0	0.008	<0.2	0.00091	0.03	<0.005	<0.1	<0.1	<0.00005	15.4	<0.0005	<0.01	0.0013	<0.03	0.00008	<0.01	4.36	<0.005
P-3	0.5 miles south of W5	68.0	0.006	<0.2	0.001	0.03	<0.005	<0.1	<0.1	<0.00005	15.8	<0.0005	<0.01	0.0011	<0.03	0.00008	<0.01	4.47	<0.005
P-4	1 mile north of W7	1.0	0.021	<0.2	0.00084	0.03	<0.005	<0.1	<0.1	<0.00005	14.8	<0.0005	<0.01	0.0014	<0.03	0.0001	0.01	4.31	<0.005
P-4	1 mile north of W7	8.0	0.009	<0.2	0.00083	0.03	<0.005	<0.1	<0.1	<0.00005	14.7	<0.0005	<0.01	0.0012	<0.03	0.00009	<0.01	4.32	<0.005
P-4	1 mile north of W7	30.0	0.007	<0.2	0.00085	0.03	<0.005	<0.1	<0.1	<0.00005	15.2	<0.0005	<0.01	0.0012	<0.03	0.00007	<0.01	4.47	<0.005
P-4	1 mile north of W7	72.0	0.006	<0.2	0.00102	0.03	<0.005	<0.1	<0.1	<0.00005	16.1	<0.0005	<0.01	0.0011	<0.03	0.00008	<0.01	4.58	<0.005

Site #	Description	Depth (m)	Dissolved Metals																
			Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Phosphorus (mg/L)	Potassium (mg/L)	Selenium (mg/L)	Silicon (mg/L)	Silver (mg/L)	Sodium (mg/L)	Strontium (mg/L)	Thallium (mg/L)	Tin (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)	
P-1	1 mile north of island	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.97	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00051	<0.03	<0.005	
P-1	1 mile north of island	9.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.15	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00052	<0.03	<0.005	
P-1	1 mile north of island	19.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	3.2	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00061	<0.03	<0.005	
P-2	1/2 way between W2 & W4	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.8	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-2	1/2 way between W2 & W4	5.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.74	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-2	1/2 way between W2 & W4	34.2	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.27	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00047	<0.03	<0.005	
P-3	0.5 miles south of W5	4.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.73	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-3	0.5 miles south of W5	30.0	<0.00005	<0.03	<0.02	<0.3	2	<0.001	2.2	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-3	0.5 miles south of W5	68.0	<0.00005	<0.03	<0.02	<0.3	2	<0.001	2.83	<0.00001	<2	0.053	<0.00005	<0.03	<0.01	0.00046	<0.03	<0.005	
P-4	1 mile north of W7	1.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.87	<0.00001	<2	0.055	<0.00005	<0.03	<0.01	0.00047	<0.03	<0.005	
P-4	1 mile north of W7	8.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	1.7	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-4	1 mile north of W7	30.0	<0.00005	<0.03	<0.02	<0.3	<2	<0.001	2.23	<0.00001	<2	0.055	<0.00005	<0.03	<0.01	0.00048	<0.03	<0.005	
P-4	1 mile north of W7	72.0	<0.00005	<0.03	<0.02	<0.3	2	<0.001	3.09	<0.00001	<2	0.054	<0.00005	<0.03	<0.01	0.00043	<0.03	<0.005	

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FINLAYSON PROJECT

Table 3.17
Piezometer/Borehole Details for Groundwater Samples, Kudz Ze Kayah 1995

Borehole	Piezometer Interval (bgs)	Borehole Depth (mbgs)	Flowing	Analyses		Field Measurements			
				General Parameters	Metals Only	pH	Conductivity	Temperature	Dissolved Oxygen
95G-13D	39.4-50.3	---	Y	X		8.2	202	3.0	4.2
95G-26	10.0-14.3	---	N	X		7.9	330	2.5	3.5
95G-29	14.3-19.2	---	N	X		8.0	228	2.5	2.4
95G-21	5.3-10.0	---	N		X	7.8	218	2.0	7.6
95G-23	8.8-12.8	---	Y		X	8.0	228	2.5	2.4
95G-31	2.4-10.0	---	N		X	8.0	160	2.0	7.4
T94-23	---	---	Y	X		8.1	252	2.5	1.9
T94-49	---	---	Y	X		7.9	398	2.5	2.0
T94-14	---	---	Y		X	7.9	398	2.5	2.0
T94-26	---	---	Y		X	8.1	235	3.5	1.8
T94-30	---	---	Y		X	8.0	245	2.5	3.2

Notes: 95G - Geotechnical Borehole
T94 - Exploration Borehole
bgs - Below Ground Surface

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Table 3.18
Groundwater Quality, Kudz Ze Kayah 1995

PARAMETER	UNIT	95G-13	95G-31	95G-26	95G-21	95G-23	95G-29	T94-23	T94-26	T94-49	T94-30	T94-14
		Tailings Dam	D/S of Ore Body	Ore Body	Ore Body	U/S of Ore Body	South Creek Divide	D/S Edge of Ore Body	D/S Edge of Ore Body	Ore Body	Ore Body	Ore Body
		Over-Burden >40m	Over-Burden <10m	Over-Burden >10m	Over-Burden <10m	Over-Burden ~10m	Over-Burden >10m	Bed Rock/ Flowing	Bed Rock/ Flowing	Bed Rock/ Flowing	Bed Rock/ Flowing	Bed Rock/ Flowing
pH	pH units	7.8	--	7.9	--	--	7.8	8.0	--	7.4	--	--
Specific Conductance	uS/cm	350	--	783	--	--	516	567	--	449	--	--
Nonfilterable Residue (TSS)	mg/L	4	--	826	--	--	28	6	--	14	--	--
Filterable Residue (TDS)	mg/L	210	--	386	--	--	224	463	--	240	--	--
Hardness, Dissolved	mg/L	177	143	320	193	111	204	238	201	170	201	355
Alkalinity Total 4.5	mg/L	160	--	254	--	--	168	185	--	98.9	--	--
Ammonia Nitrogen	mg/L	0.01	--	< 0.005	--	--	< 0.005	0.009	--	0.016	--	--
Nitrate Nitrogen	mg/L	< 0.02	--	0.13	--	--	< 0.02	< 0.02	--	< 0.02	--	--
Nitrite Nitrogen	mg/L	< 0.005	--	< 0.005	--	--	< 0.005	< 0.005	--	< 0.005	--	--
Phosphorus - Total	mg/L	< 0.003	--	0.187	--	--	0.511	0.003	--	0.013	--	--
Sulfate	mg/L	13.4	--	72.9	--	--	38.1	47.5	--	71.4	--	--
Dissolved Metals												
Silver	ug/L	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	0.03
Aluminum	ug/L	7	15	< 6	10	15	17	7	7	7	9	13
Arsenic	ug/L	0.26	0.06	0.39	0.7	61	3.8	0.29	0.06	170	33	23
Barium	ug/L	73	97	82	37	36	55	38	25	17	28	24
Cadmium	ug/L	< 0.01	0.02	0.16	< 0.01	6	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt	ug/L	< 0.4	0.4	0.4	< 0.4	4.2	< 0.4	< 0.4	< 0.4	0.7	< 0.4	< 0.4
Chromium	ug/L	0.5	11	8.7	0.3	1.3	0.5	0.3	0.3	0.6	0.3	0.3
Copper	ug/L	0.2	0.7	0.3	0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Iron	ug/L	320	54	38	8	4800	500	590	440	4300	2100	1800
Mercury	ug/L	0.02	--	0.04	--	< 0.01	0.04	0.06	--	< 0.01	< 0.01	--
Manganese	ug/L	160	10	56	46	570	120	46	20	240	250	200
Molybdenum	ug/L	2.9	0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Nickel	ug/L	< 1	8	4	< 1	9	< 1	< 1	< 1	1	< 1	< 1
Lead	ug/L	< 0.1	< 0.1	< 0.1	< 0.1	0.3	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Selenium	ug/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zinc	ug/L	2	3	27	3	2700	4	< 1	< 1	160	11	< 1

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**Table 3.19
Summary of Baseline Sediment Sampling Program for Kudz Ze Kayah**

SITE #	DESCRIPTION	1994	1995
1	headwaters of North Creek between 2 lakes	✓	✓
2	"Fault Creek" (west-side trib. to Wolf Lake)	✓	
3	unnamed west-side trib. to upper lake in Geona Creek	✓	
4	Geona Creek in ore zone (between 2 small lakes)	✓	✓
5	Geona Creek downstream of ore zone	✓	✓
6	unnamed east-side trib. of Geona Creek downstream of ore zone	✓	
7	Geona Creek downstream of confluence with Site 6 trib.	✓	✓
8	Geona Creek 0.5 km downstream of Site 7	✓	
9	lower Geona Creek 2 km downstream of Site 7		✓
10	lowermost small lake in upper Geona Creek		
11	uppermost headwater lake in Geona Creek		
12	uppermost lake in South Creek		
13	South Creek downstream of the headwater lakes		✓
14	North River downstream of South Creek confluence		
15	Finlayson Creek downstream of Geona Creek confluence		
16	Finlayson Creek upstream of Geona Creek confluence		
17	lower Geona Creek upstream of Finlayson Creek confluence		
18	unnamed east-side trib. of Geona Creek		
19	upper East Creek		
20	middle East Creek		✓
21	lower East Creek		
22	upper (eastern) North Lake		
23	lower (southern) North Lake		
24	second small lake in upper South Creek		
25	second small lake in upper Geona Creek		
26	lower Finlayson Creek at Robert Campbell Hwy.		
27	North River below eastern North Lake		
28	small lake in mid-reach of East Creek		

✓ indicates sediment sample(s) collected

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**Table 3.20
Concentrations of Metals in Sediments - Kudz Ze Kayah Baseline**

PARAMETER	MDC	UNIT	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8
Arsenic	2	ug/g	19	9	24	78	< 2	15	22	6
Cadmium	n/a	ug/g	14	1	4	60	1	2	9	2
Cobalt	n/a	ug/g	15	7	6	37	5	10	13	10
Chromium	n/a	ug/g	35	11	18	23	9	10	16	23
Copper	n/a	ug/g	69	20	37	99	27	18	40	28
Iron	n/a	ug/g	39400	18900	17300	55800	314700	36900	44600	27500
Manganese	n/a	ug/g	1129	429	284	30397	2794	3002	5043	933
Molybdenum	2	ug/g	3	< 2	< 2	8	< 2	< 2	2	2
Nickel	n/a	ug/g	40	12	17	69	12	22	37	25
Lead	n/a	ug/g	33	40	57	190	30	24	26	26
Zinc	n/a	ug/g	903	309	991	4794	295	215	1113	745

**Table 3.21
Average Metal Concentrations in Sediments from the Kudz Ze Kayah Area Compared to Metals Levels in Sediments from the Southeastern Yukon**

PARAMETER	MDC	UNIT	SITE 1	SITE 4	SITE 7	SITE 9	SITE 13	SITE 20	YUKON (1)	
									50% ile	95% ile
Arsenic	10	ug/g	14	35	10	74	11	46	9	70.0
Cadmium	0.1	ug/g	12.5	10.2	0.8	5.3	0.9	1.2	0.6	4.4
Cobalt	0.3	ug/g	13.9	14.3	7.9	17.6	9.9	15.0	10.0	23.0
Chromium	0.2	ug/g	17.5	17.4	16.0	26.5	22.7	50.1	n/a	n/a
Copper	0.1	ug/g	63.3	60.8	13.5	40.5	17.1	35.1	29.0	69.0
Iron	0.3	ug/g	29133	39633	27800	58767	24333	60600	24600	40200
Manganese	0.2	ug/g	689	798	293	9057	918	9780	345	2130
Molybdenum	0.4	ug/g	1.6	0.8	0.4	3.4	0.8	1.3	1.0	8.0
Nickel	0.8	ug/g	36.7	36.9	18.0	41.2	25.0	127.7	37.0	121.0
Lead	2.0	ug/g	25.7	81.7	13.7	21.3	14.7	12.0	14.0	45.0
Zinc	0.2	ug/g	792	1273	186	606	165	179	131	504

(1) Source: Geological Survey of Canada data (Hornbrook et al. 1988)
n/a - not available

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Table 3.22
Correlation Between Concentrations of Metals in Stream Sediments, Kudz Ze Kayah Area

1994 DATA FOR ALL SITES (2)											
Metal	Arsenic	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Molybdenum	Nickel	Lead	Zinc
Arsenic	1.000	0.973	0.934	0.214	0.864	0.706	0.965	0.975	0.873	0.966	0.976
Cadmium	0.973	1.000	0.982	0.395	0.921	0.764	0.968	0.994	0.928	0.953	0.983
Cobalt	0.934	0.982	1.000	0.438	0.901	0.842	0.948	0.995	0.965	0.897	0.956
Chromium	0.214	0.395	0.438	1.000	0.675	0.314	0.173	0.048	0.578	0.230	0.359
Copper	0.864	0.921	0.901	0.675	1.000	0.727	0.803	0.914	0.925	0.816	0.886
Iron	0.706	0.764	0.842	0.314	0.727	1.000	0.762	0.804	0.910	0.558	0.699
Manganese	0.965	0.968	0.948	0.173	0.803	0.762	1.000	0.967	0.859	0.950	0.964
Molybdenum	0.975	0.994	0.995	0.048	0.914	0.804	0.967	1.000	0.962	0.992	0.982
Nickel	0.873	0.928	0.965	0.578	0.925	0.910	0.859	0.962	1.000	0.784	0.900
Lead	0.966	0.953	0.897	0.230	0.816	0.558	0.950	0.992	0.784	1.000	0.967
Zinc	0.976	0.983	0.956	0.359	0.886	0.699	0.964	0.982	0.900	0.967	1.000
1995 DATA FOR ALL SITES											
Metal	Arsenic	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Molybdenum	Nickel	Lead	Zinc
Arsenic	1.000	0.032	0.860	0.475	0.250	0.918	0.853	0.825	0.421	0.083	0.194
Cadmium	0.032	1.000	0.452	-0.429	0.942	-0.097	-0.286	0.213	-0.216	0.634	0.880
Cobalt	0.860	0.452	1.000	0.409	0.662	0.800	0.702	0.802	0.459	0.251	0.469
Chromium	0.475	-0.429	0.409	1.000	-0.120	0.750	0.831	0.194	0.957	-0.372	-0.428
Copper	0.250	0.942	0.662	-0.120	1.000	0.196	-0.010	0.293	0.101	0.650	0.868
Iron	0.918	-0.097	0.800	0.750	0.196	1.000	0.949	0.636	0.733	-0.030	0.028
Manganese	0.853	-0.286	0.702	0.831	-0.010	0.949	1.000	0.667	0.748	-0.324	-0.245
Molybdenum	0.825	0.213	0.802	0.194	0.293	0.636	0.667	1.000	0.112	-0.149	0.150
Nickel	0.421	-0.216	0.459	0.957	0.101	0.733	0.748	0.112	1.000	-0.198	-0.234
Lead	0.083	0.634	0.251	-0.372	0.650	-0.030	-0.324	-0.149	-0.198	1.000	0.906
Zinc	0.194	0.880	0.469	-0.428	0.868	0.028	-0.245	0.150	-0.234	0.906	1.000

- (1) 95% significance levels are 0.707 for 1994 data and 0.811 for 1995 data
 (2) anomolous iron concentration at site 5 excluded

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Table 3.23
Correlation Between Concentrations of Metals in Sediments, Wolverine Area

STREAMS

	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Molybdenum	Nickel	Lead	Zinc	DOC
Cadmium		-0.075	-0.399	0.242	0.057	-0.142	-0.107	-0.097	-0.078	0.483	-0.331
Cobalt	-0.075		0.777	0.529	0.967	0.298	0.108	0.431	-0.149	0.007	0.029
Chromium	-0.399	0.777		0.537	0.730	0.218	0.005	0.684	-0.068	-0.115	-0.084
Copper	0.242	0.529	0.537		0.513	-0.089	-0.165	0.316	0.037	0.020	-0.268
Iron	0.057	0.967	0.730	0.513		0.289	0.087	0.410	-0.224	-0.024	0.002
Manganese	-0.142	0.298	0.218	-0.089	0.289		0.789	0.147	-0.248	0.501	0.321
Molybdenum	-0.107	0.108	0.005	-0.165	0.087	0.789		-0.325	-0.447	0.335	0.757
Nickel	-0.097	0.431	0.684	0.316	0.410	0.147	-0.325		0.148	0.047	-0.545
Lead	-0.078	-0.149	-0.068	0.037	-0.224	-0.248	-0.447	0.148		0.198	-0.492
Zinc	0.483	0.007	-0.115	0.020	-0.024	0.501	0.335	0.047	0.198		-0.269
DOC	-0.331	0.029	-0.084	-0.268	0.002	0.321	0.757	-0.545	-0.492	-0.269	

LAKES

	Cadmium	Cobalt	Chromium	Copper	Iron	Manganese	Molybdenum	Nickel	Lead	Zinc	DOC
Cadmium		0.641	0.699	0.929	0.015	-0.145	-0.756	0.270	0.773	0.981	0.843
Cobalt	0.641		0.377	0.820	0.578	0.557	-0.853	0.696	0.266	0.719	0.192
Chromium	0.699	0.377		0.747	-0.399	-0.374	-0.248	0.465	0.391	0.780	0.650
Copper	0.929	0.820	0.747		0.212	0.013	-0.783	0.556	0.522	0.968	0.651
Iron	0.015	0.578	-0.399	0.212		0.583	-0.523	0.355	-0.304	0.018	-0.346
Manganese	-0.145	0.557	-0.374	0.013	0.583		-0.323	0.244	-0.177	-0.066	-0.571
Molybdenum	-0.756	-0.853	-0.248	-0.783	-0.523	-0.323		-0.507	-0.587	-0.738	-0.495
Nickel	0.270	0.696	0.465	0.556	0.355	0.244	-0.507		-0.097	0.396	0.058
Lead	0.773	0.266	0.391	0.522	-0.304	-0.177	-0.587	-0.097		0.691	0.850
Zinc	0.981	0.719	0.780	0.968	0.018	-0.066	-0.738	0.396	0.691		0.768
DOC	0.843	0.192	0.650	0.651	-0.346	-0.571	-0.495	0.058	0.850	0.768	

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Table 3.24
Chronology of Fisheries Fieldwork Methods and Observations in the Kudz Ze Kayah Area, 1994&95

DATES	METHODS	OBSERVATIONS
940715	WATER QUALITY SAMPLING	LOW WATER
940815	WATER QUALITY SAMPLING	LOW WATER
941130	TRAVEL VAN-WH-RR	
941201	AERIAL SURVEY OF TOTE ROAD	SNOW/ICE, MAINSTEMS MOSTLY OPEN
941202	AERIAL SURVEY OF ALL ROAD CORRIDORS	
941203	WATER QUALITY SAMPLING AT STATIONS 2,3,6,9,13,14,15,16&17	#3 DRY/FROZEN
941204	HABITAT RE ROAD CROSSINGS	SOME FROZEN; STEEP GRADIENTS
950410	WATER QUALITY	SOME FROZEN...
950503	AERIAL RECONN. AT SPRING BREAKUP	LAKES STILL FROZEN, STREAMS MOSTLY OPEN
950504	SET UP LAB & ASSEMBLED WEIR TRAPS	
950505	SET UP LAB & ASSEMBLED TRAPS	
950506	ELECTROFISHING IN GEONA CREEK AND TOTE ROAD CREEKS	NO FISH FOUND
950507	SET WEIR TRAPS IN UPPER GEONA AND SOUTH CREEKS	GOOD SETS ACROSS THE CREEKS
950508	WATER QUALITY AT STATIONS 26,21,15,16,5,13	
950509	TOTE ROAD STREAM SURVEYS	STEEP GRADIENT & FALLS BARRIERS IN MOST
950510	TOTE ROAD STREAM SURVEYS	SEE ABOVE
950511	ELECTROFISHING IN GEONA AND FINLAYSON CREEKS	ARCTIC GRAYLING
950512	TRAVEL	
*		
950530	TRAVEL	
950531	ELECTROFISHING IN FINLAYSON/GEONA CREEKS & NORTH RIVER	ARCTIC GRAYLING IN FINLAYSON/GEONA; AG+WF+LT+BB+SS IN NORTH LAKES
950601	ELECTRO. IN NORTH RIVER AND LOWER GEONA CREEK	SEE ABOVE; LARGE AG IN LOWER FINLAYSON
950602	ELECTRO. IN MID & LOWER FINLAYSON	AS ABOVE
950603	ELECTRO. IN GEONA & SOUTH CREEK PONDS	AG IN BOTH SYSTEMS; BB ALSO IN SOUTH CREEK
950604	ANGLING IN EAST CREEK LAKE AND NORTH LAKE	NO FISH CAUGHT IN EAST CREEK; AG IN NORTH LAKE
950605	BOAT ELECTRO. IN GEONA PONDS; ELECTRO. UPPER EAST CREEK	AG IN GEONA PONDS; NO FISH IN UPPER EAST
950606	ELECTRO. MID EAST CREEK; RECONN. UPPER CAMPBELL CREEK	NO FISH IN MID EAST CREEK
950607	ELECTRO. LOWER GEONA AT ALL BEAVER PONDS; ANGLED CAMPBELL LAKE	NO FISH IN GEONA; AG IN CAMPBELL CREEK LAKE
950608	RECONN. TOTE ROAD CREEKS; REPORT PREPARATION	BRIDGE REQUIRED FOR FINLAYSON AND ONE OTHER CREEK ONLY
950609	ELECTRO. GEONA CREEK IN PROPOSED TAILINGS AREA; LIFTED TRAPS FROM CAMPBELL CREEK	NO FISH CAUGHT IN MID-LOWER GEONA CREEK
950610	WATER QUALITY SAMPLING	
950611	WATER QUALITY SAMPLING	
950612	TRAVEL	
*	WEIR TRAP IN EAST CREEK REMOVED ON AUGUST 1, 1995	CAPTURED APPROXIMATELY 595 AG
950908	TRAVEL; BENTHIC SAMPLING AT STNS 19 & 20	
950909	BENTHIC SAMPLING AT STNS 9 & ____	
950910	ELECTRO. & GEE TRAPS IN GEONA CREEK; ELECTRO. IN NORTH LAKES RIVER; DIVE IN UPPER EAST CREEK POND	NO FISH FOUND IN GEONA; AG, BB & SS IN NORTH SYSTEM
950911	ELECTRO. LOWER FINLAYSON CREEK	LARGE AG (FROM FINLAYSON RIVER?)
950912	WATER QUALITY AT STATIONS 26,15,17,16,7&5 WITH DIAND, AND AT 21,15,9,10,23,27,22,28,20&19	AUDIT/DUPLICATE SAMPLING WITH DIAND
950913	WATER QUALITY AT STATIONS 2,3,13,24,1,12,18	
950914	SEDIMENT SAMPLING AT STATIONS 1,4,5,7,9,13&20; CHECKED TRAPS	SEDIMENTS READILY FOUND; NO FISH AT TRAPS
950915	LAKE BENTHIC SAMPLING IN UPPER GEONA AT STATIONS 11 AND 25	SILTY SUBSTRATES
950916	DIVE IN CIRQUE LAKE AND SMALL POND NEAR NORTH LAKE RE COMPENSATION PLAN	NO FISH; GOOD HABITAT
950917	ZOOPLANKTON SAMPLING IN NORTH LAKES AT STATIONS 23 & 24	SUNNY DAY; LOTS OF PLANKTON
950918	ZOOPLANKTON AND BENTHIC SAMPLING IN UPPERMOST LAKE IN SOUTH CREEK AND PLANKTON SAMPLING IN THE SECOND LAKE	SUNNY DAY; LOTS OF PLANKTON; SILTY BOTTOM
950919	ZOOPLANKTON SAMPLING IN EAST LAKE; BENTHIC SAMPLING IN SOUTH CREEK AT STATION 13; REVISITED CIRQUE LAKE	MODERATE PLANKTON; CIRQUE LAKE BEGINNING TO FREEZE OVER
950920	ZOOPLANKTON SAMPLING IN UPPER GEONA PONDS AT STATIONS 11 AND 25	MODERATE AMOUNTS OF PLANKTON
950921	RETRIEVED WEIR TRAPS FROM GEONA AND SOUTH CREEKS	NO FISH
950922	TRAVEL	
*	WEIR TRAPS CONTINUED TO FISH IN THESE PERIODS AND WERE MONITORED BY AN ON-SITE ENVIRONMENTAL TECHNICIAN	

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Table 3.25
Summary of Benthic Invertebrate Sampling Results in the Kudz Ze Kayah Study Area, September 1995

STATION	# TAXA	DIVERSITY	#/m2	COMMENTS
9	34.2	0.85	162,886	Geona Creek below Kudz Ze Kayah
11	20.6	0.32	224,944	uppermost Geona pond; many chironomids
12	18.4	1.01	35,503	uppermost pond in South Creek
13	35.2	0.84	78,186	lower South Creek
14	34.8	1.16	109,726	North River below eastern North Lake
15	35.0	1.18	53,251	Finlayson Creek just below Geona Creek
16	27.6	0.98	30,086	Finlayson Creek just above Geona Creek
19	27.2	1.21	9,620	upper East Creek; large substrate
20	32.6	0.81	245,866	East Creek above East Lake
21	38.0	1.15	74,577	lower East Creek
25	12.6	0.78	8,997	second Geona Creek pond; many chironomids
27	31.2	1.15	118,080	North River below South Creek

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Table 3.26
In-Situ Water Quality at the Kudz Ze Kayah Zooplankton Sampling Sites, September 1995

STATION	DATE	DEPTH	SUBSTRATE	TEMP	OXYGEN	COND	COMMENTS
GEONA POND (11)	950920	2	SILT, BOULDER	7	11.6	152	SUNNY DAY
GEONA POND (25)	950920	2	SILT, BOULDER	6	9.2	130	SUNNY DAY
UPPER SOUTH LAKE (12)	950918	6	SILT	9	10.4	120	SUNNY DAY
SECOND SOUTH LAKE (24)	950918	4	SILT	10	10.2	110	SUNNY DAY
UPPER NORTH LAKE (22)	950917	6	SILT	7	11.2	67	SUNNY DAY
SECOND NORTH LAKE (23)	950917	20	SILT	7	10.8	75	SUNNY DAY
EAST LAKE (28)	950919	6	SILT	7.5	10.3	215	SUNNY DAY

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**Table 3.27
Summary of Zooplankton Sampling Results in the Kudz Ze Kayah Study Area
September, 1995**

STATION	# TAXA	#/m³	Kg/m³	COMMENTS
11	41	368,558	2.3	uppermost pond in Geona Creek; includes "benthic forms" esp. chironomids
12	6	82,516	4.7	uppermost pond in South Creek; includes benthic forms
22	9	16,992		eastern North Lake
23	8	18,426		largest North Lake
24	5	41,055	1.6	second pond in upper South Creek
25	32	784,982	2.9	second Geona pond; many chironomids
28	4	28,690	1.7	East Creek lake

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Table 3.28
Fish Catches in the Kudz Ze Kayah Study Area, 1995

LOCATION	DATE	SPECIES	SAMPLE #	SEX	LENGTH	WEIGHT	=K x 10 ⁵	C=LB/IN ³	AGE	NOTES	
GEONA CREEK	950506	AG		I	80				(2+)	RELEASED; 2 - 70-80 mm AG sighted	
		AG		I	89				(2+)	METALS ANAL.	
	950603	AG	GCAG-1	I	83	5.0	0.87	3.16E-04	(2+)	METALS	
		AG	GCAG-2	I	87	6.0	0.91	3.29E-04	(2+)	METALS	
		AG	GCAG-3	I	84	5.0	0.84	3.05E-04	(2+)	METALS	
		AG	GCAG-4	I	84	6.5	1.10	3.96E-04	(2+)	METALS	
		AG	GCAG-5	I	87	6.9	1.05	3.79E-04	(2+)	METALS	
		AG	GCAG-6	I	94	8.0	0.96	3.48E-04	(2+)	METALS	
		AG	GCAG-7	I	95	8.0	0.93	3.37E-04	(2+)	METALS	
		AG	GCAG-8	I	82	5.2	0.94	3.41E-04	(2+)	METALS	
		AG	GCAG-9	I	90	6.3	0.86	3.12E-04	(2+)	METALS	
		AG	GCAG-10	I	85	6.0	0.98	3.53E-04	(2+)	METALS	
		AG	GCAG-11	I	85	6.3	1.03	3.71E-04	(2+)	METALS	
		AG	GCAG-12	I	100	9.6	0.96	3.47E-04	(2+)	METALS	
		AG	GCAG-13	I	90	7.0	0.96	3.47E-04	(2+)	METALS	
		AG	GCAG-14	I	98	8.0	0.85	3.07E-04	(2+)	METALS	
		AG	GCAG-15	I	84	5.3	0.89	3.23E-04	(2+)	METALS	
		AG	GCAG-16	I	100	9.5	0.95	3.43E-04	(2+)		
		AG	GCAG-17	I	95	8.0	0.93	3.37E-04	(2+)		
		AG	GCAG-18	I	84	4.6	0.78	2.80E-04	(2+)		
		AG	GCAG-19	I	91	7.4	0.98	3.55E-04	(2+)		
		AG	GCAG-20	I	93	6.6	0.82	2.96E-04	(2+)		
		AG	GCAG-21	I	83	5.7	1.00	3.60E-04	(2+)		
		AG	GCAG-22	I	95	8.2	0.96	3.46E-04	(2+)		
		AG	GCAG-23	I	85	6.1	0.99	3.59E-04	(2+)		
		AG	GCAG-24	I	83	5.5	0.96	3.48E-04	(2+)		
		AG	GCAG-25	I	84	6.0	1.01	3.66E-04	(2+)		
		AG	GCAG-26	I	87				(2+)		
		AG	GCAG-27	I	84				(2+)		
		AG	GCAG-28	I	87				(2+)		
		AG	GCAG-29	I	88				(2+)		
		AG	GCAG-30	I	87				(2+)		
		AG	GCAG-31	I	88				(2+)		
		AG	GCAG-32	I	88				(2+)		
		AG	GCAG-33	I	84				(2+)		
		AG	GCAG-34	I	85				(2+)		
		AG	GCAG-35	I	77				(2+)		
		AG	GCAG-36	I	83				(2+)		
		AG	GCAG-37	I	88				(2+)		
		AG	GCAG-38	I	95				(2+)		
		AG	GCAG-39	I	97				(2+)		
		AG	GCAG-40	I	93				(2+)		
		AG	GCAG-41	I	88				(2+)		
		AG	GCAG-42	I	85				(2+)		
		AG	GCAG-43	I	96				(2+)		
		AG	GCAG-44	I	85				(2+)		
		950605	AG	GCAG-45	I	147	36.6	1.15	4.16E-04	2+	
		950606	AG	GCAG-46	I	80	5.0	0.98	3.53E-04		POND AREA
			AG	GCAG-47	I	71	3.9	1.09	3.94E-04		POND AREA
			AG	GCAG-48	M	172	55.0	1.08	3.91E-04	2+	POND AREA
			AG	GCAG-49	I	162	50.0	1.18	4.25E-04	2+	POND AREA
		AG	GCAG-50	I	163	42.0	0.97	3.50E-04	2+	POND AREA	
		AG	GCAG-51	I							
		MEANS	GCAG1-60	M/F/I	93.62	11.6	0.97	3.49E-04			
		SLOPE	GCAG1-60					3.17		SLOPE OF LOG/LOG REGRESSION	
NORTH RIVER/LAKES	950531	AG	NLAG-1	M	246	162.0	1.09	3.93E-04	4+	METALS	
		AG	NLAG-2	F	231	141.0	1.14	4.13E-04	4+	METALS	
		AG	NLAG-3	I	159	36.5	0.91	3.28E-04		PLUS 2 AG ESCAPEES	
	950601	AG	NLAG-4	M	382	620.0	1.11	4.02E-04	4+	METALS	
		AG	NLAG-5	M	375	600.0	1.14	4.11E-04	6+	METALS	
		AG	NLAG-6	M	372	590.0	1.15	4.14E-04	4+	METALS	
		AG	NLAG-7	M	402	640.0	0.99	3.56E-04	6+	METALS; PEDUCNACLE DISEASE	
		AG	NLAG-8	I	80	4.9	0.96	3.46E-04		METALS	
		AG	NLAG-9	I	163	41.0	0.95	3.42E-04		METALS	
	950604	AG	NLAG-10	M	399	685.0	1.08	3.90E-04	10+	ANGLED	
		AG	NLAG-11	M	408	795.0	1.17	4.23E-04	10+	ANGLED; SEE ABOVE	
		MEANS	NLAG1-11		292.45	392.3	1.06	3.83E-04			
		SLOPE						3.12		LOG/LOG REGRESSION	

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Table 3.28
Fish Catches in the Kudz Ze Kayah Study Area, 1995

LOCATION	DATE	SPECIES	SAMPLE #	SEX	LENGTH	WEIGHT	=K x 10 ⁵	C=LB/IN ³	AGE	NOTES
	950601	MW	NLWF-1	F	341	430.0	1.08	3.92E-04		ARCHIVED
		MW	NLWF-2	M	402	620.0	0.95	3.45E-04		ARCHIVED
		MW	NLWF-3	F	300	290.0	1.07	3.88E-04		ARCHIVED
		MW	NLWF-4	F	357	480.0	1.05	3.81E-04		EGGS <1 MM; ARCHIVED
		MW	NLWF-5	F	359	440.0	0.95	3.44E-04		ARCHIVED
		MW	NLWF-6	F	292	210.0	0.84	3.05E-04		ARCHIVED
		MW	NLWF-7	M	298	215.0	0.81	2.94E-04		IMMATURE; ARCHIVED
		MW	NLWF-8	F	271	186.0	0.93	3.38E-04		ARCHIVED
		MEANS	NLWF1-8	M&F	327.5	368.9	0.96	3.48E-04		
	950531	BB	NLBB-1	I	110	8.5	0.64	2.31E-04		METALS
		BB	NLBB-2	I	120	13.0	0.75	2.72E-04		METALS
		BB	NLBB-3	I	131	17.5	0.78	2.81E-04		METALS
		BB	NLBB-4	I	260	112.0	0.64	2.30E-04		PLUS 1 BB ESCAPEE
	950601	BB	NLBB-5	I	112	8.1	0.58	2.08E-04		METALS
		BB	NLBB-6	I	126	12.5	0.62	2.26E-04		METALS
		MEANS	NLBB1-6	I	143.16667	37.8	0.67	2.64E-04		
	950531	SS	NLSS-1	?	90	6.7				METALS
		SS	SIX (6)	?	80-120					METALS
FINLAYSON CREEK	950602	AG	FCAG-1	M	347	400.0	0.96	3.46E-04	4+	
		AG	FCAG-2	F	319	380.0	1.17	4.23E-04	4+	
		AG	FCAG-3	M	339	425.0	1.09	3.94E-04	6+	SPAWNED
		AG	FCAG-4	M	361	510.0	1.08	3.92E-04	6+	SPAWNED
		AG	FCAG-5	F	357	615.0	1.35	4.88E-04	12+	
		AG	FCAG-6	F	339	400.0	1.03	3.71E-04	6+	
		AG	FCAG-7	F	320	320.0	0.98	3.53E-04	7+	
		AG	FCAG-8	F	313	293.0	0.96	3.45E-04	4+	
		MEANS	FCAG1-8	M&F	336.9	417.9	1.08	3.89E-04		
		SLOPE						3.95		LOG/LOG REGRESSION
	950511	SS		?	110					METALS
	950602	SS	FCSS	?	70-90					LOWER CREEK; TWO (2) SS; METALS
		SS	FCSS	?	70-110					UPPER CREEK; ELEVEN (11); METALS
SOUTH CREEK LAKES	950603	AG	SCAG-1	F	299	300.0	1.12	4.05E-04	7+	SPAWNED OUT; METALS
		AG	SCAG-2	M	296	290.0	1.12	4.04E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-3	M	283	205.0	0.90	3.27E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-4	M	303	305.0	1.10	3.96E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-5	M	327	323.0	0.92	3.34E-04	7+	PARTIALLY SPAWNED; METALS
		AG	SCAG-6	M	326	340.0	0.98	3.55E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-7	M	292	280.0	1.12	4.06E-04	4+	PARTIALLY SPAWNED; METALS
		AG	SCAG-8	F	286	225.0	0.96	3.47E-04	6+	RETAINED EGGS (3 MM); METALS
		AG	SCAG-9	F	282	285.0	1.27	4.59E-04	6+	SPAWNED OUT; METALS
		AG	SCAG-10	M	316	320.0	1.01	3.66E-04	6+	PARTIALLY SPAWNED; CYSTS ON STOMACH; METALS
		AG	SCAG-11	M	294	275.0	1.08	3.91E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-12	F	293	250.0	0.99	3.59E-04	6+	SPAWNED OUT; METALS
		AG	SCAG-13	M	276	240.0	1.14	4.12E-04	6+	PARTIALLY SPAWNED; METALS
		AG	SCAG-14	I	78					
		AG	SCAG-15	I	80					
		MEANS	SCAG1-15	M/F/I	268.7	279.8	1.06	3.82E-04		
		SLOPE	SCAG1-13					2.25		LOG/LOG REGRESSION
		SS	SCBB-1	I	120	120.0		2.51E-03		
		SS	SCBB-2	I	188	356.0		1.94E-03		
EAST CREEK		AG	ECAG-1		305.0	325.0	1.15	4.14E-04		
		AG	ECAG-2		345.0	522.0	1.27	4.59E-04		
		AG	ECAG-3		346.0	505.0	1.22	4.40E-04		
		AG	ECAG-4		265.0	185.0	0.99	3.59E-04		
		AG	ECAG-5		234.0	130.0	1.01	3.67E-04		
		AG	ECAG-6		213.0	92.0	0.95	3.44E-04		
		MEANS	ECAG1-6		284.7	293.2	1.10	3.97E-04		
		SLOPE						3.66		LOG/LOG REGRESSION

PLUS APPROX. 650 ARCTIC GRAYLING DURING THE SUMMER IN THE EAST CREEK FISH TRAP (SEE APPENDIX 3.4A).
(these fish were measured but not weighed due to sampling volume and live-release)

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Table 3.28
Fish Catches in the Kudze Kayah Study Area, 1995

LOCATION	DATE	SPECIES	SAMPLE #	SEX	LENGTH	WEIGHT	=K x 10 ⁵	C=LB/IN ³	AGE	NOTES
FISH CATCHES IN THE FALL OF 1995 IN THE KUDZE KAYAH PROJECT AREA										
LOCATION	DATE	SPECIES	SAMPLE #	SEX	LENGTH	WEIGHT		C=LB/IN ³	AGE	COMMENTS
NORTH RIVER/LAKE	950910	LT	NLLT-1	M	460	1000		3.71E-04		partially spawned
		AG	NLAG-12	M	366	420	0.86	3.10E-04		
			NLAG-13	M	355	560	1.25	4.52E-04		
			NLAG-14	M	259	190	1.09	3.95E-04		
			NLAG-15	M	170	40	0.81	2.94E-04		
			NLAG-16	M	236	150	1.14	4.12E-04		
			NLAG-17	I	240	145	1.05	3.79E-04		immature
			NLAG-18	I	216	105	1.04	3.76E-04		
			NLAG-19	I	199	90	1.14	4.13E-04		
			NLAG-20	I	205	85	0.99	3.56E-04		
			NLAG-21	I	129	22.5	1.05	3.79E-04		
			NLAG-22	I	85	5.5	0.90	3.24E-04		
			NLAG-23	I	87	5.5	0.84	3.02E-04		
			NLAG-24	I	70	3.1	0.90	3.27E-04		
			MEANS	NLAG12-24	M&I	201.30769	140.12308	1.00	3.63E-04	
SLOPE						3.13				
FINLAYSON CREEK	950911	AG	FCAG-9	M	390	590	0.99	3.59E-04		
			FCAG-10	I	161	46	1.10	3.98E-04		
			FCAG-11	I	183	68	1.11	4.01E-04		
			MEANS	FCAG9-11	M/I	244.7	234.7	1.07	3.86E-04	
		SLOPE						2.87		

PLUS FISH OBSERVED DURING DIVER AND BOAT SURVEYS IN GEONA PONDS

NOTES:

1. The Condition Factor (C=W/L³) is expressed in English units to coincide with Piper, 1986. Typical condition factors cited in Piper (1986) include the following:

CF	SPECIES
2.00E-04	Northern Pike
2.50E-04	Lake Trout
3.00E-04	chinook salmon, walleye
3.50E-04	cutthroat trout, coho salmon, steelhead trout
4.00E-04	rainbow, brook and brown trout
4.50E-04	largemouth bass

Age data in parentheses () are probable, based on determined ages of fish samples.

N.B. For species,
AG = Arctic grayling
BB = Burbot
SS = Slimy sculpin
MW = Mountain whitefish
LT = Lake Trout

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**Table 3.29
Habitat Types, Food Preferences, and Body Sizes of the Invertebrate Organisms most Prevalent in Fish Stomach Samples
from the Kudz Ze Kayah Study Area**

TAXON	COMMON NAME	LENGTH (mm)	WEIGHT (mg)	FEEDING STYLE	FOOD	HABITAT
INSECTA	insects					
DIPTERA	two-winged Flies					
Chironomidae	midges & mosquitos	2-7	0.2-8	filter	plankton, detritus	lake, pond
Tipulidae	craneflies	3-20	0.4-416	detritivore/predator	detritus, invertebrates	streams, lakes, swamps
EPHEMEROPTERA	mayflies					
Beatidae	mayflies	3-6	1-11	detritivore/ grazer	detritus, periphyton	streams
PLECOPTERA	stoneflies					
Setipalpia	stoneflies	6-8	5-15	predators	other invertebrates	streams
TRICHOPTERA	caddisflies					
Limnophilidae	caddisflies	10-18	27-400	shredders/ detritivores	detritus	lakes, ponds, streams
MOLLUSCA	shellfish					
Gastropoda	snails					
Lymnaeidae	freshwater snails	3-13	10-384	grazers/ detritivores	periphyton, detritus	ponds, lakes, streams

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Table 3.30
Background Concentrations of Metals in Fish Tissues Near the Kudz Ze Kayah Project

LOCATIONS	SPECIES	SAMPLE #'S	TISSUES	METALS AND CONCENTRATIONS (UG/GM)								
				ARSENIC	CADMIUM	COPPER	LEAD	MERCURY	SELENIUM	TIN	ZINC	
GEONA CREEK	ARCTIC GRAYLING	GCAG-48	WHOLE BODY	<0.2	0.2	4.9	3.5	<0.05	7.5	<2	125	
		GCAG-9-15	WHOLE BODY	<0.2	0.2	4.6	0.5	<0.05	7.6	<2	119	
		GCAG-14-18	WHOLE BODY	<0.2	0.3	5.2	0.5	<0.05	9	<2	126	
		GCAG-45	WHOLE BODY	<0.2	0.2	3.8	1.5	<0.05	8.4	<2	90.6	
		GCAG-46-47	WHOLE BODY	<0.2	1	5.5	0.4	<0.05	9.9	<2	202	
		GCAG-MUSCLE	MUSCLE	<0.2	0.1	1.7	0.1	?	5.8	<2	53.9	
		GCAG-LIVER	LIVER	<0.2	3.6	10.9	0.2	?	26	<2		
		GCAG-GONAD	GONAD	<0.2	0.3	10.9	1.0	?	9.1	<2	211	
		GCAG@#5	WHOLE BODY	<0.2	0.7	3	<0.1	?	3.5	<2	109	
		FINALAYSON CREEK	ARCTIC GRAYLING	FCAG-MUSCLE	MUSCLE	<0.2	<0.1	1.6	0.4	0.1	4.2	<2
FCAG-LIVER	LIVER			<0.2	1.9	16.5	0.2	0.1	21	<2	109	
FCAG-GONAD	GONAD			<0.2	<0.1	4.3	0.3	<0.05	16	<2	156	
SCULPINS	FCSS-1		WHOLE	0.5	0.9	3.9	<0.1	<0.05	3.5	<2	112	
	FCSS-2		WHOLE	0.3	0.2	4.2	0.1	<0.05	5.1	<2	101	
	FCSS-11		WHOLE	0.2	0.3	4.4	2.7	<0.05	5.9	<2	125	
SOUTH CREEK	ARCTIC GRAYLING	SCAG-MUSCLE	MUSCLE	<0.2	<0.1	1.7	0.5	<0.05	9	<2	20.5	
		SCAG-LIVER	LIVER	<0.2	8.7	15.1	<0.1	<0.05	25	<2	109	
		SCAG-GONAD	GONAD	<0.2	0.2	3.9	0.2	<0.05	14	<2	100	
		SCAG-14&15	WHOLE	<0.2	0.2	4.1	<0.1	0.1	7.3	<2	125	
NORTH LAKES	BURBOT	SCBB-1&2	WHOLE	<0.2	<0.1	3.9	0.8	<0.05	7.8	<2	65.1	
		ARCTIC GRAYLING	NLAG-8	WHOLE	<0.2	<0.1	3.8	<0.1	?	5.7	<2	152
NLAG-9	WHOLE		<0.2	<0.1	5.6	6.6	<0.05	7.7	<2	121		
NLAG-MUSCLE	MUSCLE		<0.2	<0.1	1.9	<0.1	0.1	2.5	<2	62.5		
NLAG-LIVER	LIVER		<0.2	0.5	11.9	0.2	?	13	<2	97.5		
NLAG-LIVER (DUP)	LIVER		<0.2	0.1	3.7	0.6	0.1	2.5	<2	23.9		
NLAG-GONAD	GONAD		<0.2	<0.1	9.3	<0.1	?	16	<2	280		
NLAG-GONAD (DUP)	GONAD		<0.2	<0.1	3.3	0.2	<0.05	6	<2	60.9		
BURBOT	NLBB-4		WHOLE	0.3	0.2	5.5	0.6	<0.05	4.1	<2	92.1	
	NLBB-5		WHOLE	<10	<0.1	4.6	<0.1	<0.05	1.5	<2	74.1	
	NLBB-WHOLE		WHOLE	<0.2	<0.1	4.4	0.3	<0.05	1.6	<2	80.2	
SLIMY SCULPIN	NLSS	WHOLE	0.2	0.2	4.3	3.0	<0.05	4.5	<2	128		
	NLSS-WHOLE	WHOLE	<0.2	<0.1	3.2	<0.1	0.2	3.2	<2	128		
EAST CREEK	ARCTIC GRAYLING (ARCHIVED WHOLE)	NLWF-WHOLE	ARCHIVED									
		SLIMY SCULPIN (ARCHIVED)	ECSS	WHOLE								
			LAKE TROUT	NLLT-MUSCLE	MUSCLE	<0.2	0.5	1.4	0.3	0.1	1.7	,2
	NLLT-LIVER			LIVER	<0.2	1.2	47.2	0.1	?	11	<2	169
	NLLT-GONAD	GONAD		<0.2	<0.1	4.1	0.2	?	8.4	<2	95.8	
	ARCTIC GRAYLING (ARCHIVED WHOLE)	ECAG-MUSCLE	MUSCLE									
ECAG-LIVER		LIVER										
ECAG-GONAD		GONAD										

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**Table 3.31
Morphoedaphic Indices for the Lakes in the Kudz Ze Kayah Study Area**

LAKE	AREA (m ²)	MEAN DEPTH (m)	TDS (mg/l)	Ryder Bio-Index	N&L Index	Ryder Total "Yield"	N&L Total "Yield"
UPPER GEONA POND	17,700	1	148	24.3	24.1	349	346
SECOND GEONA POND	8,280	1	120	21.9	22.2	147	149
THIRD GEONA POND	20,500	1.5	120	17.9	21.6	446	539
UPPER SOUTH POND	38,800	2	119	15.4	21.2	970	1,330
SECOND SOUTH POND	91,000	2	100	14.1	19.8	2,085	2,917
UPPER NORTH LAKE	1,120,000	3	87	10.8	18.3	29,318	49,691
LARGE NORTH LAKE	2,544,000	10	100	6.3	17.8	130,352	366,647
UPPER EAST LAKE	80,000	1.5	200	23.1	26.3	2,245	2,562
EAST CREEK LAKE	163,000	3	224	17.3	26.3	6,847	10,417
CIRQUE LAKE	61,500	3	150	14.1	22.5	2,114	3,367

Notes:

The Ryder index is based on the formula $Y = 2 \cdot \text{SQRT}(\text{TDS}/\text{DEPTH})$

The N&L (Northcote and Larkin) index is based on the formula:

$$0.38585 (\text{Log TDS}) + 0.54453$$

"Yields" are predicted from the morphoedaphic indices and represent potential instantaneous yield (standing crop) of all fish species in each lake in pounds, based on the mean depth and TDS data.

Mean depths are based on visual observations for all but the largest North Lake for which the mean depth is assumed.

The TDS values for Upper East Creek Lake and Cirque Lake are approximate from nearby/downstream readings

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Table 3.32
Summary of Stream Benthic Invertebrate Communities - Wolverine Area

Station	Nougha Cr @ outlet W1		Go Creek W12		Money Cr d/s Go Cr W14		Nougha Cr @ Hwy W21		Money Cr u/s Dollar W23		Wind Cr W26	
Date Sampled (1996)	Aug 22		Aug 21		Aug 21		Aug 22		Aug 21		Aug 22	
Sensitive	709		349		1493		616		709		266	
Facultative	9816		1201		1750		1250		2664		15735	
Tolerant	91		53		52		28		46		0	
Total	10616		1604		3295		1894		3418		16002	
%												
Sensitive	6.7		21.8		45.3		32.5		20.7		1.7	
Facultative	92.46		74.9		53.1		66.0		77.9		98.3	
Tolerant	0.86		3.3		1.6		1.5		1.3		0.0	
# of Taxa	45		46		50		52		50		63	
Shannon Wiener Diversity	3.07		3.35		3.03		3.92		3.02		2.83	
Dominance	0.21		0.19		0.22		0.10		0.24		0.22	
Equitability	0.56		0.61		0.54		0.69		0.54		0.47	
Richness	4.75		6.10		6.05		6.76		6.02		6.40	
TU Diversity	0.79		0.81		0.78		0.90		0.76		0.78	
Variance	0.12		0.11		0.08		0.02		0.14		0.08	
Date	July 16	Aug 22	July 15	Aug 21	July 15	Aug 21	July 16	Aug 22	July 15	Aug 21	July 16	Aug 22
Temp (°C)	11.9	10.5	5.9	5.4	6.1	5.7	9.8	9.7	8.3	8.1	15.6	10.0
D.O. (mg/L)	10.2	11.5	11.3	12	11.2	12.9	10.3	10.9	10.1	11.9	18.8	10.1
D.O. (% Sat.)	109	120	102	112	106	121	103	109	100	117	218	105
Cond (µS/cm)	134.4	140.7	128.6	139.4	124.3	136.3	174.9	188.6	95.5	104.6	294	299
pH	9.02	8.73	8.44	8.27	7.76	7.95	8.53	8.16	7.73	8.02	8.73	7.98
Depth at Basket (m)	0.3 - 0.4		0.4		0.5 - 0.6		0.2 - 0.3		0.5		0.2	
Velocity at Basket (m/s)	0.8		0.4		0.6		1.1		0.2		0.1	

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**Table 3.33
Summary of Wolverine Creek Benthic Community**

Station	Wolverine Creek W9			
	Date Sampled (1997)	May	July	September
Density (#/m ²)		280	1367	4103
Sensitive		27	157	793
Facultative		240	1200	3233
Tolerant		13	10	77
%				
Sensitive		9.52	11.46	19.33
Facultative		85.71	87.80	78.80
Tolerant		4.76	0.73	1.87
# of Taxa		18	20	39
Shannon Wiener Diversity		2.88	2.20	2.92
Dominance		0.22	0.36	0.22
Equitability		0.69	0.51	0.55
Richness		5.102	3.864	6.315
TU Diversity		0.804	0.642	0.779
Variance		0.081	0.222	0.097

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**Table 3.33
Taxonomic Composition of Wolverine Creek Benthic Community**

THE PERCENTAGE OF COMPOSITION OF DIFFERENT TAXONOMIC GROUPS AT WOLVERINE CREEK IN 1997			
Taxonomic Order	May	July	September
Ephemeroptera	7.1	8.8	0.2
Plecoptera	1.2	2.4	18.3
Diptera	72.6	81.0	74.1
Hydracarina	3.6	5.9	1.0
Other	15.6	1.8	6.4
Note: Other includes one or more of the following: Collembola Homoptera Thysanoptera Aranaea Copepoda Oligochaeta Nematoda Turbellaria Amphipoda			

TAXONOMIC DISTRIBUTION OF BENTHIC INVERTEBRATES AT WOLVERINE CREEK IN 1997				
Month	Dominant	Subdominant	Common	Rare
May	Diptera	Other	Ephemeroptera Hydracarina Plecoptera	
July	Diptera		Ephemeroptera Hydracarina Plecoptera Other	
September	Diptera	Plecoptera	Other Hydracarina	Ephemeroptera

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Table 3.34
Summary of Lake Benthic Invertebrate Communities - Wolverine Area

Station	Little Jimmy L. M1a	Wolverine Lake west of island W3a	Wolverine Lake in bay near mouth of Wolf Creek W5a	Wolverine Lake off point 1 km east of Viking Creek W7a	Little Wolverine L. near outlet W10a
Date Sampled	23-Aug-96	23-Aug-96	23-Aug-96	23-Aug-96	20-Aug-96
Sensitive	2	11	1	0	6
Facultative	853	513	2692	1832	1583
Tolerant	614	128	735	439	510
Total	1469	652	3428	2272	2099
%					
Sensitive	0.2	1.6	0.0	0.0	0.3
Facultative	58.03	78.8	78.5	80.6	75.4
Tolerant	41.81	19.6	21.4	19.3	24.3
# of Taxa	35	48	43	36	54
Shannon Wiener Diversity	3.37	3.92	3.26	3.21	3.89
Dominance	0.15	0.11	0.18	0.18	0.11
Equitability	0.66	0.70	0.60	0.62	0.68
Richness	4.66	7.25	5.16	4.53	6.93
TU Diversity	0.85	0.89	0.83	0.82	0.89
Variance	0.05	0.03	0.07	0.07	0.02
Date	July 16	July 15	July 15	July 16	July 15
Temp (°C)	11.3	11.0	11.2	11.3	11.7
D.O. (mg/L)	10.3	10.2	9.9	10.2	12.5
D.O. (% Sat.)	108	107	107	108	135
Cond (µS/cm)	84.7	116.9	116.9	116.6	114.9
pH	8.24	8.16	8.16	8.31	7.90
Average Depth of Samples (m)	1.8	3.0	1.2	2.5	0.5

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Table 3.35
Summary of Zooplankton Data for Lakes in the Wolverine Area

	Little Wolverine	Little Jimmy	Wolverine	
Density (#/m³)				
Cladocerans	192		12	
Copepods	3,591	16,141	3,177	
Rotifers	7,322	411	1,412	
Total	11,105	16,552	4,601	
Average size (microns)				
Cladocerans				
DAPHNIA pulex			2128	
BOSMINA longispina	654		615	
Copepods				
HETEROCOPE septentrionalis	Female	2436	2790	3073
	Male	2339	2770	2998
DIAPTOMUS pribilofensis	Female	1547	1332	1438
	Male	1413	1204	1288
DIAPTOMUS ashlandi	Female			801
	Male			781

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Table 3.36
Catch Composition by Lake, Species, and Mesh Size for Index Gillnetting in the Wolverine Area

Location	Species	mesh size (cm)			total
		3.8	6.4	8.9	
Wolverine Lake	Arctic grayling				
	N	3	28	32	63
	Kg of fish	1.7	14.28	22.04	38.02
	Lake Trout				
	N	5	27	25	57
	Kg of Fish	1.83	21.65	48.52	72.00
	TOTALS				
N	8	55	57	120	
Kg of Fish	3.53	35.93	70.56	110.02	
Little Wolverine Lake					
	Species	3.8	6.4	8.9	total
	Arctic grayling				
	N	5	30	22	57
	Kg of Fish	1.92	11.2	9.45	22.57
	Lake Trout				
	N	5	11	9	25
	Kg of Fish	5.28	14.83	13.5	33.6
	Longnose sucker				
	N	0	0	4	4
	Kg of Fish	0	0	4.63	4.63
	TOTALS				
	N	10	41	35	86
Kg of Fish	7.19	26.03	27.58	60.79	
Little Jimmy Lake					
	Species	3.8	6.4	8.9	total
	Arctic grayling				
	N	7	44	28	79
	Kg of Fish	2.08	16.40	11.65	30.12
	Lake Trout				
	N	0	1	2	3
	Kg of Fish	0	3.55	5.45	9
	TOTALS				
	N	7	45	30	82
Kg of Fish	2.08	19.95	17.10	39.115	
Wind Lake					
	Species	2.54	5.1	6.4	total
	Arctic grayling				
	N	2	6	7	15
	Lake Trout				
	N	0	0	1	1
	Longnose sucker				
	N	0	0	3	3
TOTALS					
N	2	6	11	19	

N represents number of fish

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Table 3.37
Species Composition from Spring Index Gillnetting Surveys, Wolverine Area 1996

Location	Species	% Catch by Number	% Catch by Weight
Wolverine Lake	Arctic grayling	52.5	35
	lake trout	47.5	65
Little Wolverine Lake	Arctic grayling	66	37
	lake trout	29	55
	longnose sucker	5	8
Little Jimmy Lake	Arctic grayling	96	77
	lake trout	4	23
Wind Lake	Arctic grayling	64	n/a
	lake trout	9	n/a
	longnose sucker	27	n/a

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**Table 3.38
Mean Length, Weight, and Condition Factor (K) by Species, Wolverine Area Fisheries Surveys, 1996**

<i>Location</i>	<i>Species</i>	<i>N</i>	<i>Length (mm)</i>		<i>Weight (g)</i>		<i>K</i>	
			<i>mean</i>	<i>Range</i>	<i>mean</i>	<i>Range</i>	<i>mean</i>	<i>Range</i>
Wolverine Lake	Arctic grayling	63	370.8	(263 - 479)	603.4	(200 - 850)	1.15	(0.59 - 1.51)
	lake trout	57	431.6	(87 - 846)	1284.7	(50 - 7500)	1.18	(0.90 - 1.46)
Little Wolverine Lake	Arctic grayling	57	333.2	(262 - 398)	395.9	(175 - 675)	1.04	(0.82 - 1.29)
	lake trout	25	453	(338 - 786)	1344	(425 - 6500)	1.18	(0.89 - 1.45)
	longnose sucker	4	442.5	(400 - 480)	1156.3	(875 - 1400)	1.32	(1.26 - 1.39)
Little Jimmy Lake	Arctic grayling	79	325.4	(223 - 368)	381.2	(100 - 550)	1.09	(0.84 - 1.58)
	lake trout	3	609.7	(472 - 705)	3000	(650 - 4800)	1.09	(0.62 - 1.34)
Wind Lake	Arctic grayling	15	276.7	(210 - 345)	n/a	n/a	n/a	n/a
	lake trout	1	700	n/a	n/a	n/a	n/a	n/a
	longnose sucker	3	336.7	(310 - 380)	n/a	n/a	n/a	n/a

N refers to number of fish collected

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Table 3.39
Biological Data by Length Class for Fish Captured in the Wolverine Area, 1996.

Location	Species	Length Class (mm)	N	% Frequency	mean length (mm)	mean weight (g)	mean K
Wolverine Lake	Arctic grayling	259 -279	4	6.3	271.3	237.5	1.19
		279 -299	3	4.8	292.7	283.3	1.13
		299 -319	4	6.3	310.8	325	1.08
		319 -339	1	1.6	334	500	1.34
		339 -359	5	7.9	350.6	545	1.27
		359 -379	10	15.9	367.2	592.5	1.20
		379 -399	19	30.2	387.7	673.2	1.16
		399 -419	14	22.2	407.6	762.5	1.13
		419 -439	2	3.2	422.5	825	1.09
		459 -479	1	1.6	479	650	0.59
Wolverine Lake	Lake trout	79 -99	1	1.8	87	n/a	n/a
		159 -179	1	1.8	172	50	0.98
		259 -279	1	1.8	273	225	1.11
		279 -299	1	1.8	293	250	0.99
		339 -359	1	1.8	345	480	1.17
		359 -379	3	5.3	373.3	650	1.25
		379 -399	10	17.5	390.8	725	1.21
		399 -419	15	26.3	407.7	802.7	1.18
		419 -439	11	19.3	427.5	897.7	1.15
		439 -459	6	10.5	446.2	995.8	1.12
		459 -479	1	1.8	471	1200	1.15
		559 -579	1	1.8	578	2600	1.35
		679 -699	1	1.8	680	4200	1.34
		759 -779	2	3.5	765	5975	1.33
799 -819	1	1.8	802	6400	1.24		
839 -859	1	1.8	846	7500	1.24		
Little Wolverine Lake	Arctic grayling	259 -279	3	5.3	266	188.3	1.00
		279 -299	4	7.0	294	262.5	1.03
		299 -319	12	21.1	309.8	312.5	1.05
		319 -339	11	19.3	330.5	370.5	1.03
		339 -359	16	28.1	348.1	445.3	1.06
		359 -379	8	14.0	368.3	521.9	1.04
		379 -399	3	5.3	386	608.3	1.06
Little Wolverine Lake	lake trout	319 -339	1	4	338	425	1.10
		359 -379	2	8	366	525	1.07
		379 -399	3	12	389.7	725	1.22
		399 -419	5	20	405.4	805	1.21
		419 -439	4	16	429.8	993.8	1.25
		439 -459	2	8	442	950	1.10
		459 -479	4	16	468	1162.5	1.13
		499 -519	1	4	500	1400	1.12
		519 -539	1	4	528	1450	0.99
		759 -779	1	4	770	6500	1.42
		779 -799	1	4	786	6050	1.25
Little Wolverine Lake	longnose sucker	399 -419	1	25	400	875	1.37
		419 -439	1	25	430	1000	1.26
		459 -479	1	25	460	1350	1.39
		479 -499	1	25	480	1400	1.27
Little Jimmy Lake	Arctic grayling	219 -239	1	1.3	223	100	0.90
		239 -259	1	1.3	249	175	1.13
		259 -279	6	7.7	272.2	208.3	1.03
		279 -299	6	7.7	289.2	270.8	1.12
		299 -319	8	10.3	314.1	375	1.21
		319 -339	25	32.1	327.6	386.8	1.10
		339 -359	26	33.3	347	445	1.07
		359 -379	5	6.4	362.8	475	0.99
Little Jimmy Lake	lake trout	459 -479	1	33.3	472	650	0.62
		639 -659	1	33.3	652	3550	1.28
		699 -719	1	33.3	705	4800	1.37
Wind Lake	Arctic grayling	199 -219	2	13.3	210	n/a	n/a
		239 -259	2	13.3	245	n/a	n/a
		259 -279	3	20	266.7	n/a	n/a
		279 -299	2	13.3	290	n/a	n/a
		299 -319	5	33.3	303	n/a	n/a
339 -359	1	6.7	345	n/a	n/a		
Wind Lake	lake trout	699 -719	1	100	700	n/a	n/a
Wind Lake	longnose sucker	299 -319	1	33.3	310	n/a	n/a
		319 -339	1	33.3	320	n/a	n/a
		379 -399	1	33.3	380	n/a	n/a

N indicates number of fish. K represents the condition factor

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FINLAYSON PROJECT**

**Table 3.40
Metals Concentrations in Vegetation**

		Al (ppm)	Sb (ppm)	As (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)	Ca (ppm)	Cr (ppm)	Co (ppm)	Cu (ppm)
Willow Leaves 5 samples	Minimum	< 50	< 0.05	< 0.1	20	< 0.20	< 1.00	1.00	2400	1.0	< 0.50	6.5
	Maximum	50	< 0.05	0.2	160	< 0.20	< 1.00	2.60	9800	2.5	2.50	15.5
Willow Twigs 5 samples	Minimum	< 50	< 0.05	0.2	45	< 0.20	< 1.00	1.20	3000	2.0	< 0.50	14.5
	Maximum	< 50	< 0.05	0.2	305	< 0.20	< 1.00	4.40	7000	11.0	1.50	71.0
Lichens 5 samples	Minimum	50	< 0.05	0.1	5	< 0.20	< 1.00	< 0.20	550	1.5	< 0.50	1.0
	Maximum	250	< 0.05	0.2	85	< 0.20	< 1.00	0.20	1250	4.5	< 0.50	4.0
		Ga (ppm)	Au (ppb)	Fe (ppm)	La (ppm)	Pb (ppm)	Mg (ppm)	Mn (ppm)	Hg (ppm)	Mo (ppm)	Ni (ppm)	P (ppm)
Willow Leaves 5 samples	Minimum	< 5	1.7	< 50	< 0.1	< 0.50	1350	57	< 1	< 0.50	1.5	2370
	Maximum	< 5	7.6	50	1.3	2.5	3500	780	< 1	1.00	11.0	4420
Willow Twigs 5 samples	Minimum	< 5	3.4	< 50	< 0.1	1.0	1050	49	< 1	< 0.50	2.5	2170
	Maximum	< 5	3.4	50	< 0.1	2.5	2700	550	< 1	1.00	10.5	4100
Lichens 5 samples	Minimum	< 5	0.4	50	< 0.1	1.0	200	55	< 1	< 0.50	0.5	305
	Maximum	< 5	5.0	250	0.2	2.5	400	210	< 1	.50	2.0	645
		K (ppm)	Sc (ppm)	Ag (ppm)	Na (ppm)	Sr (ppm)	Tl (ppm)	Ti (ppm)	W (ppm)	U (ppm)	V (ppm)	Zn (ppm)
Willow Leaves 5 samples	Minimum	5900	< 2	< .10	< 50	13.0	< 5	< 50	< 2	< 5	< 0.5	54
	Maximum	8900	< 2	< .10	< 50	51.0	< 5	< 50	< 2	< 5	< 0.5	220
Willow Twigs 5 samples	Minimum	6900	< 2	< .10	< 50	12.0	< 5	< 50	< 2	< 5	< 0.5	79
	Maximum	160000	< 2	< .10	100	44.0	< 5	< 50	< 2	< 5	< 0.5	240

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**Table 3.41
Comparison of Vegetation Types Described for the Kudz Ze Kayah and Wolverine
Study Areas.**

V-Type	Kudz Ze Kayah Study Area (Geomatics 1995)	Wolverine Lake Study Area (Zoladeski et al. 1996)	Comment
Forested V-Types			
V2	Closed Trembling Aspen Forest	Closed Trembling Aspen Forest	
V3	Not described	Closed Balsam Poplar Forest	
V15	Open Subalpine Fir Forest	Not described	
V16	Open White Spruce Forest (Alluvial)	Open Subalpine Fir Forest	
V17	Open Black Spruce Forest (Upland)	Open White Spruce Forest (Upland)	
V18	Open Black Spruce Forest (Lowland)	Open Black Spruce Forest (Upland)	
V19	Not described	Open Black Spruce Forest (Lowland)	
V23	Not described	Open Tamarack-Spruce Forest	Observed near vegetation mapping area
Non-Forested V-Types			
V101	Dwarf Birch Tall Shrub (Herb poor - Moss rich)	Shrub Birch Low Shrub	Some disagreement on classification and characteristics
V102	Not described	Shrub Birch-Labrador Tea Medium/Tall Shrub	
V104	Willow Medium/Tall Shrub and Willow Medium/Tall Shrub (Riparian)	Willow Low Shrub	
V105	Willow-Dwarf Birch Tall Shrub (herb poor) and (herb rich)	Willow -Shrub Birch Low/Tall Shrub	
V107	Not described	Mountain Aven Dwarf Shrub	
V108	Not described	Willow Dwarf Shrub	
V110	Dwarf Birch Dwarf Shrub	Not described	
V111	Mountain Avens Dwarf Shrub	Not described	
V113	Willow Dwarf Shrub	Not described	
V115	Not described	White Heather Dwarf Shrub	
V118	Not described	Alpine Bearberry Dwarf Shrub	
V120	Subalpine Fir Tall Shrub	Not described	
V121	Not described	Mountain Cranberry Dwarf Shrub	
V172	Alpine Dwarf Shrub	Not described	
V200	Woodrush Herb	Not described	
V202	Not described	Mesic Grass Herb	
V206	Not described	Wet Sedge Herb	
V208	Wet Sedge Herb	Not described	
V213	Not described	Mesic Mixed Herb	
V214	Not described	Wet Mixed Herb	
V300	Not described	<i>Cetraria-Alectoria ochroleuca</i> Fruticose Lichen	
V301	Mesic Mixed Herb	<i>Rhizocarpon-Umbilicaria</i> Crustose Lichen (Crustose - Fruticose Lichen)	
V302	Not described	<i>Cladina</i> Fruticose Lichen	
none		Labrador Tea Dwarf Shrub	Not described as a V-Type

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FINLAYSON PROJECT**

**Table 4.1
Sample Significance Criteria Definitions**

Criterion	Low	Moderate	High
Magnitude (of the effect)	Effect is evident only at or nominally above baseline conditions	Effect exceeds baseline conditions however is less than regulatory criteria or published guideline values	Effect exceeds regulatory criteria or published guideline values
Geographic Extent (of the effect)	Effect is limited to the project site/footprint.	Effect extends into areas beyond the project site/footprint boundary	Effect extends beyond the boundary of the Airport Authority.
Duration (of the effect)	Effect is evident only during the construction phase of the project	Effect is evident during construction and/or the operational phase of the project.	Effects will be evident beyond the operational life of the project.
Frequency (of conditions causing the effect)	Conditions or phenomena causing the effect occur infrequently (i.e. < once per year)	Conditions or phenomena causing the effect occur at regular intervals although infrequent intervals (i.e. < once per month)	Conditions or phenomena causing the effect occur at regular and frequent intervals (i.e. < once per year)
Ecological Importance (of resource or attribute)	Resource is of little recognized value in terms of uniqueness, rarity, importance to the ecosystem or scientific knowledge.	Resource is recognized to be of some, yet limited value in terms of uniqueness, rarity, importance to the ecosystem or scientific knowledge.	Resource is recognized to be of significant value in terms of uniqueness, rarity, importance to the ecosystem or scientific knowledge.
Societal Value (of resource or attribute)	Resource is of little recognized value in terms of uniqueness, rarity, importance to the the public or community.	Resource is recognized to be of some, yet limited value in terms of uniqueness, rarity, importance to the public or community	Resource is recognized to be of significant value in terms of uniqueness, rarity, importance to the public or community.
Permanence (of effect)	Effect is readily reversible over a short period of time (i.e. one growing season)	Effect is not readily reversible during the life of the project.	Effect is permanent.

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FINLAYSON PROJECT

Table 4.1a
Potential Direct Project - Environment Interactions for the Finlayson Project

		Environmental Attribute												
		Air Quality	Topography and Landscape Appearance	Hydrogeology	Groundwater Quality	Surface Hydrology	Surface Water Quality	Aquatic Resources	Vegetation	Wildlife	Socio-economic Conditions	Heritage Resources	Land Use	Human Health
Project Component/Activity	Wolverine													
	Underground mine			✗	✗									
	Backfill Borrow Area	✗	✗			✗								
	Infrastructure - cumulative													
	backfill plant													
	shotcrete plant													
	water treatment plant					✗	✗							
	power plant	✗												
	emergency camp													
	Cumulative Operations									✗				
	Ore Haul Route	✗	✗			✗				✗	✗			
	Kudz Ze Kayah													
	Open Pit	✗	✗	✗	✗	✗	✗	✗	✗					
	Tailings Storage Facility		✗	✗	✗	✗	✗	✗	✗					
	Waste Rock Stockpiles	✗	✗			✗	✗		✗					
	Infrastructure - cumulative													
	concentrate plant													
	worker housing													
	incinerator	✗												
	water and sewage treatment plants					✗	✗							
	pipelines, ponds, and sumps													
	power plant	✗												
	Cumulative Operations									✗				
	Concentrate Haul Route	✗	✗			✗				✗	✗			✗
	Cumulative Project										✗	✗	✗	

**EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT**

**Table 4.2
Summary of Base Case Water Quality Predictions for the Operations Phase of the Finlayson Project¹**

		Year 1		Year 6		Year 9		Worst Case*
		Min	Max	Min	Max	Min	Max	
Finlayson Creek below Geona Creek	Copper (µg/L)	0.9	2.1	0.9	2.2	0.9	2.2	5.7
	Selenium (µg/L)	0.5	2.1	0.5	2.3	0.5	2.3	6.7
	Zinc (µg/L)	10	15	11	17	10	16	37
	Lead (µg/L)	0.3	0.7	0.3	0.8	0.3	0.7	2
	Aluminium (µg/L)	20	27	21	29	21	28	55
Finlayson Creek below East Creek	Copper (µg/L)	0.8	1.3	0.8	1.4	0.8	1.4	3.2
	Selenium (µg/L)	0.4	1.1	0.4	1.2	0.4	1.2	3.4
	Zinc (µg/L)	10	12	10	13	10	13	23
	Lead (µg/L)	0.3	0.5	0.3	0.5	0.3	0.5	1.1
	Aluminium (µg/L)	20	23	20	24	20	23	37
Geona Creek at the Mouth	Copper (µg/L)	1	4	1.2	4.4	1.2	4.3	10
	Selenium (µg/L)	0.7	2.8	1	5.1	1	5.2	12
	Zinc (µg/L)	11	22	12	28	12	26	62
	Lead (µg/L)	0.4	1.2	0.5	1.6	0.4	1.3	3.6
	Aluminium (µg/L)	21	37	23	42	23	40	88

*Worst Case Condition is 10-year, 7-day low flow for the month of August

1) Based on models completed by Norecol, Dames and Moore for the Kudz Ze Kayah Water Licence Application. These numbers will be modified for the Finlayson Project Environmental Assessment

CCREM Guidelines

- Copper 3 to 4 µg/L (Finlayson Creek), 2 to 3 µg/L (Geona Creek) based on range of hardness
- Selenium 1 µg/L
- Zinc 30 µg/L
- Lead 4 to 7µg/L (Finlayson Creek), 2 to 4 µg/L (Geona Creek) based on range of hardness
- Copper 100 µg/L

**EXPATRIATE RESOURCES LTD.
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**Table 4.3
Parameters that Exceed the CCREM Guidelines
in Response to Different Model Assumptions**

Assumptions	Finlayson Creek D/S Geona Creek	Geona Creek at Mouth
Base Case, Average Flows	Selenium	Copper Selenium
10-Year, 7-day low flow	Copper Selenium Zinc	Copper Selenium Zinc
450 m3/d Seepage through the Tailings Dam	Selenium	Copper Selenium Zinc
1200 m3/d Seepage through the Tailings Dam	Copper* Selenium	Copper Selenium Zinc Lead
Worst Case Tailings Supernatant Quality	Selenium	Copper Selenium Zinc
Worst Case Mine Water Treatment Plant Quality	Selenium	Copper Selenium Zinc
Worst Case WPAG Dump Runoff	Selenium	Copper Selenium Zinc
Decant Treatment Fails (No Treatment)	Copper* Selenium	Copper Selenium Zinc
Background Water Quality at 90%ile Concentrations	Copper* Selenium Aluminium	Copper Selenium Zinc Aluminium

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FINLAYSON PROJECT**

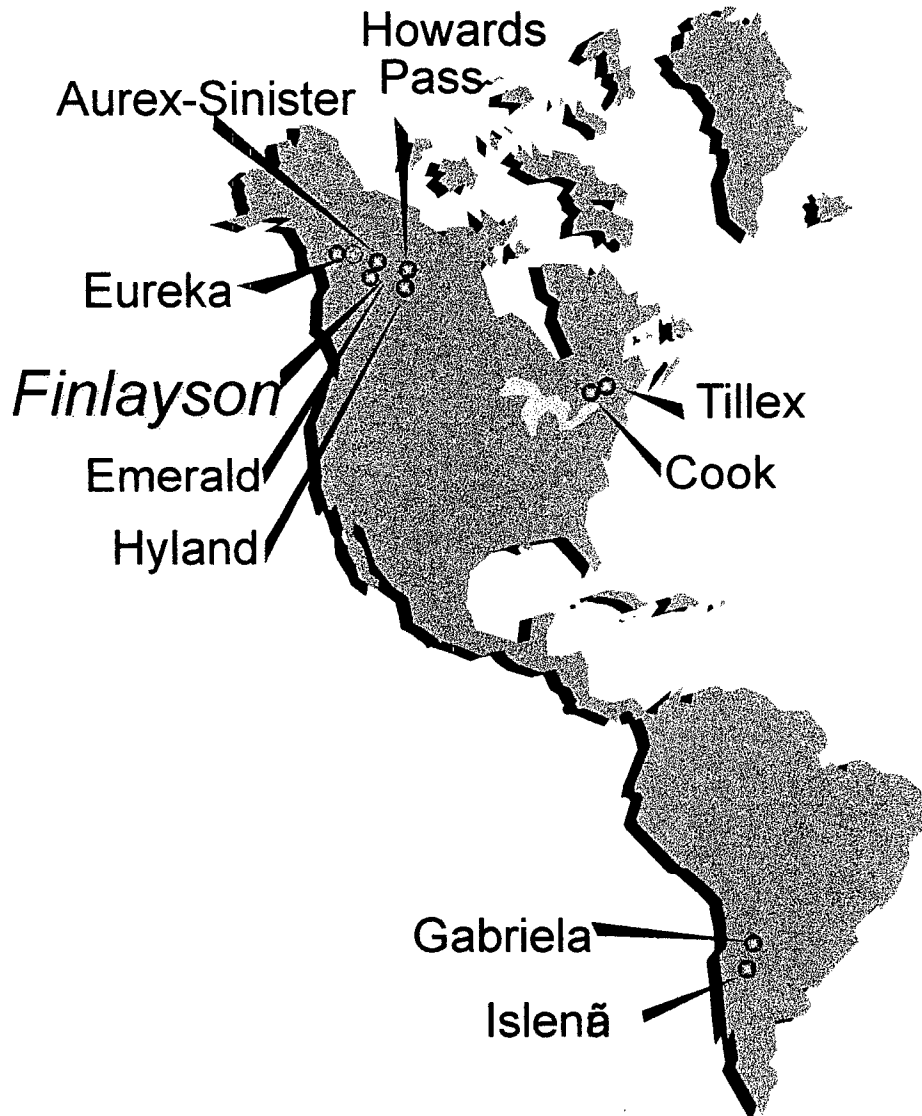
Table 4.4

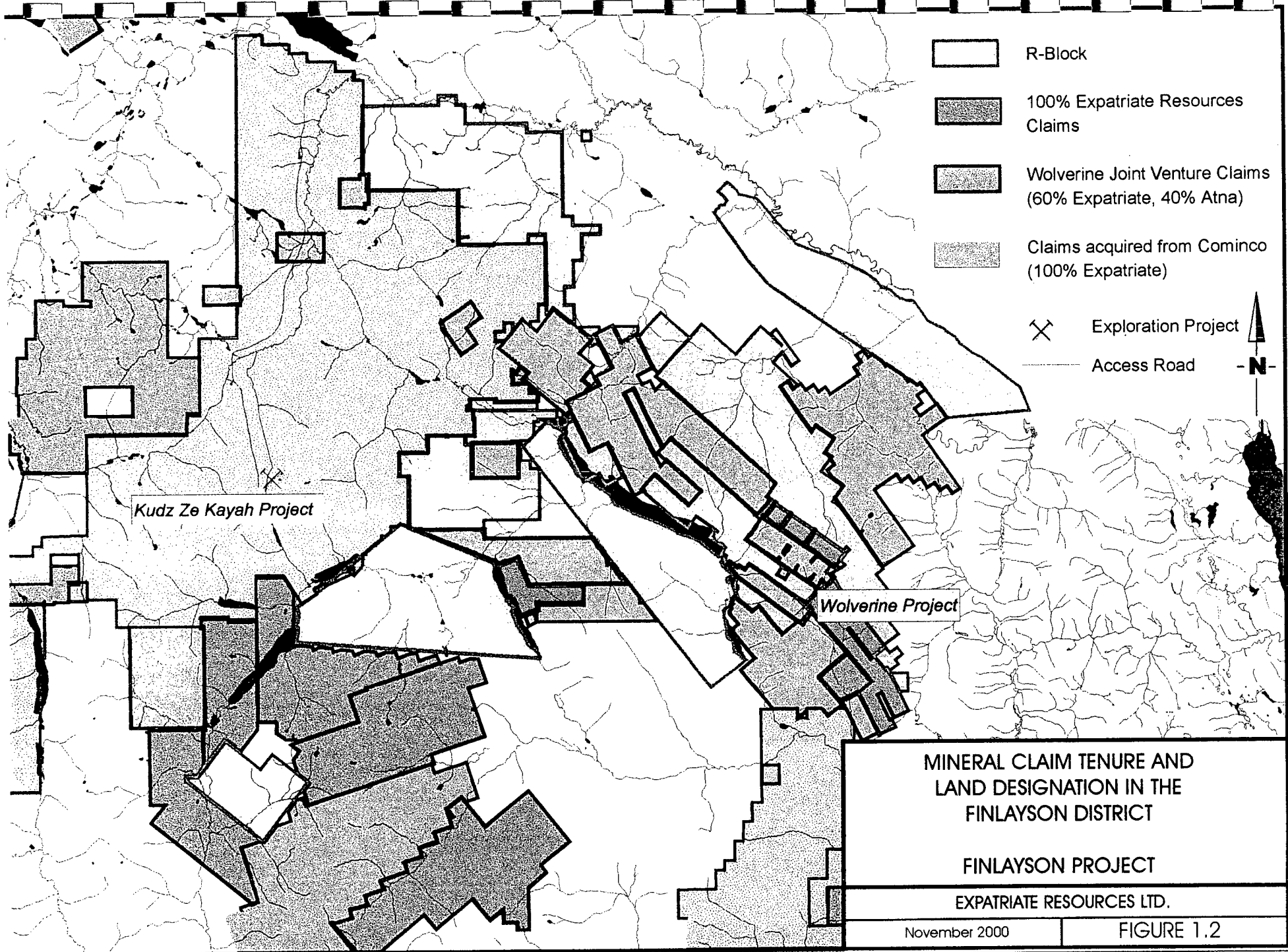
Habitat Types Affected by the Kudz Ze Kayah Operations Area







Vegetation Type	Ha	%
Mine Site		
Open Canopy Sub-alpine Fir Forest	38.4	12.8
Dwarf Birch Tall Shrub: herb poor, moss rich	54.6	18.2
Dwarf Birch Tall Shrub: wet phase	24.0	8.0
Willow Tall Shrub	20.6	6.9
Willow Tall Shrub: wetland (riparian)	23.5	7.8
Willow-Dwarf Birch Tall Shrub: herb rich	93.9	31.3
Willow-Dwarf Birch Tall Shrub: dry, herb poor	2.2	0.7
Dwarf Birch Dwarf Shrub	1.6	0.5
Sub-alpine Fir Tall Shrub	27.0	9.0
Alpine Dwarf Shrub (misc.)	2.4	0.8
Wet Sedge Herb: lowland (riparian)	4.8	1.6
Mesic Mixed Herb	7.0	2.4
TOTAL	300	100
Access Road		
Trembling Aspen Forest	0.5	1.2
Open Canopy Sub-alpine Fir Forest	5.4	12.7
Open Canopy Black Spruce Forest: mineral soil	10.4	24.4
Open Canopy Black Spruce Forest: organic soil	3.0	7.0
Open Canopy White Spruce Forest	0.2	0.5
Dwarf Birch Tall Shrub: herb poor, moss rich	6.2	14.6
Dwarf Birch Tall Shrub: wet phase	0.2	0.5
Willow Tall Shrub: wetland (riparian)	0.1	0.2
Willow-Dwarf Birch Tall Shrub: herb rich	4.7	11.0
Willow-Dwarf Birch Tall Shrub: dry, herb poor	11.9	27.9
TOTAL	42.6	100
Airstrip		
Open Canopy Black Spruce Forest: mineral soil	17.6	80
Open Canopy Black Spruce Forest: organic soil	4.4	20
TOTAL	22.0	100

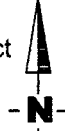
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 1.1
Expatriate Resources' Mineral Properties





-  R-Block
-  100% Expatriate Resources Claims
-  Wolverine Joint Venture Claims (60% Expatriate, 40% Atna)
-  Claims acquired from Cominco (100% Expatriate)
-  Exploration Project
-  Access Road



Kudz Ze Kayah Project

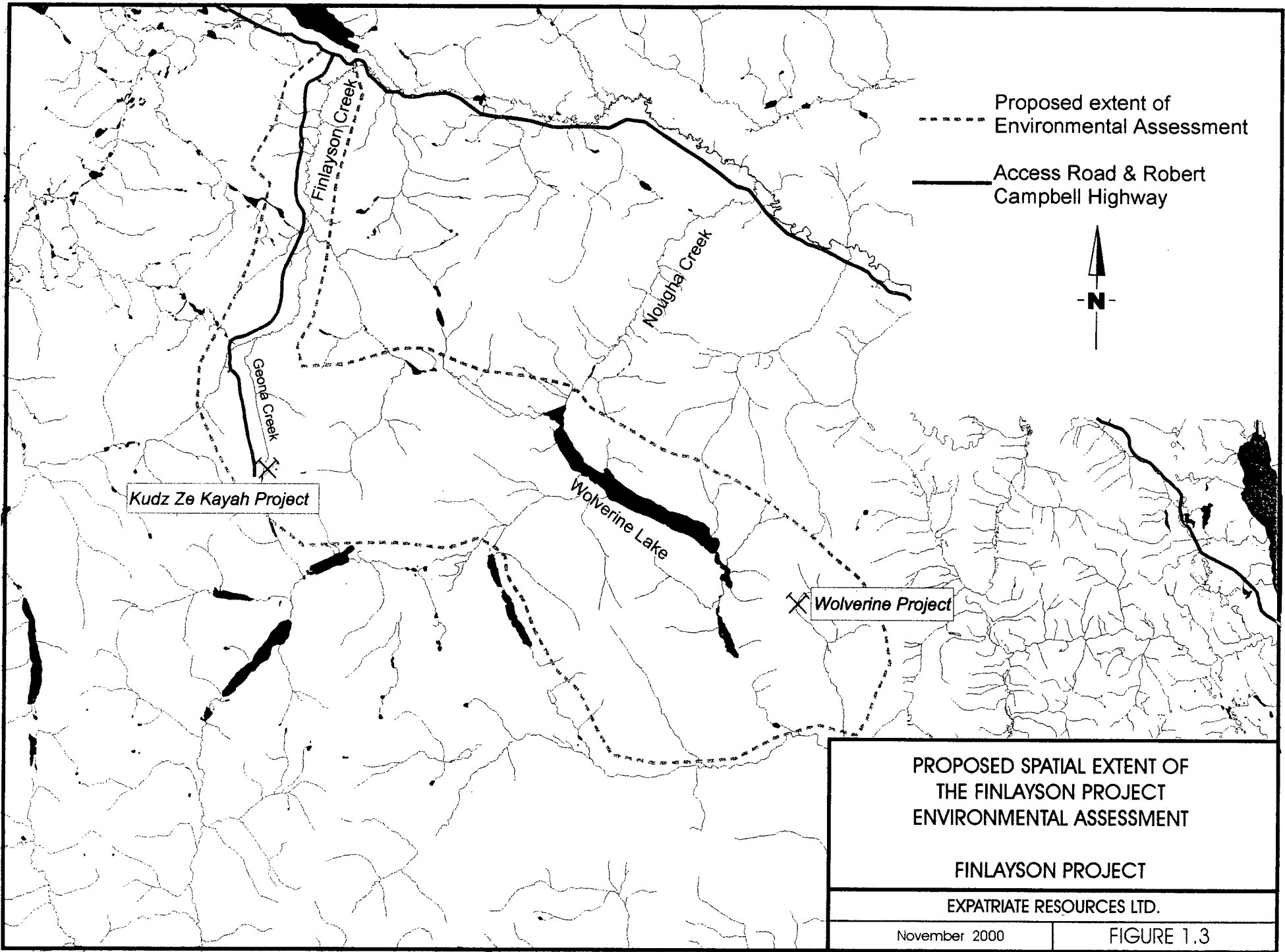
Wolverine Project

**MINERAL CLAIM TENURE AND
LAND DESIGNATION IN THE
FINLAYSON DISTRICT**

FINLAYSON PROJECT

EXPATRIATE RESOURCES LTD.

November 2000	FIGURE 1.2
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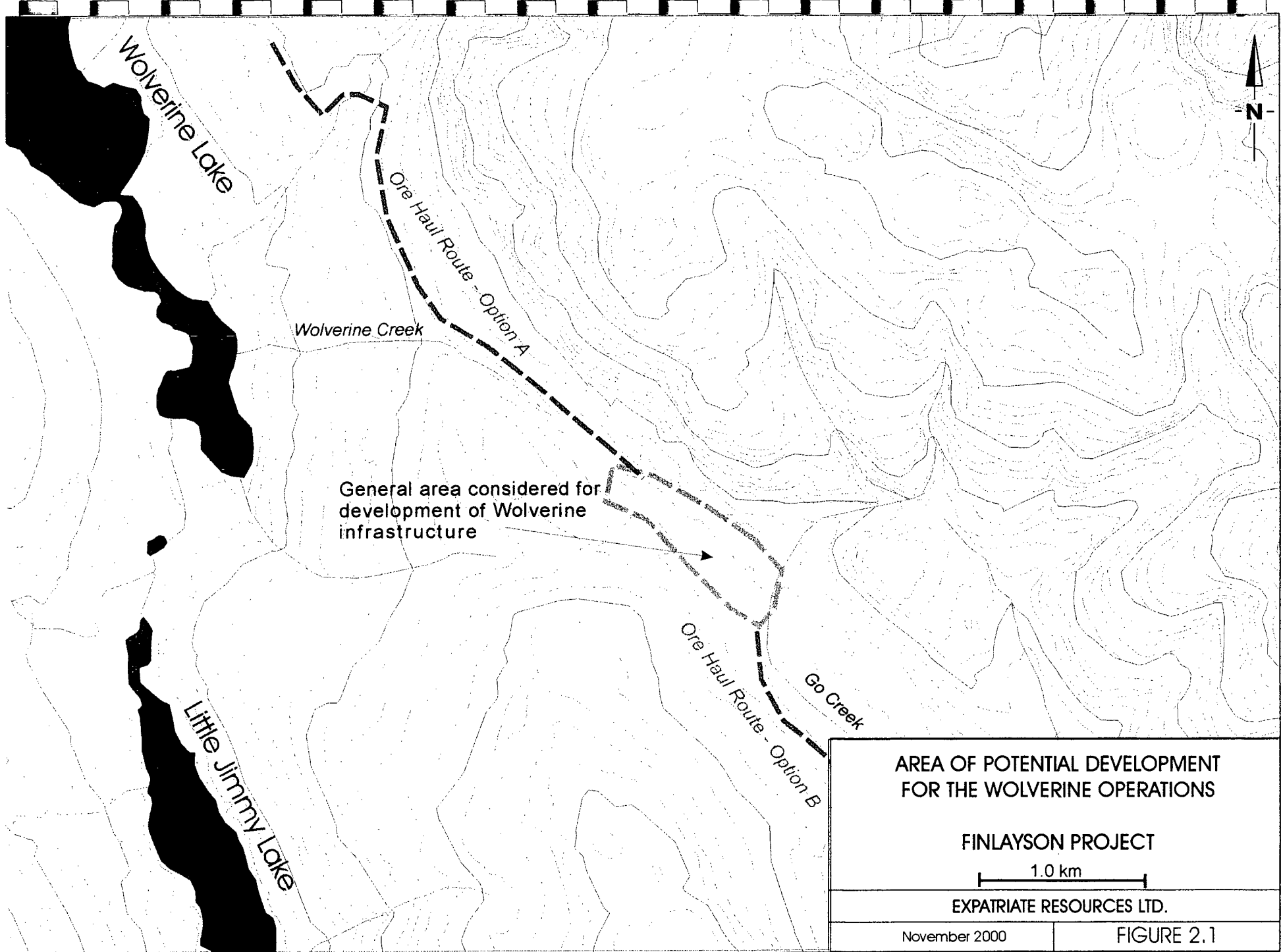
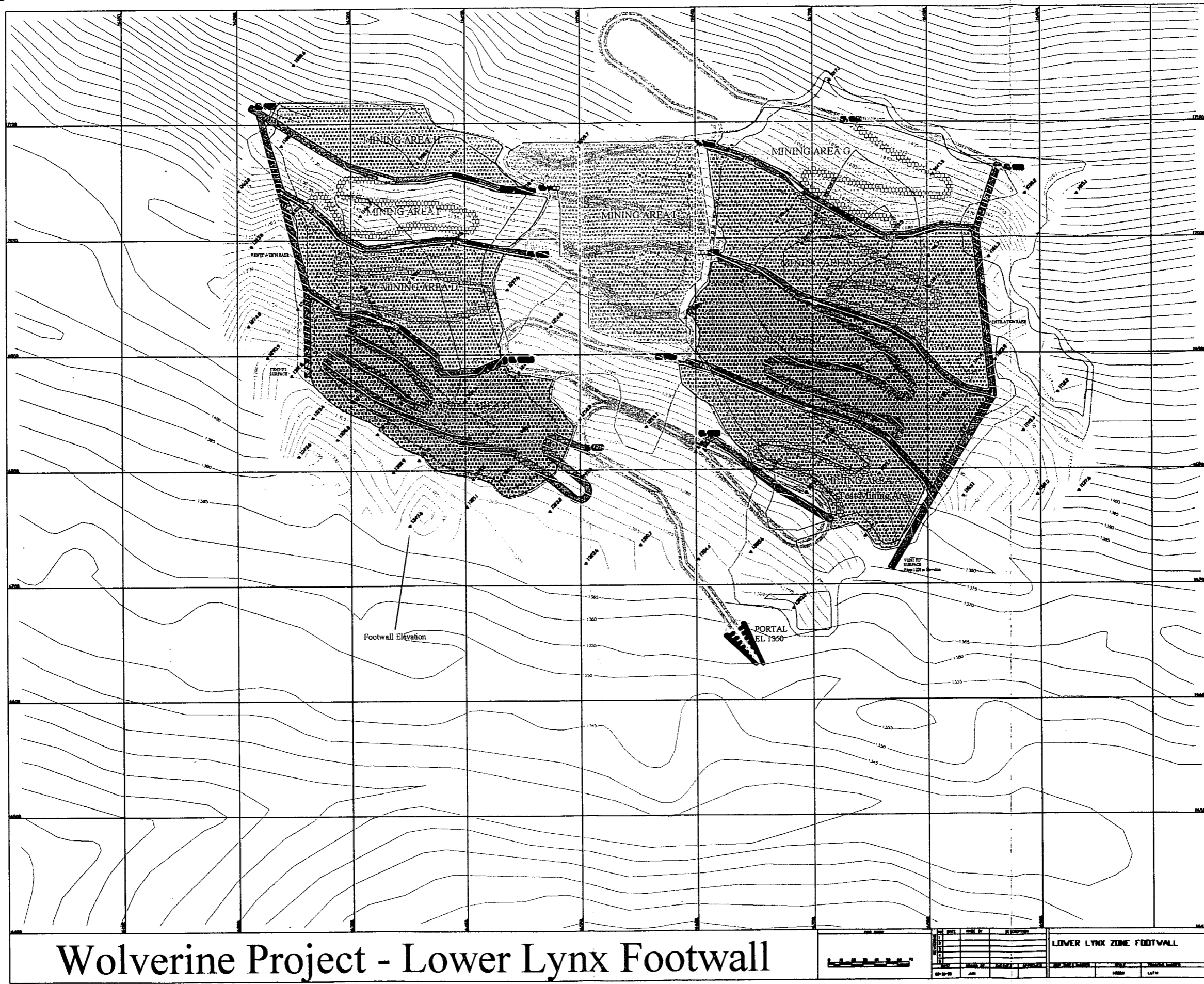
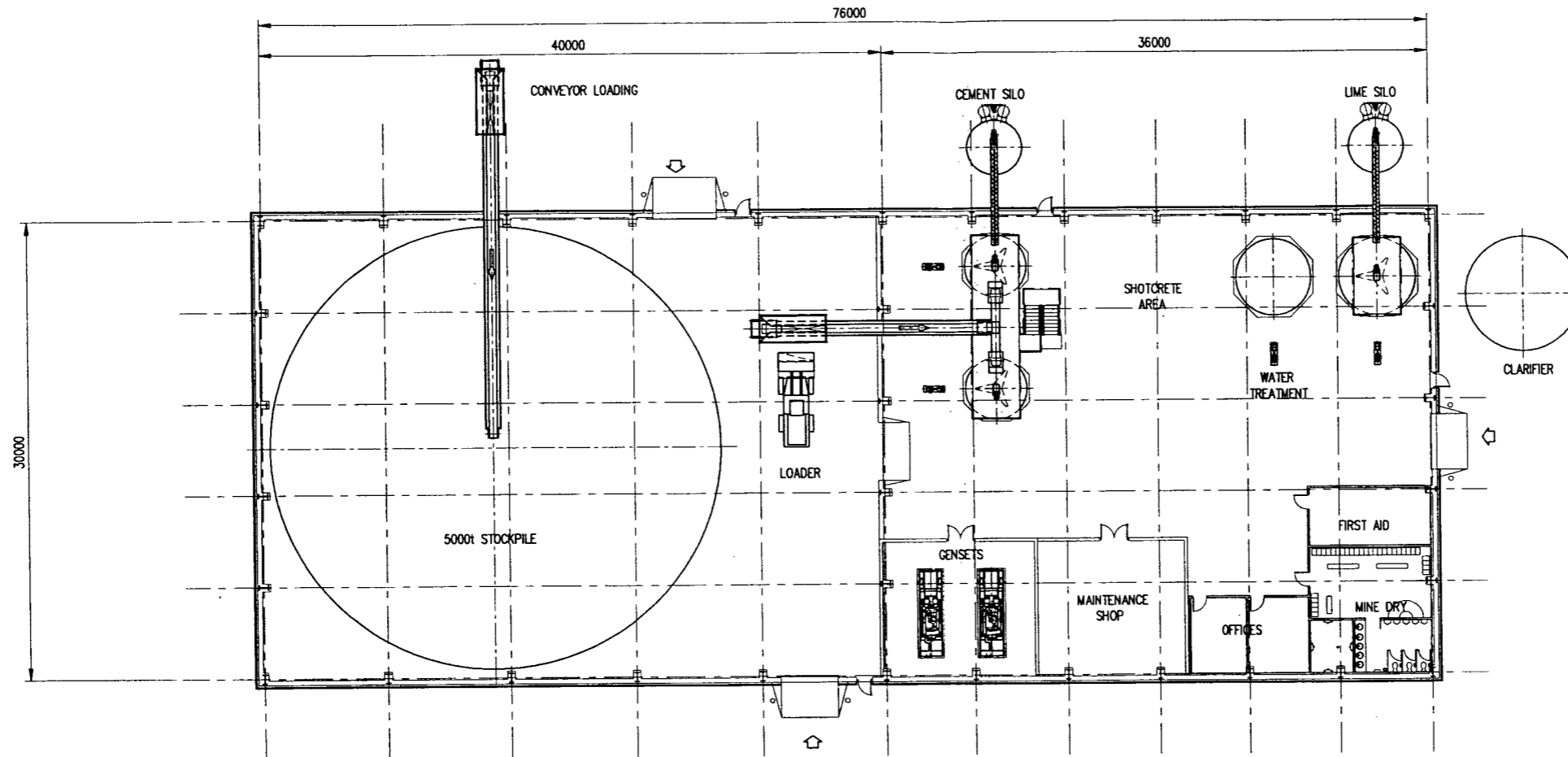
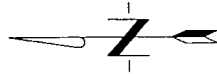


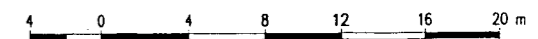
Figure 2.2 Wolverine Mine Plan





GROUND FLOOR PLAN

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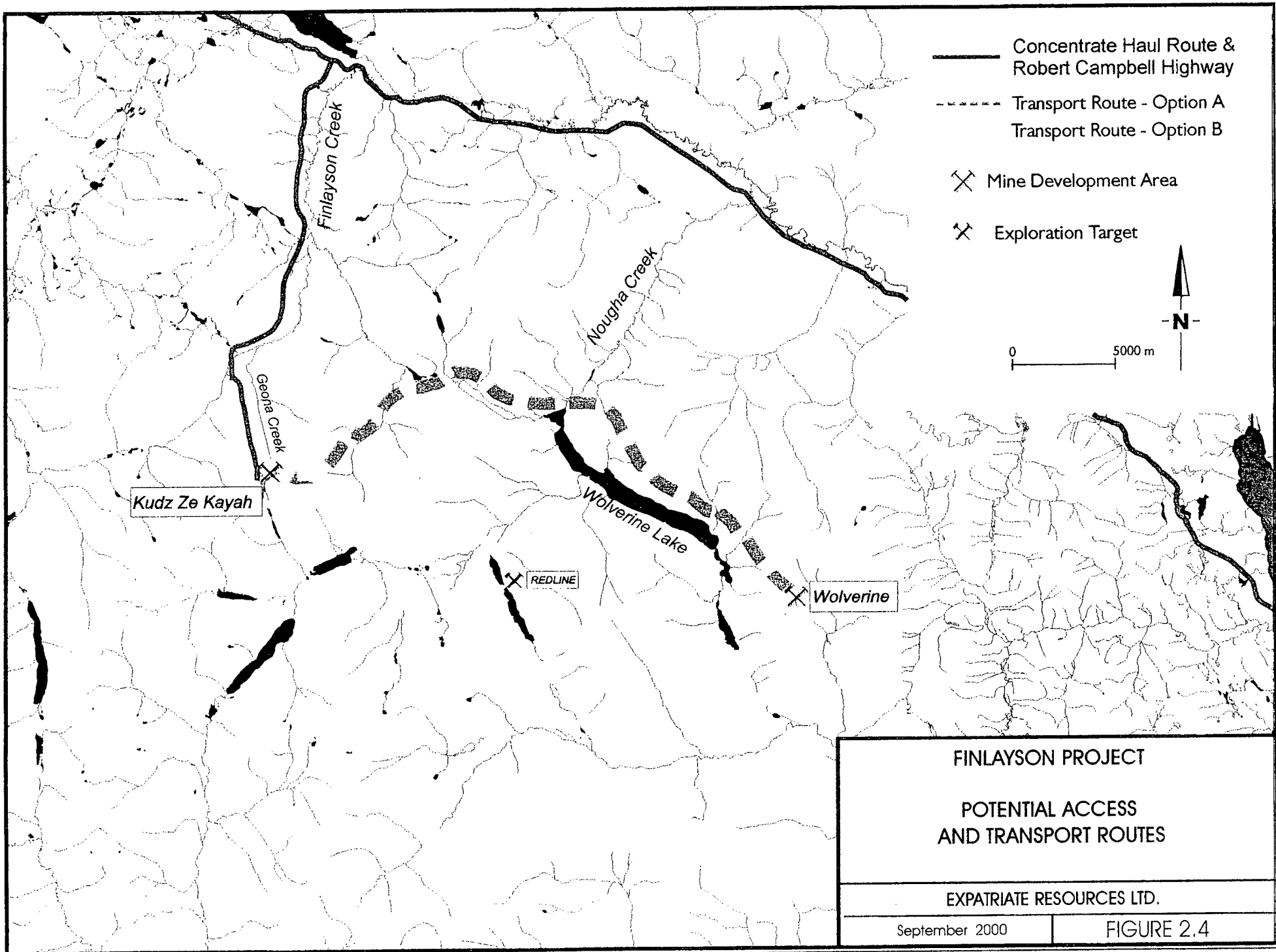
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2	ISSUE / REVISIONS		

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SCALE:	1:200
DATE:	AUG/00
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TITLE	FINLAYSON PROJECT
FIGURE 2.3	
WOLVERINE	
GROUND FLOOR PLAN	
FILENAME:	A0G007.DWG
PROJECT NUMBER	36272
DRAWING NUMBER	A0-G-007
REV	A



— Concentrate Haul Route & Robert Campbell Highway

- - - - - Transport Route - Option A
 - - - - - Transport Route - Option B

✕ Mine Development Area

✕ Exploration Target



0 5000 m

Kudz Ze Kayah

REDLINE

Wolverine

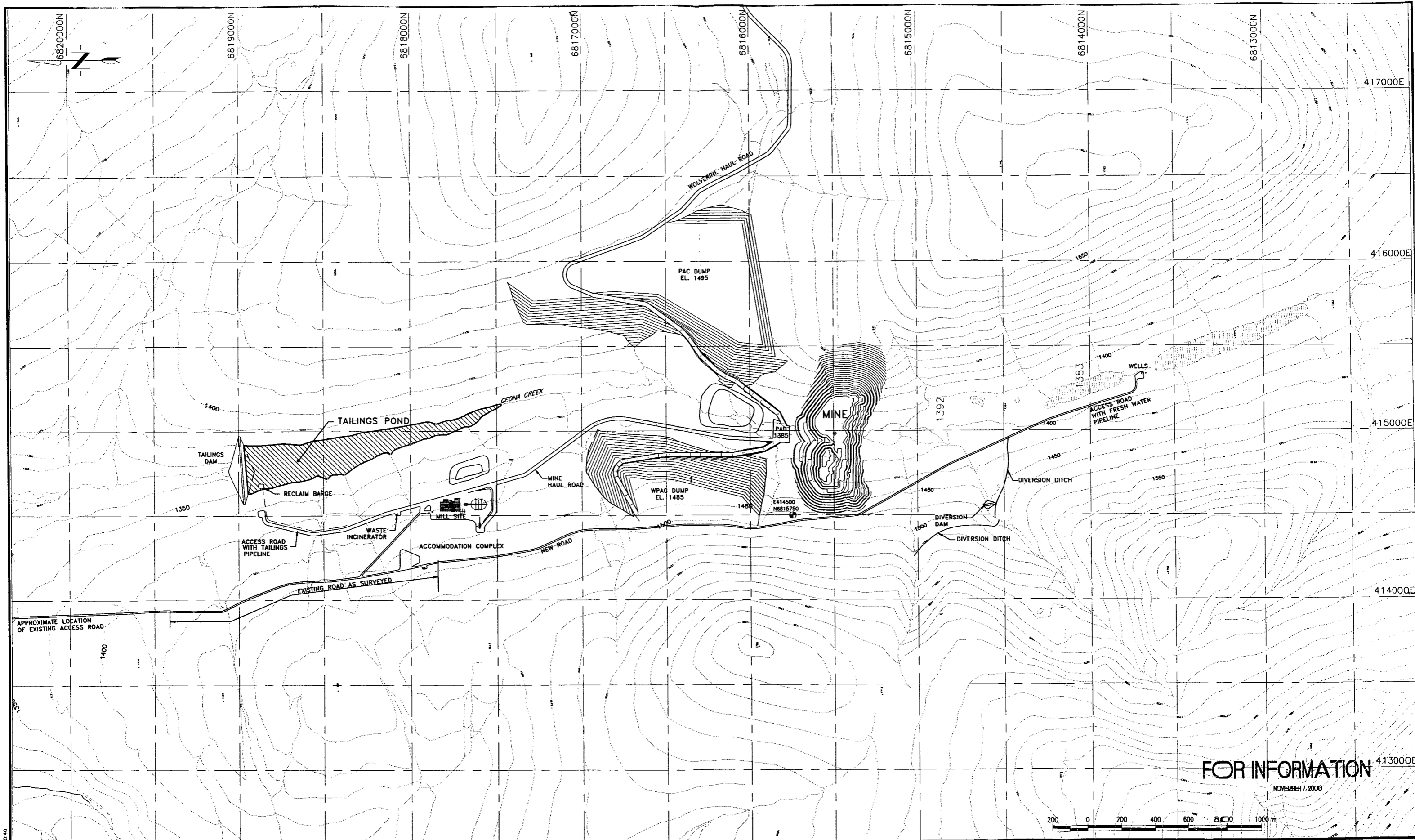
FINLAYSON PROJECT

POTENTIAL ACCESS
 AND TRANSPORT ROUTES

EXPATRIATE RESOURCES LTD.

September 2000

FIGURE 2.4



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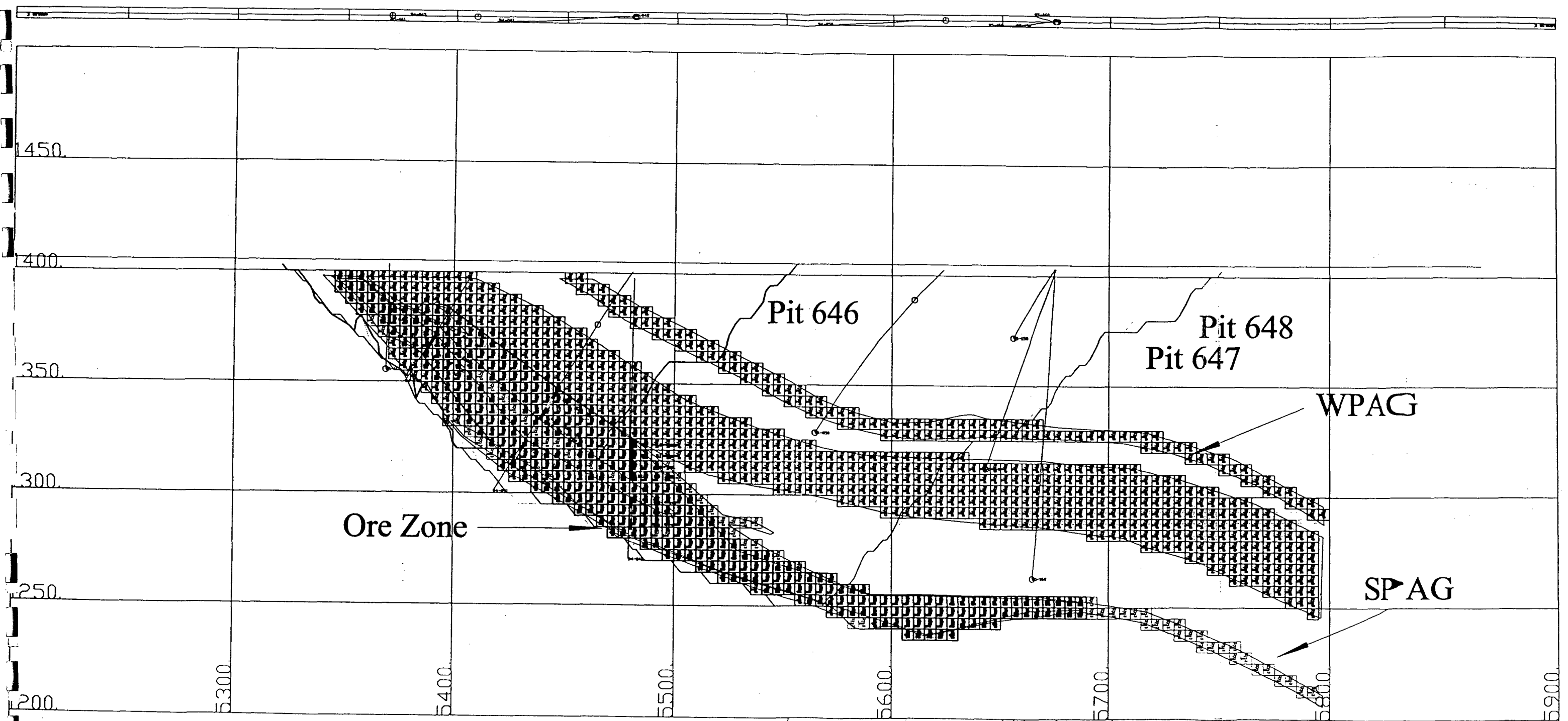
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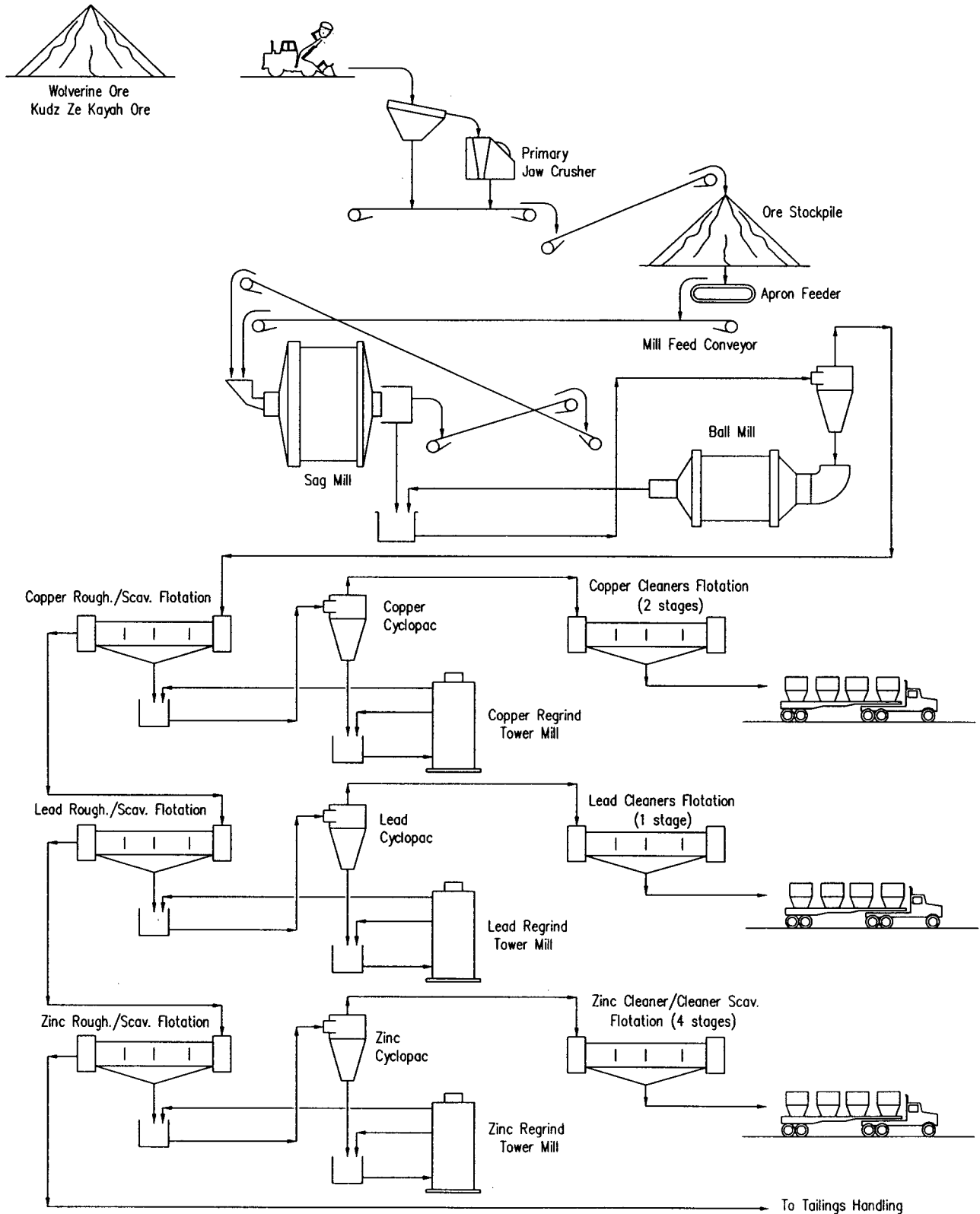
FINLAYSON PROJECT			
FIGURE 2.5 KUDZ ZE KAYAH SITE ARRANGEMENT			
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36272	A0-C-002	A	



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Figure 2-6 Pit Design and Cross Section

FIGURE 2.7
FINLAYSON SIMPLIFIED FLOWSHEET



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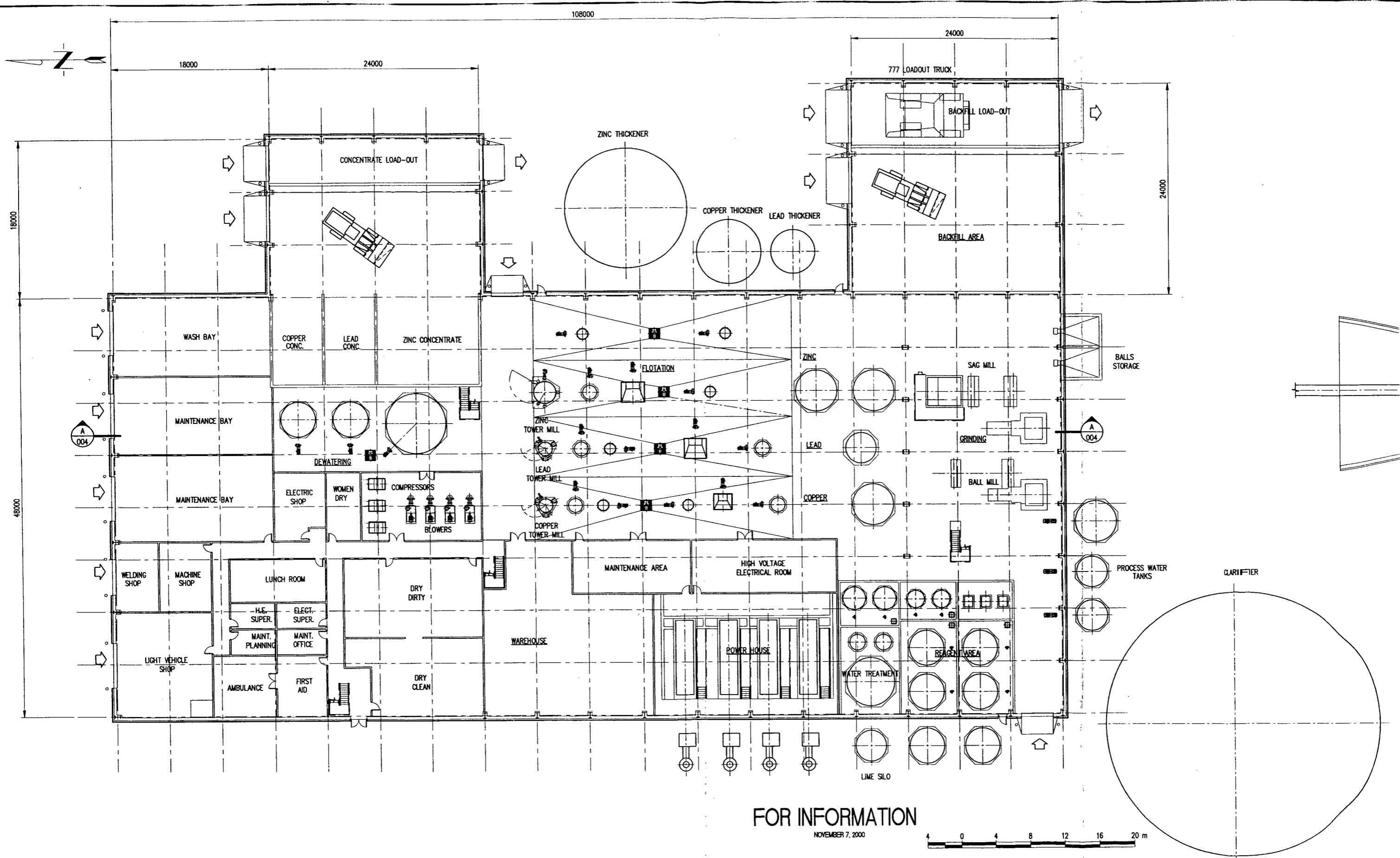
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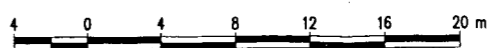
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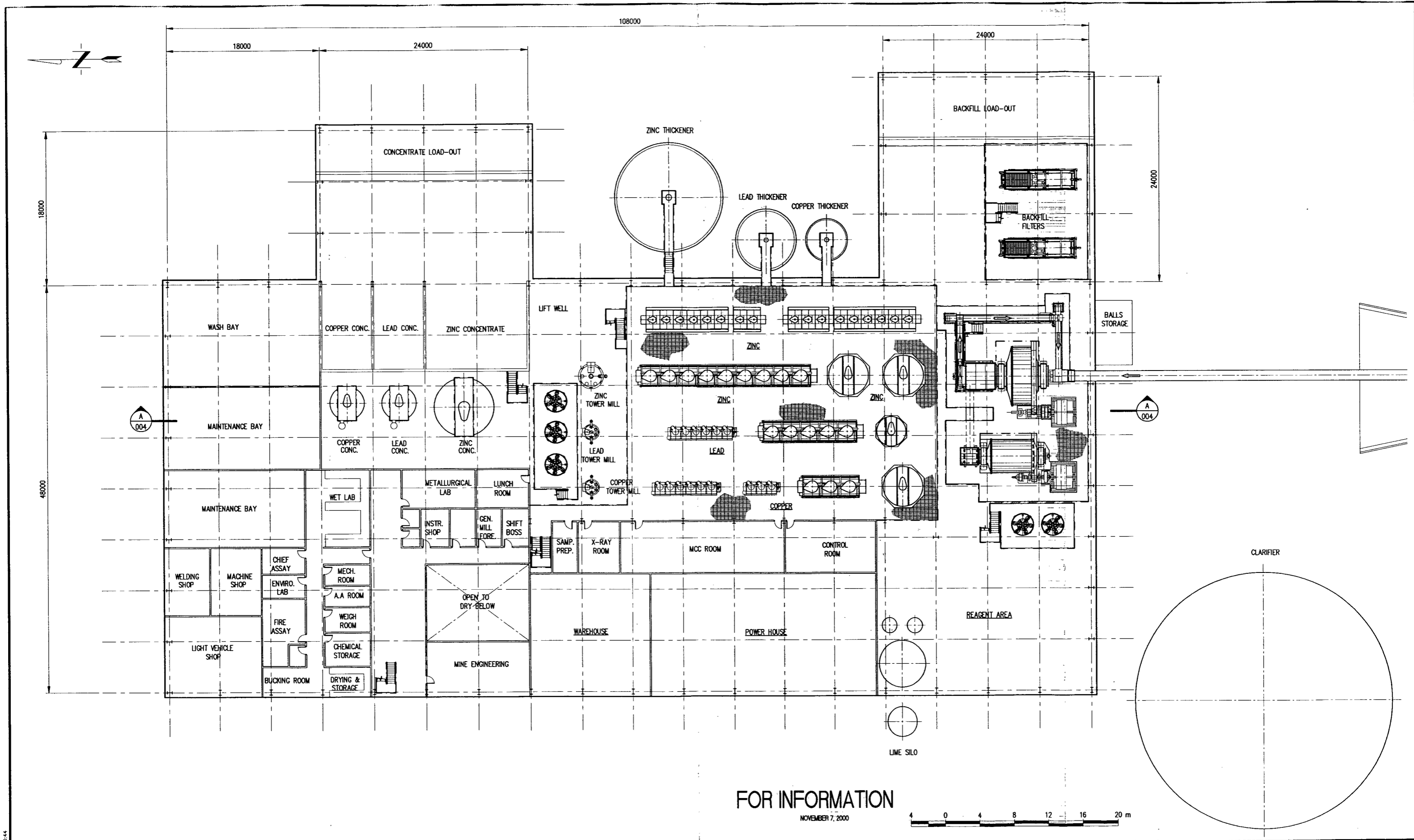
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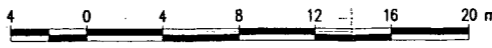
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DATE:	OCT/00

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FINLAYSON PROJECT			
FIGURE 2.8a			
GENERAL ARRANGEMENT			
GROUND FLOOR PLAN			
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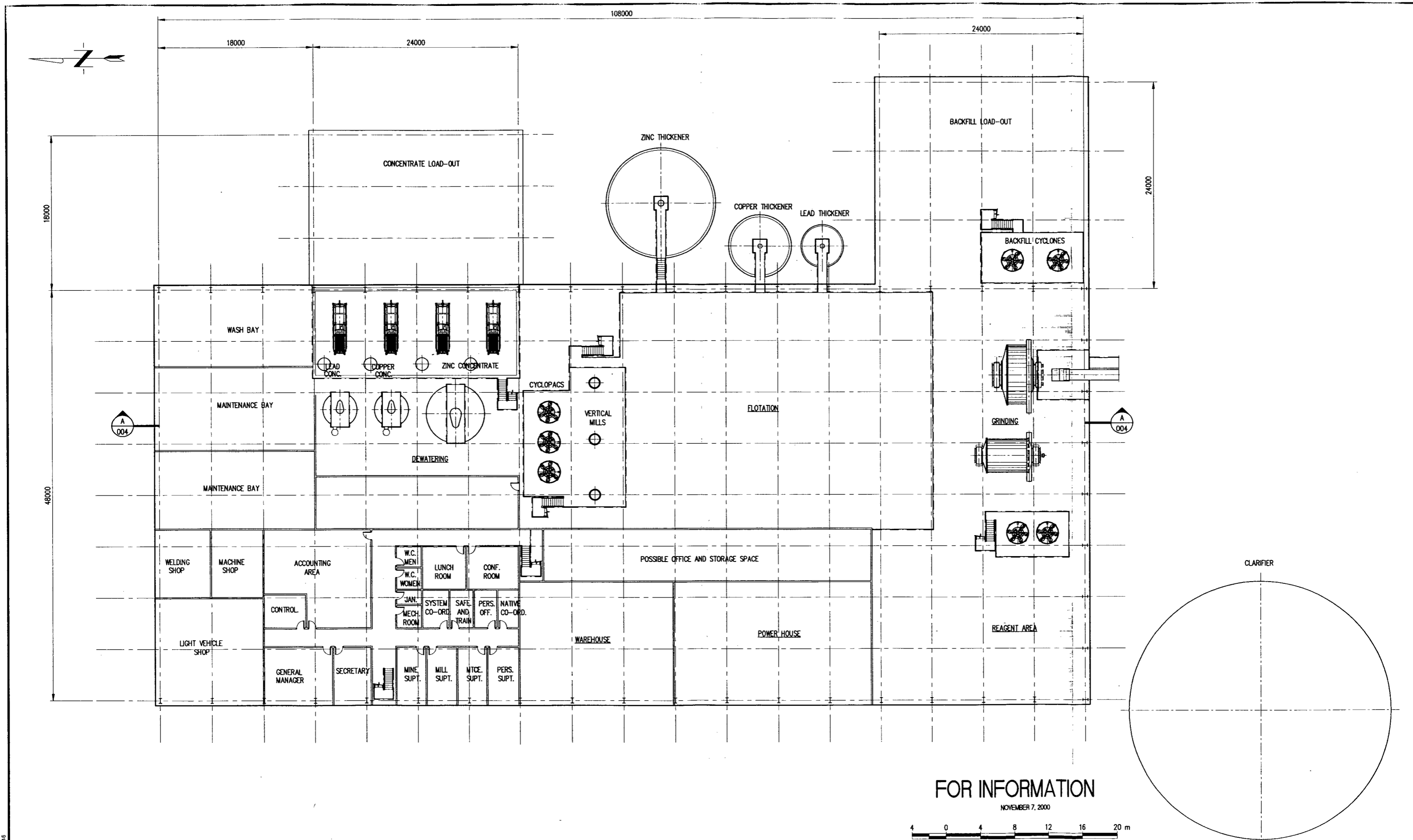


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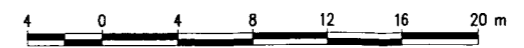


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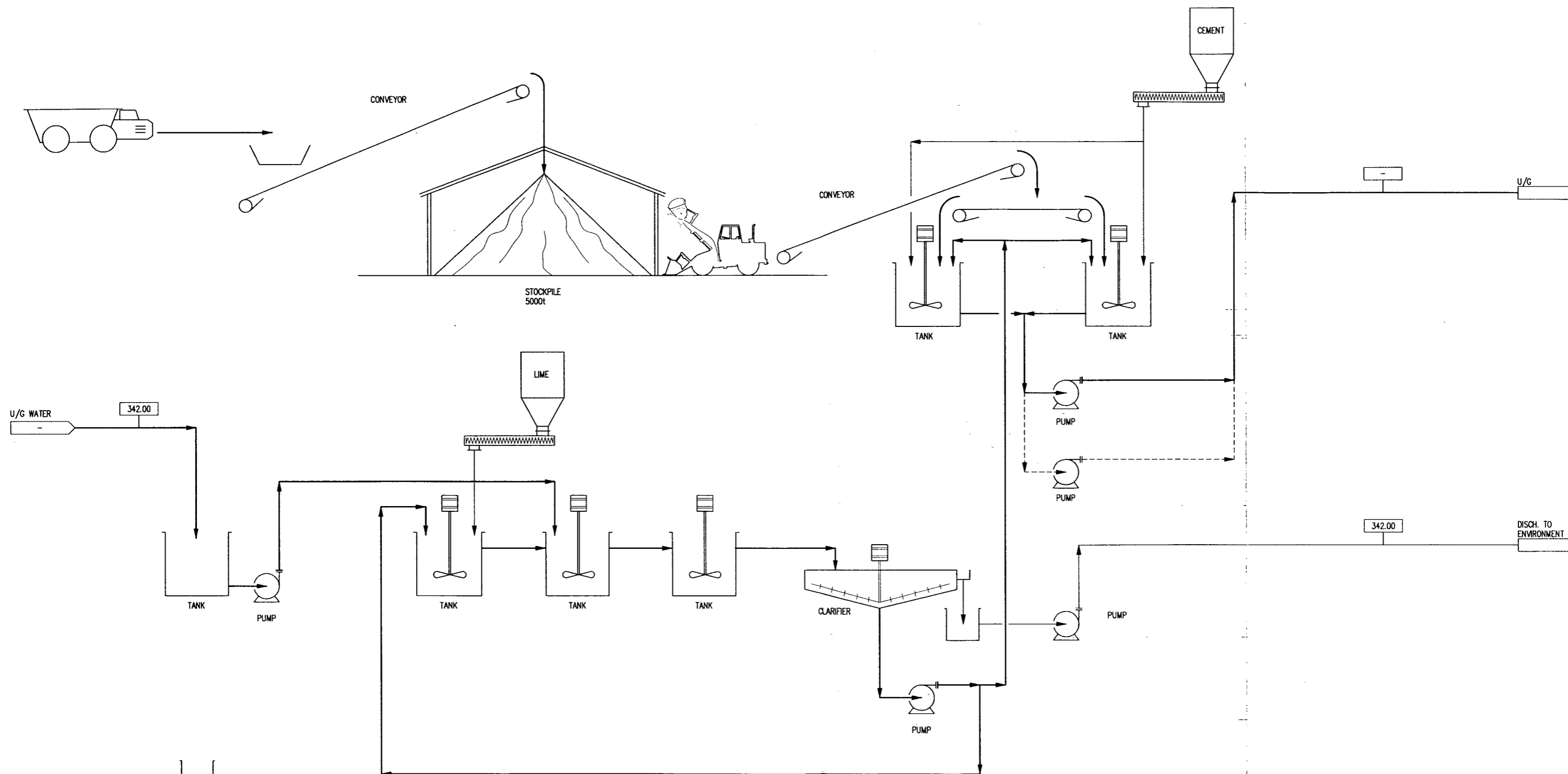
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LEGEND
 1/HR solids S.G. solids/m³/HR solids
 1/HR water % solids/m³/HR water
 1/HR pulp S.G. pulp/m³/HR pulp

WATER SOLUTIONS
 1/HR-m³/HR

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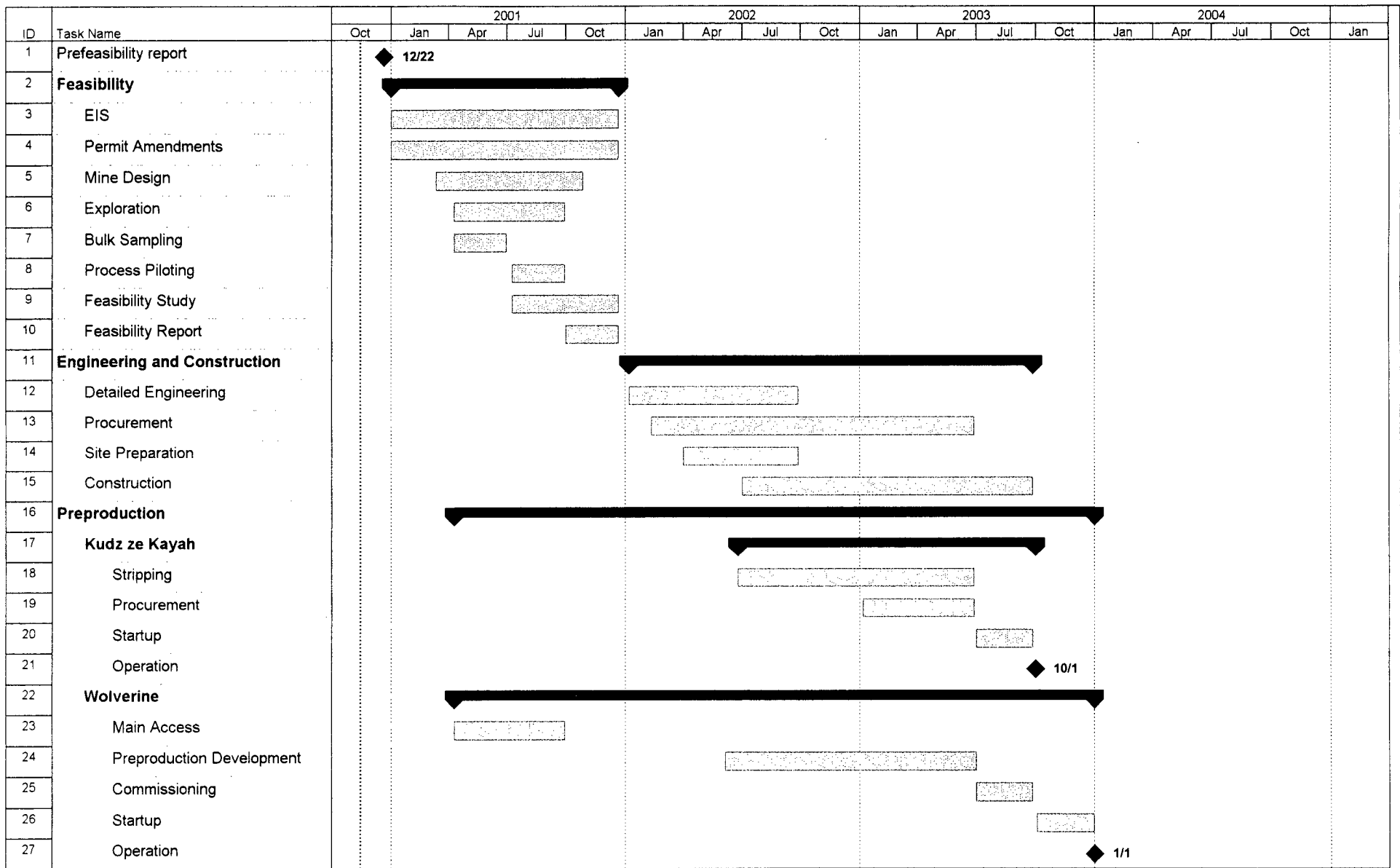
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Date: Tue 11/14/00

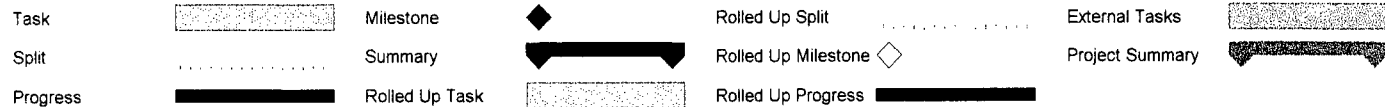
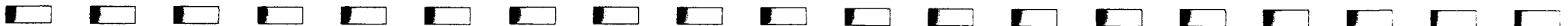
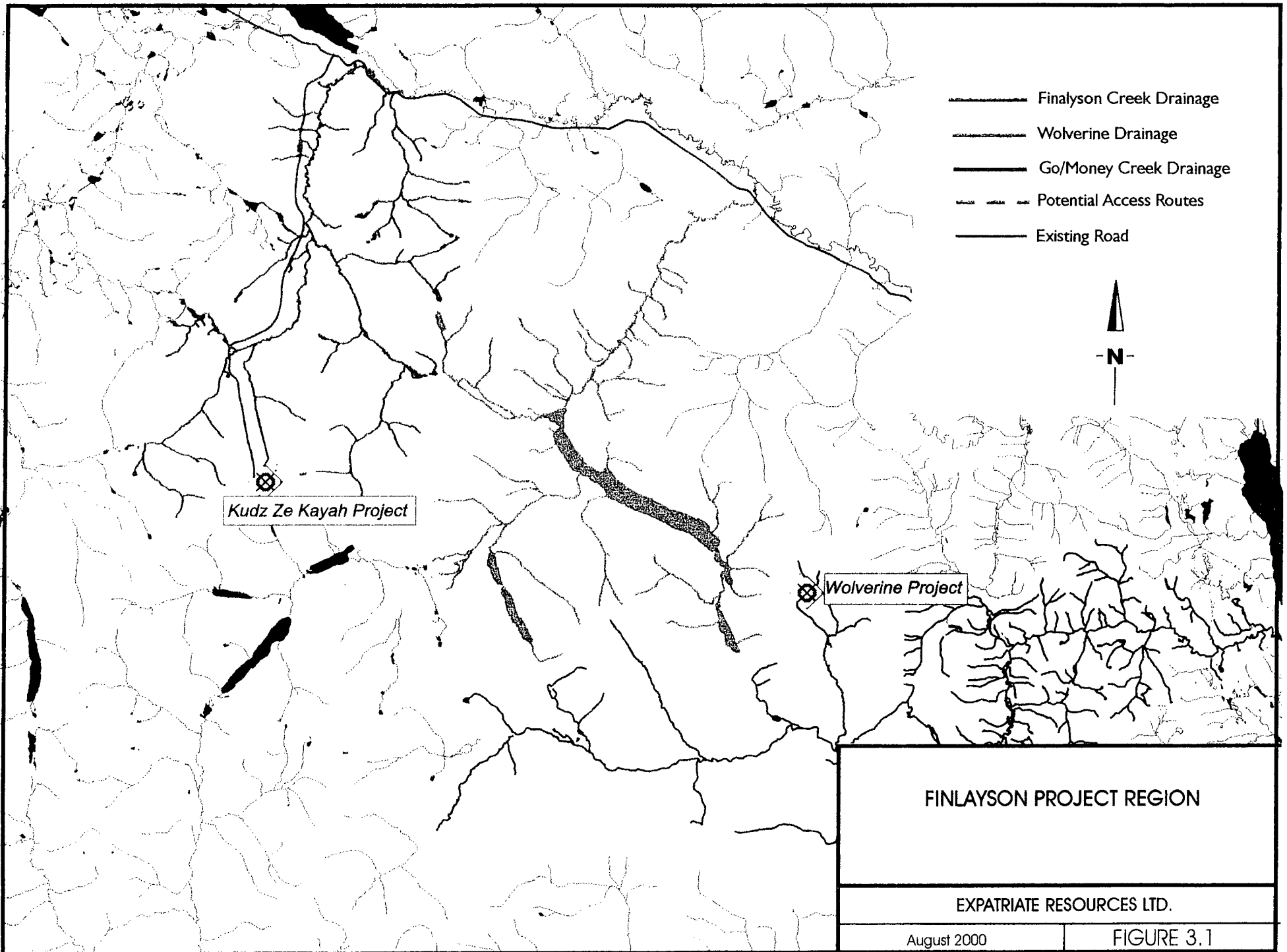
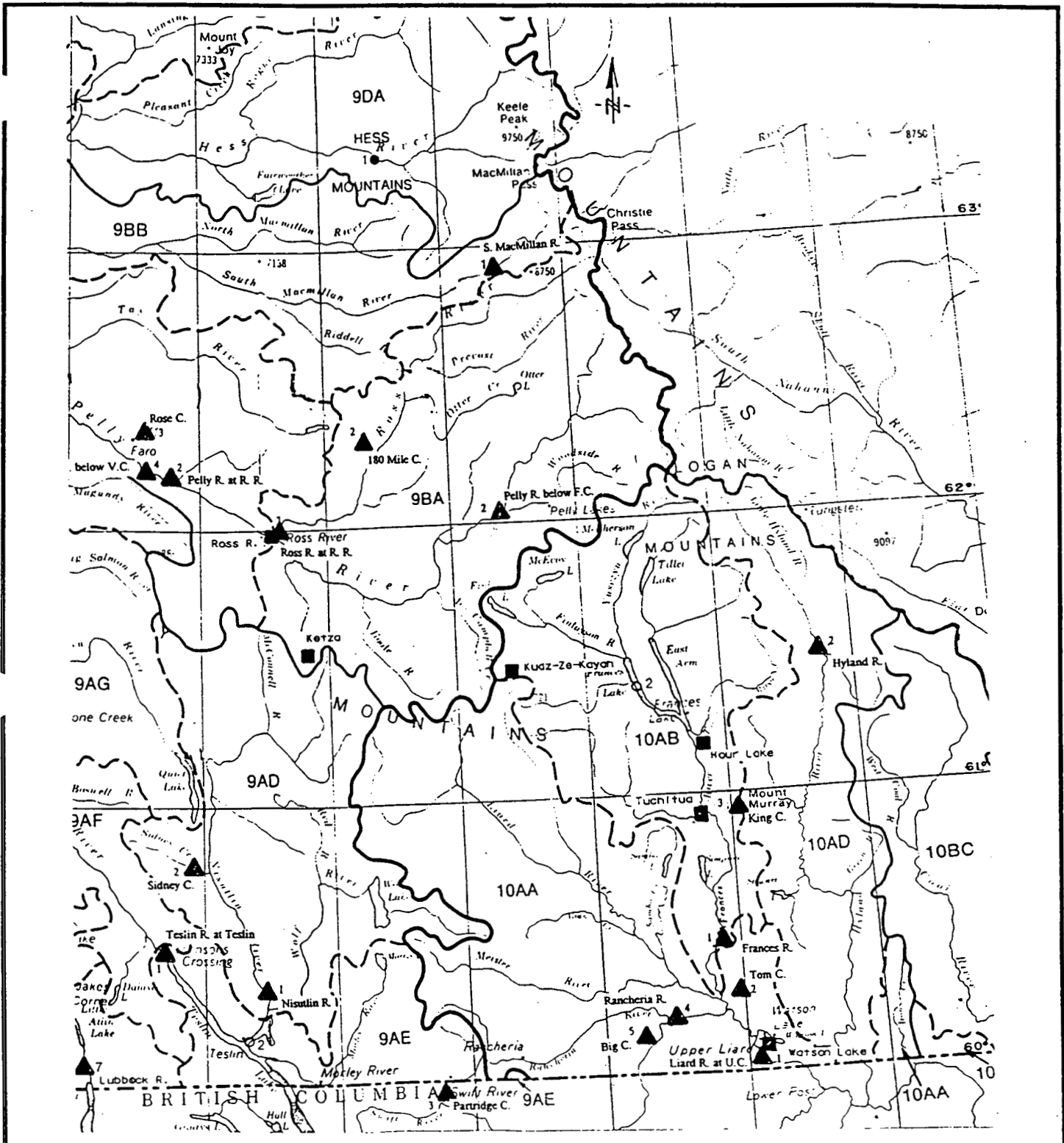


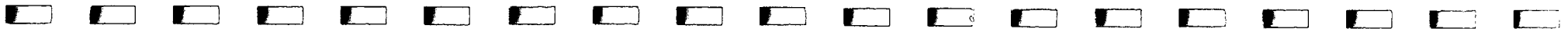
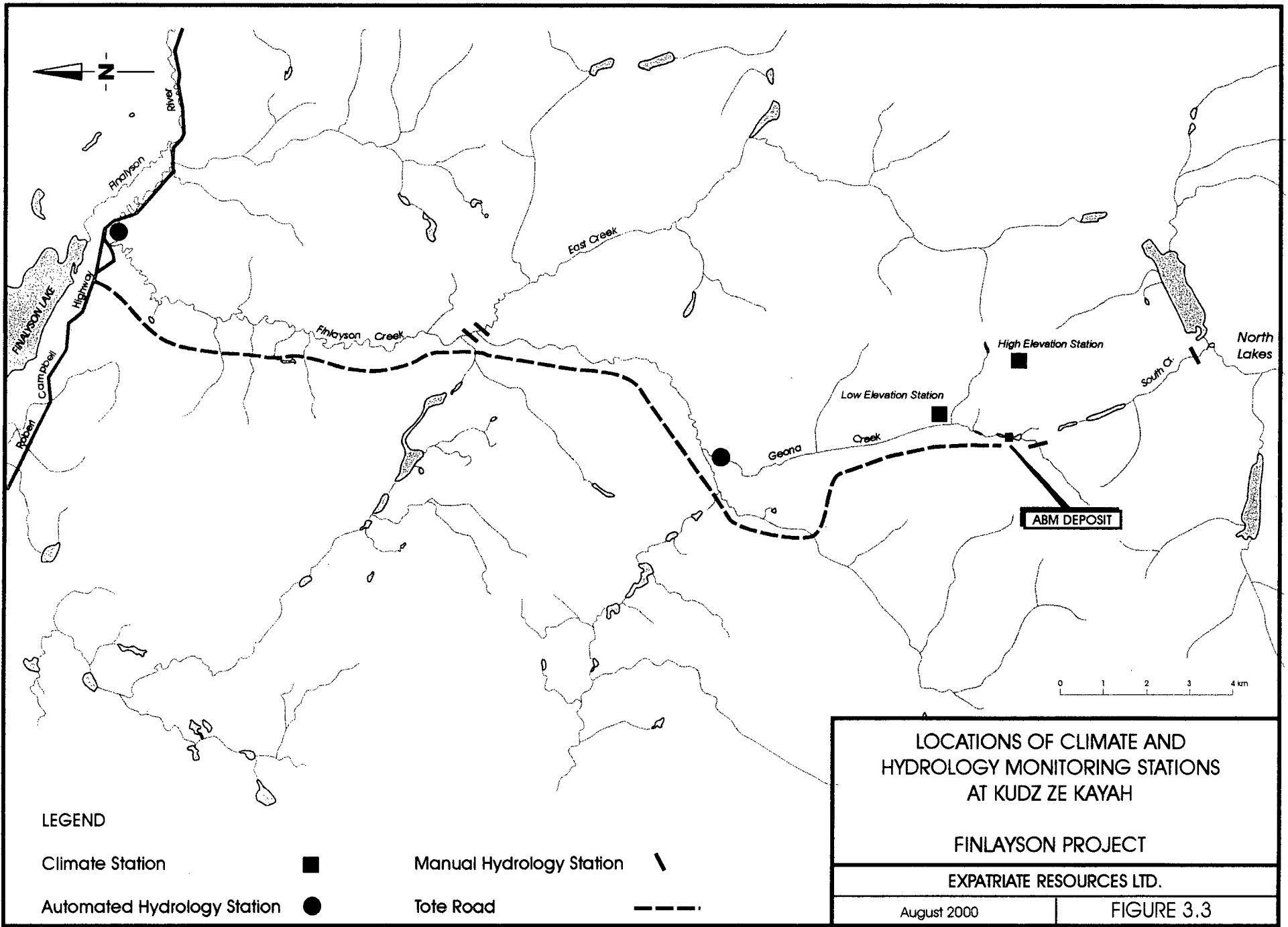
Figure 2-10 Summary Project Schedule





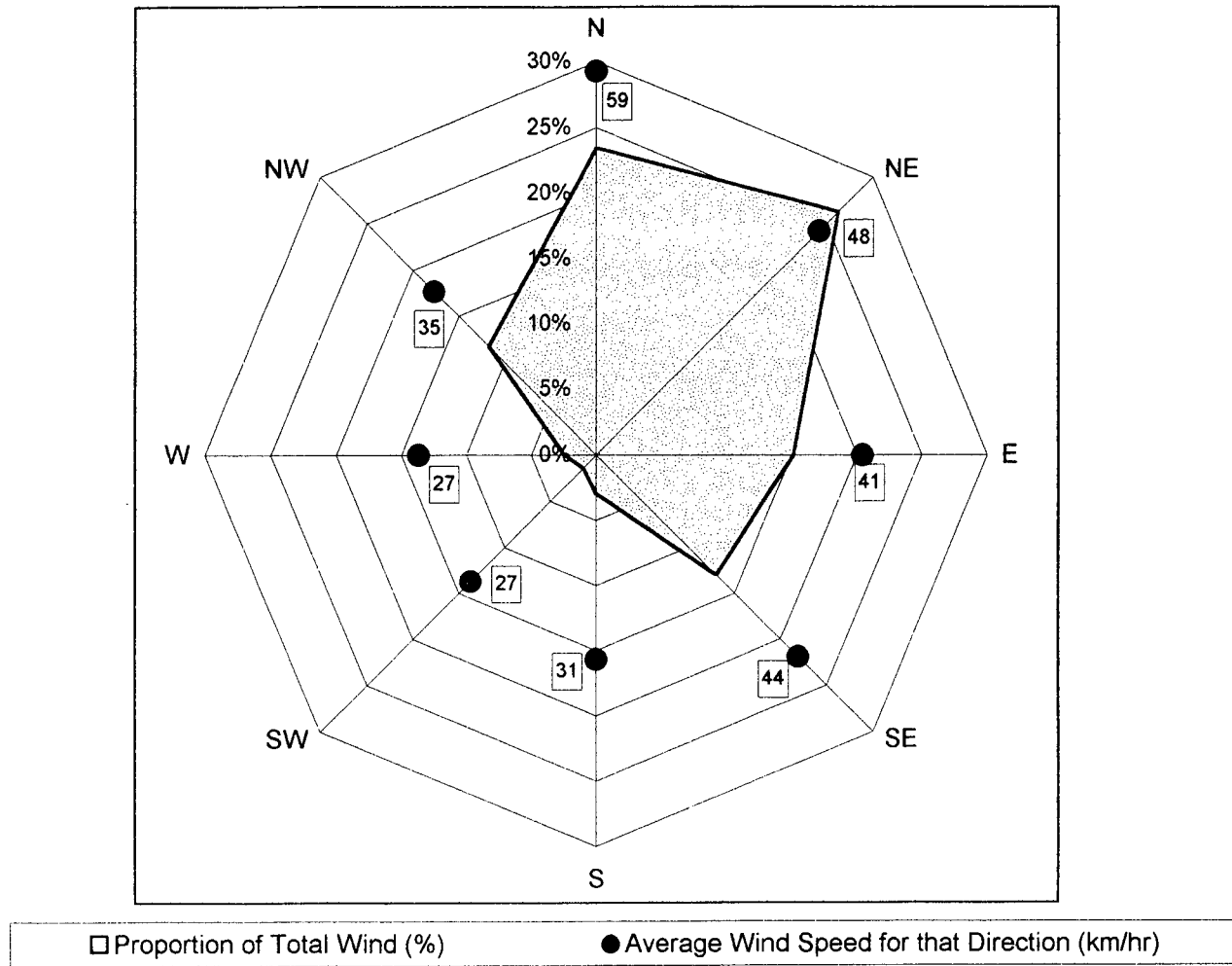
LEGEND
 Hydrometric Station ▲
 Climate Station ■
 Watershed Boundary —

REGIONAL HYDROMETRIC AND CLIMATE STATIONS FINLAYSON PROJECT	
EXPATRIATE RESOURCES LTD.	
FEBRUARY 1996	FIGURE 3.2



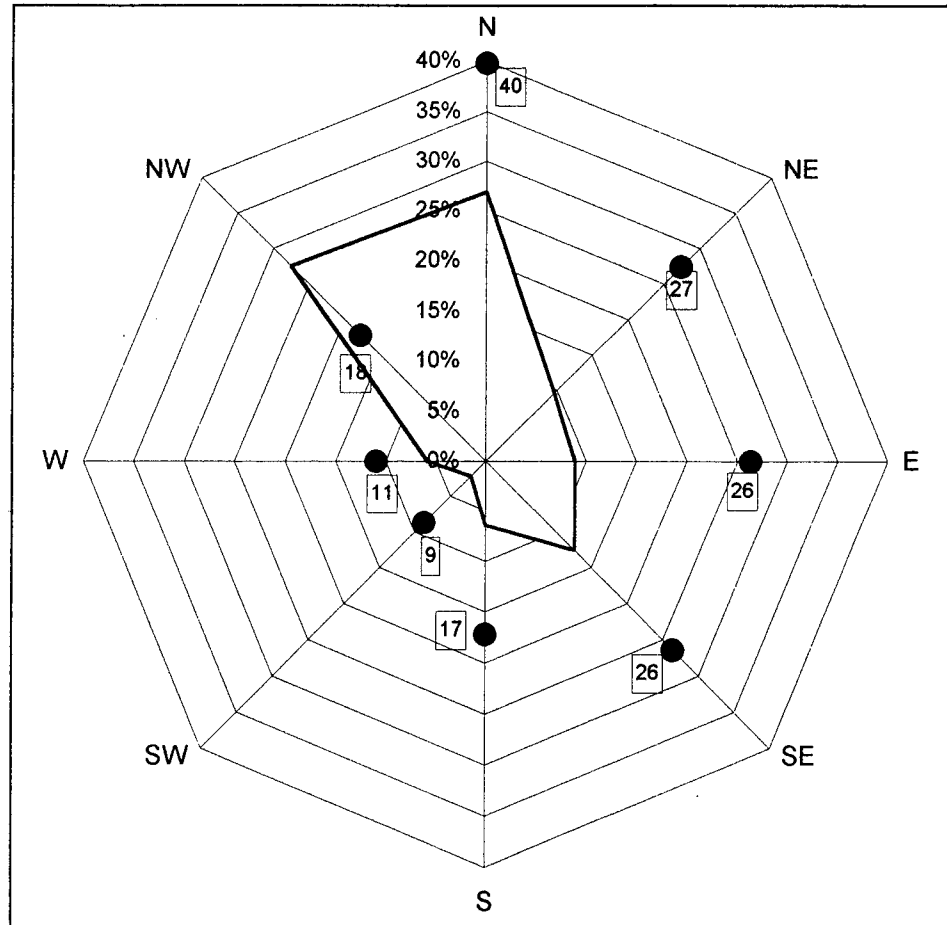
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FINALYSON PROJECT

Figure 3.4
Wind Direction and Speed at the Kudz Ze Kayah High Elevation Weather Station



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FINALYSON PROJECT

Figure 3.5
Wind Direction and Speed at the Kudz Ze Kayah Low Elevation Weather Station



□ Proportion of Total Wind (%) ● Average Wind Speed for that Direction (km/hr)



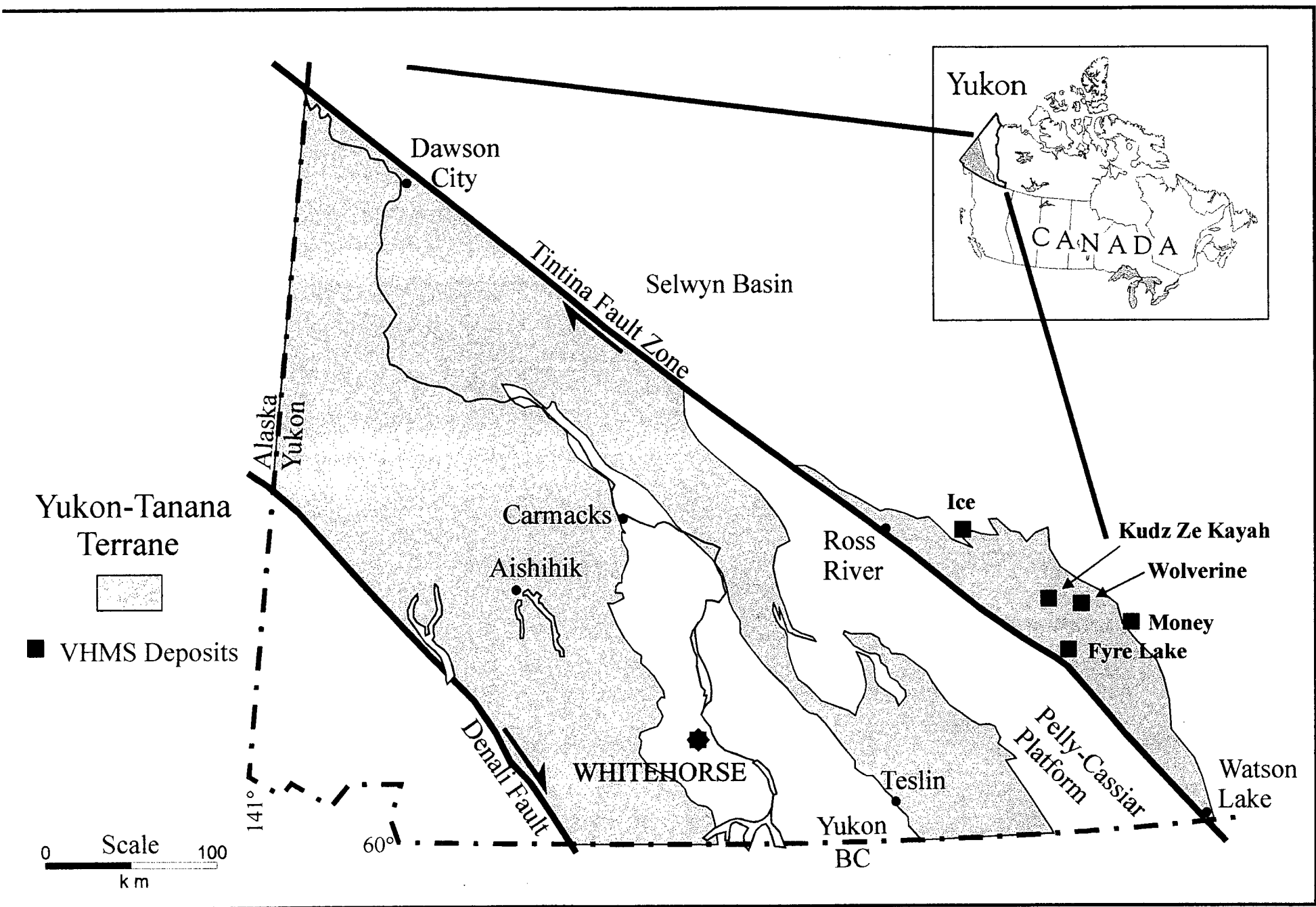


Figure 3.6. Location of the Finlayson Lake VHMS district.

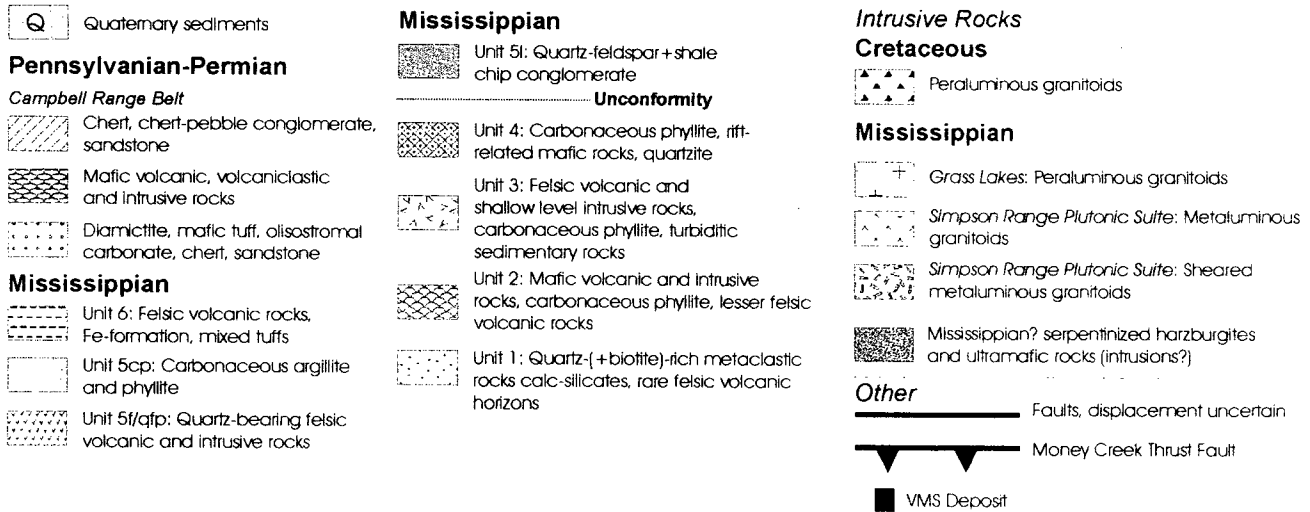
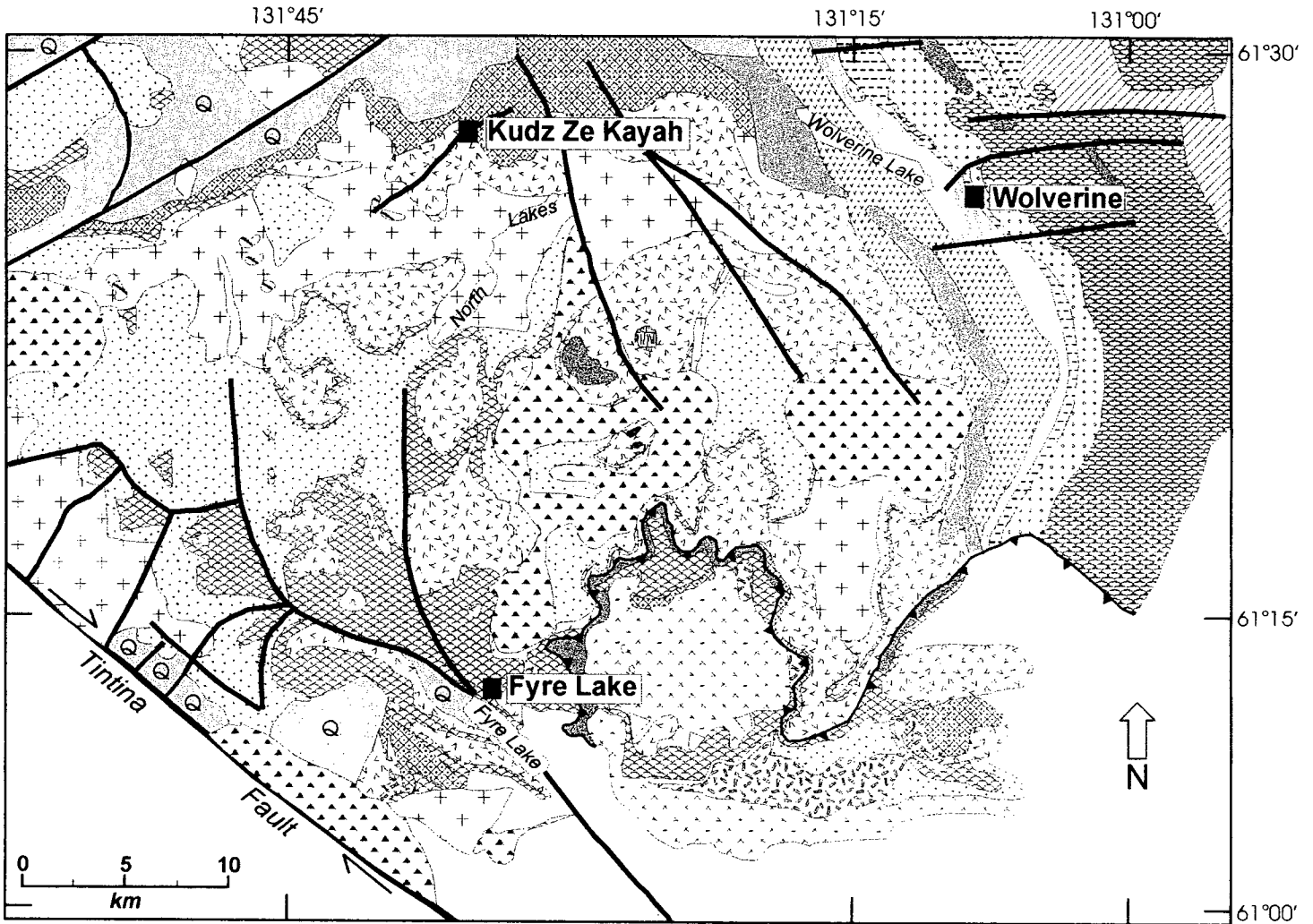


Figure 3.7. Geology of the Finlayson Lake region.

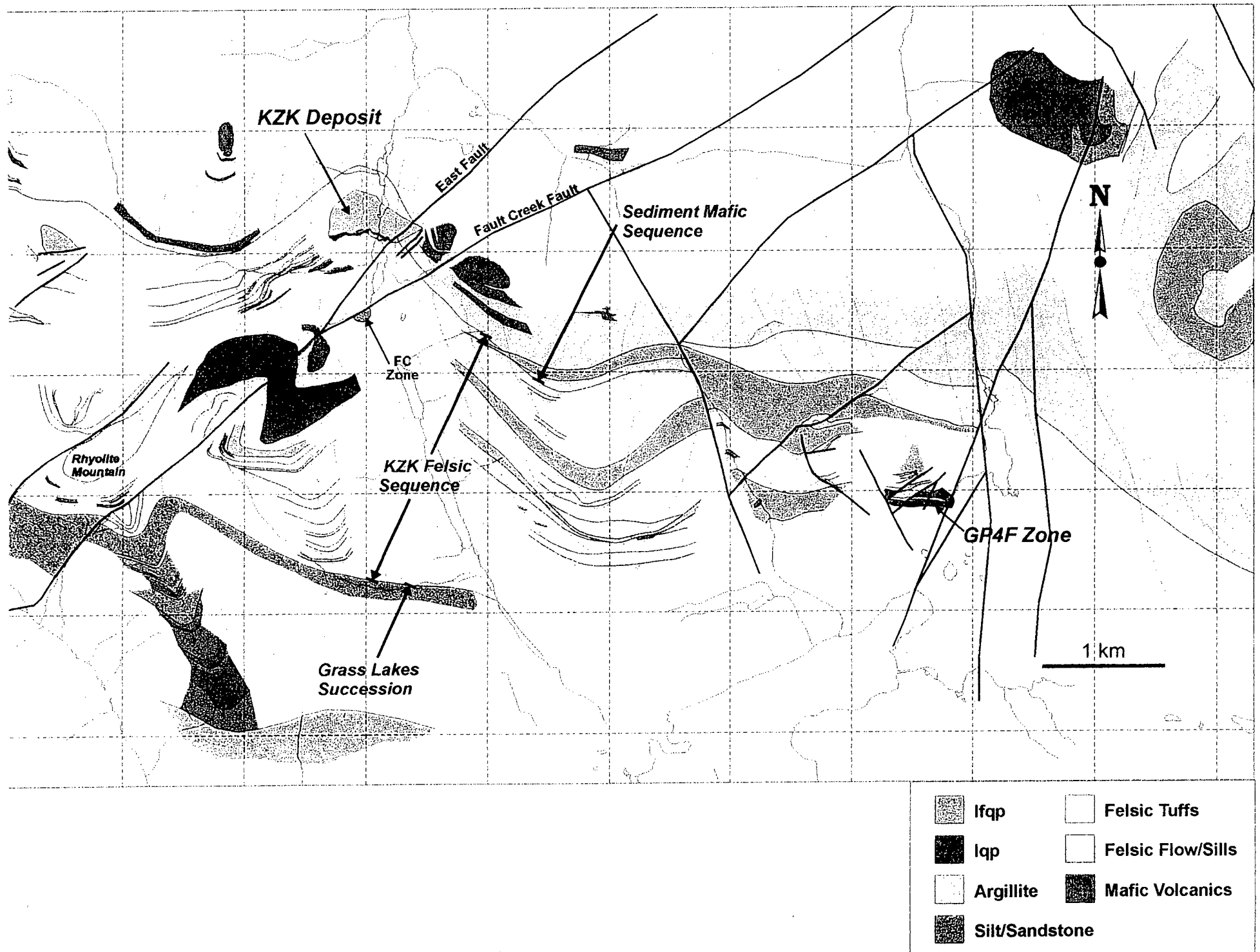


Figure 3.8. Plan View of the Kudz Ze Kayah Area Geology.

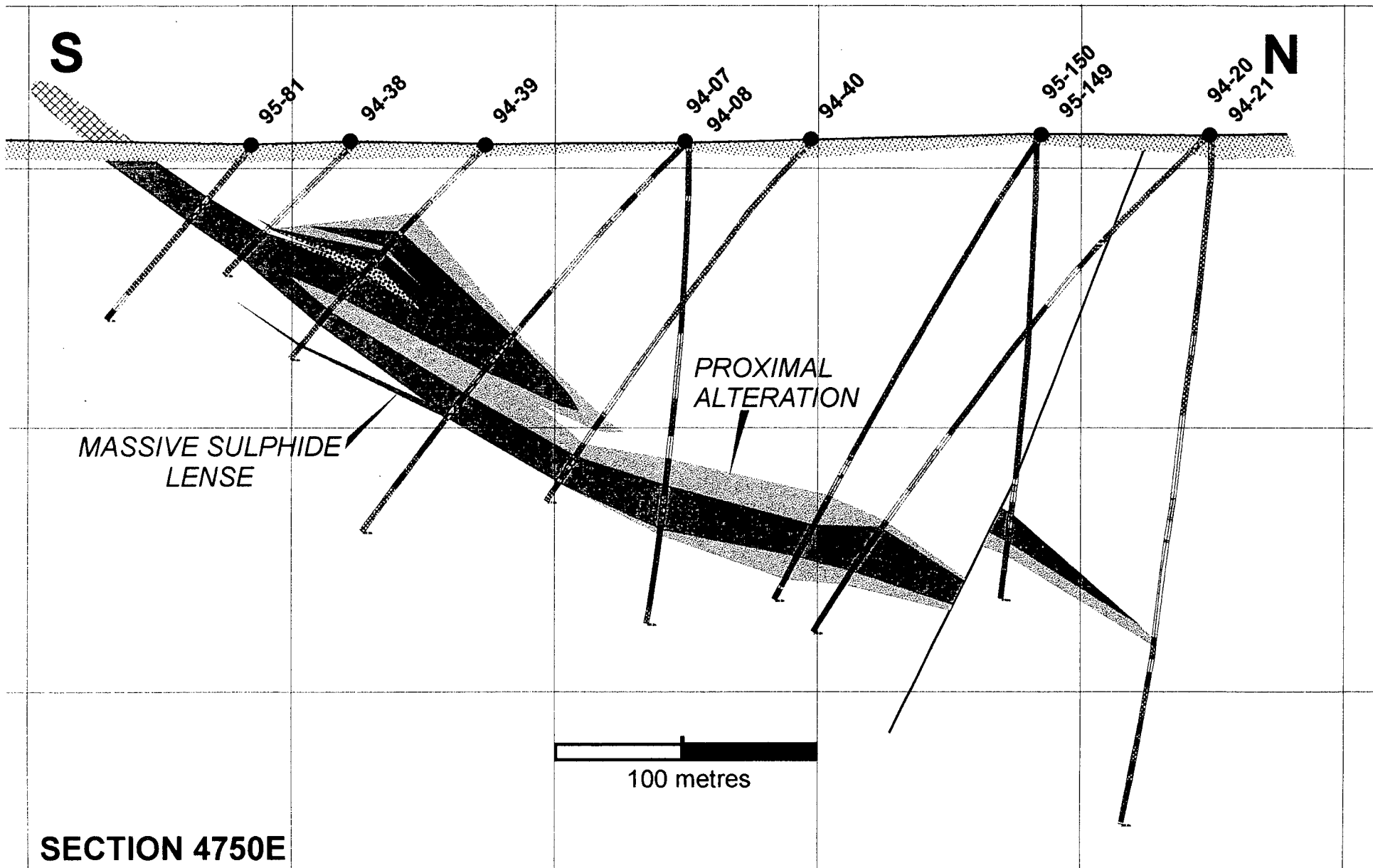
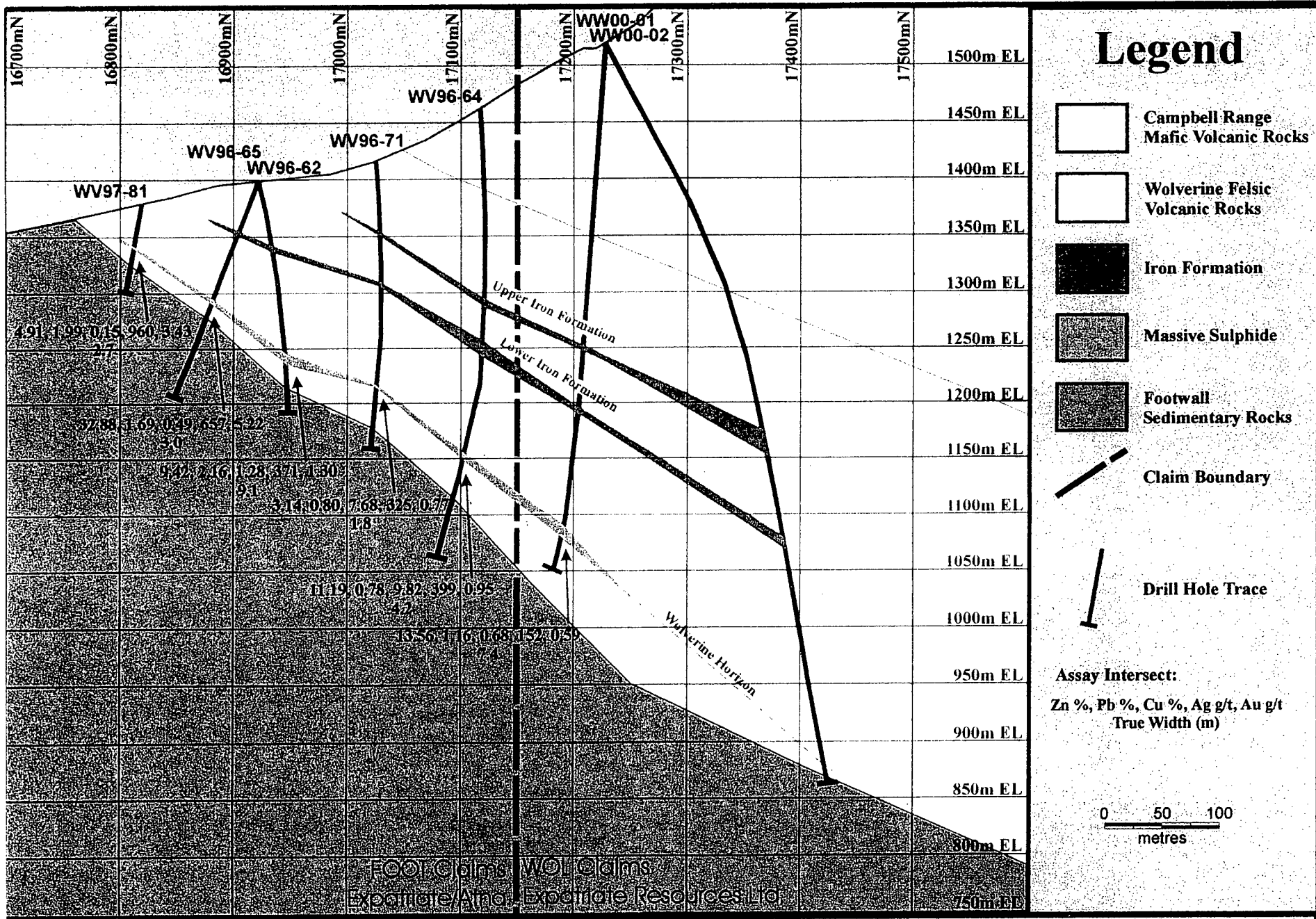


Figure 3.9. Simplified cross-section of the KudZe Kayah deposit.





Legend

- Campbell Range Mafic Volcanic Rocks
- Wolverine Felsic Volcanic Rocks
- Iron Formation
- Massive Sulphide
- Footwall Sedimentary Rocks
- Claim Boundary
- Drill Hole Trace

Assay Intersect:
 Zn %, Pb %, Cu %, Ag g/t, Au g/t
 True Width (m)

0 50 100

metres

Figure 3.10: Wolverine Deposit Cross Section

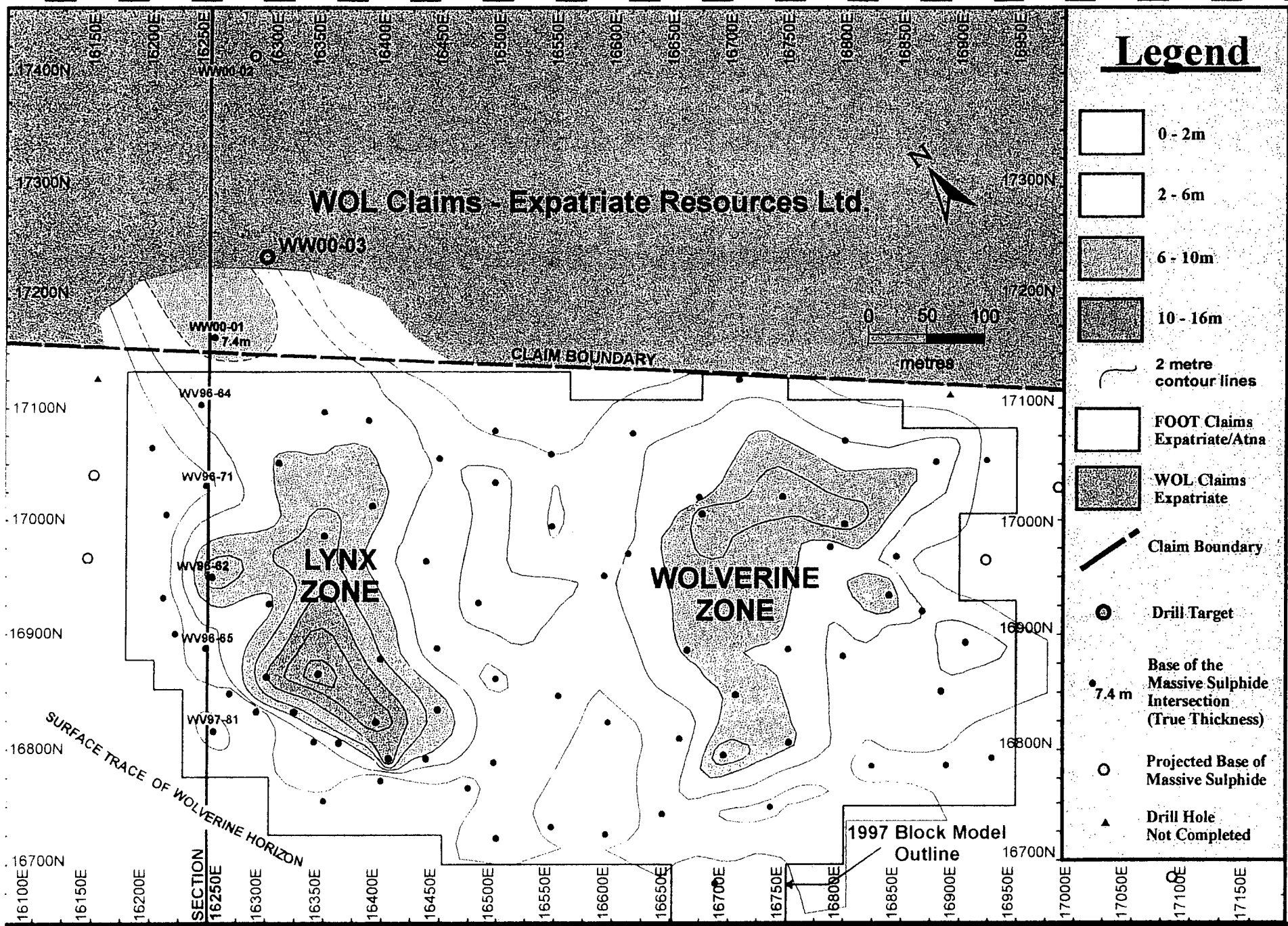
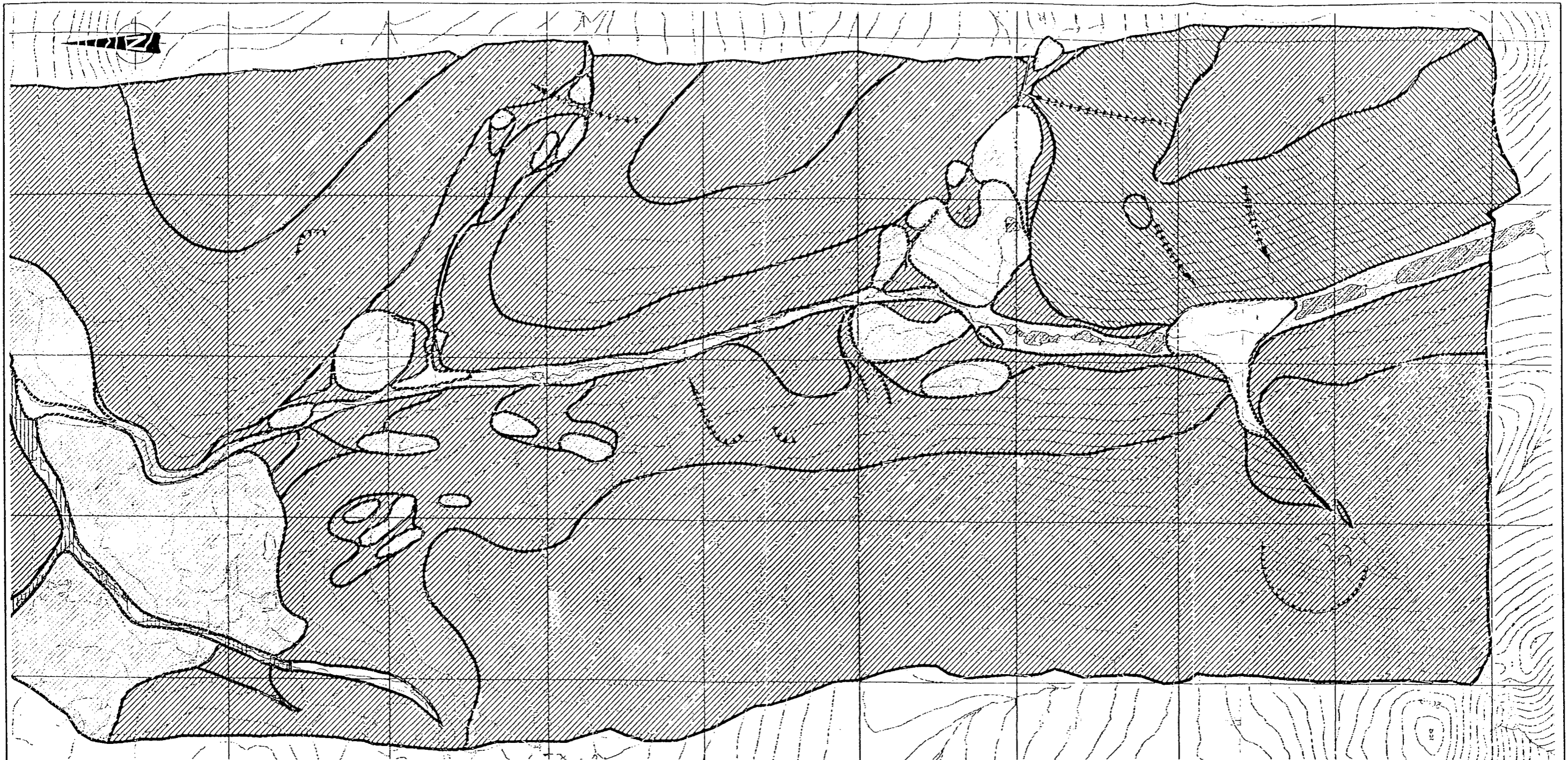






Figure 3.11: Wolverine Deposit Plan View

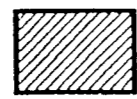
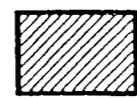
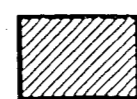
Project: 952-1523 Drawn: S.S.S. Reviewed: J.B. Rev.: 26 JAN '96 \952-1523\PI523-06.DWG




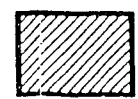
LEGEND

-  MELTWATER CHANNEL (Major)
-  MELTWATER CHANNEL (Minor)
-  CIRQUE
-  LANDSLIDE



MORAINAL DEPOSITS

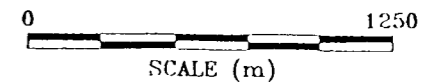
-  **TILL APRON:**
Till like material forming slope-toe complex of solifluction deposits, debris flow and avalanche fans over 10m thick.
-  **TILL BLANKET:**
Greater than 1m thick but conforming to the underlying topography.
-  **TILL VENEER:**
Less than 1m thick or discontinuous; may contain extensive areas of thin and patchy colluvium.

GLACIOFLUVIAL DEPOSITS

-  **GLACIOFLUVIAL COMPLEX:**
Sand, gravel, diamicton, and minor silts and clay; greater than 5m thick; including minor elements of glaciofluvial terrace sediments.
-  **GLACIOFLUVIAL FAN SEDIMENTS:**
Gravel, sand, and minor silt, greater than 1m thick.

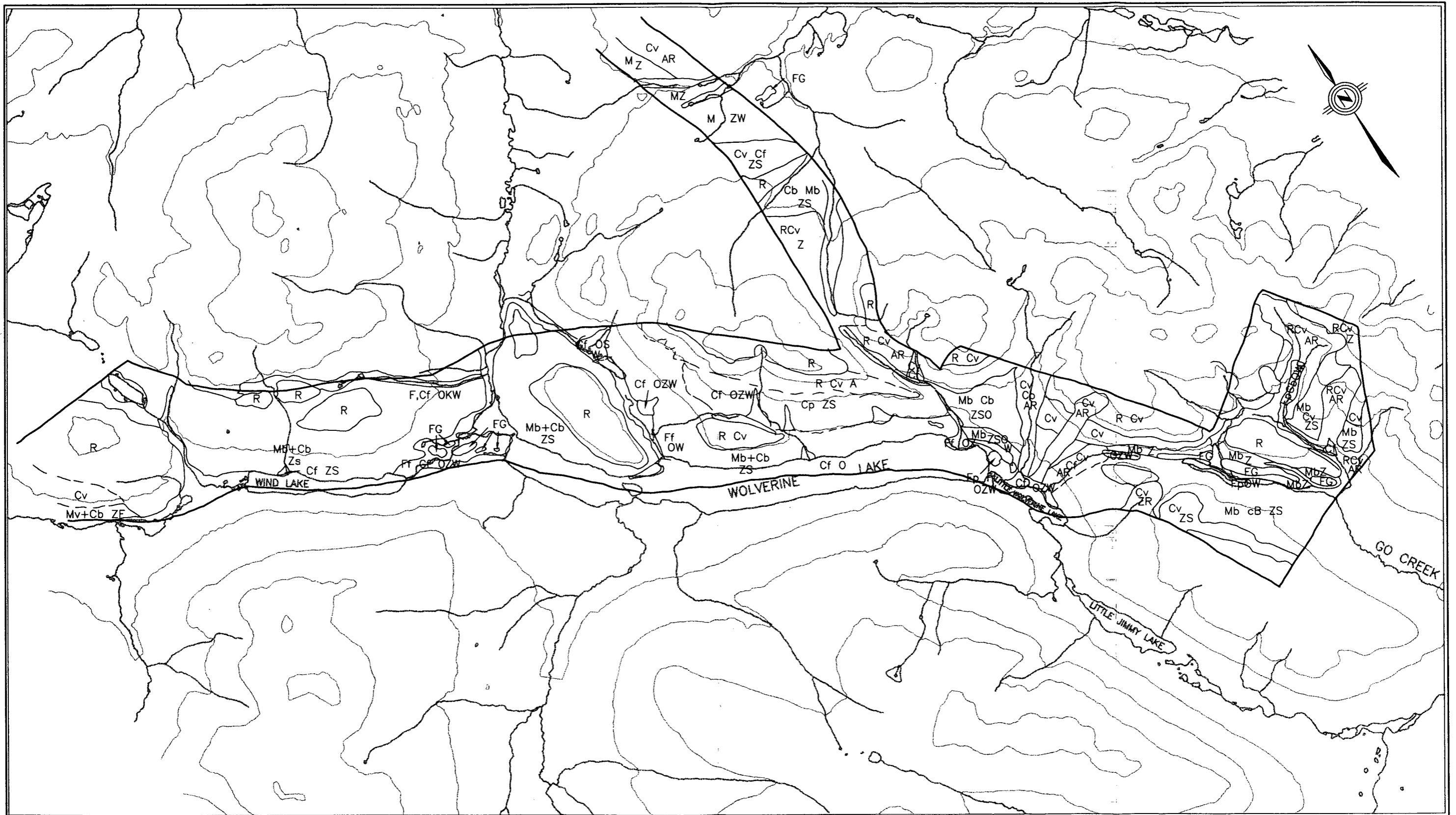
ALLUVIAL DEPOSITS

-  **ALLUVIAL SEDIMENTS, UNDIVIDED:**
of gravel and sand with minor silt, including lacustrine and organic sediments.
-  **ALLUVIAL FAN SEDIMENTS:**
Gravel, sand, silt, and diamicton up to 10m or more thick; on smaller and steeper fans subject to inundation by debris flows.



SITE PLAN
SURFICIAL GEOLOGY - GEONA VALLEY

Figure
FIGURE 3.12




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R Rock
 Cv Colluvial Veneer (less than 1m)
 Cb Colluvial Blanket (1 to 3m)
 Cf Colluvial Fan
 Mb Marginal Blanket (1-3m)
 FP Fluvial Plain
 FF Fluvial Fan
 FG Glacio Fluvial (sd + gravel)

LEGEND:

AR Avalanche, Rapid mass movement, Rock fall
 ZS Permafrost, Slow mass movement (solifluction, creep, mudflow)
 ZW Permafrost, Very poorly drained depression
 OKW Organic, Thermokarst (Permafrost), poorly drained
 Z Permafrost
 A Avalanche

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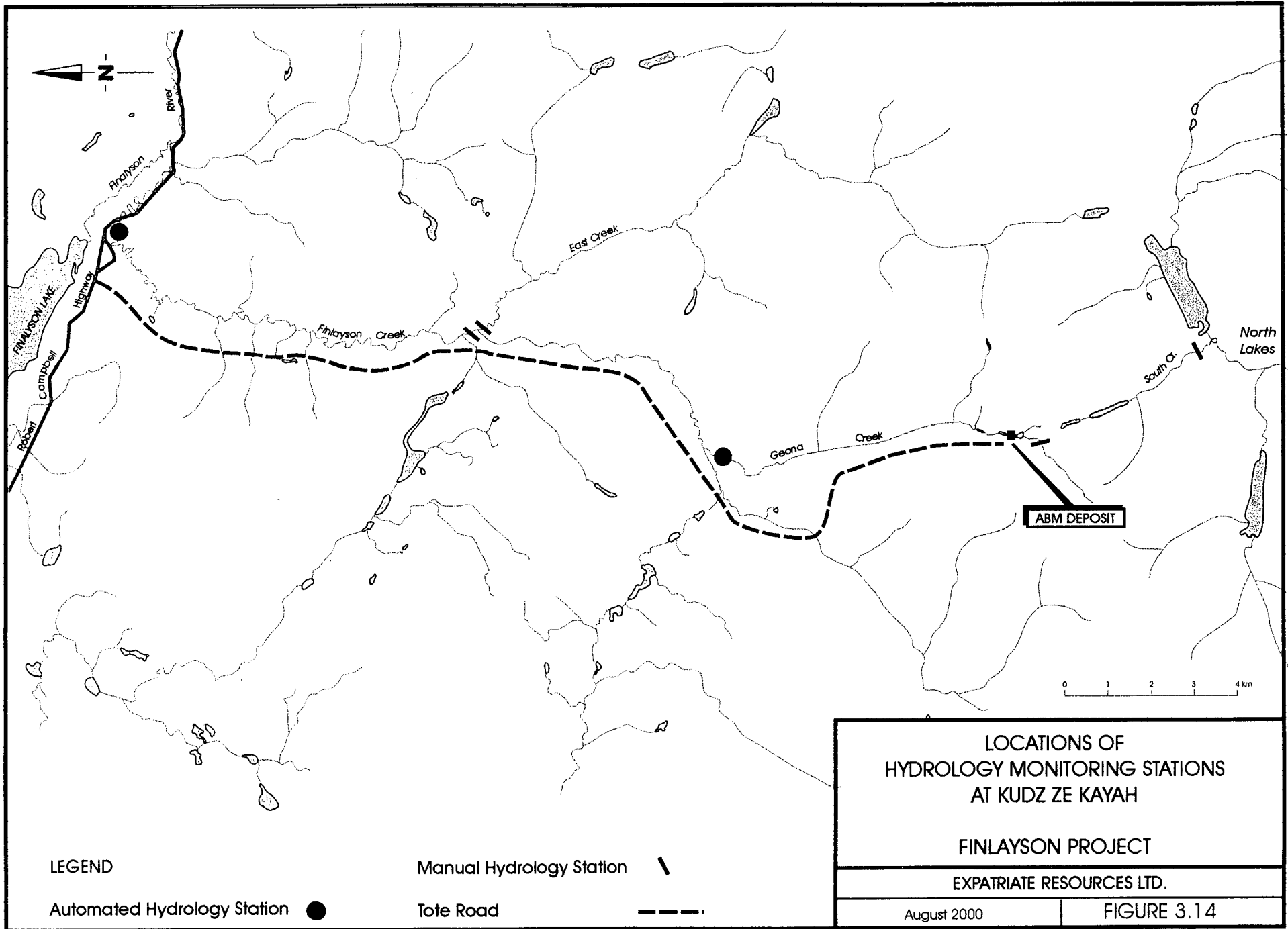
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM

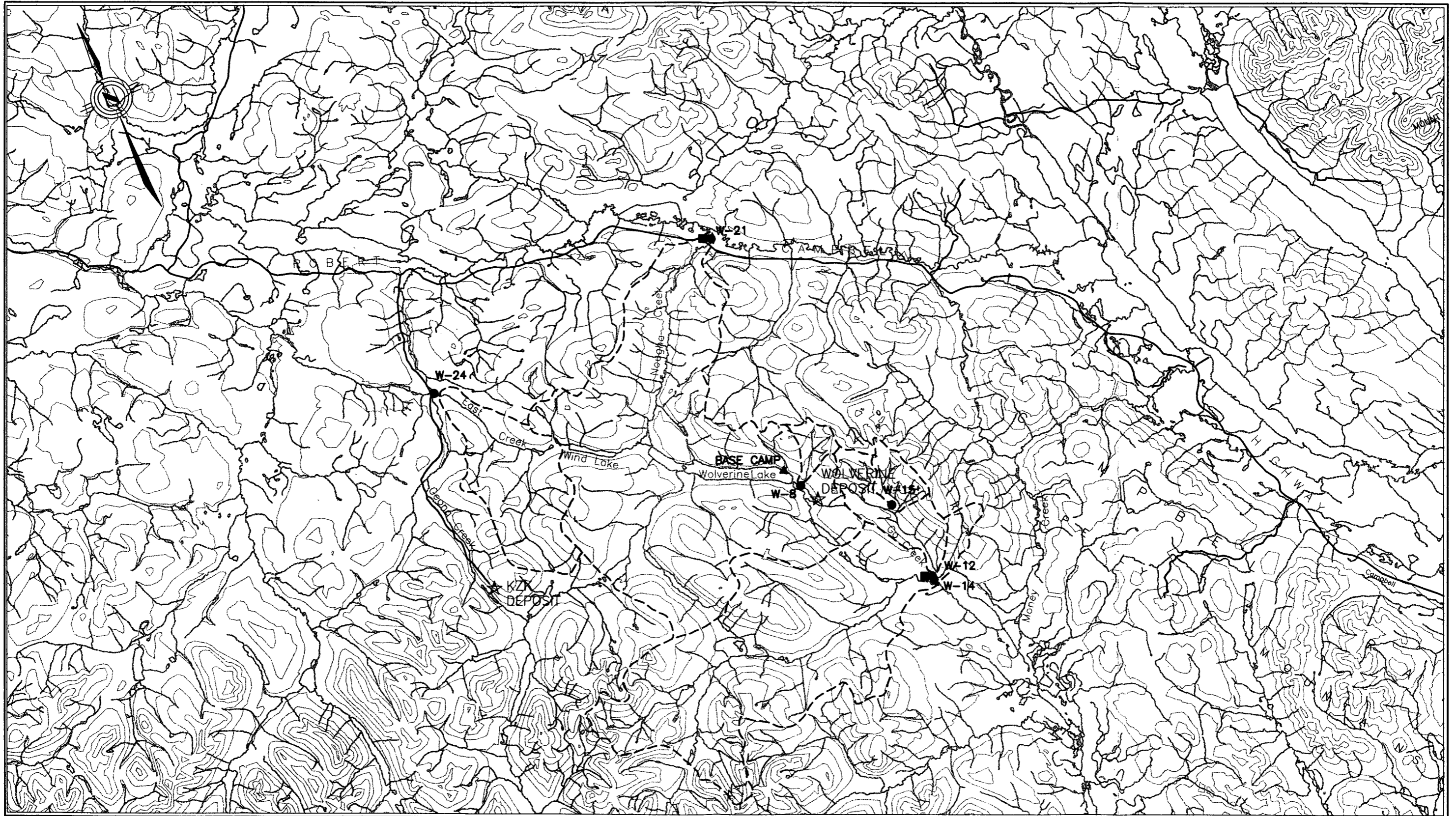
SURFICIAL GEOLOGY OF THE WOLVERINE LAKE AREA

PREPARED BY: ACCESS MINING CONSULTANTS LTD.

SCALE: 1:75,000 | DATE: 11/14/00 | FILE: 9607R/TOPO-50

FIG. 3.13






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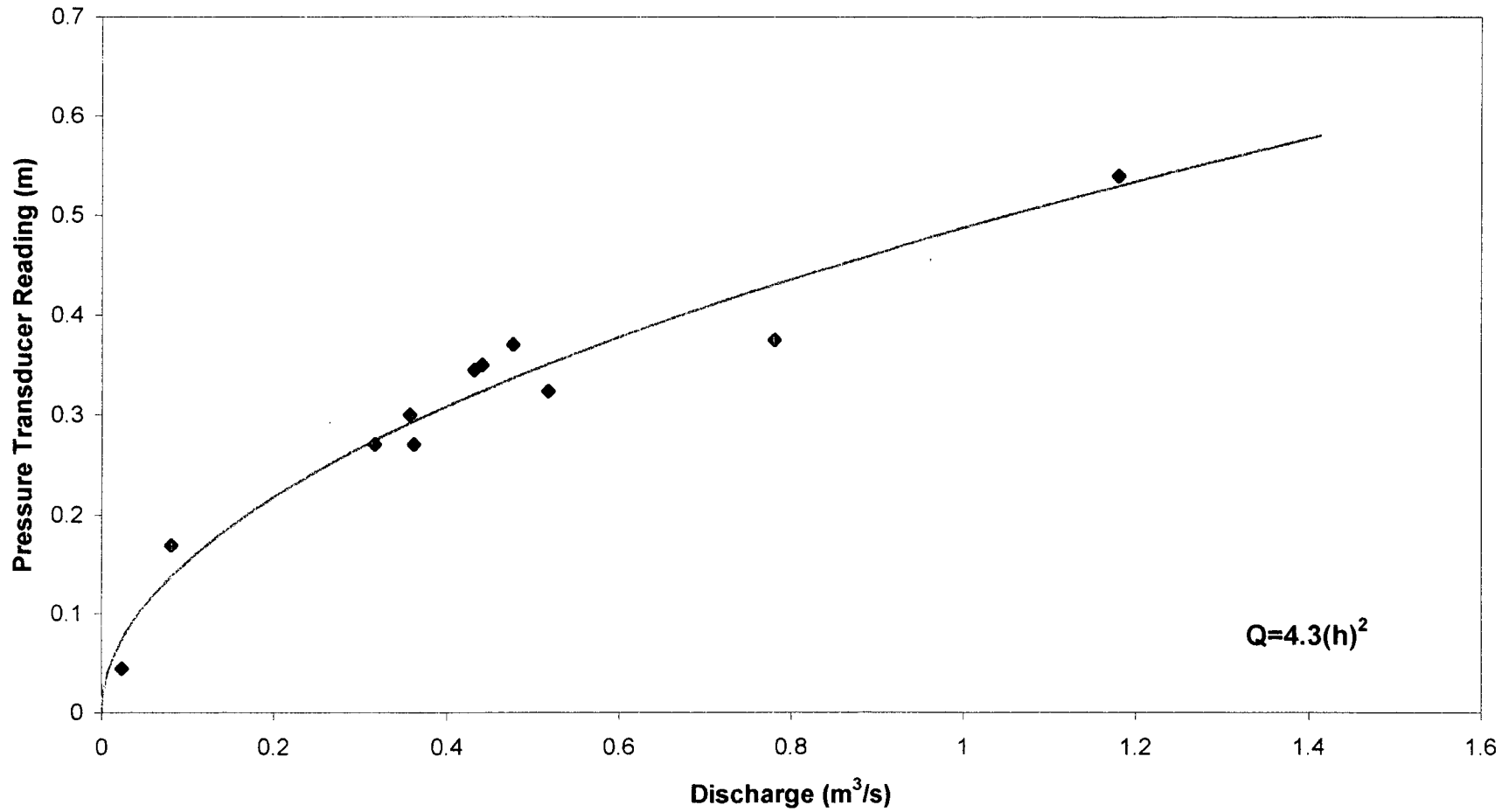
- LEGEND:
- ▲ MANUAL CLIMATE STATION
 - AUTOMATIC HYDROLOGY STATIONS
 - MANUAL HYDROLOGY STATIONS
 - CATCHNET BOUNDARY FOR STATIONS EQUIPPED WITH AN AUTOMATIC WATER LEVEL RECORDER AND/OR STAFF GAUGE PLATE

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM	
CLIMATE AND HYDROLOGY MONITORING STATIONS	
WOLVERINE AREA	
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.
SCALE: 1:250,000	DATE: 11/14/00 FILE: FIN-3_15

FIG. 3.15

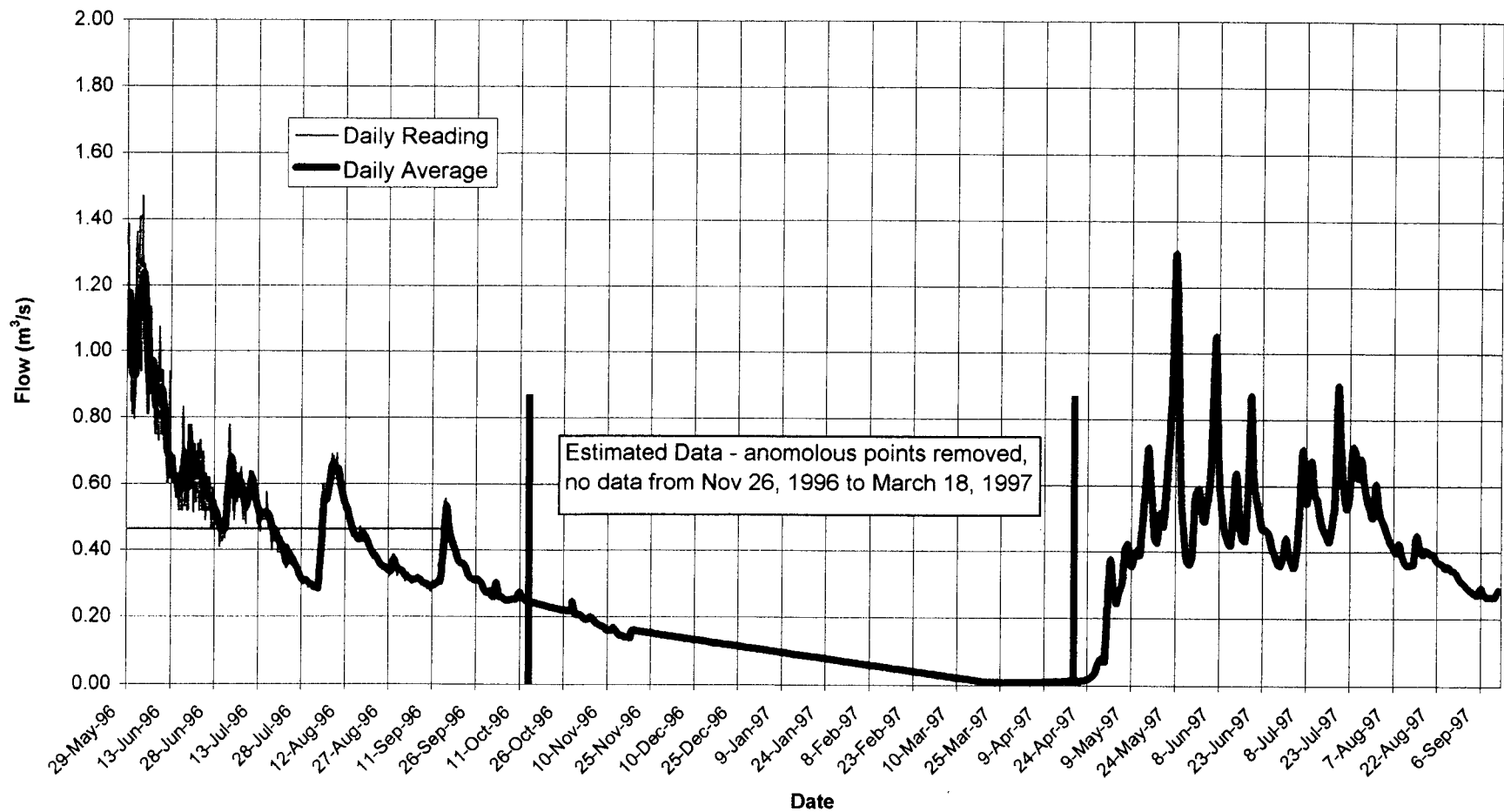
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Figure 3.15a
Rating Curve for Station W12 (Go Creek)



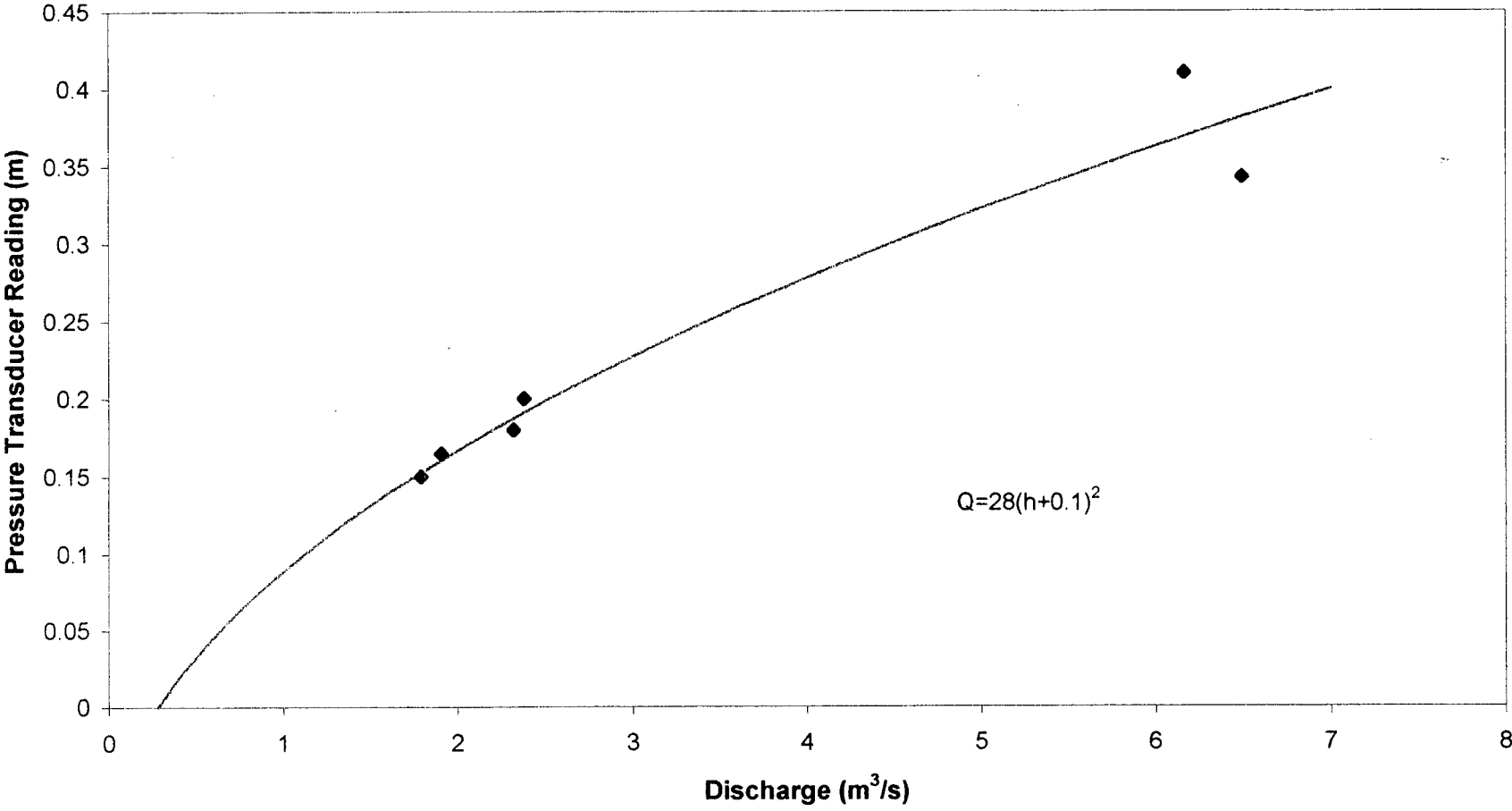
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.16
Stream Discharge at Station W12 (Go Creek)



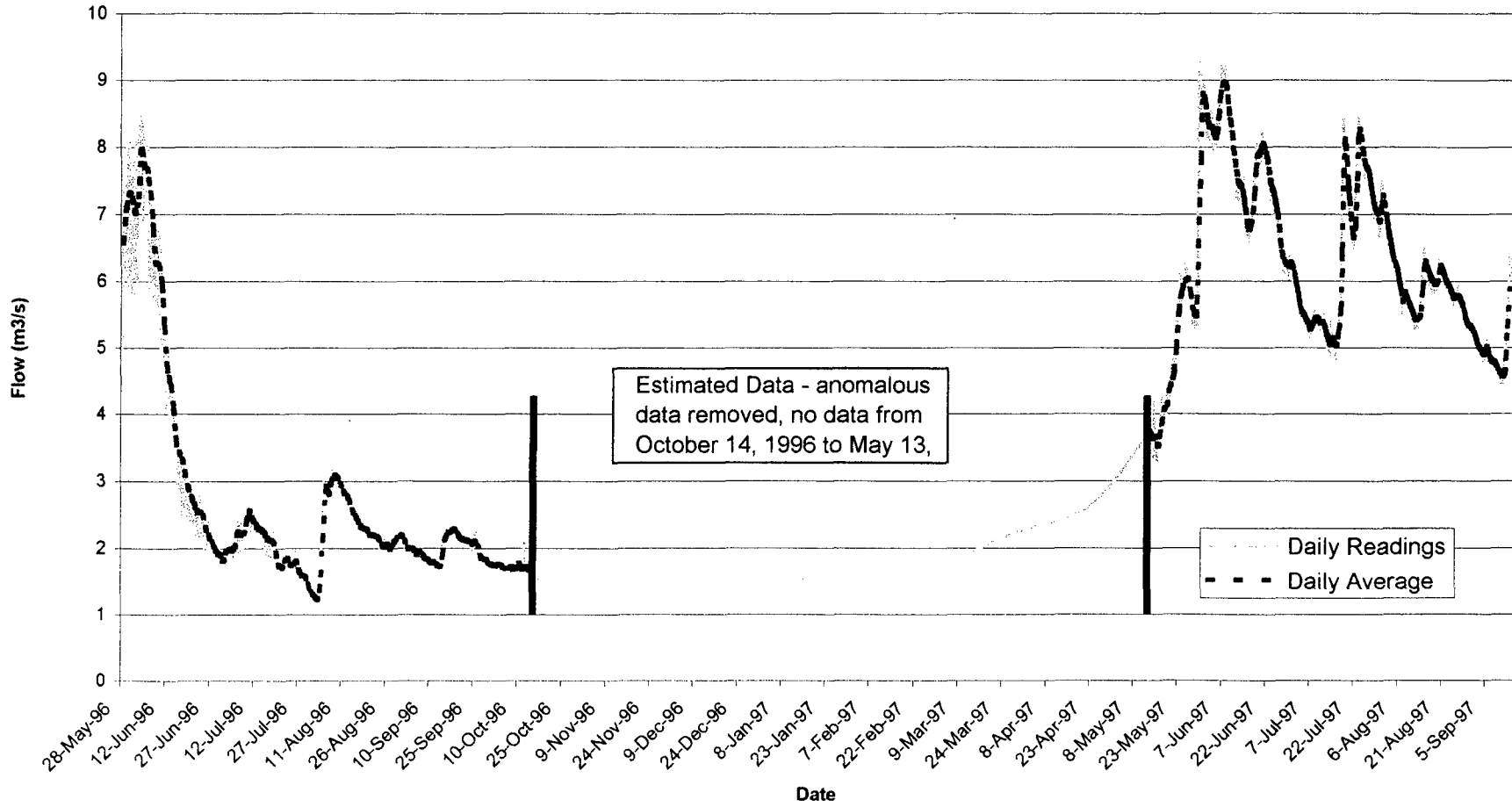
EXPATRIATE RESOURCES LTD.
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Figure 3.17
Stage - Discharge Curve for Station W21 (Nougha Creek)



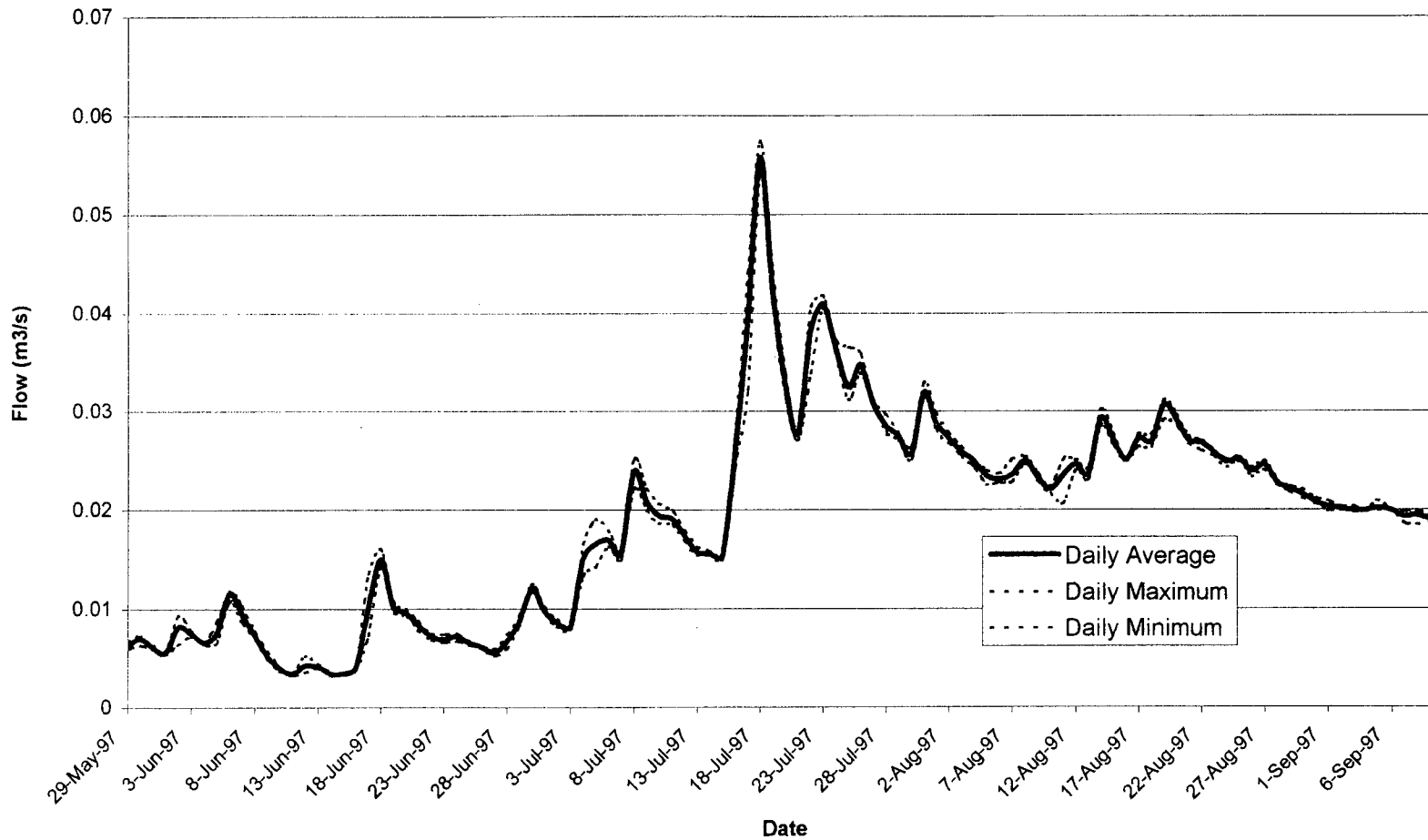
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Figure 3.18
Stream Discharge at Station W21 (Nougha Creek)



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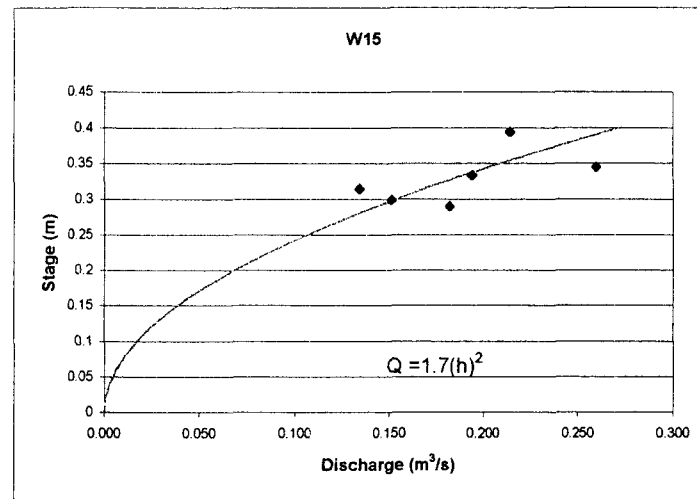
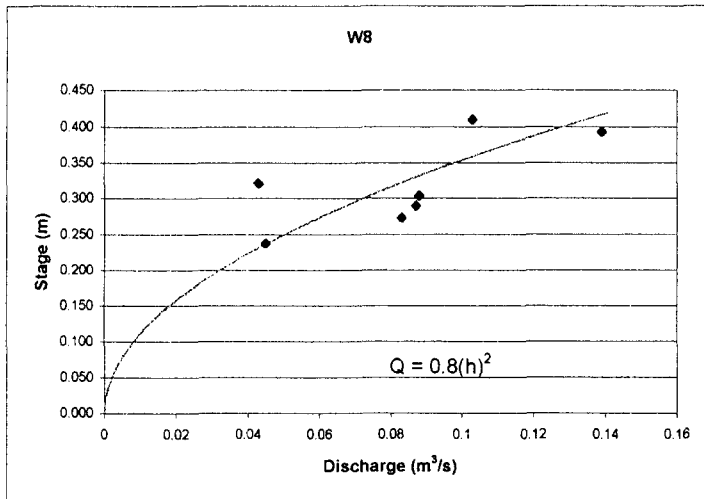
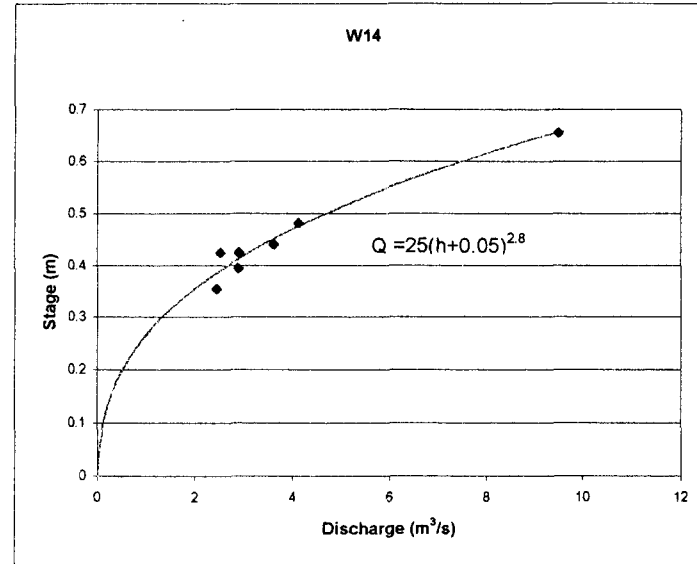
Figure 3.19
Stream Discharge at Station W9 (Wolverine Creek)



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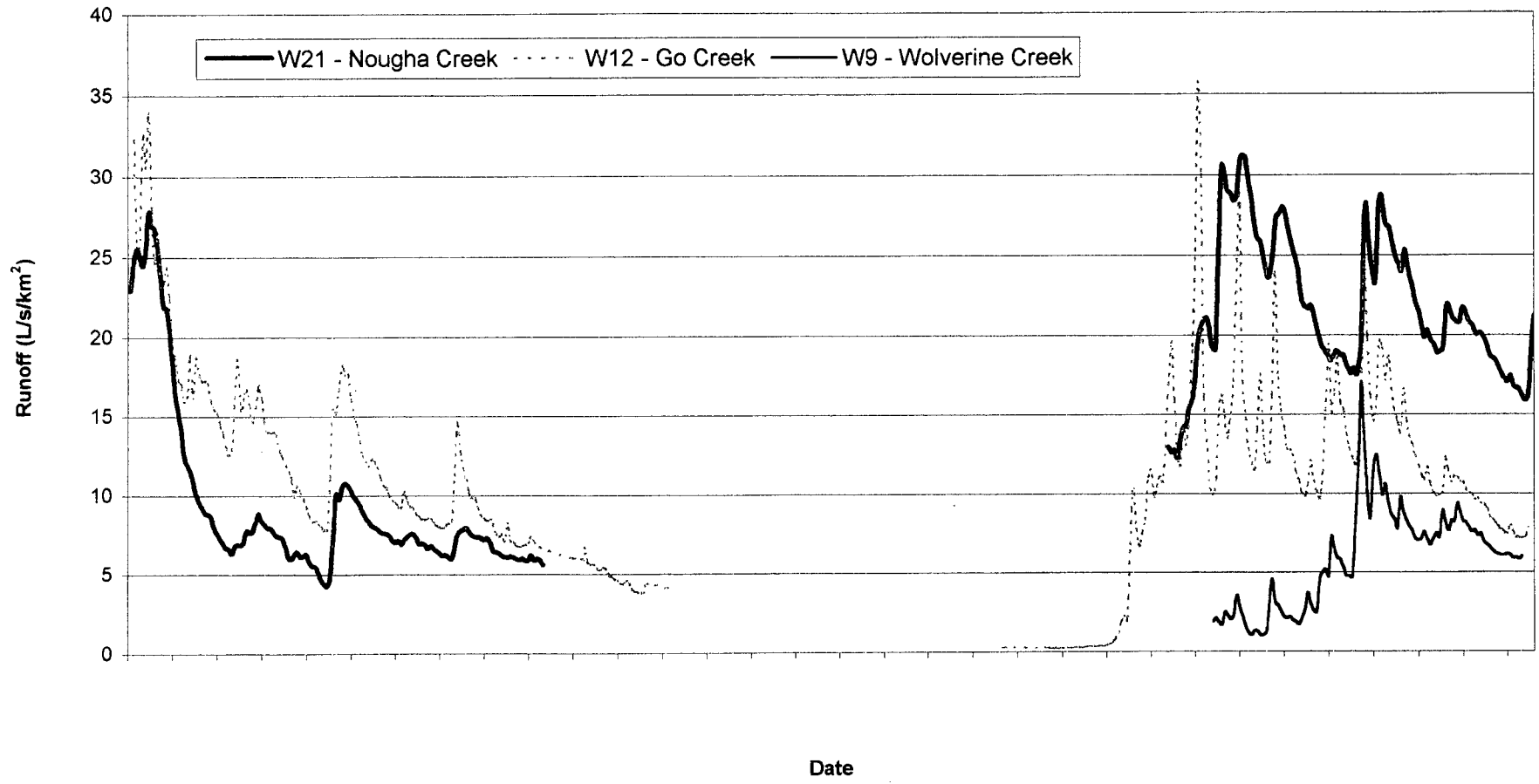
Figure 3.20
Stage-Discharge Calibrations at Manual Hydrology Stations - Wolverine Baseline Studies

Station ID No.	Station Name	Date	Discharge (m ³ /s)	Gauge Plate Reading (m)
W8	Campbell Creek near the mouth	29-May-96	0.103	0.410
		25-Jun-96	0.139	0.393
		17-Jul-96	0.087	0.290
		20-Aug-96	0.088	0.304
		29-May-97	0.043	0.321
		15-Jul-97	0.083	0.273
		11-Sep-97	0.045	0.238
W14	Money Creek below Go Creek	25-Mar-96	0.34	n/a
		29-May-96	9.48	0.655
		15-Jul-96	2.88	0.395
		06-Aug-96	3.62	0.44
		21-Aug-96	2.44	0.355
		26-Nov-96	0.326	
		28-May-97	2.528	0.425
		14-Jul-97	4.123	0.482
		12-Sep-97	2.912	0.425
W15	Hawkowi Creek near the mouth	29-May-96	0.260	0.345
		25-Jun-96	0.214	0.395
		21-Jul-96	0.151	0.299
		24-Aug-96	0.182	0.290
		15-Jul-97	0.194	0.334
		12-Sep-97	0.134	0.315



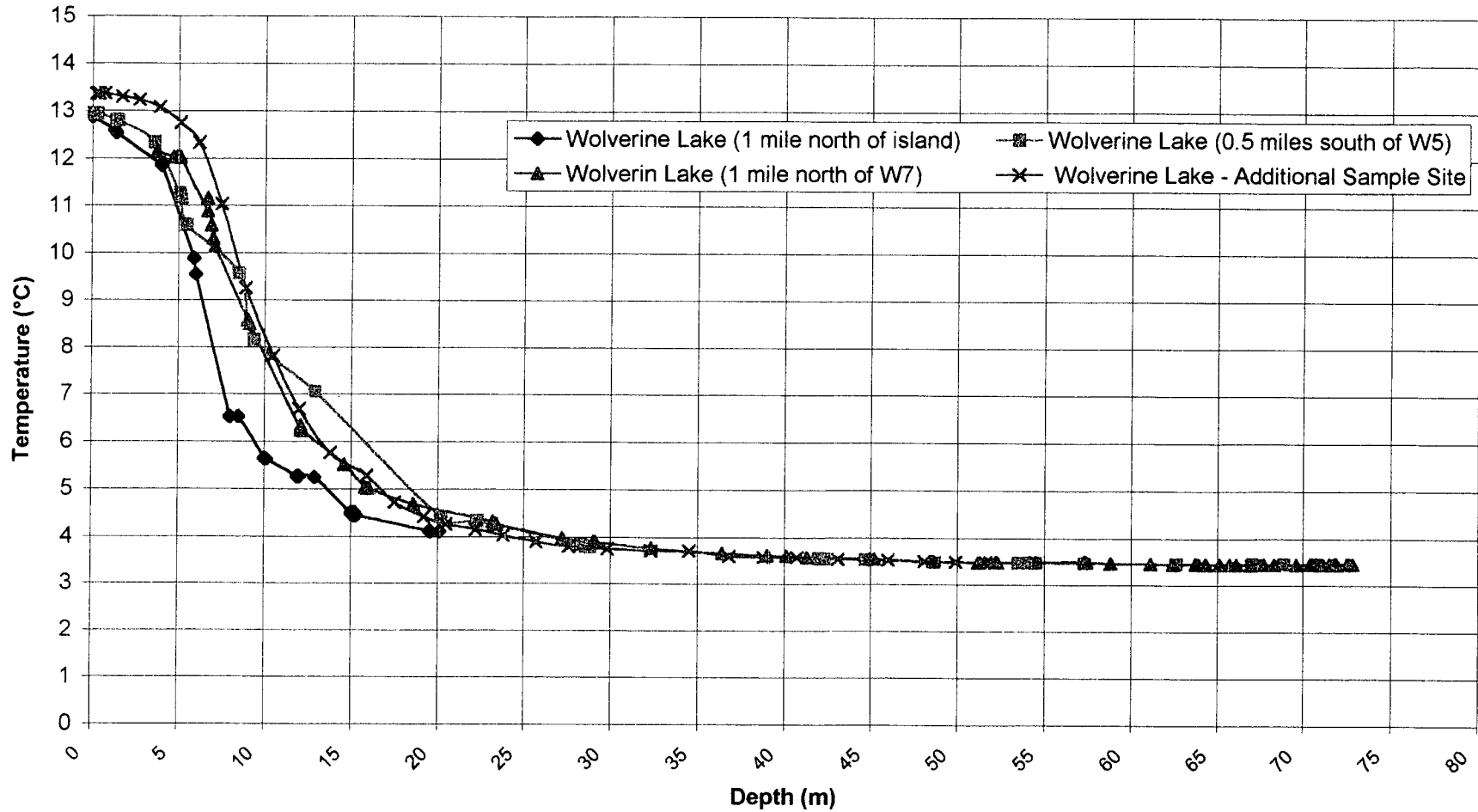
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Figure 3.21
Runoff Characteristics at Automated Hydrology Stations W12, W21, and W9 -
Wolverine Baseline Studies



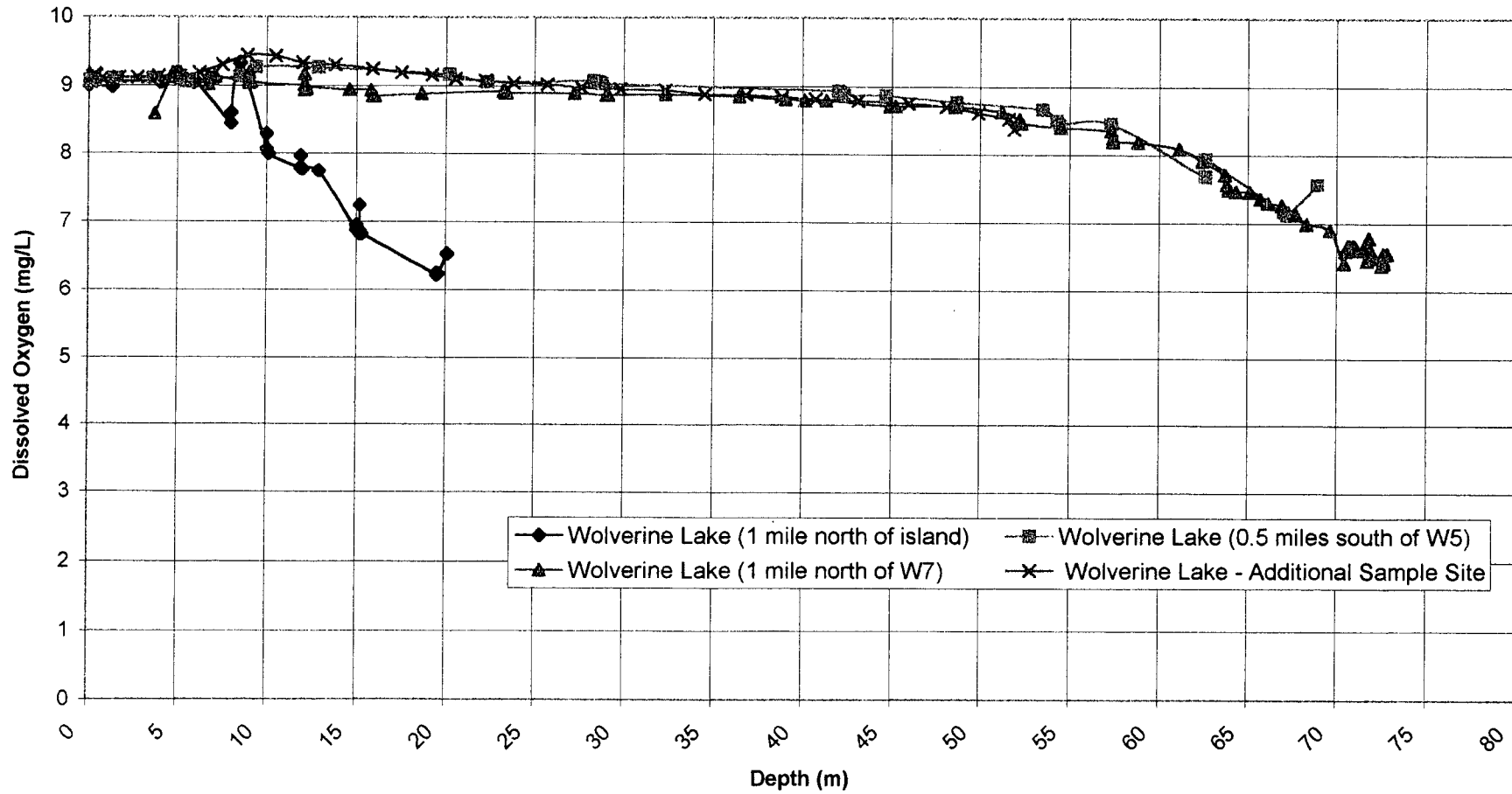
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Figure 3.22
Temperature Profile of Wolverine Lake



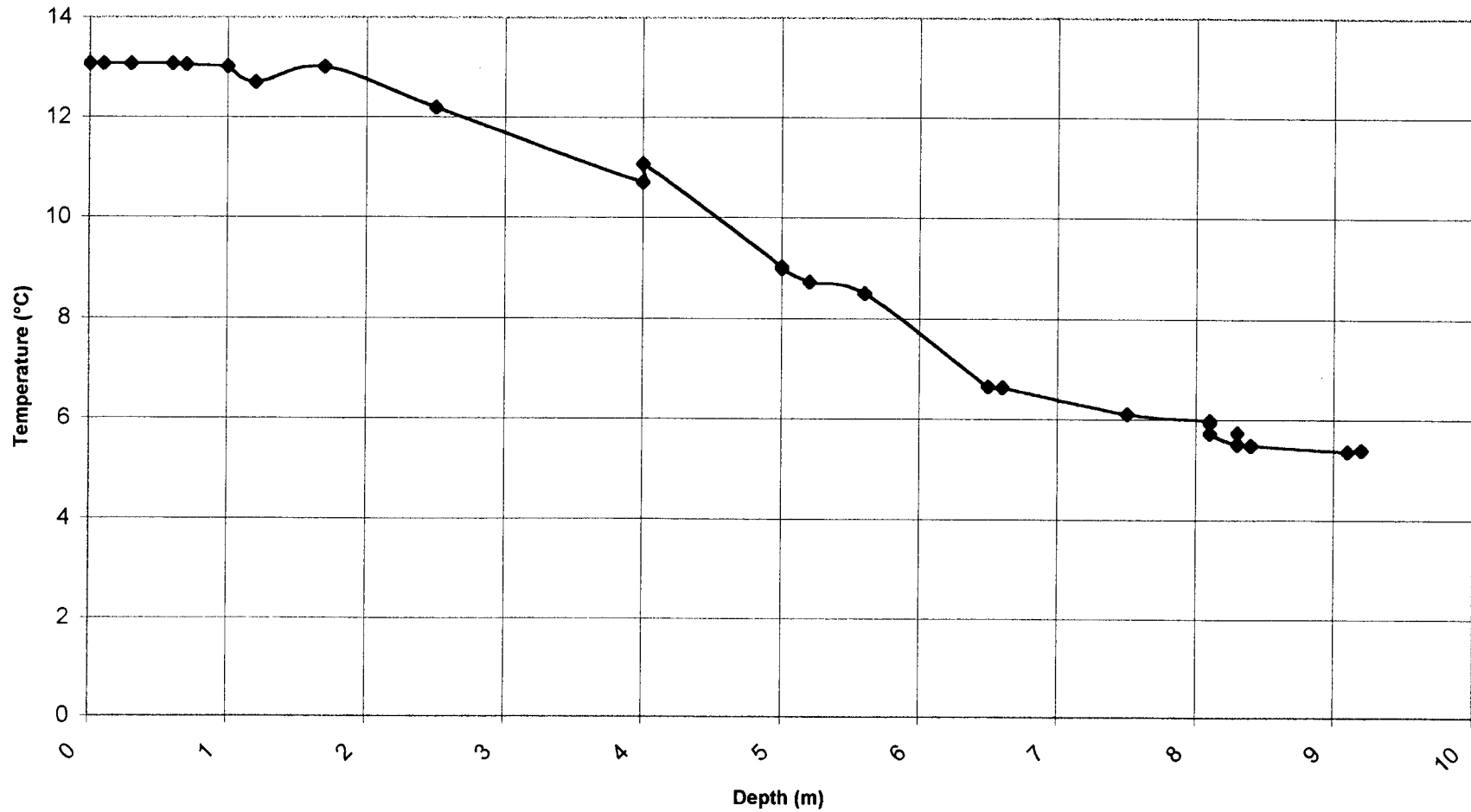
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Figure 3.23
Dissolved Oxygen Profile
of Wolverine Lake



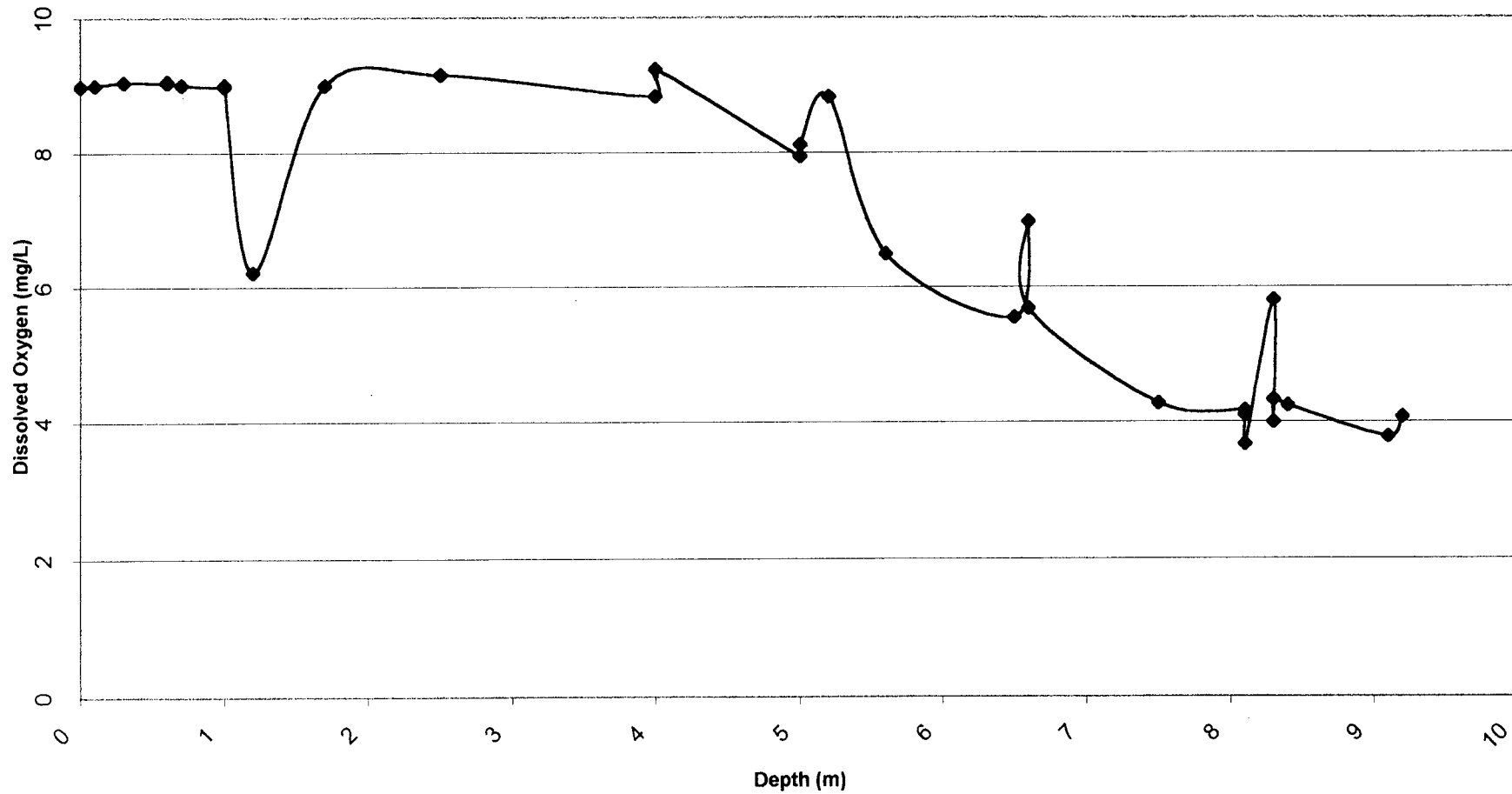
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Figure 3.24
Temperature Profile of Little Wolverine Lake



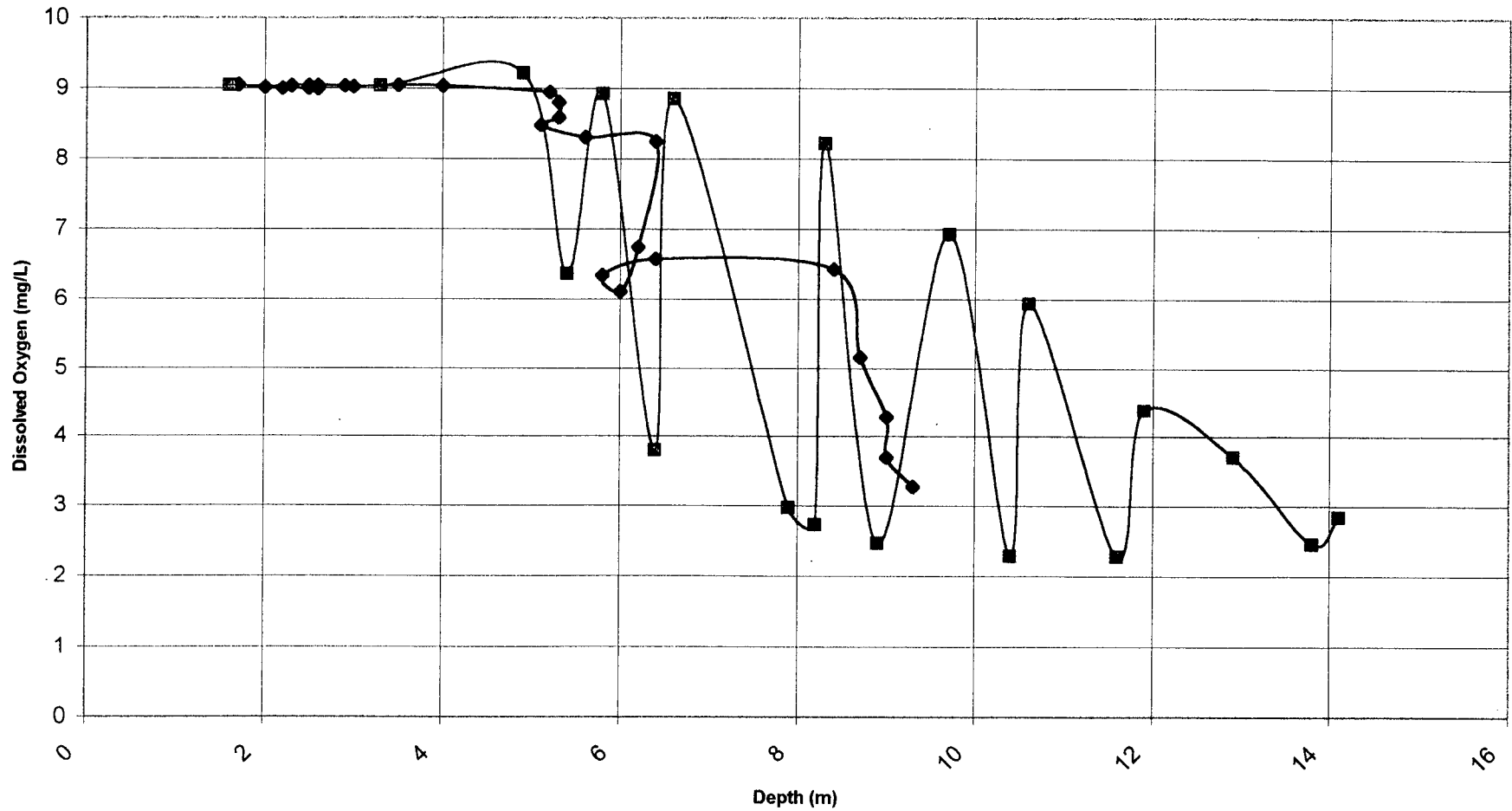
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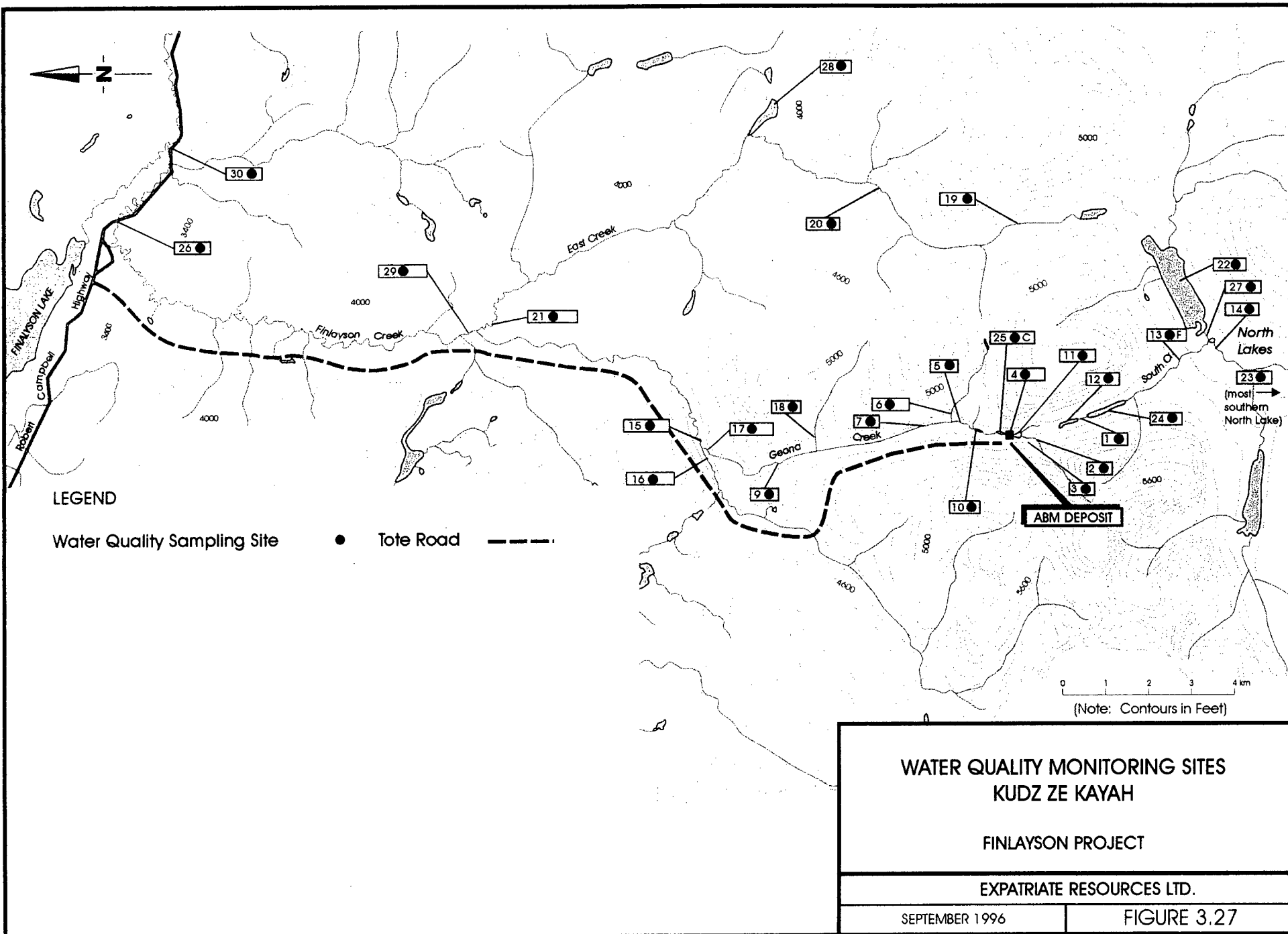
Figure 3.25
Dissolved Oxygen Profile of Little Wolverine Lake



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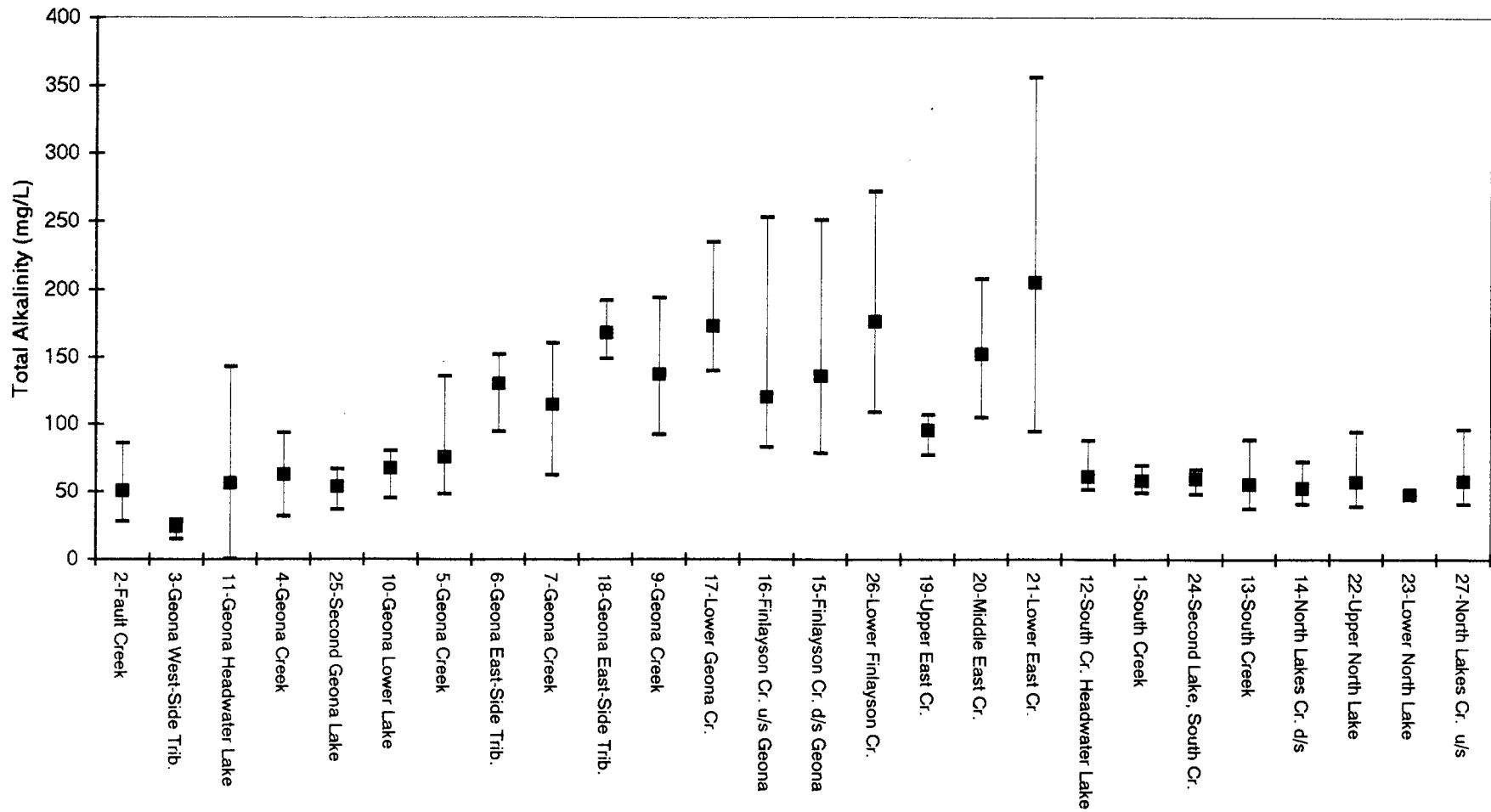
Figure 3.26
Dissolved Oxygen Profile of Little Jimmy Lake





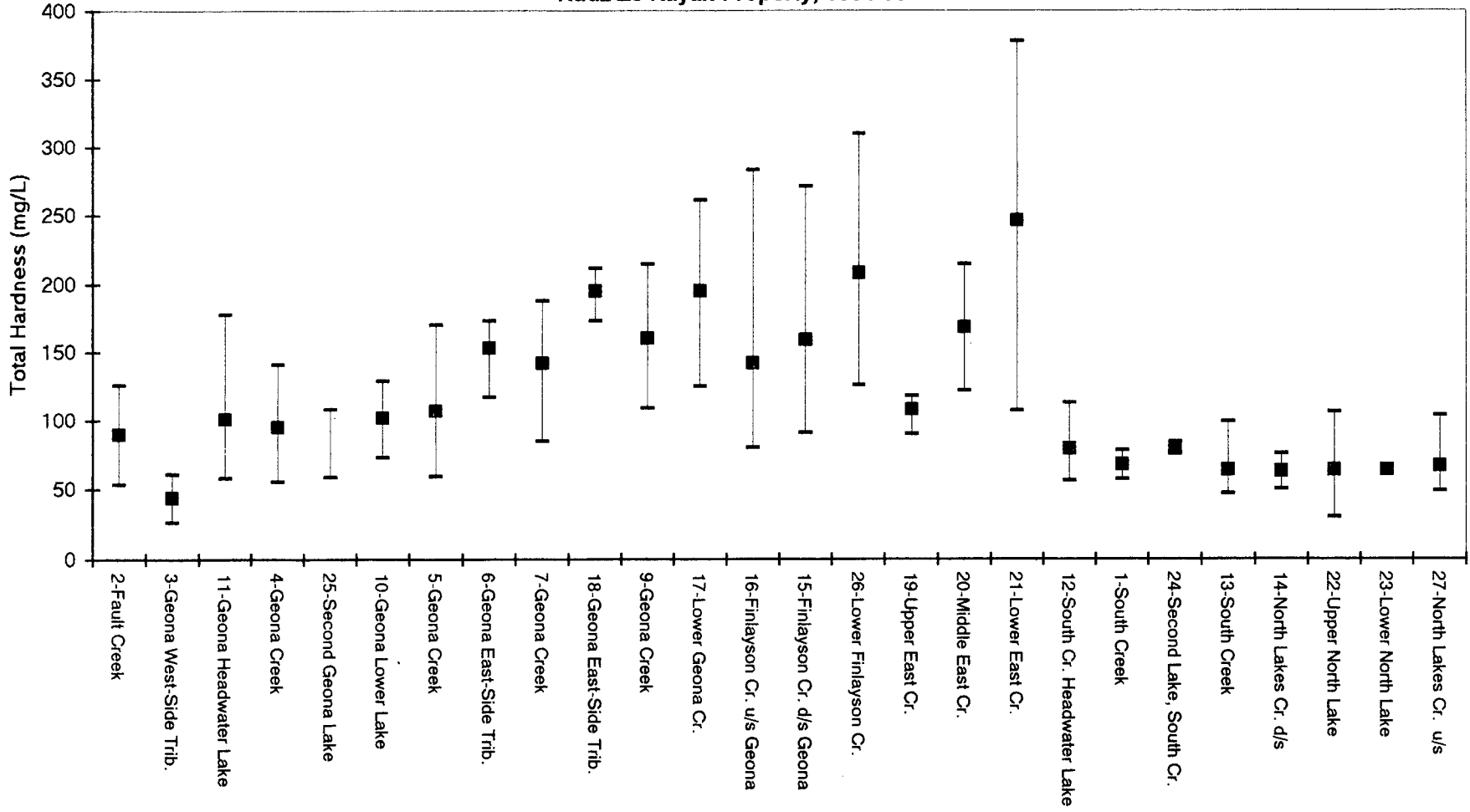
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Figure 3.28
Mean and Range of Total Alkalinity Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



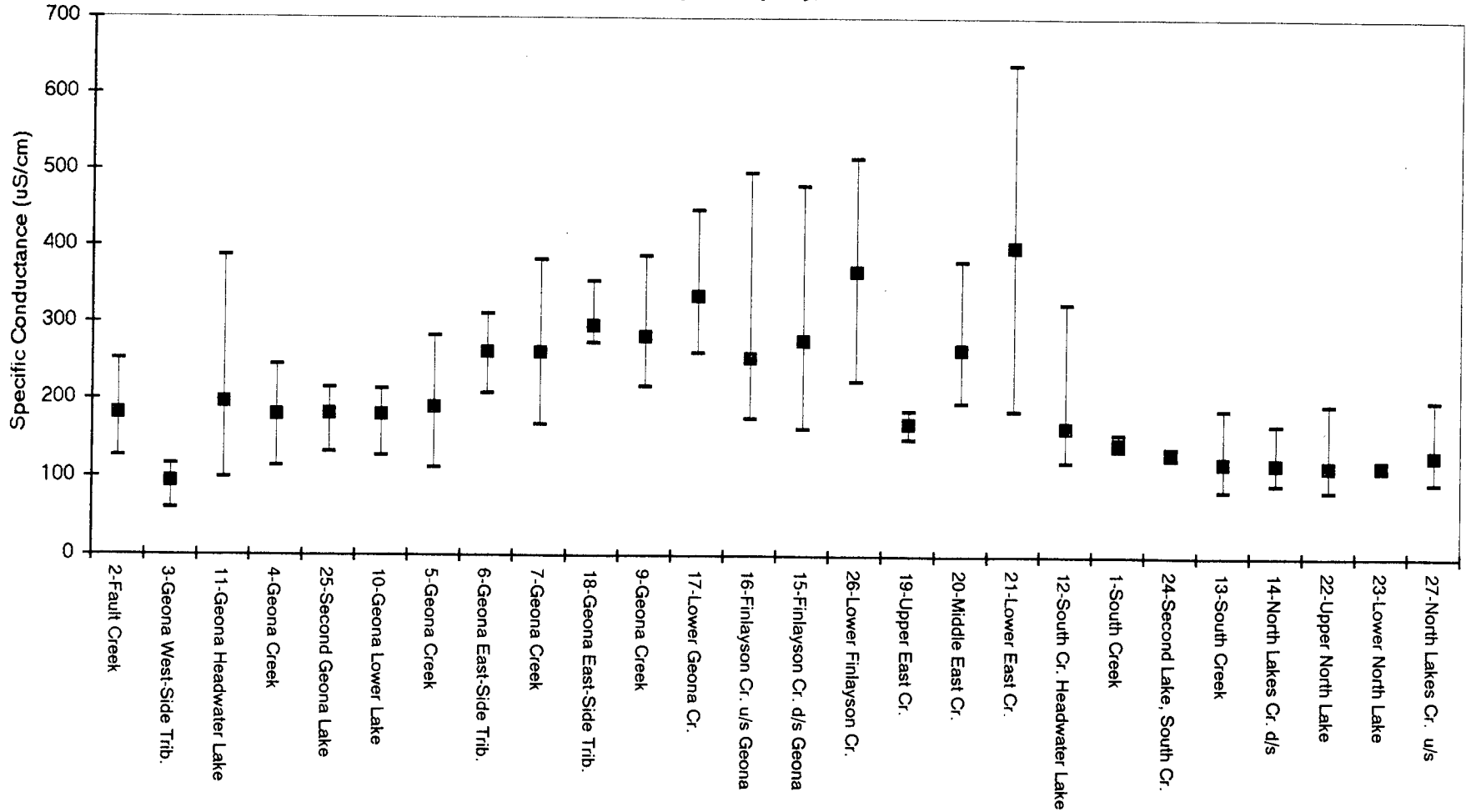
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Figure 3.29
Mean and Range of Total Hardness Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



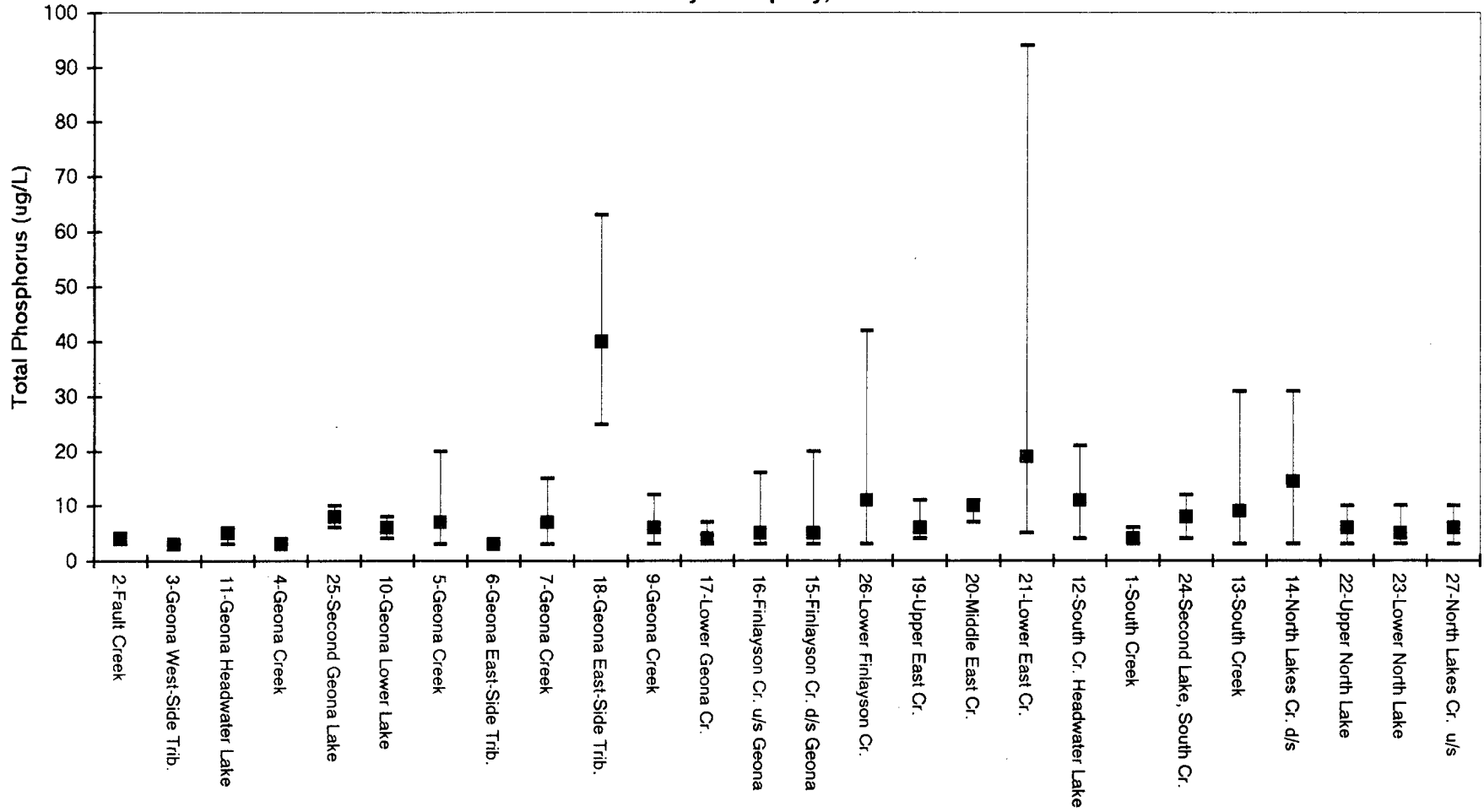
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Figure 3.30
Mean and Range of Specific Conductance Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



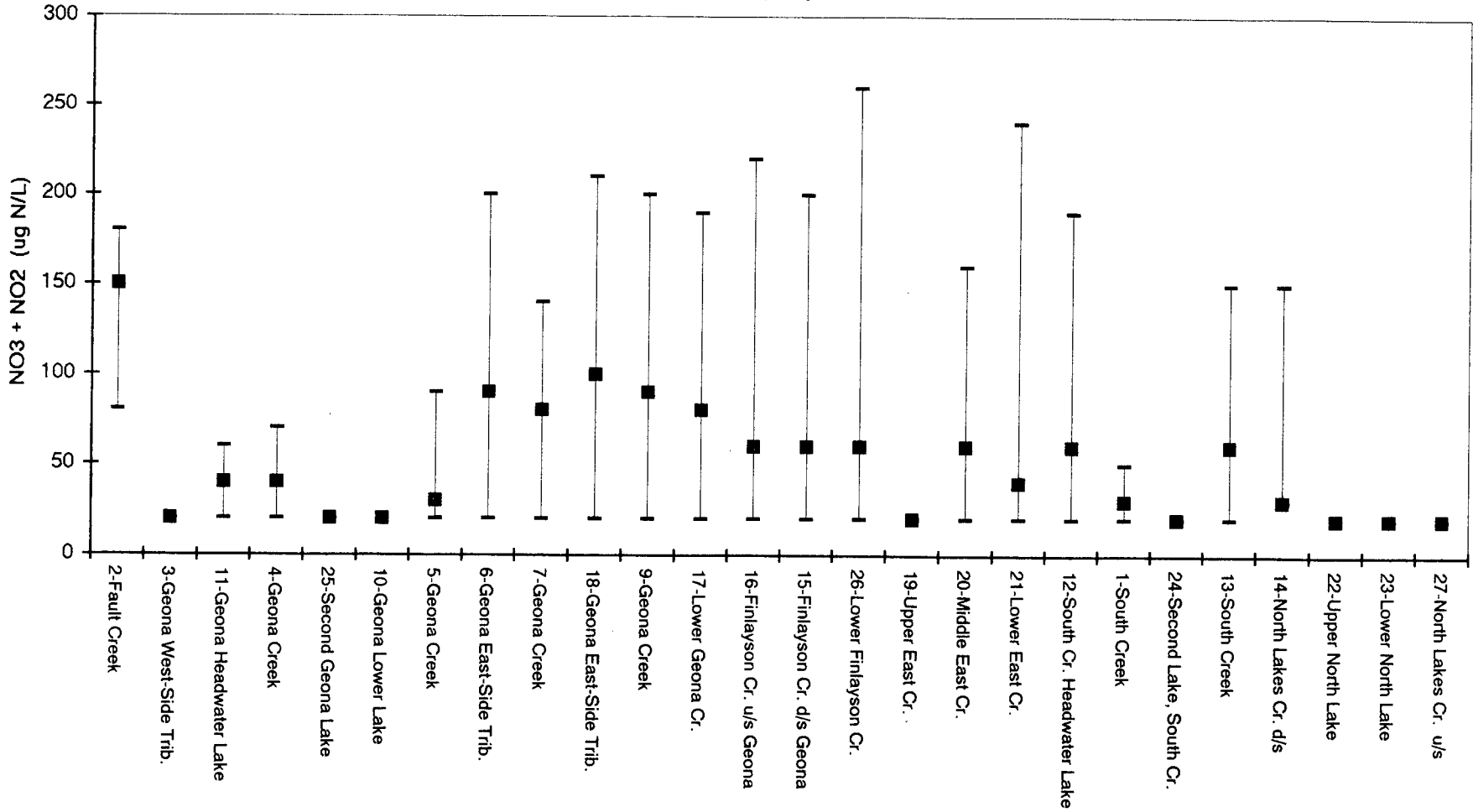
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Figure 3.31
Mean and Range of Total Phosphorus Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



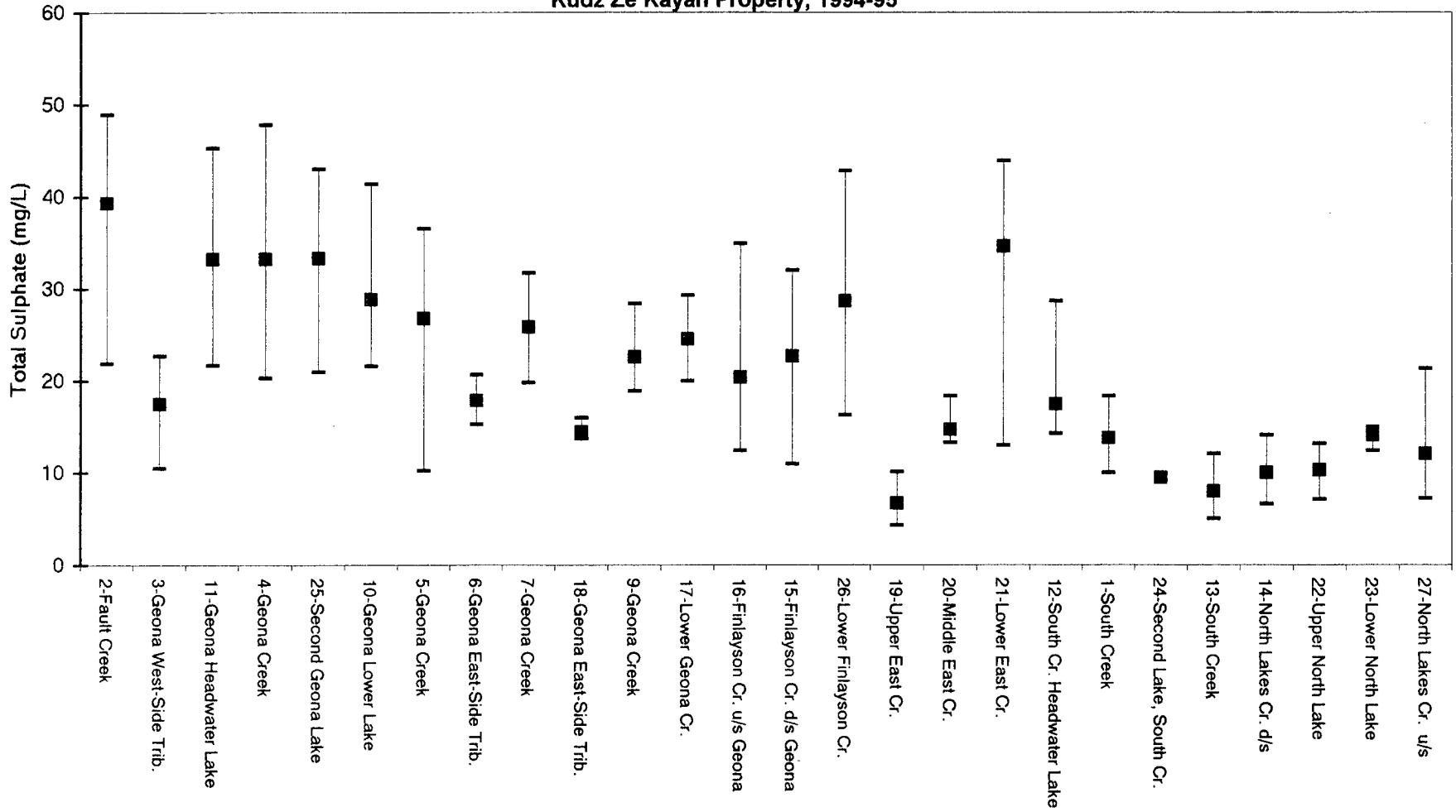
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Figure 3.32
Mean and Range of Nitrate + Nitrite Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



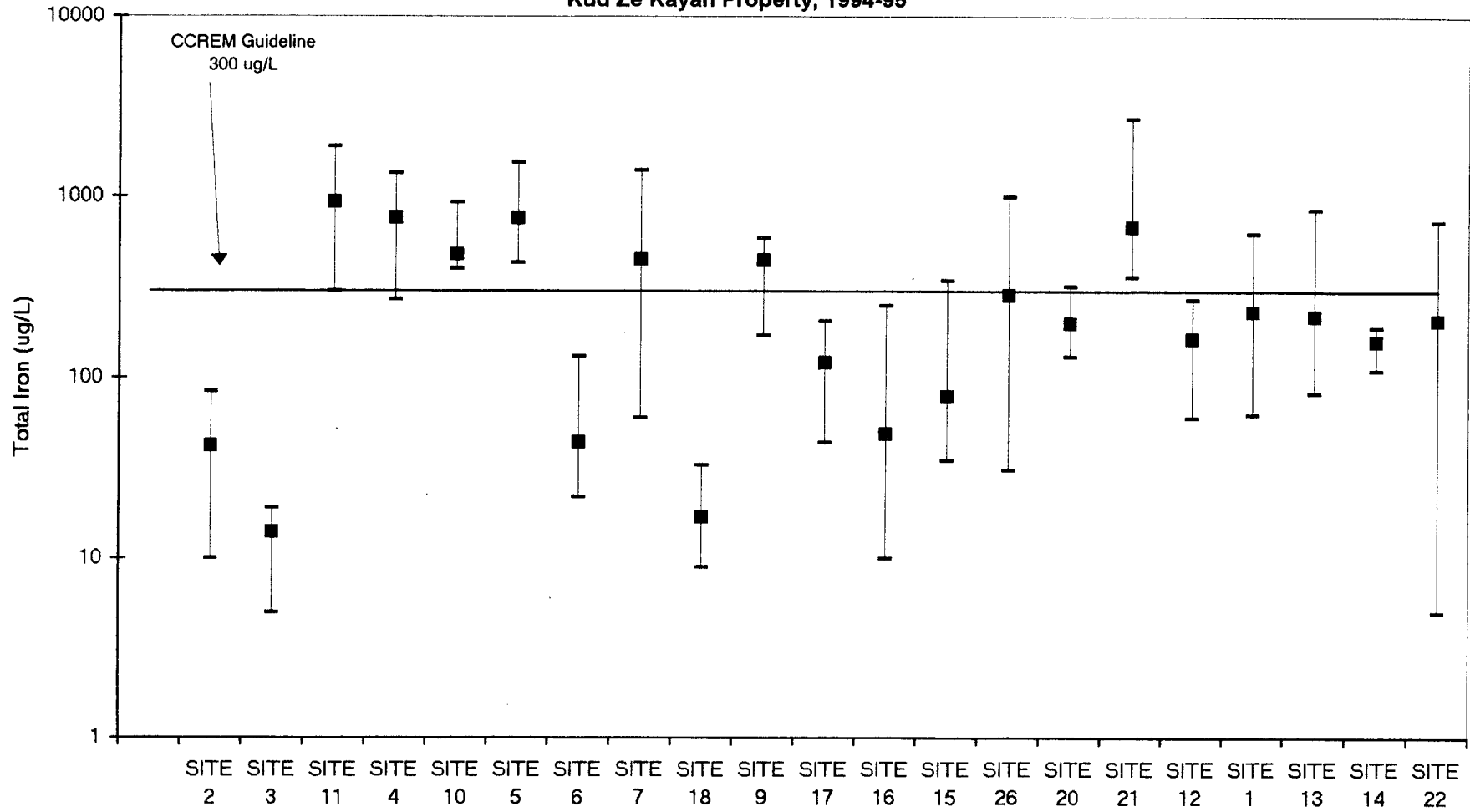
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Figure 3.33
Mean and Range of Sulphate Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



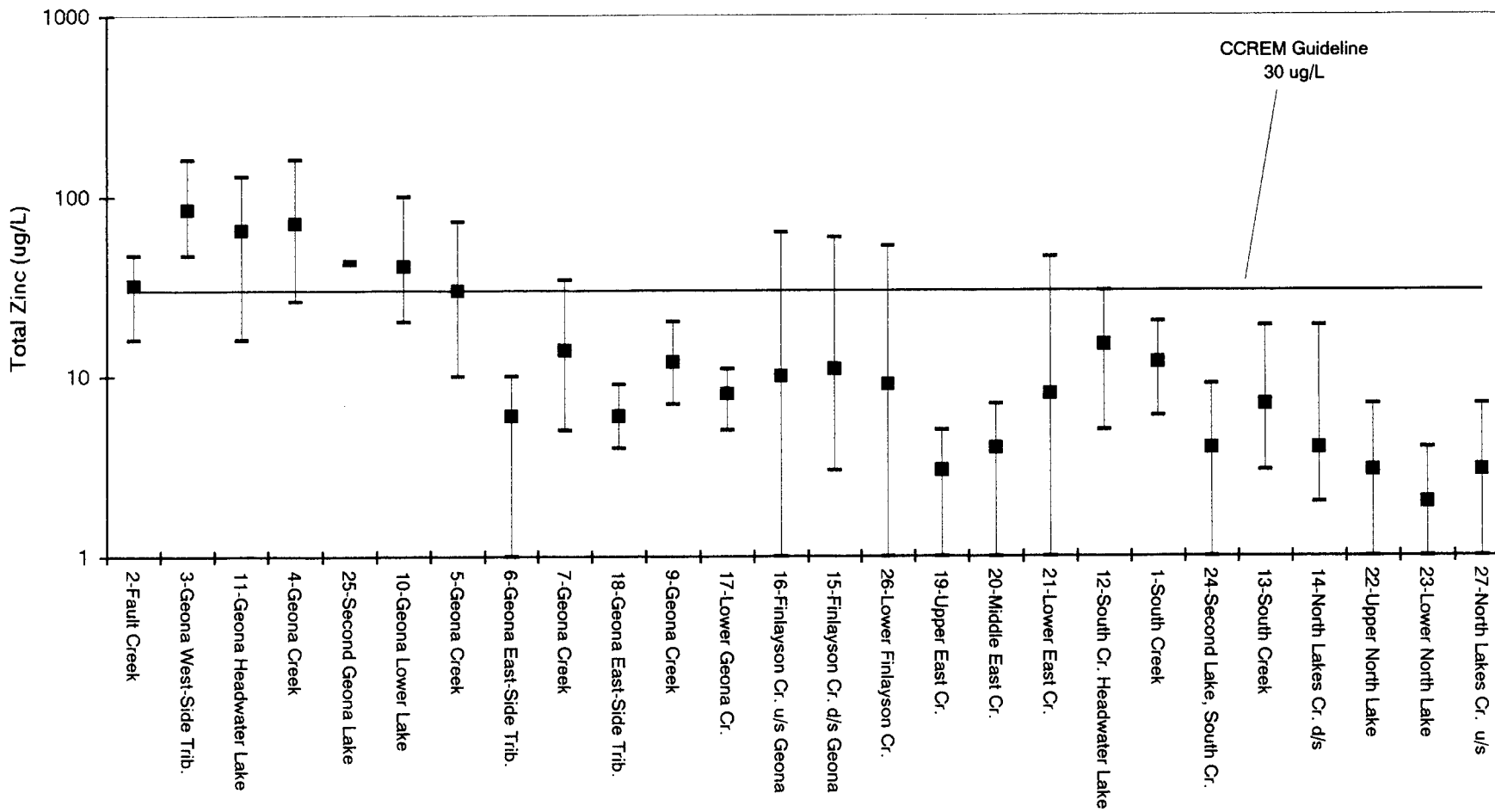
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Figure 3.34
Mean and Range of Total Iron Measured at Water Quality Sites,
Kud Ze Kayah Property, 1994-95



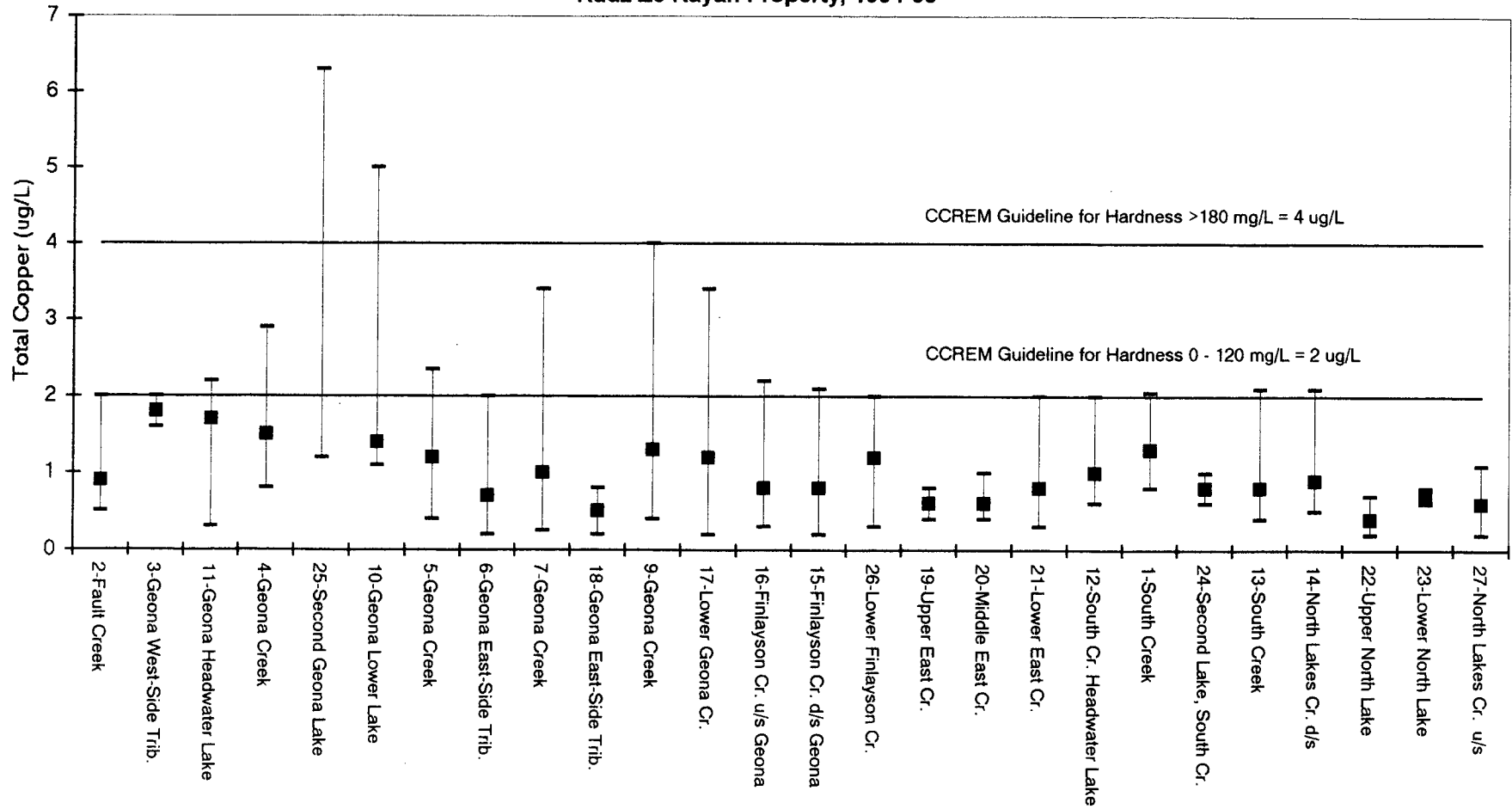
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Figure 3.35
Mean and Range of Total Zinc Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



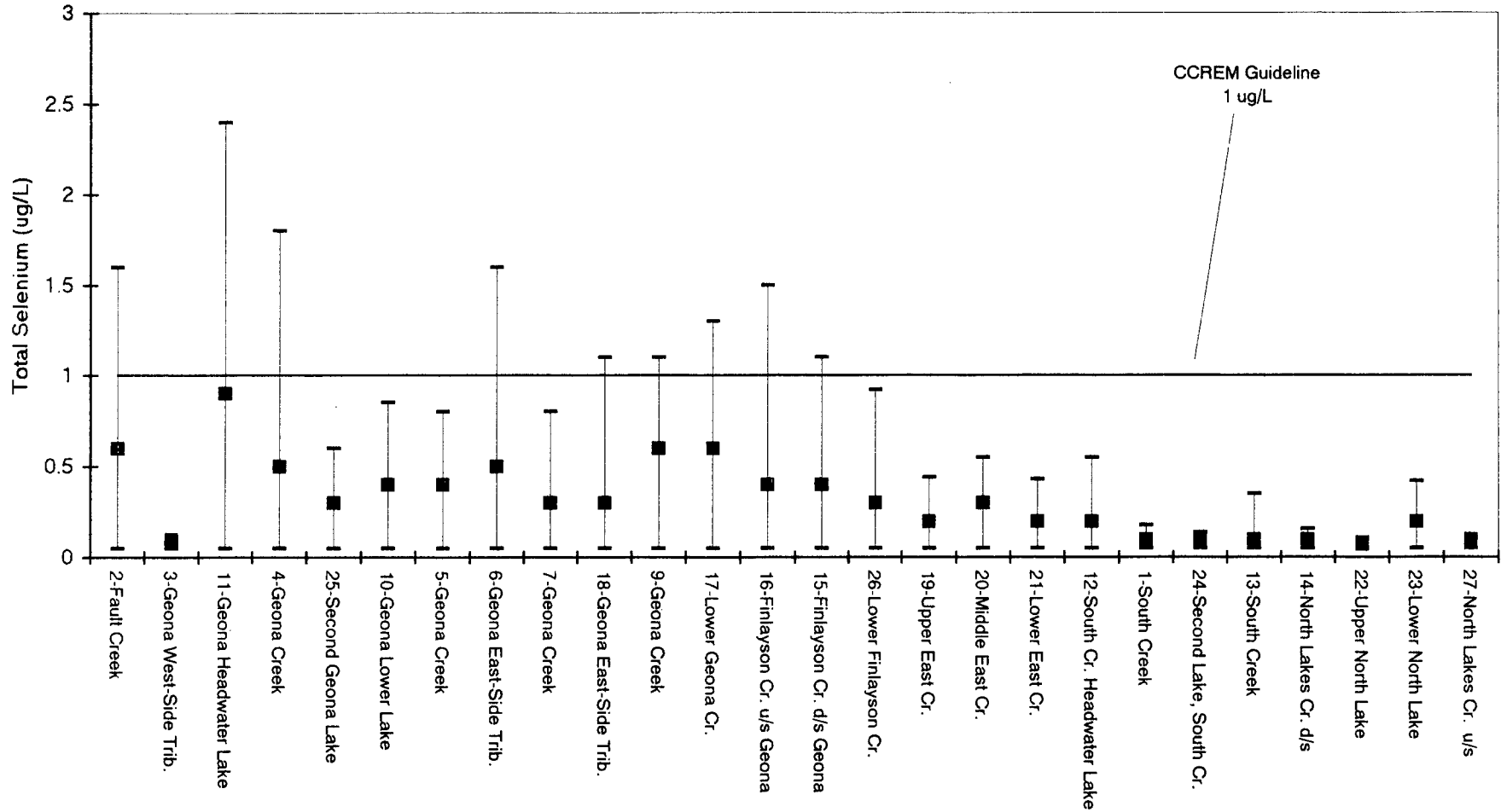
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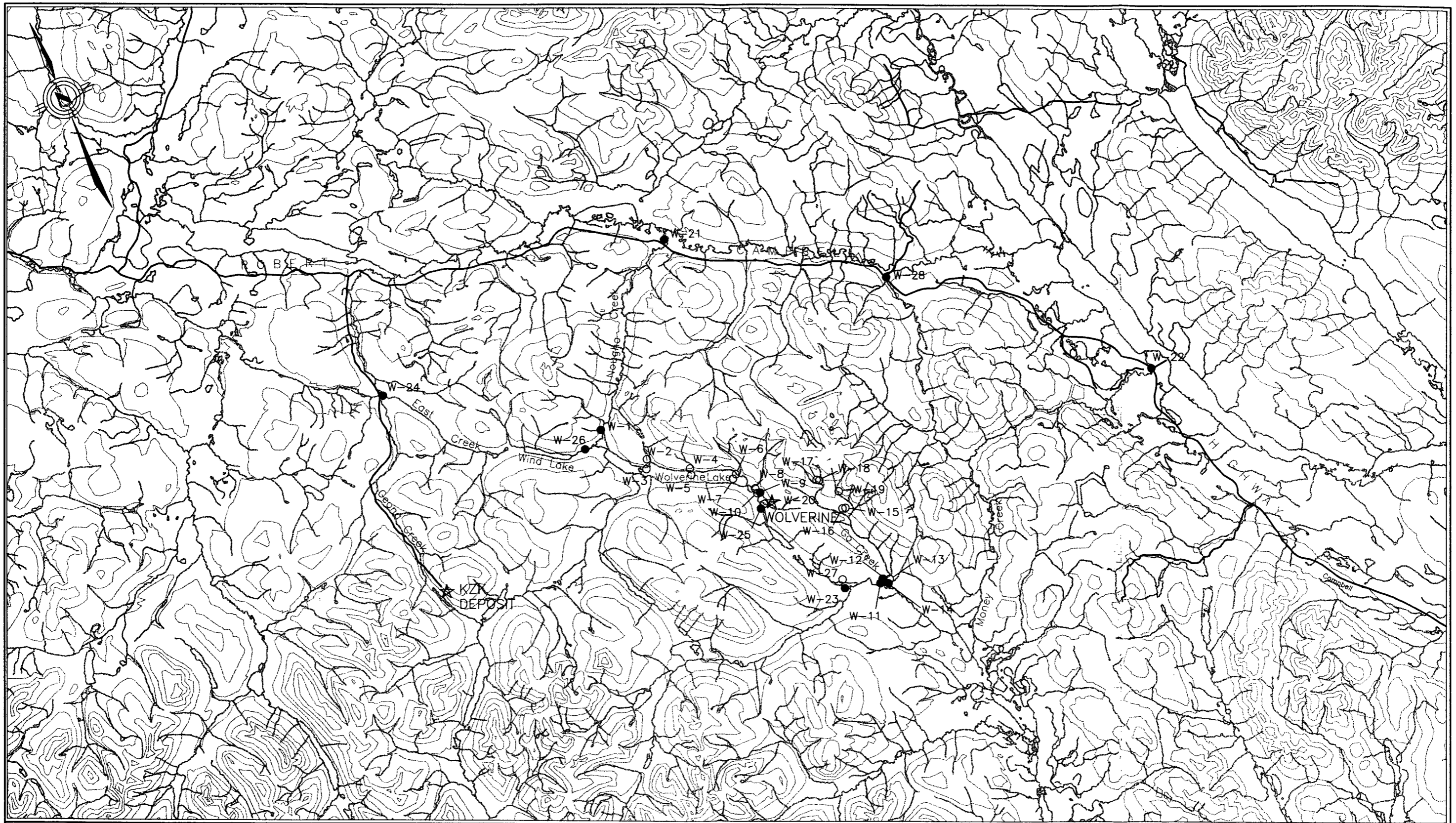
Figure 3.36
Mean and Range of Total Copper Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95



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Figure 3.37
Mean and Range of Total Selenium Measured at Water Quality Sites,
Kudz Ze Kayah Property, 1994-95






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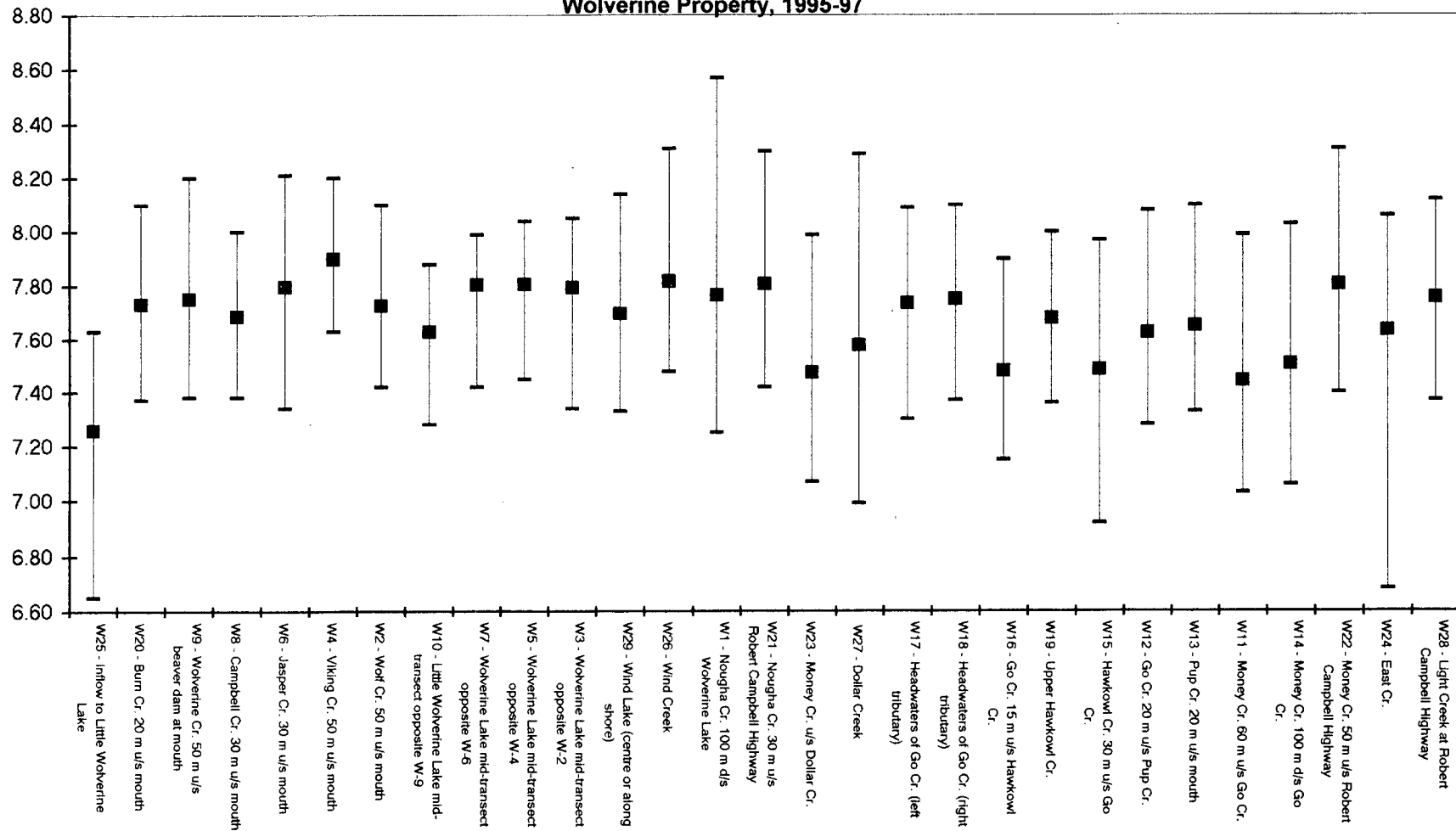
LEGEND: ○ COMPREHENSIVE MONITORING STATIONS
 ● COMPREHENSIVE AND ROUTINE MONITORING STATIONS

EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
LOCATIONS OF SURFACE WATER QUALITY STATIONS IN THE AREA SURROUNDING WOLVERINE LAKE			
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FIG. 3.38

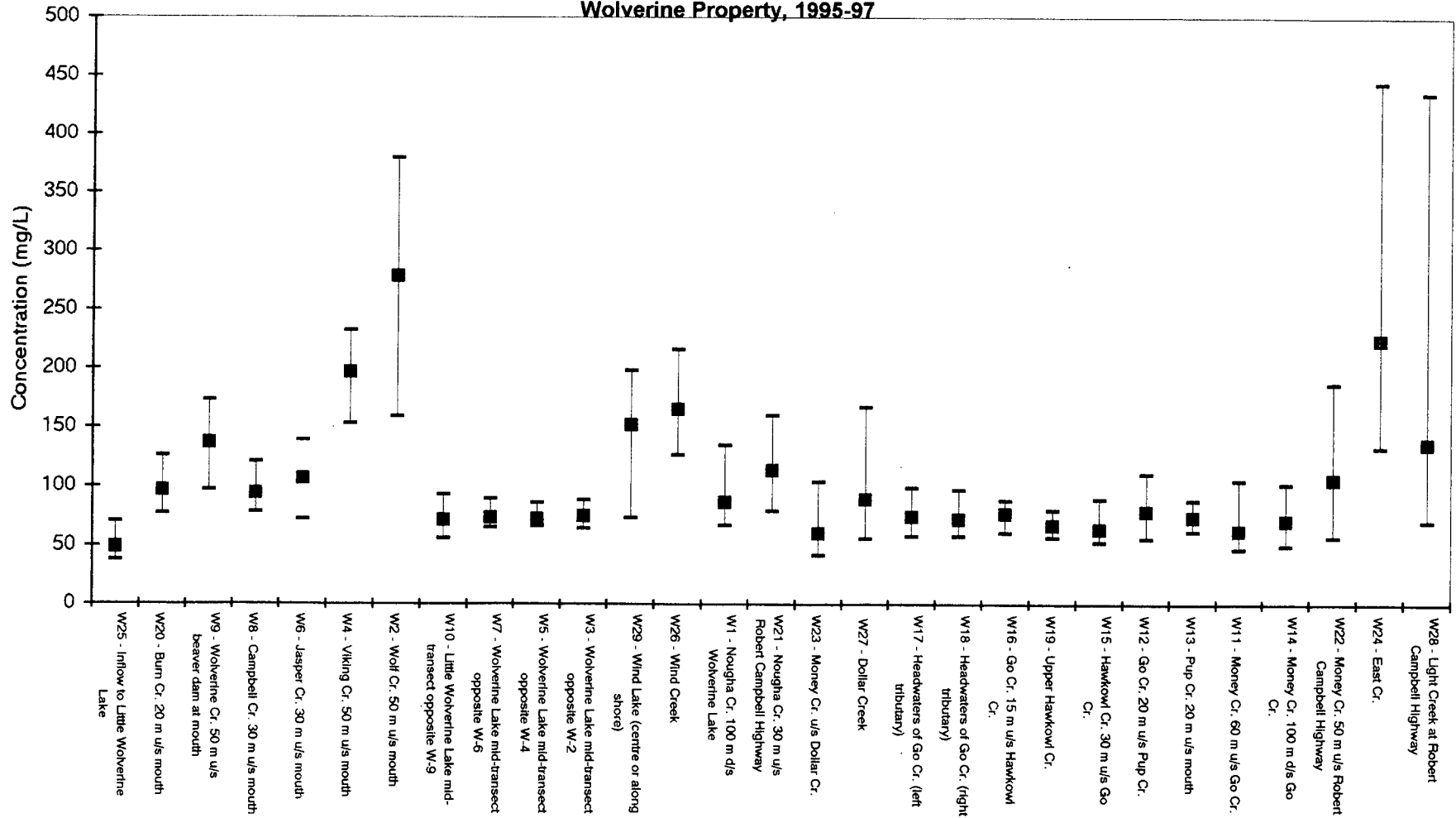
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Figure 3.39
Mean and Range of pH at Water Quality Sites,
Wolverine Property, 1995-97



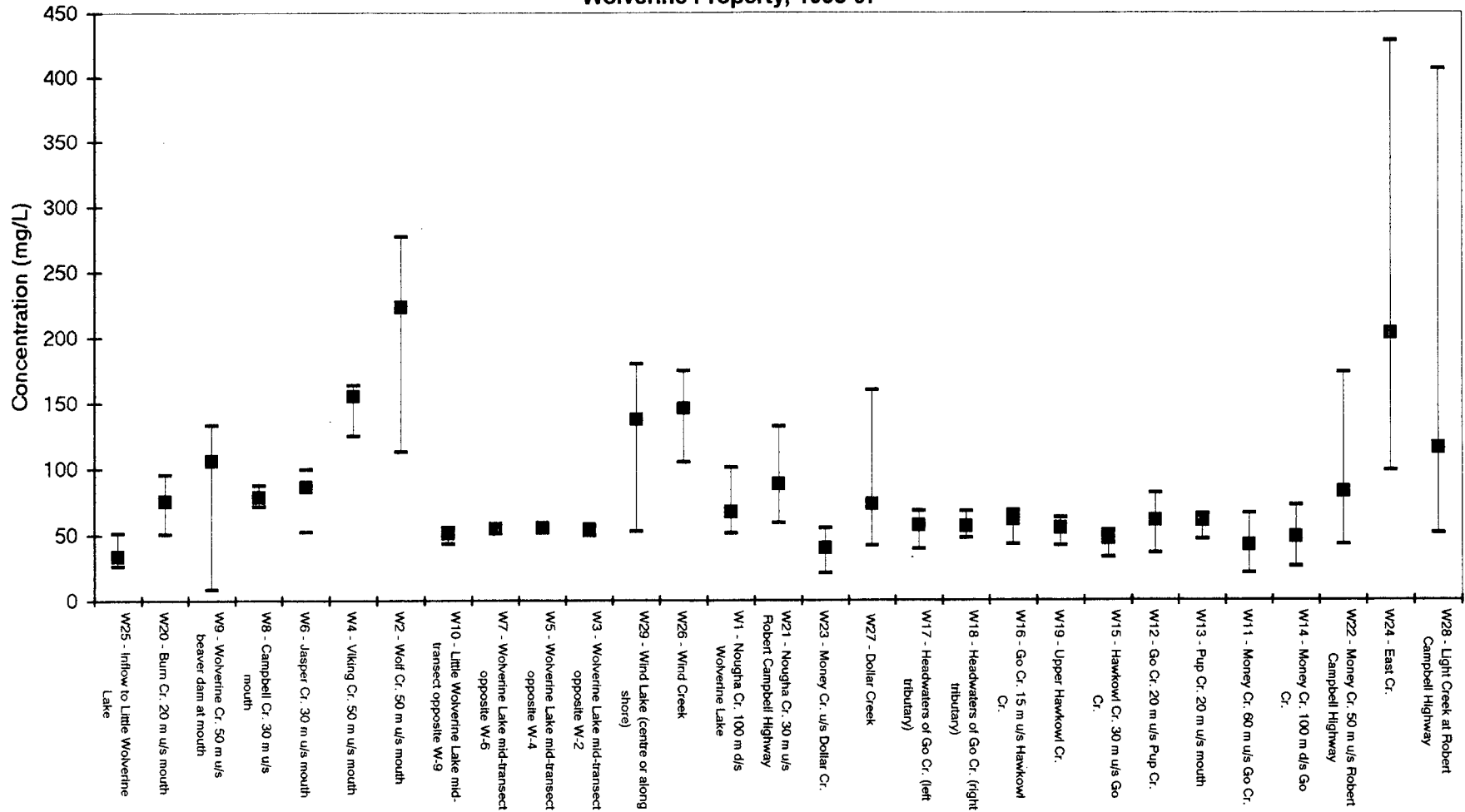
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Figure 3.40
Mean and Range of Total Dissolved Solids Measured at Water Quality Sites,
Wolverine Property, 1995-97



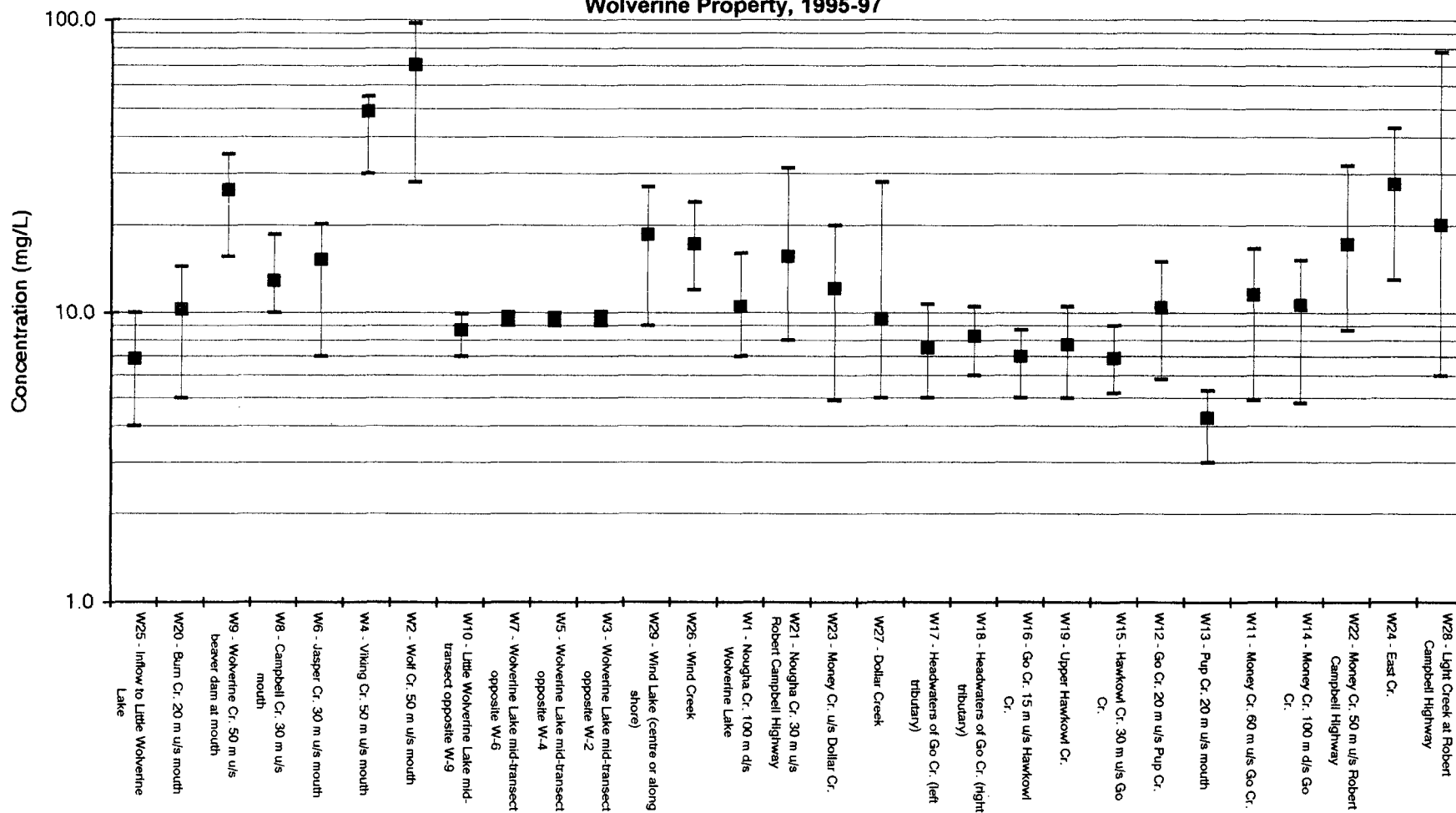
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Figure 3.41
Mean and Range of Total Hardness Measured at Water Quality Sites,
Wolverine Property, 1995-97



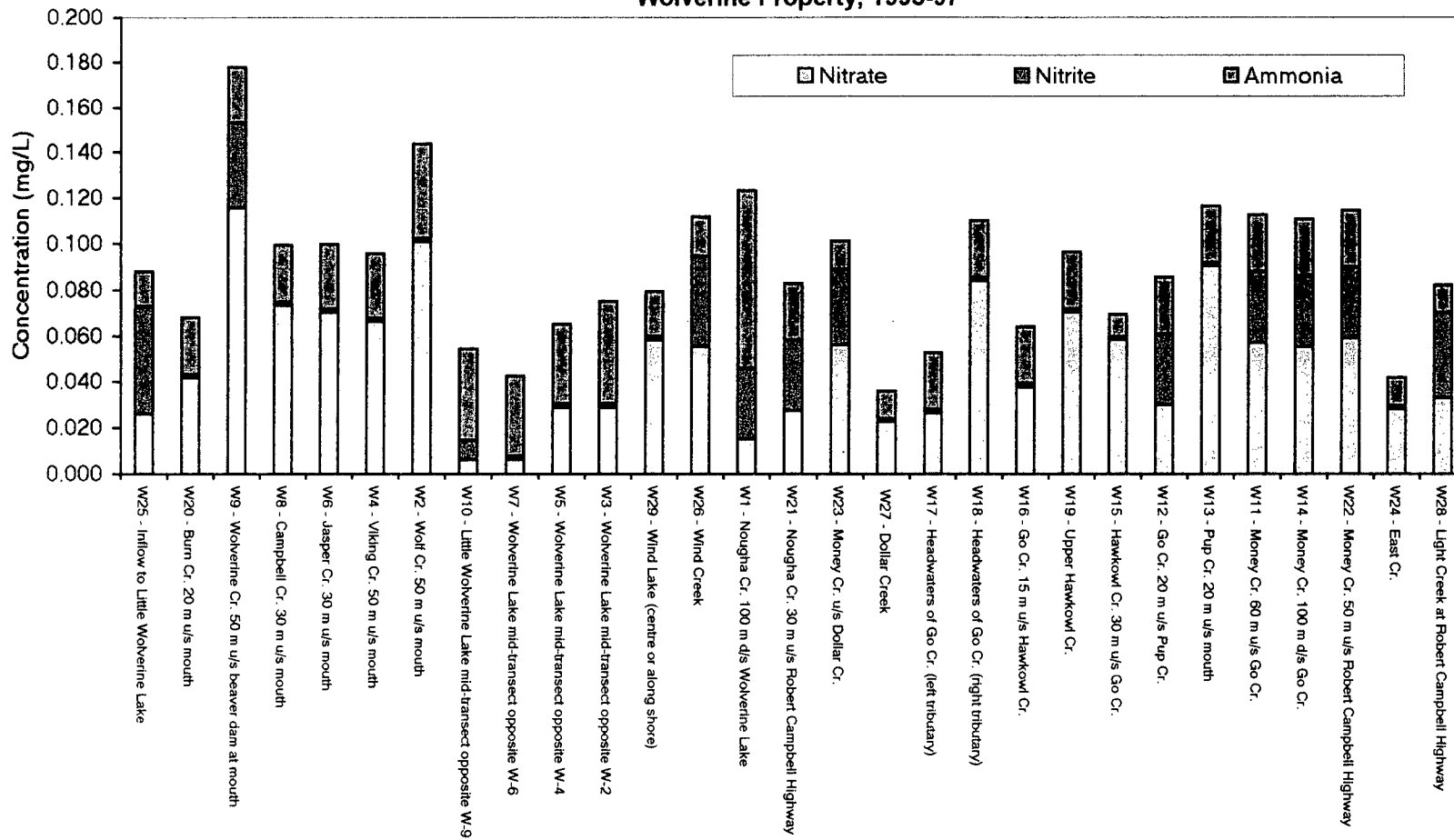
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Figure 3.42
Mean and Range of Sulphates at Water Quality Sites,
Wolverine Property, 1995-97



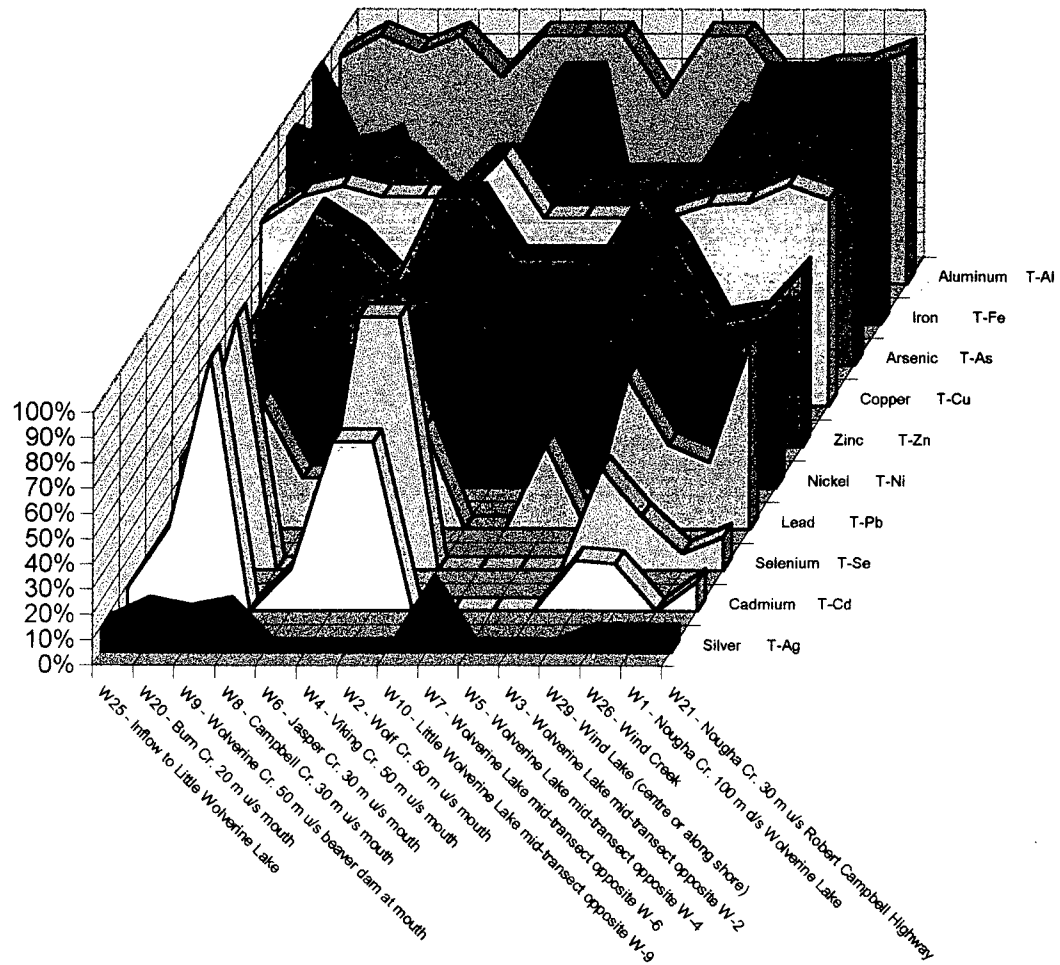
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Figure 3.43
Summary Averages of Nutrients at Water Quality Sites,
Wolverine Property, 1995-97



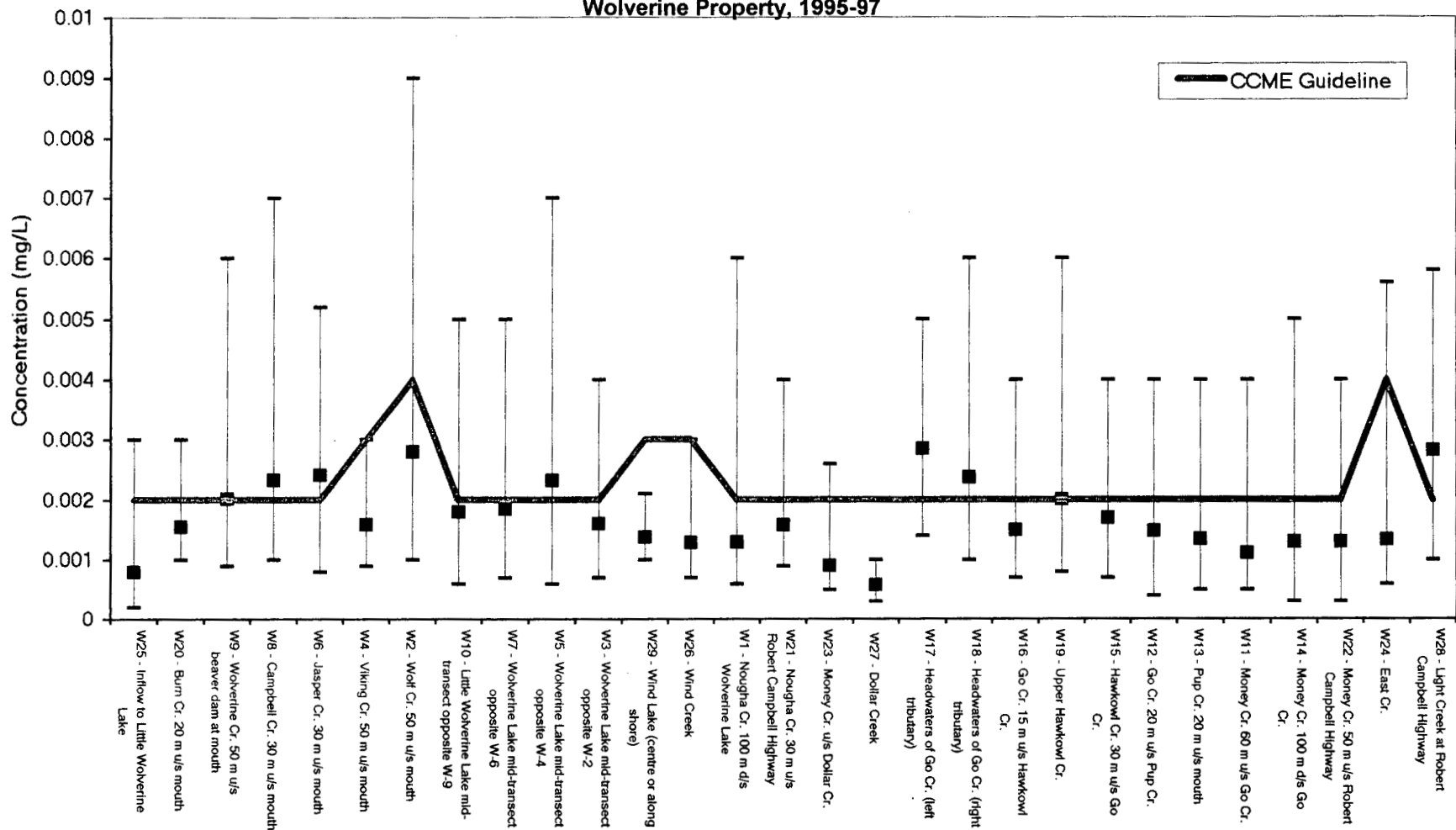
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Figure 3.44
% Detection of Heavy Metals in Water Samples from the Wolverine Drainage



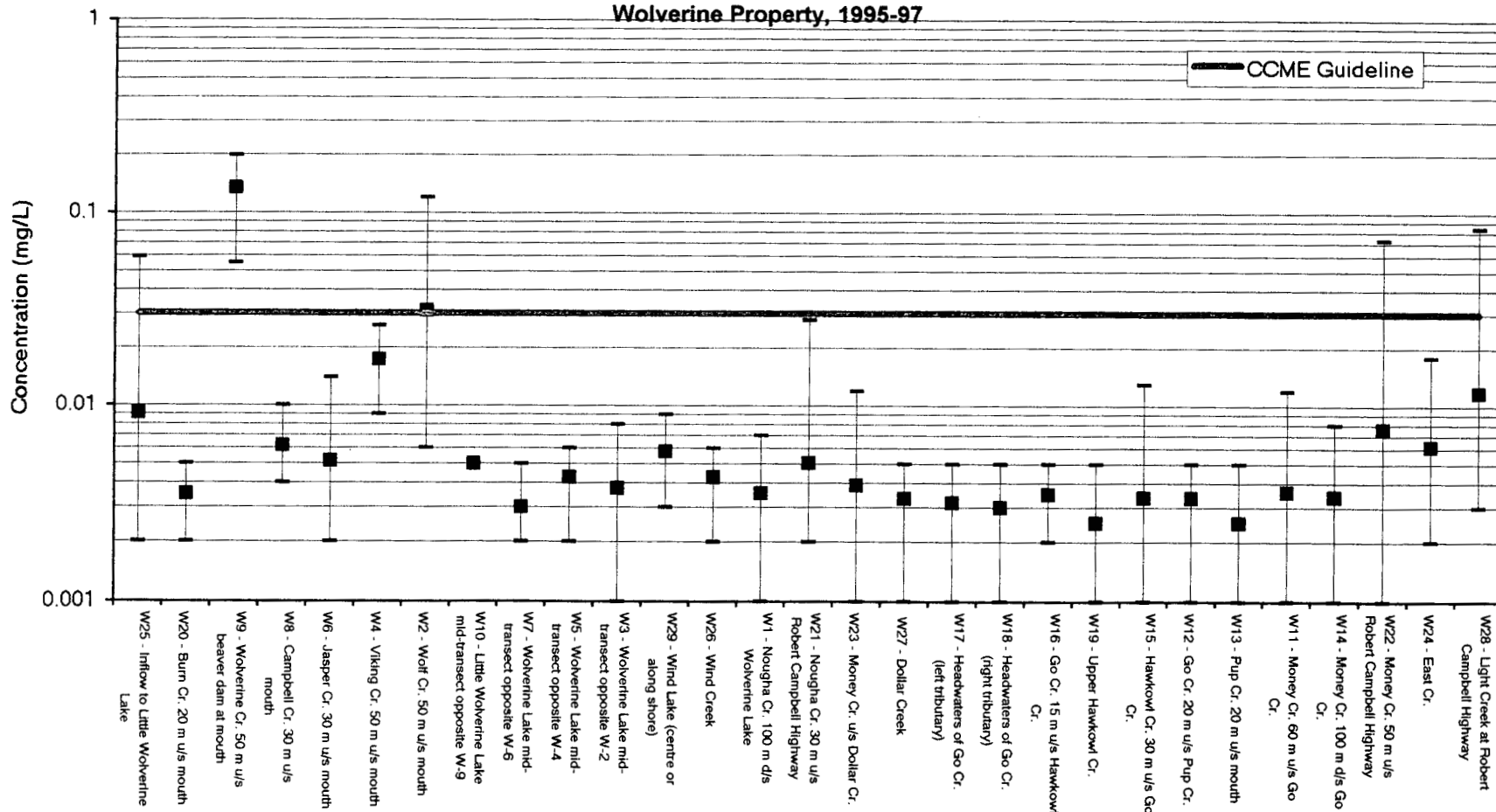
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Figure 3.45
Mean and Range of Total Copper Measured at Water Quality Sites,
Wolverine Property, 1995-97



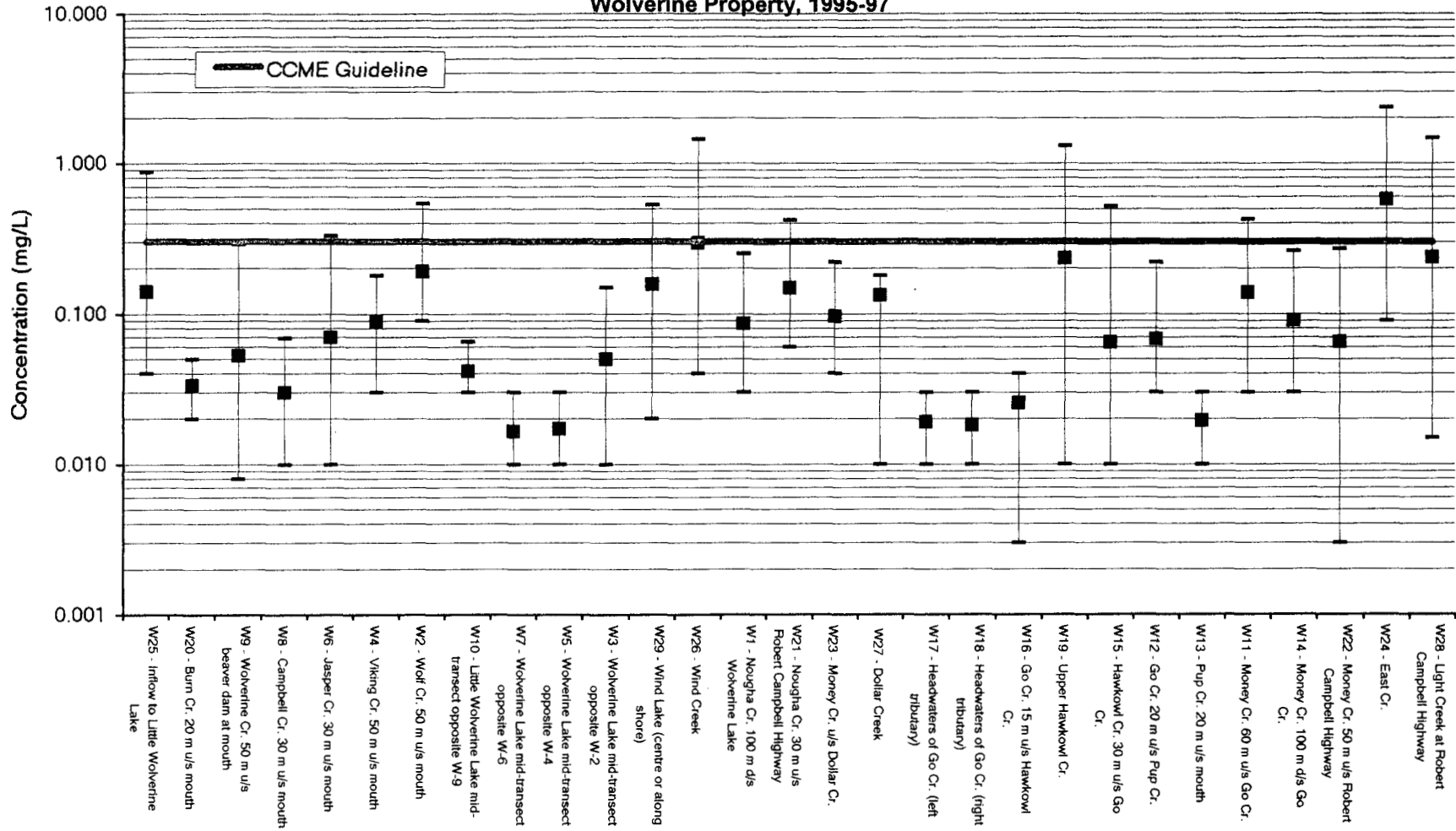
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Figure 3.46
Mean and Range of Total Zinc Measured at Water Quality Sites,
Wolverine Property, 1995-97



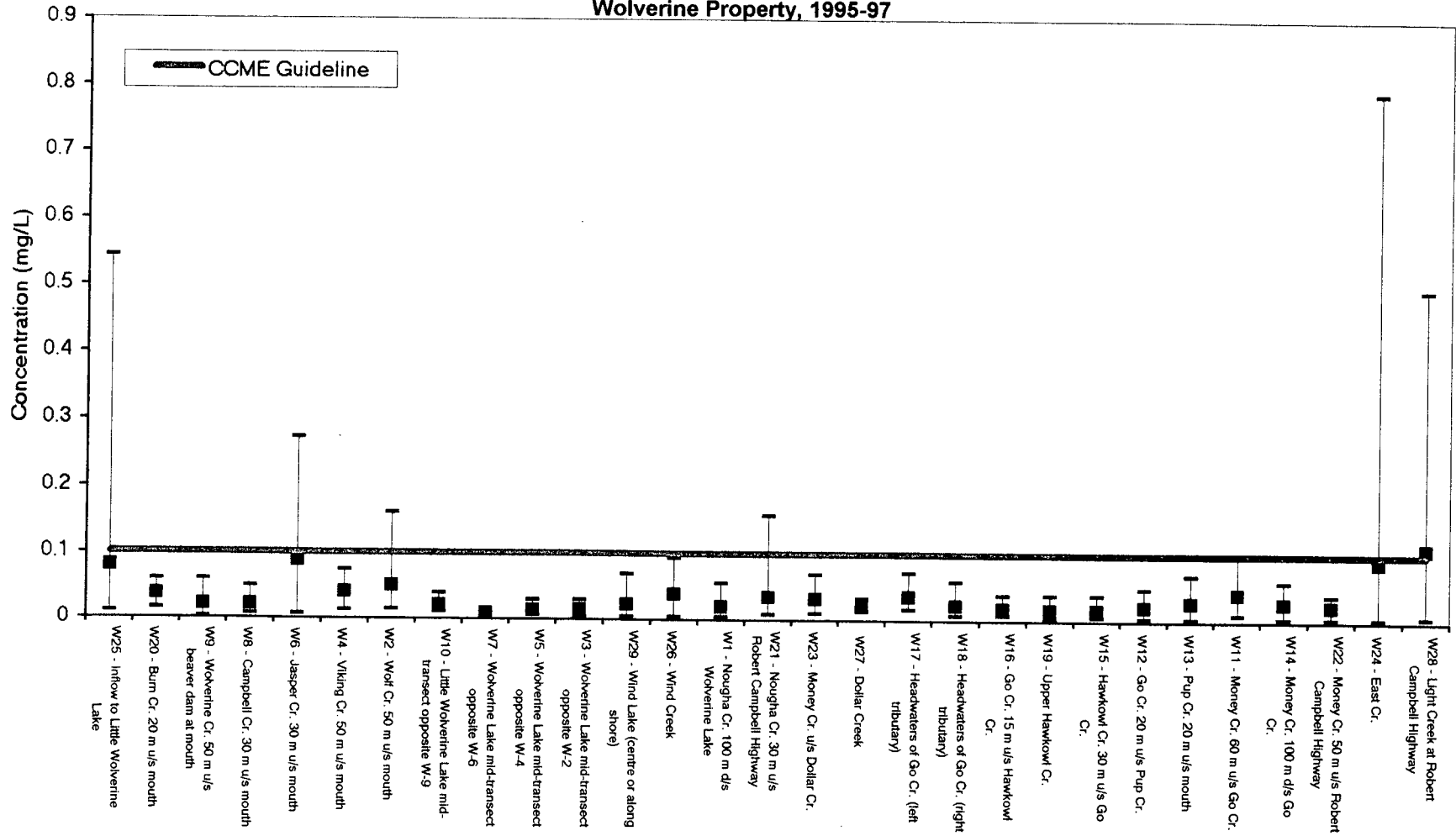
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Figure 3.47
Mean and Range of Total Iron Measured at Water Quality Sites,
Wolverine Property, 1995-97



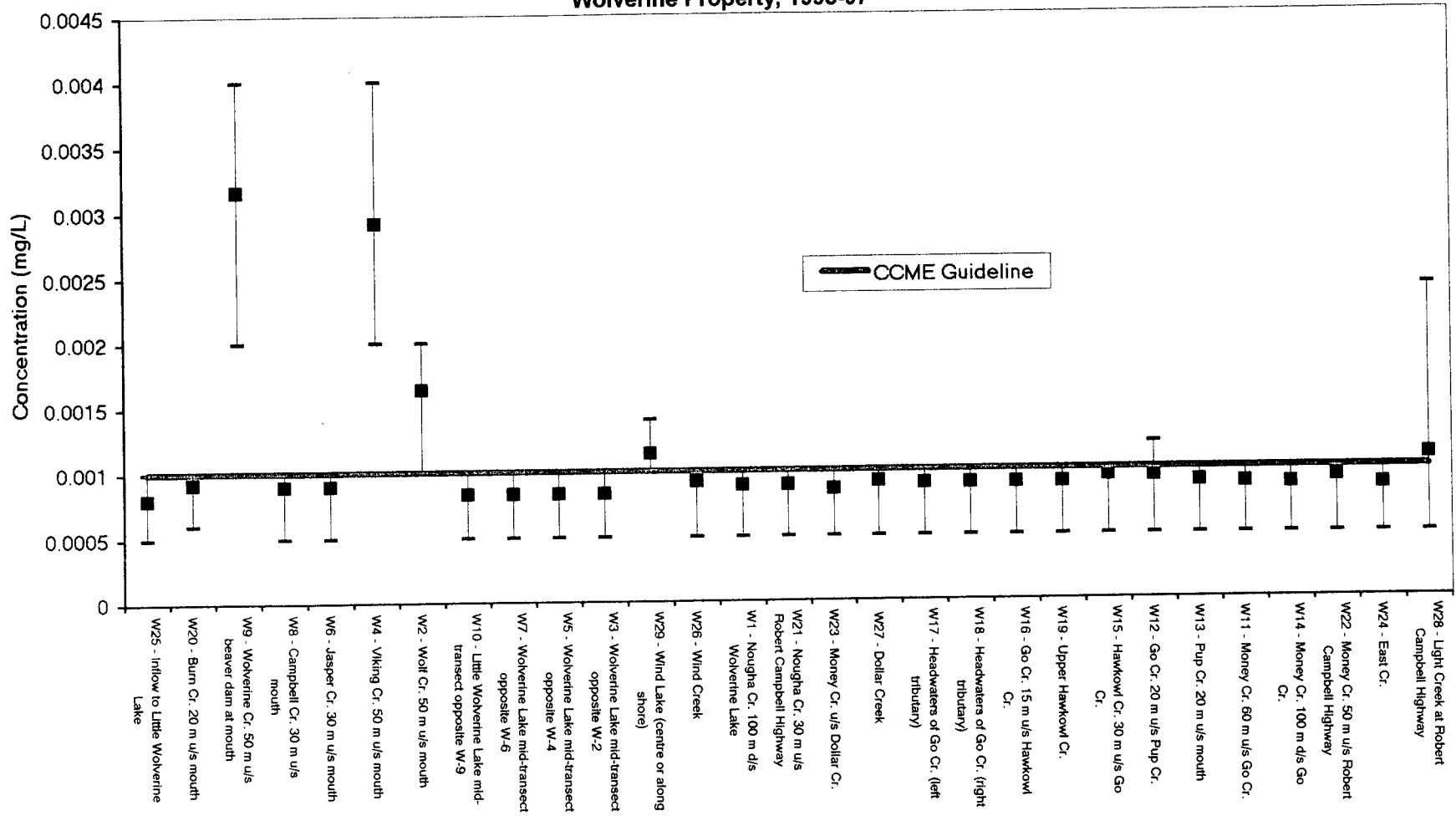
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Figure 3.48
Mean and Range of Total Aluminum Measured at Water Quality Sites,
Wolverine Property, 1995-97



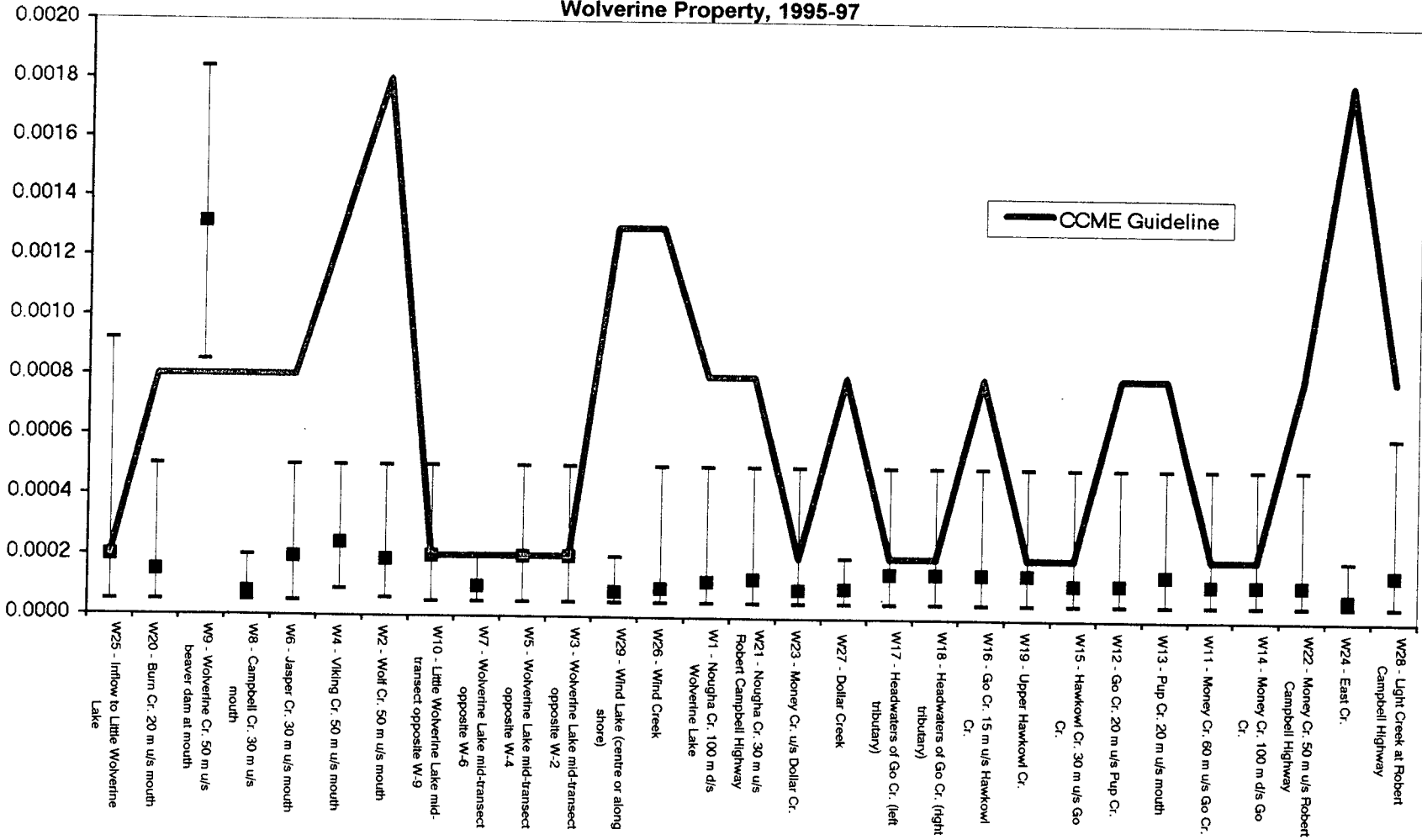
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Figure 3.49
Mean and Range of Total Selenium Measured at Water Quality Sites,
Wolverine Property, 1995-97



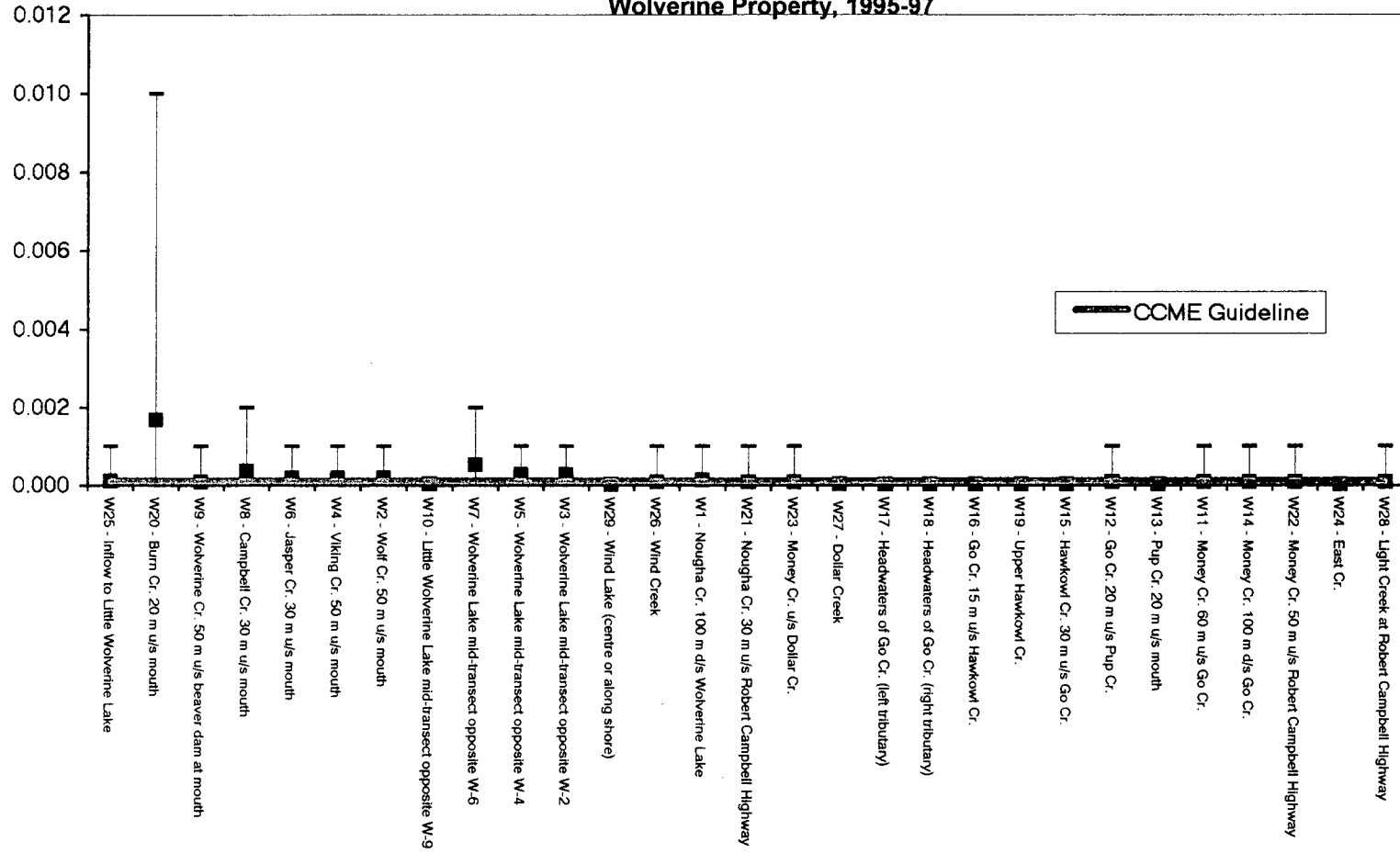
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Figure 3.50
Mean and Range of Total Cadmium Measured at Water Quality Sites,
Wolverine Property, 1995-97



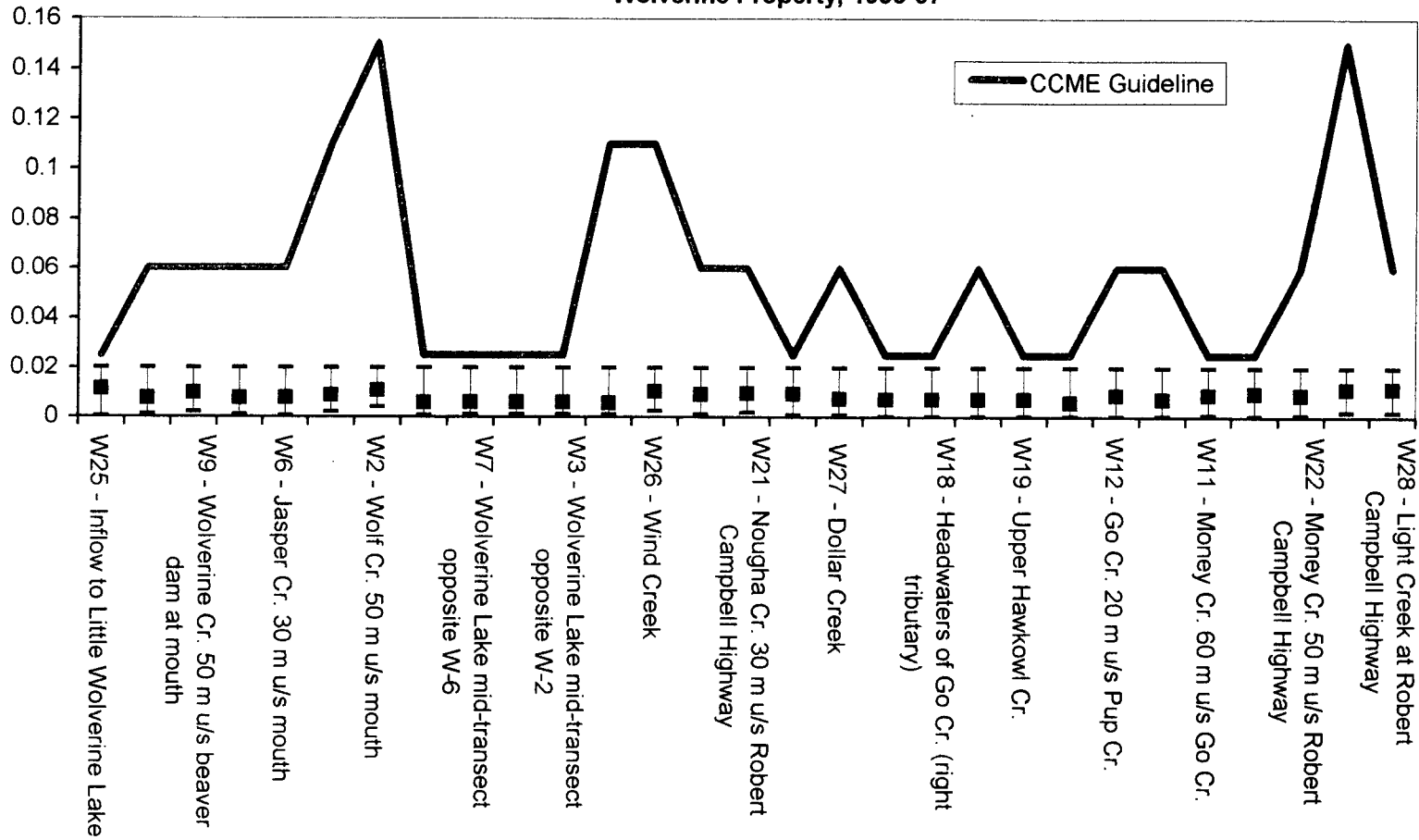
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Figure 3.51
Mean and Range of Total Silver Measured at Water Quality Sites,
Wolverine Property, 1995-97



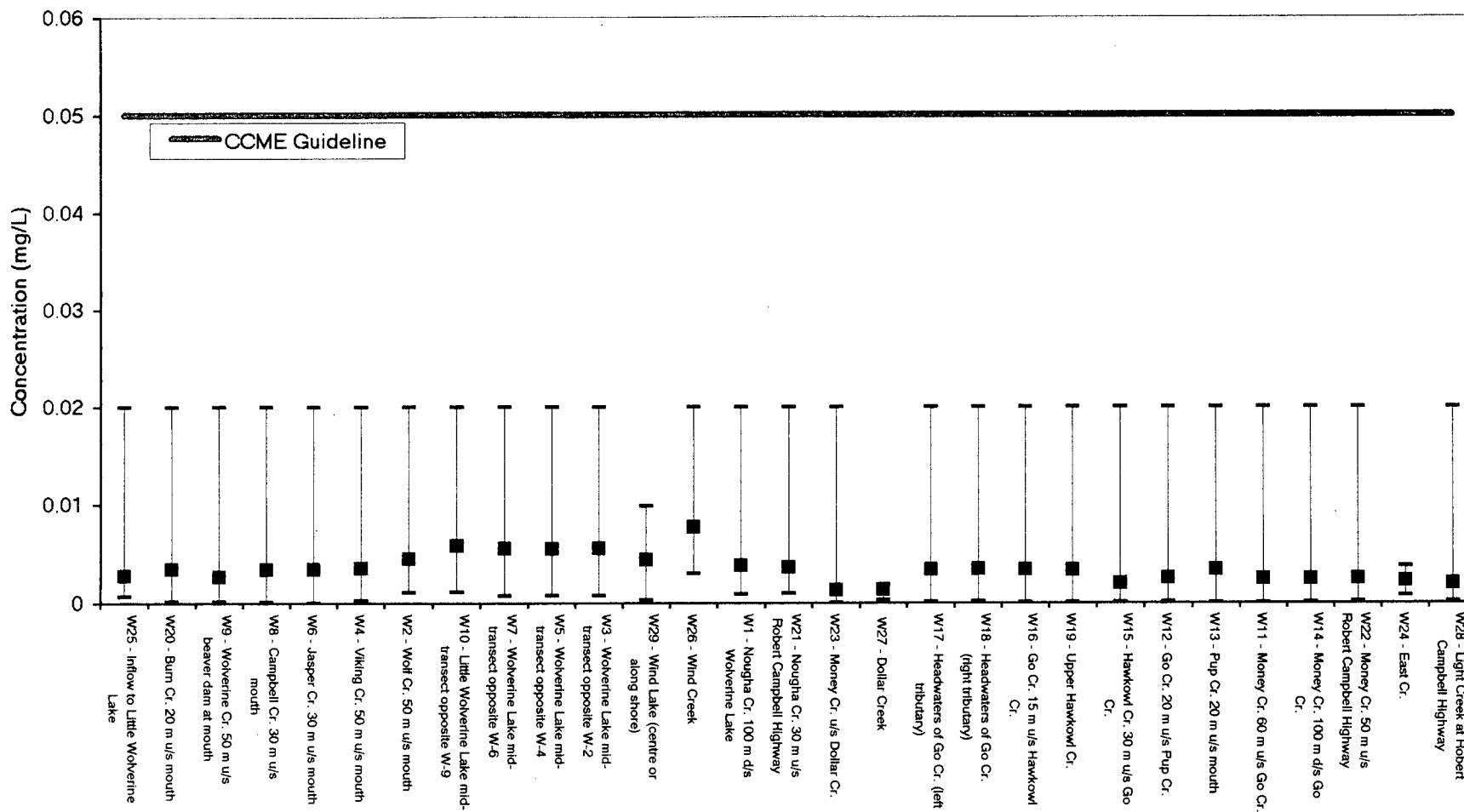
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Figure 3.52
Mean and Range of Total Nickel Measured at Water Quality Sites,
Wolverine Property, 1995-97



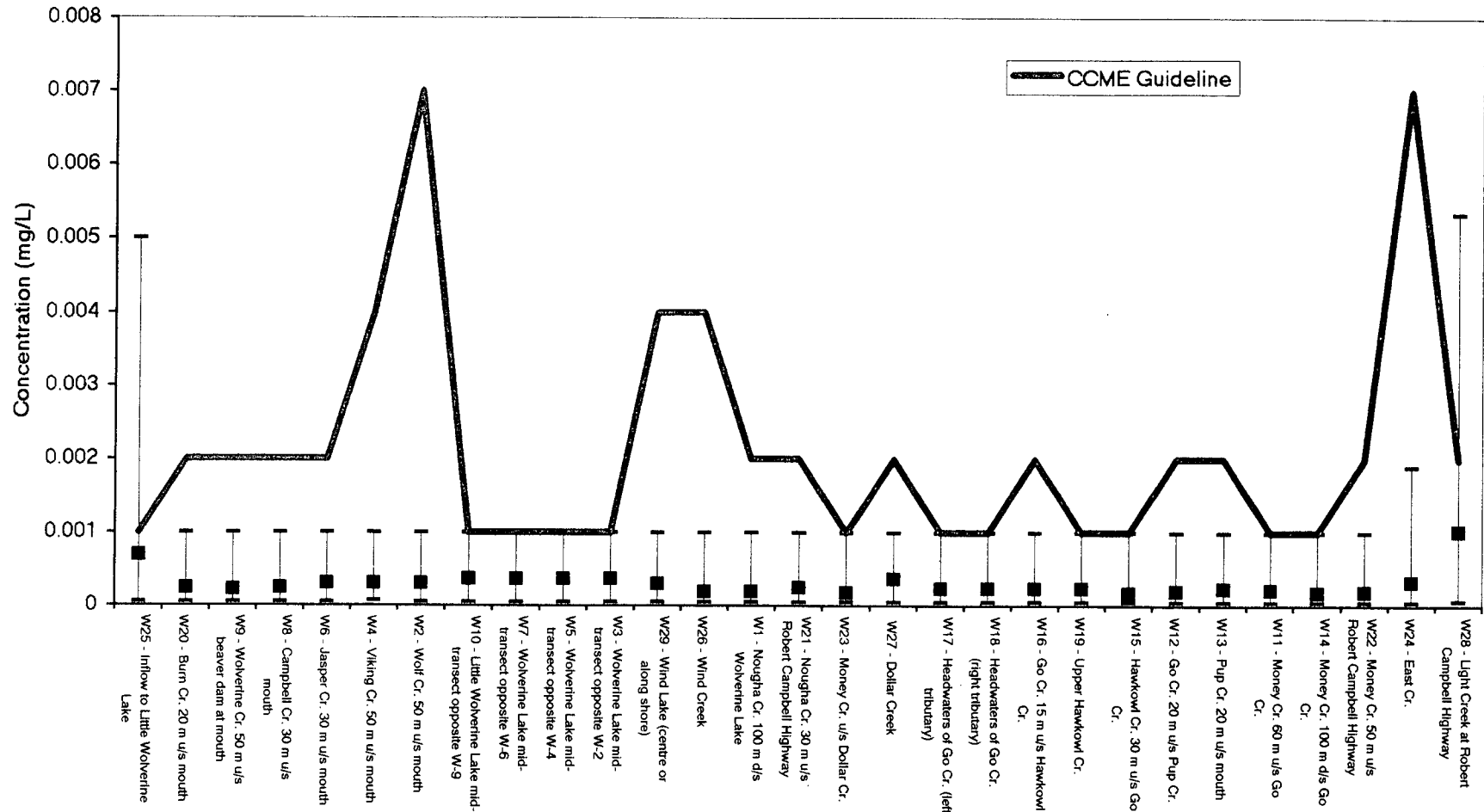
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.53
Mean and Range of Total Arsenic Measured at Water Quality Sites,
Wolverine Property, 1995-97



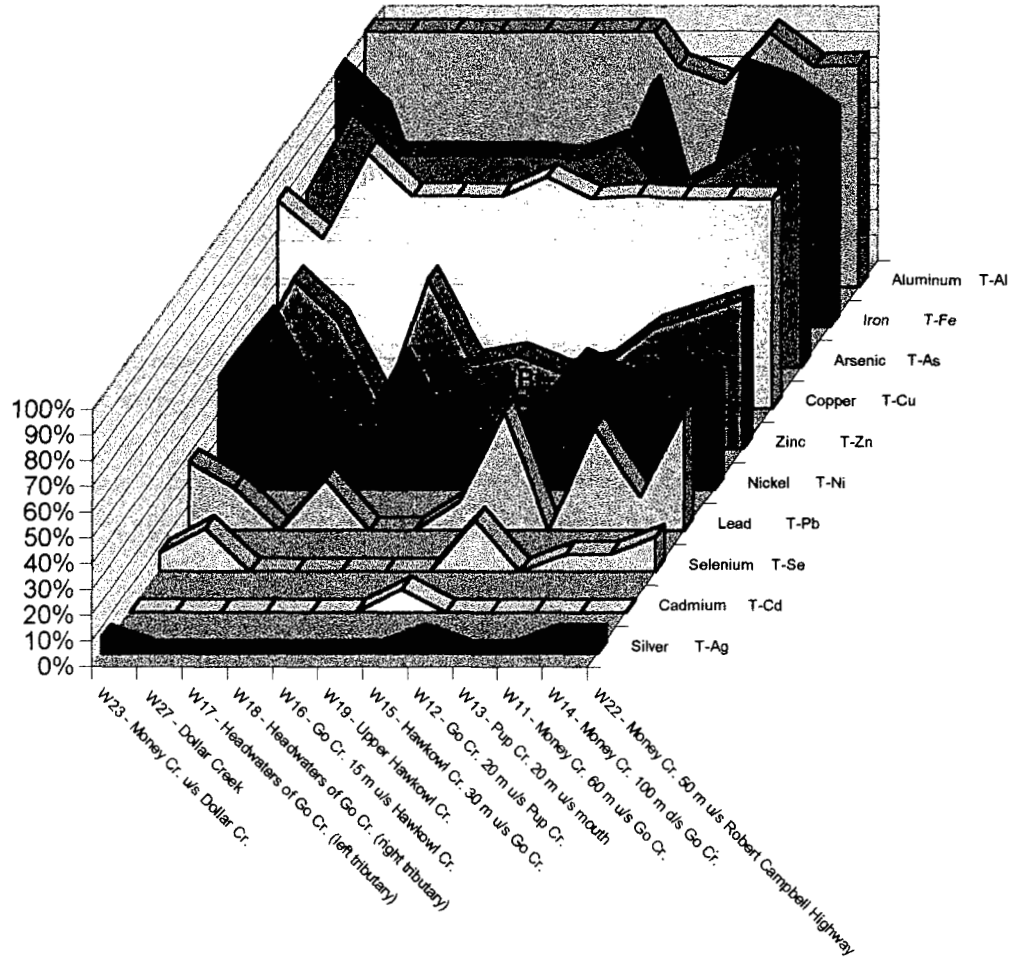
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

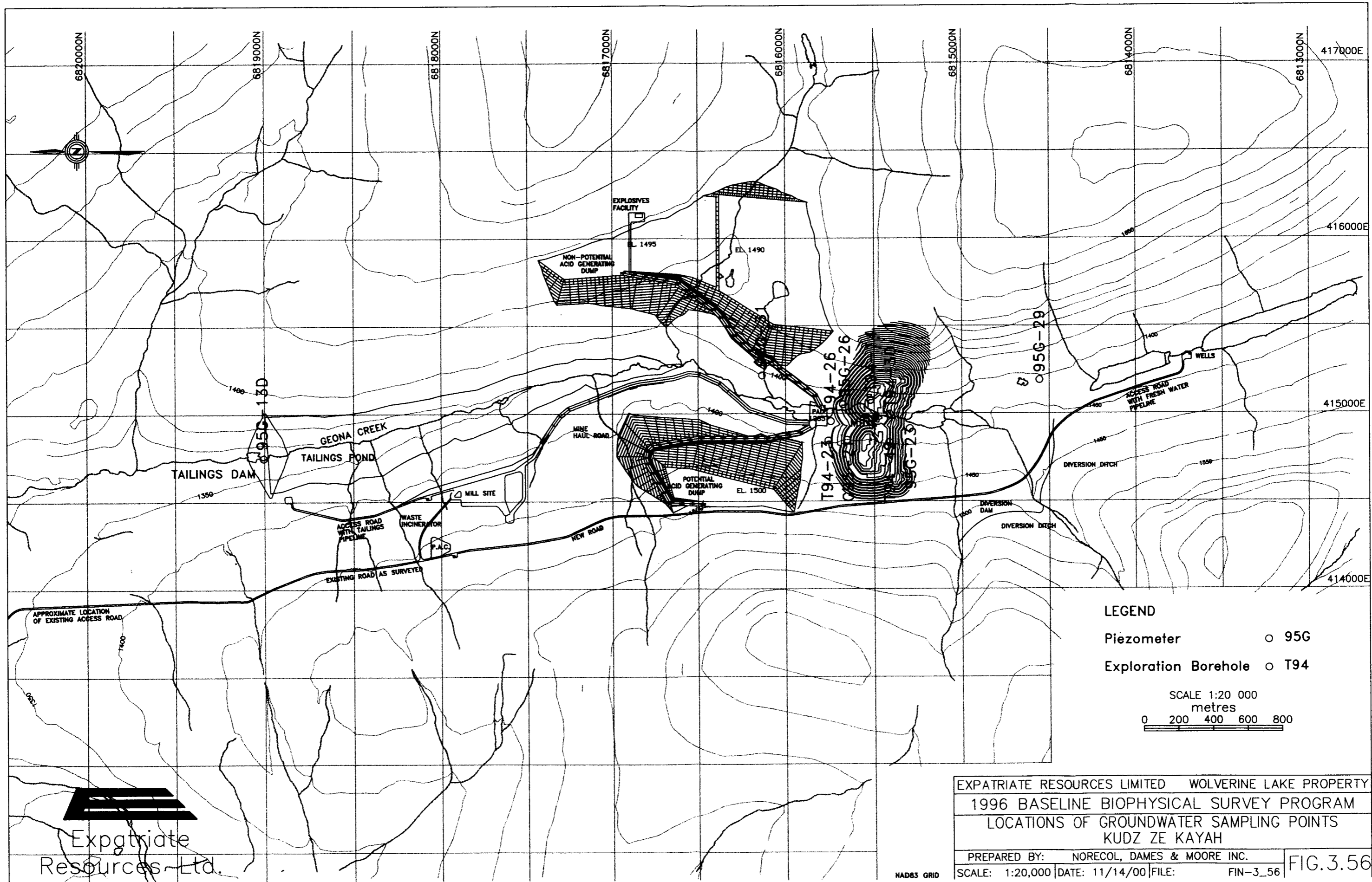
Figure 3.54
Mean and Range of Total Lead Measured at Water Quality Sites,
Wolverine Property, 1995-97



EXPATRIATE RESOURCES FINLAYSON PROJECT

Figure 3.55
% Detection of Heavy Metals in Water Samples from the Go/Money Creek Drainage





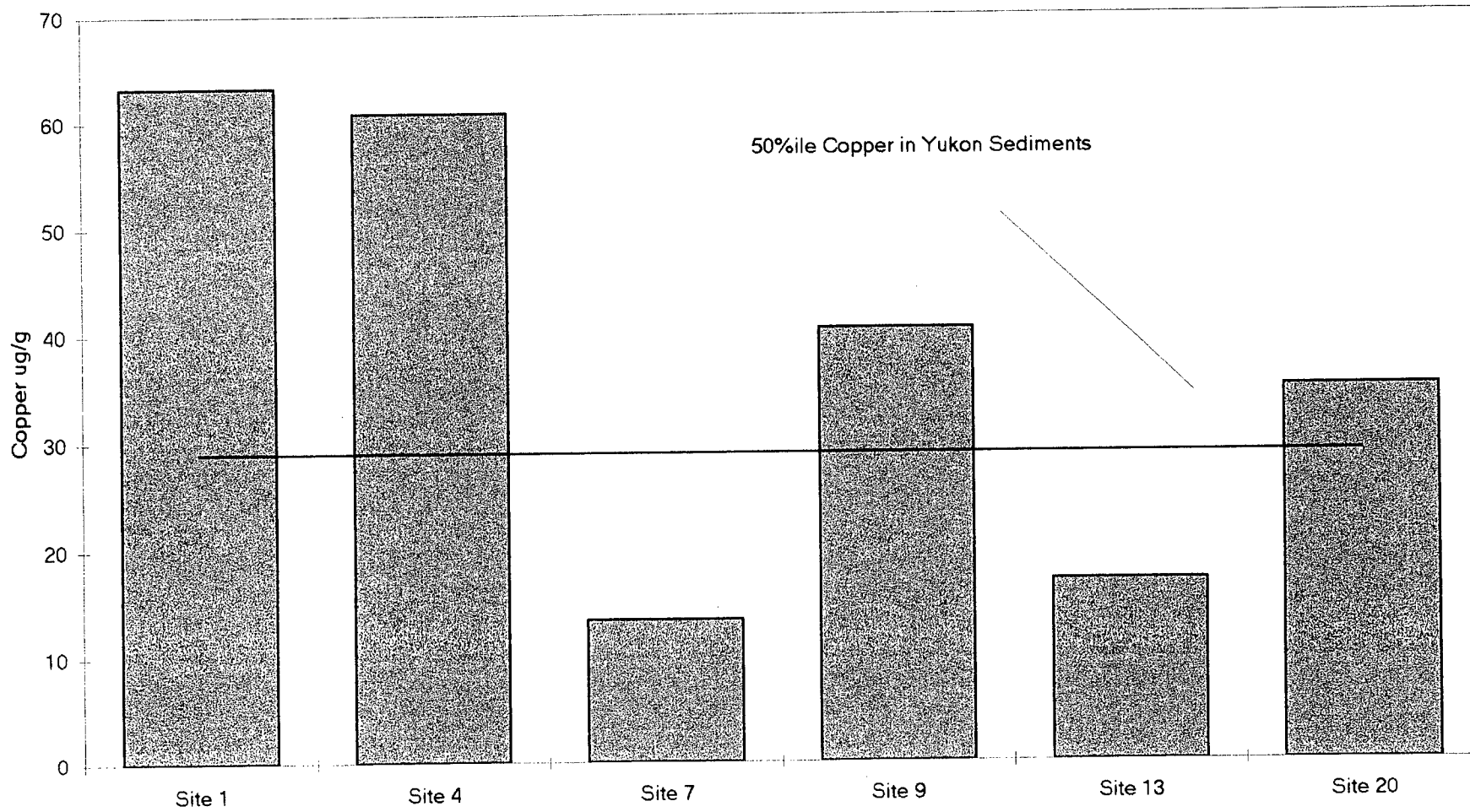
Expatriate Resources Ltd.

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM	
LOCATIONS OF GROUNDWATER SAMPLING POINTS	
KUDZ ZE KAYAH	
PREPARED BY: NORECOL, DAMES & MOORE INC.	FIG. 3.56
SCALE: 1:20,000 DATE: 11/14/00 FILE: FIN-3_56	

NAD83 GRID

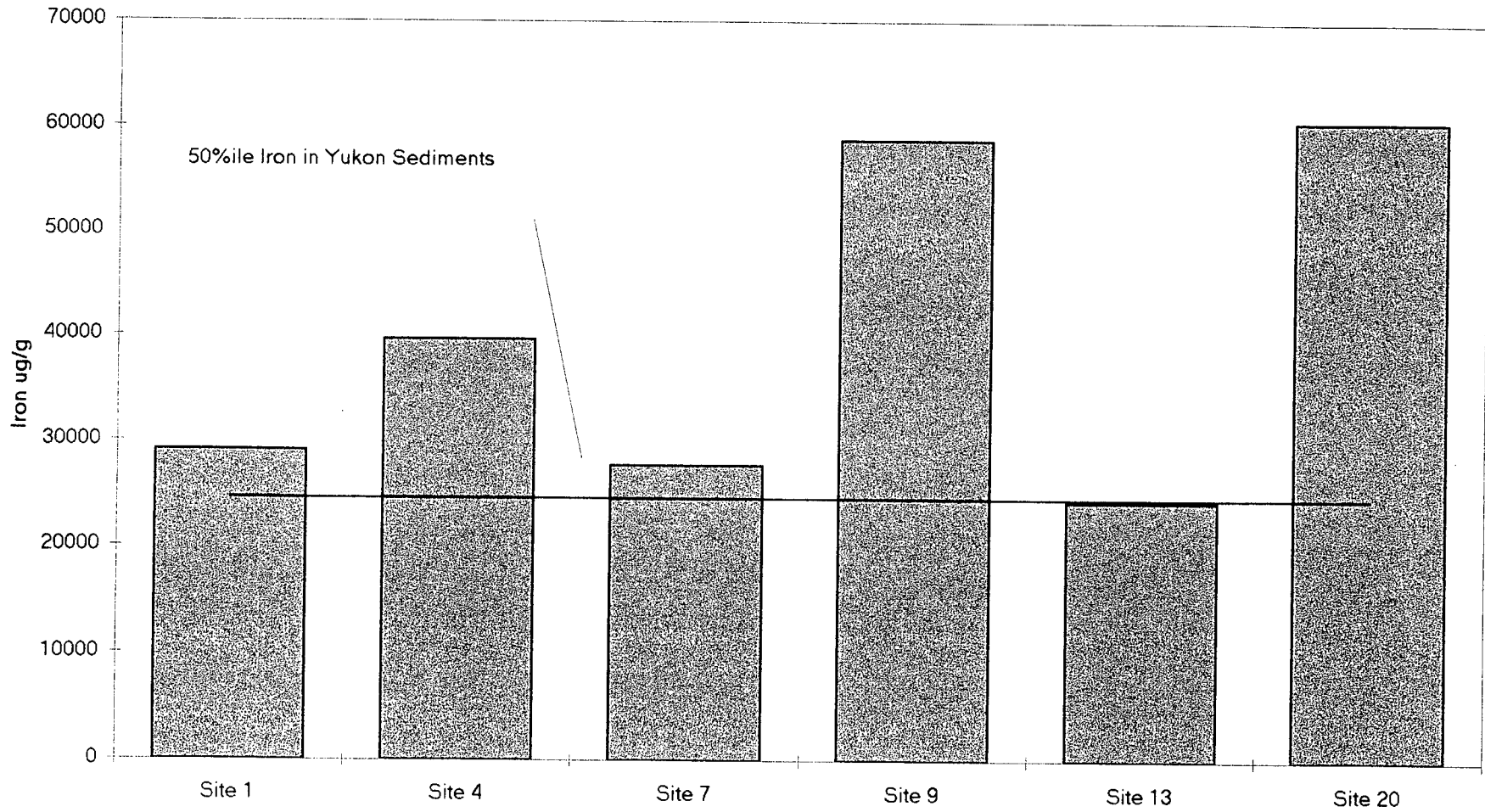
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.57
Copper Concentrations in Stream Bed Sediments
Kudz Ze Kayah Property, 1995



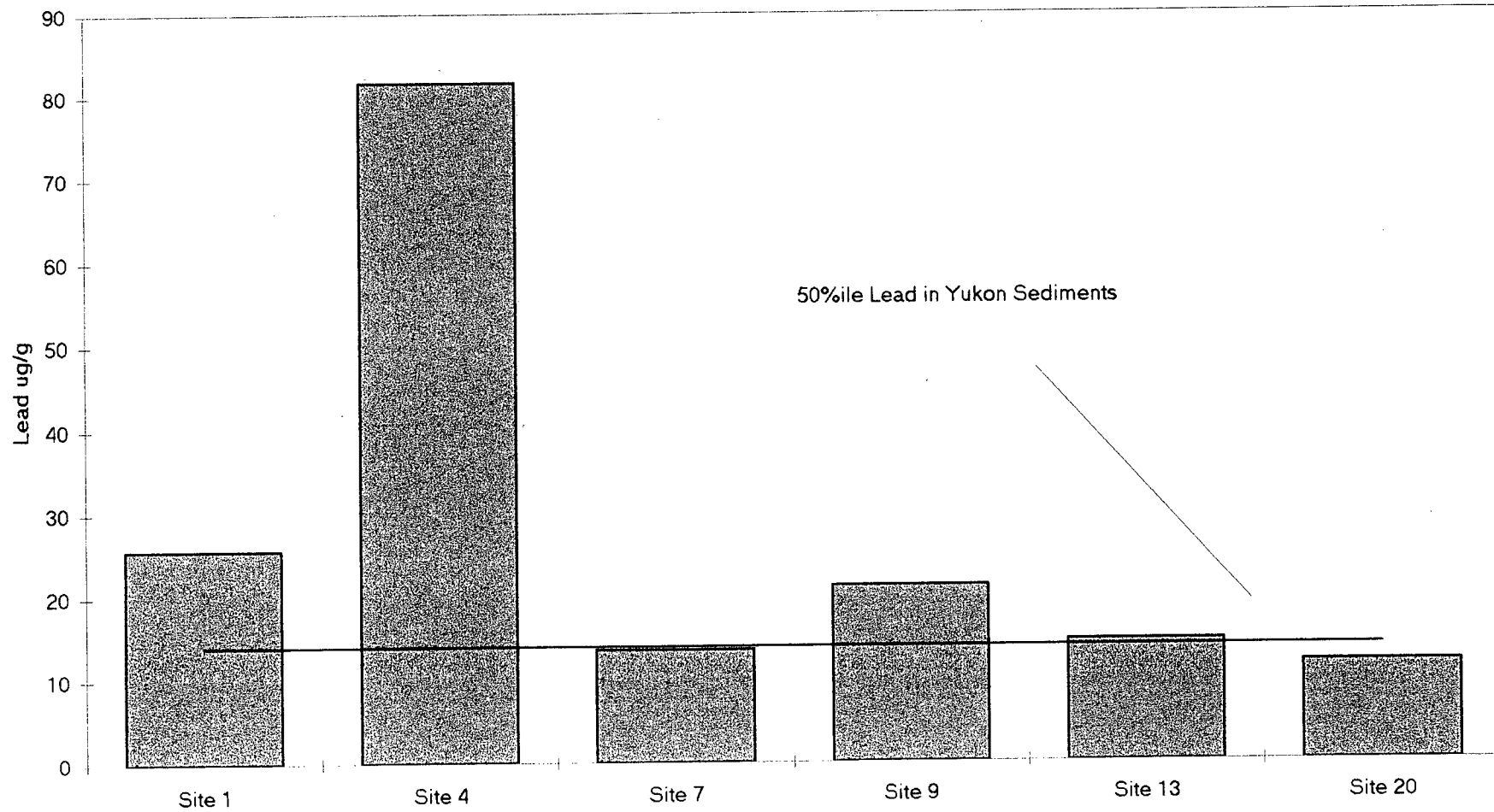
EXPATRIATE RESOURCES
FINLAYSON PROJECT

Figure 3.58
Iron Concentrations in Stream Bed Sediments
Kudz Ze Kayah Property, 1995



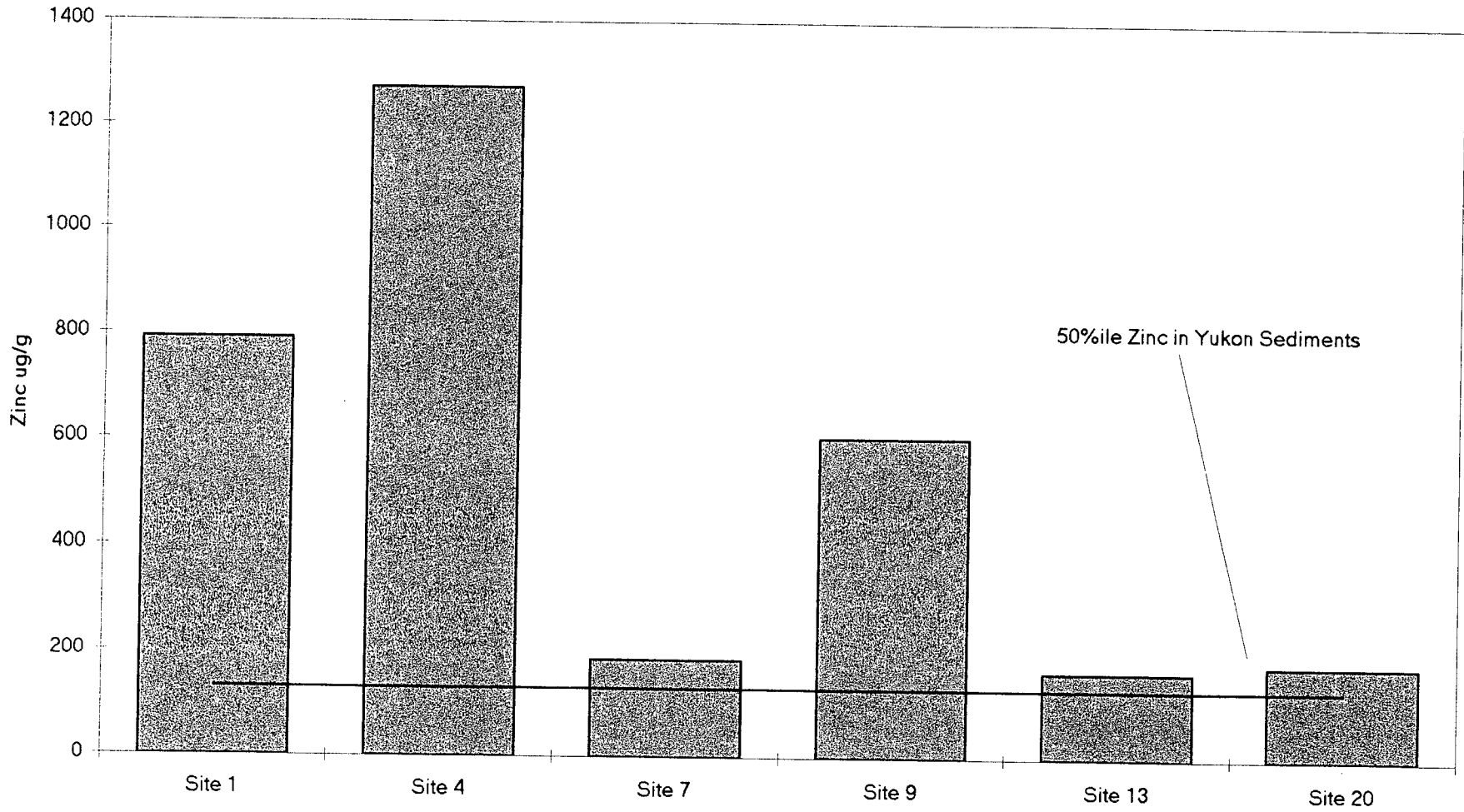
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.59
Lead Concentrations in Stream Bed Sediments
Kudz Ze Kayah Property, 1995



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

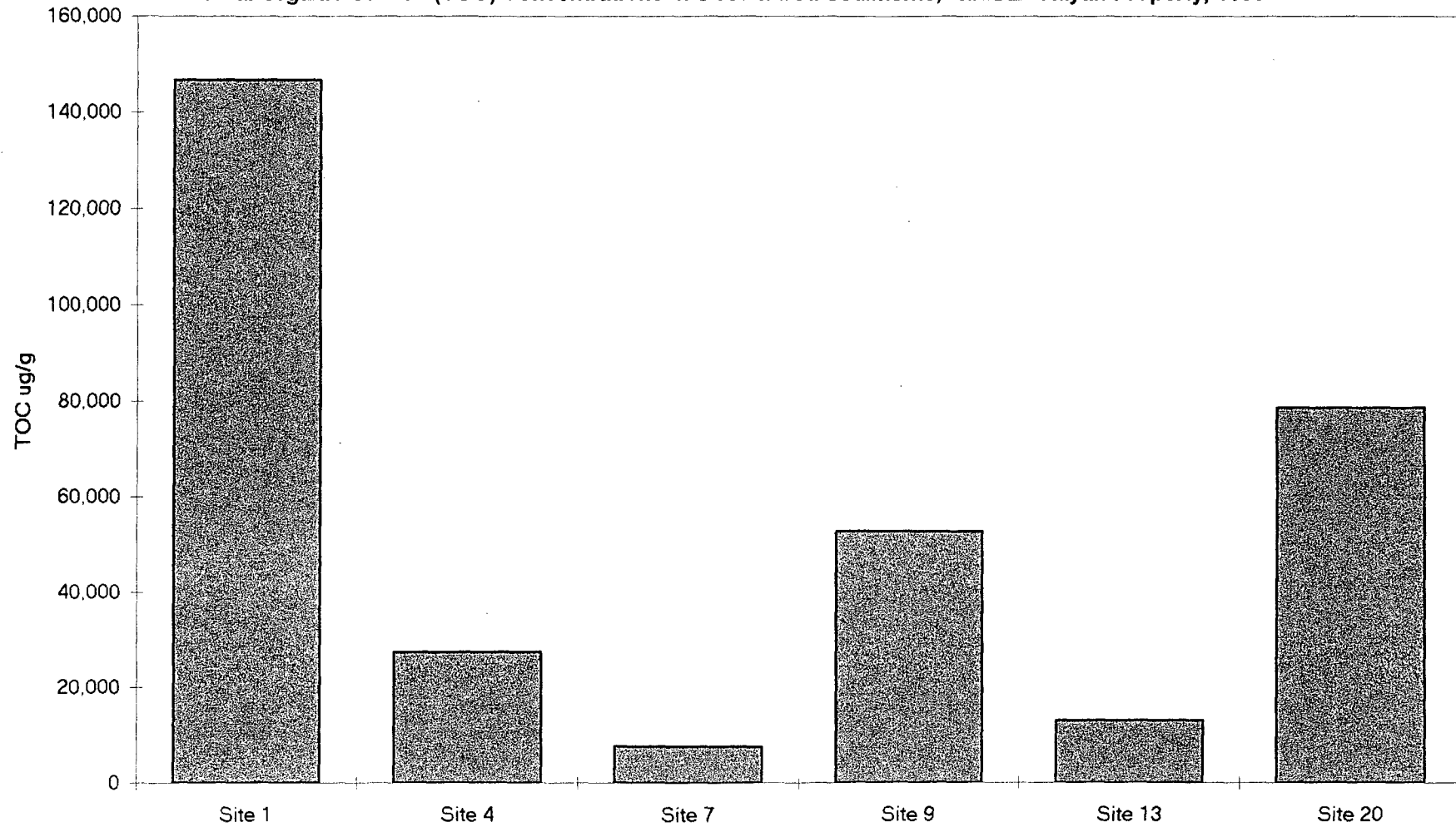
Figure 3.60
Zinc Concentrations in Stream Bed Sediments
Kudz Ze Kayah Property, 1995



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

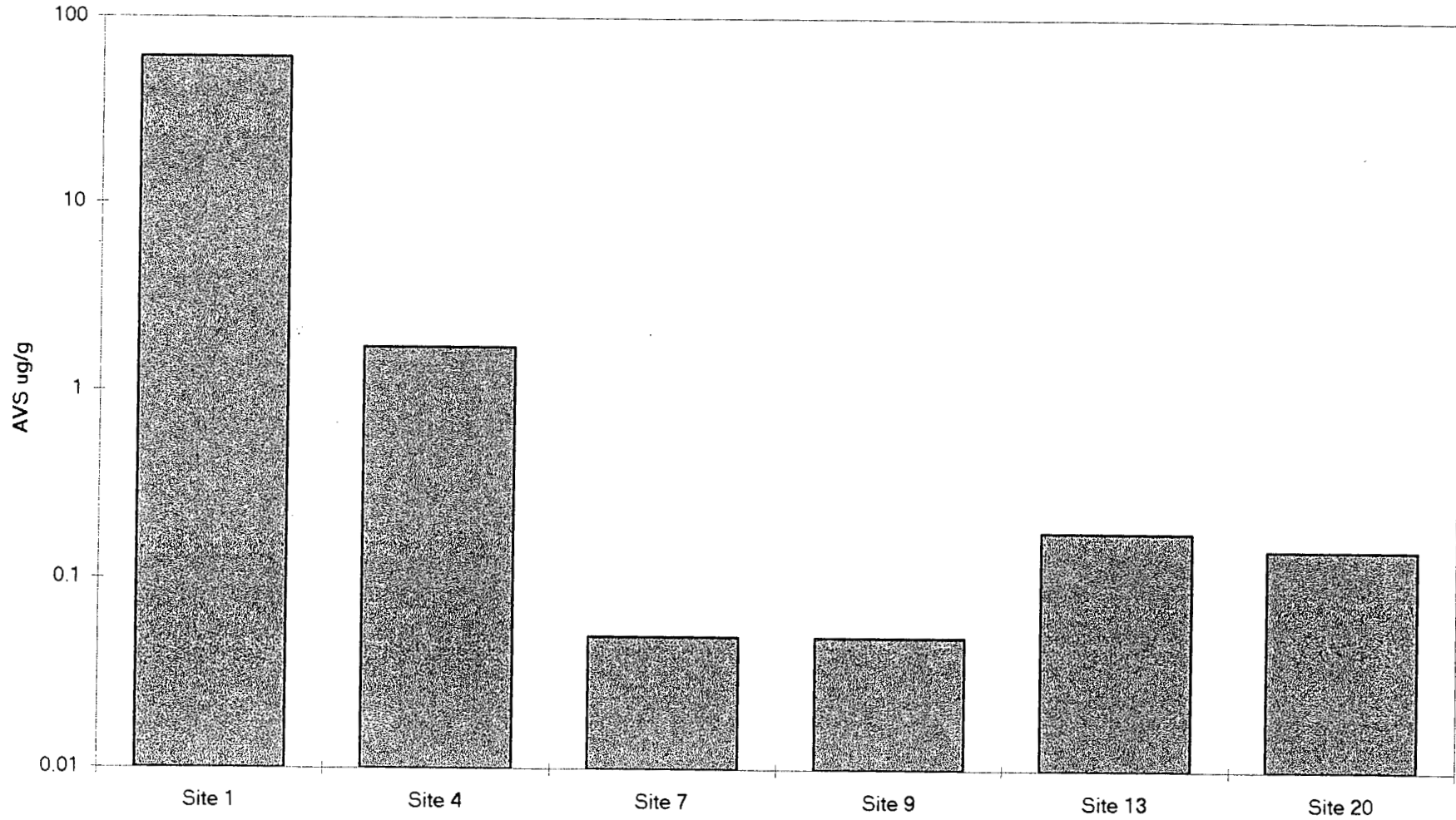
Figure 3.61

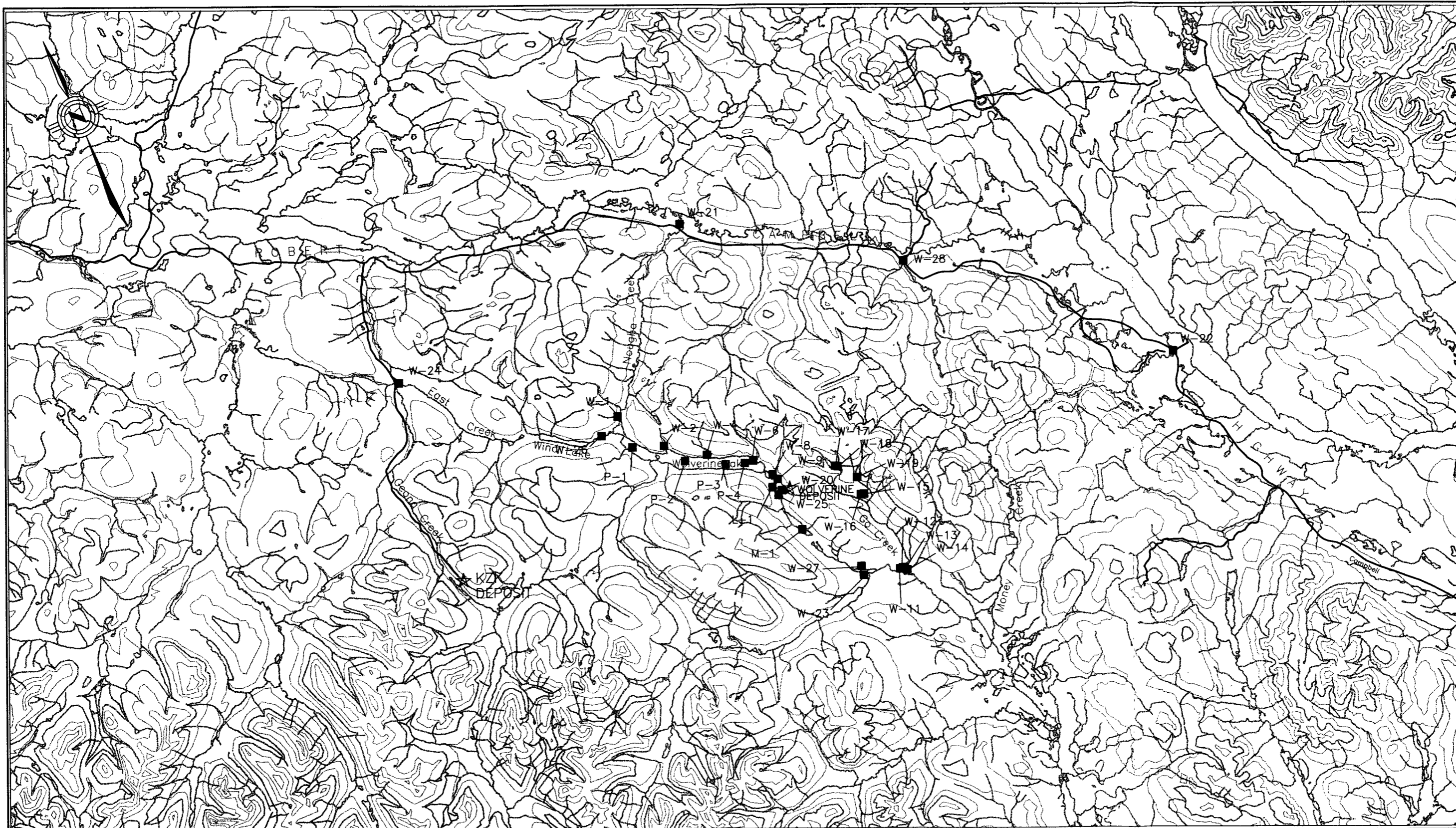
Total Organic Carbon (TOC) Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property, 1995



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.62
Acid Volatile Sulphide (AVS) Concentrations in Stream Bed Sediments, Kudz Ze Kayah Property, 1995






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LEGEND: ■ SEDIMENT MONITORING STATIONS

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY

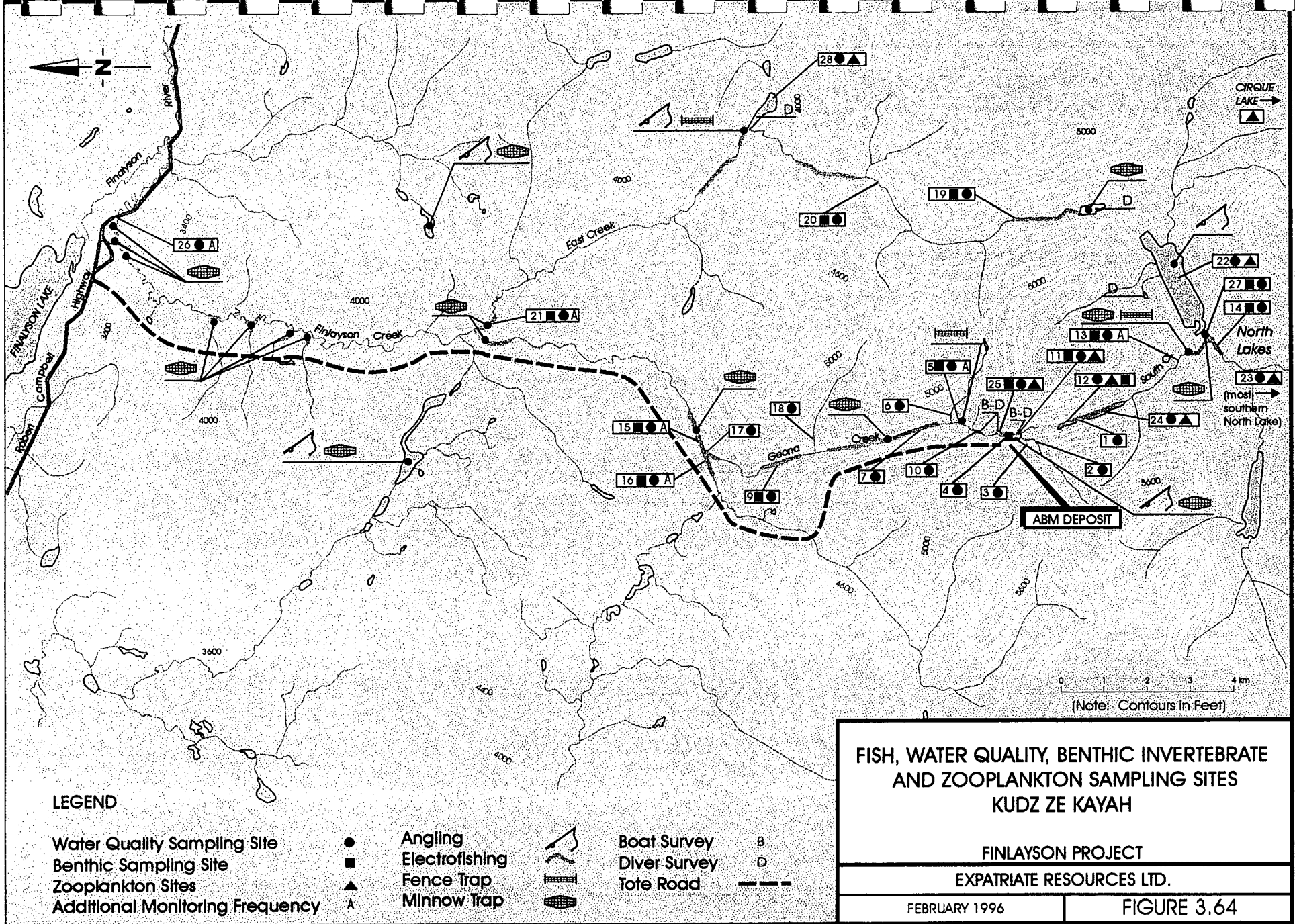
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM

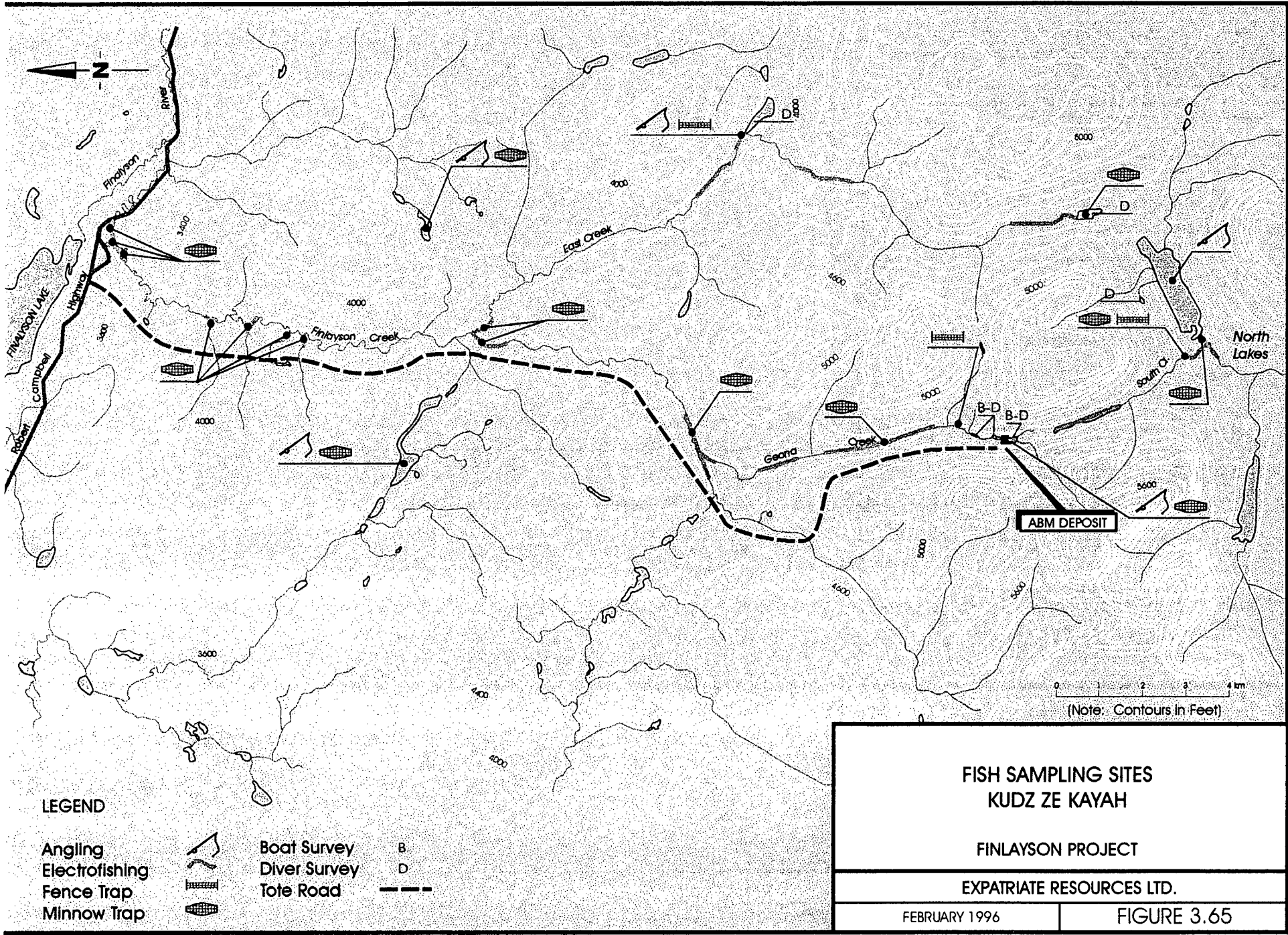
SEDIMENT MONITORING STATIONS
 FINLAYSON PROJECT AREA

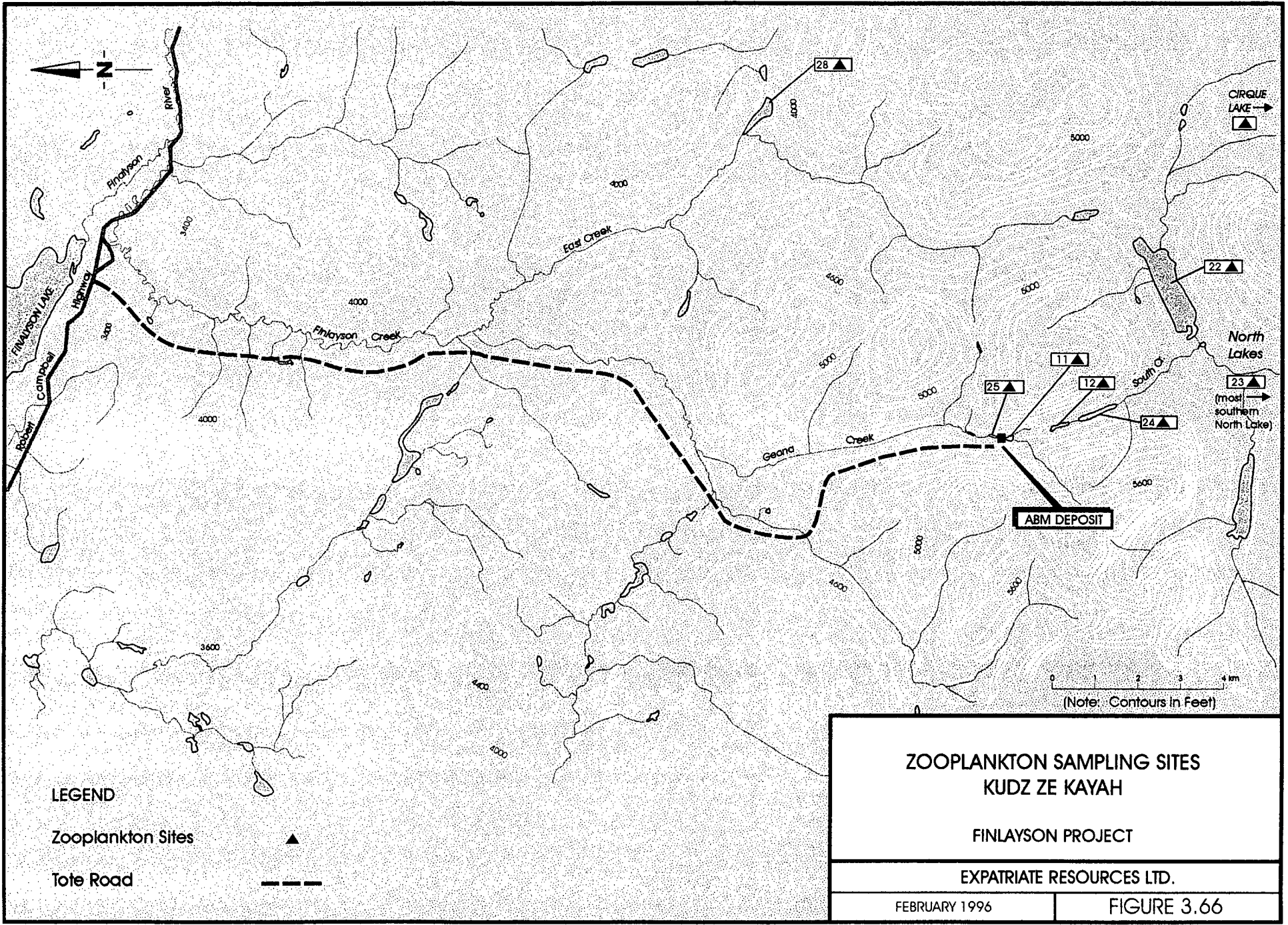
PREPARED BY: ACCESS MINING CONSULTANTS LTD.

SCALE: 1:250,000 DATE: 11/14/00 FILE: FIN-3 63

FIG. 3.63







LEGEND

Zooplankton Sites ▲

Tote Road - - - -

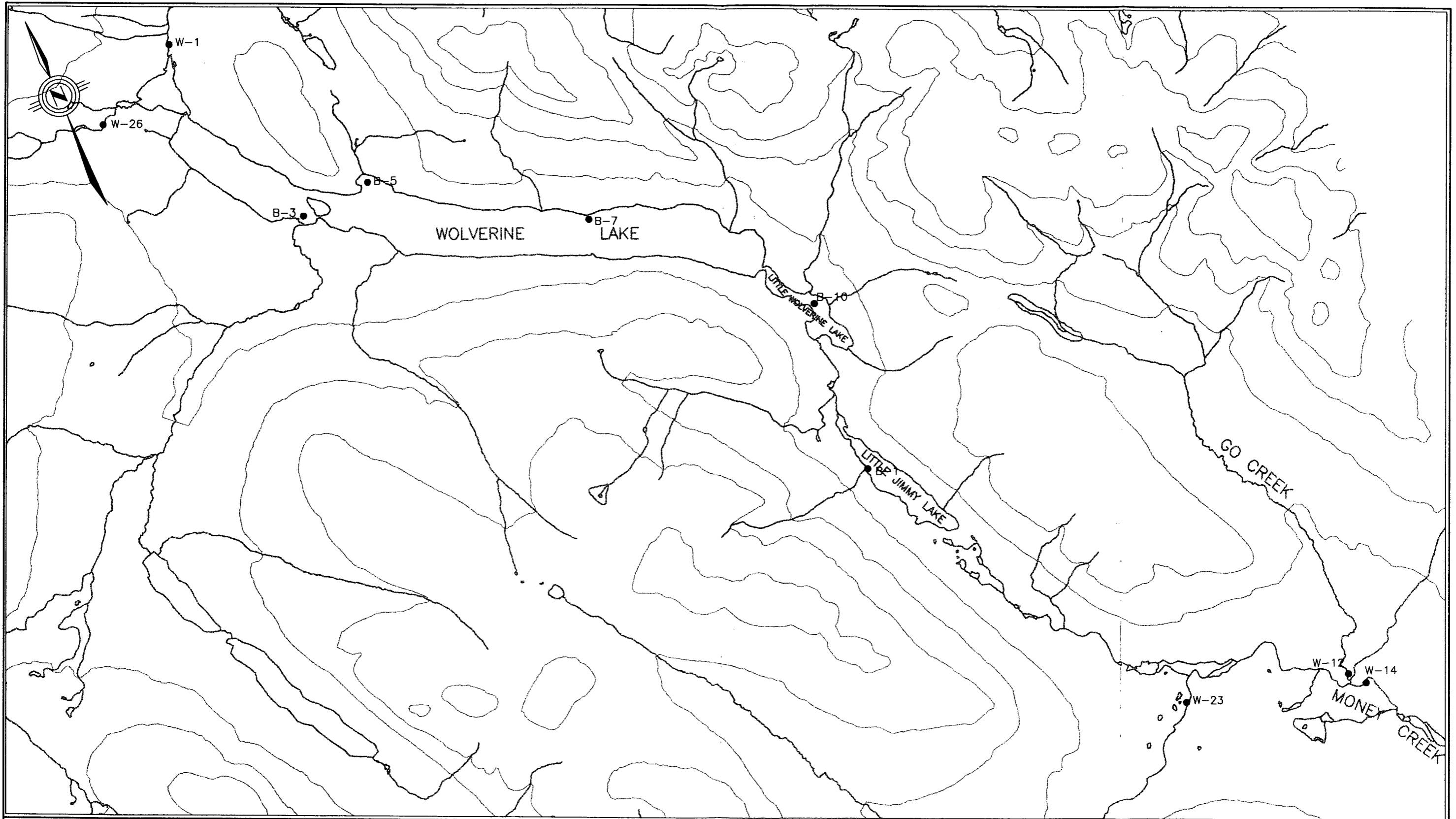
**ZOOPLANKTON SAMPLING SITES
KUDZ ZE KAYAH**

FINLAYSON PROJECT

EXPATRIATE RESOURCES LTD.

FEBRUARY 1996

FIGURE 3.66

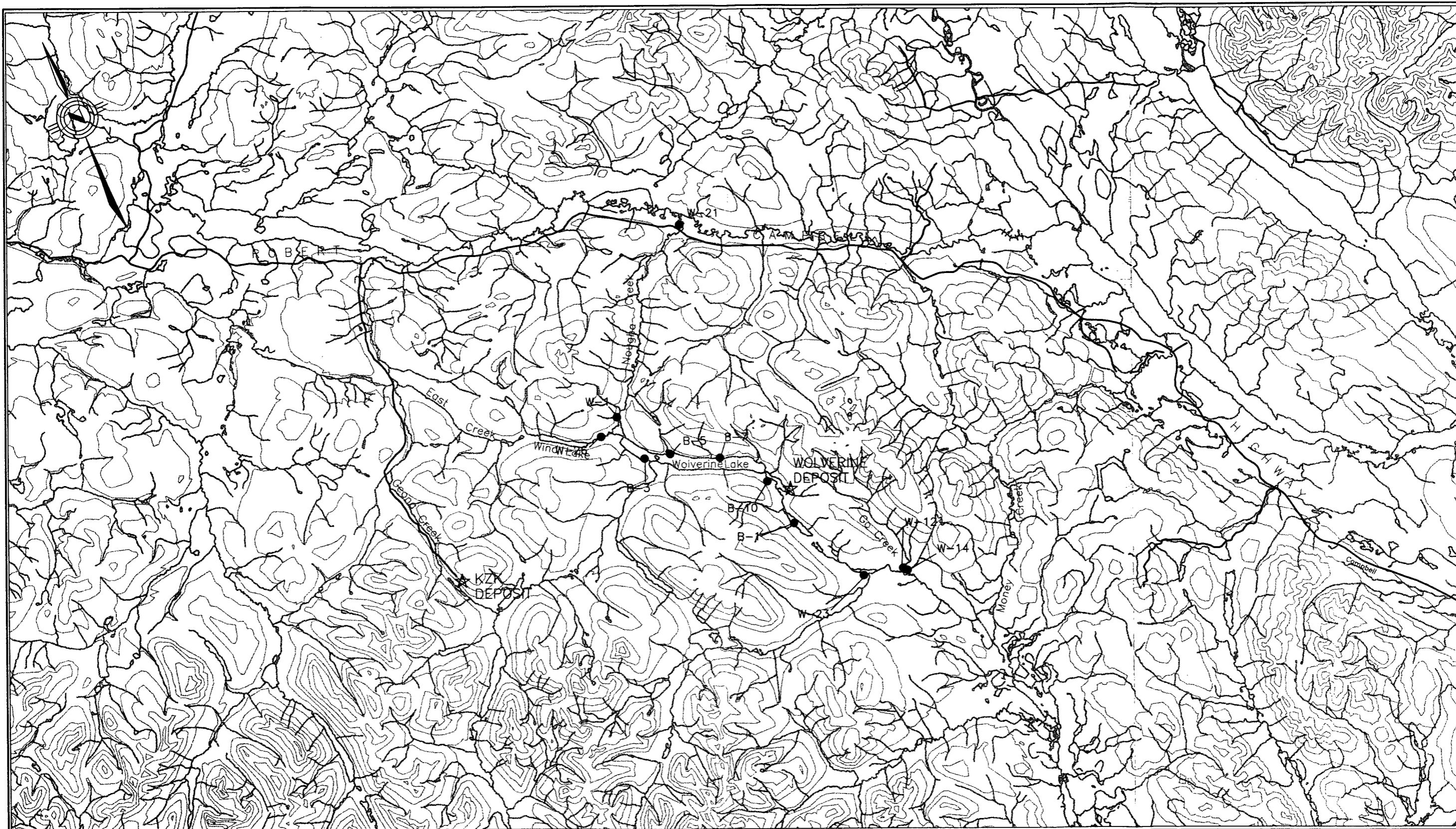


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Resources Ltd.

LEGEND: ● BETHNIC MONITORING STATIONS

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM	
BENTHOS MONITORING STATIONS	
WOLVERINE AREA	
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.
SCALE: 1:60,000	DATE: 11/14/00 FILE: FIN-3_67

FIG. 3.67



LEGEND: ● BETHNIC MONITORING STATIONS

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY

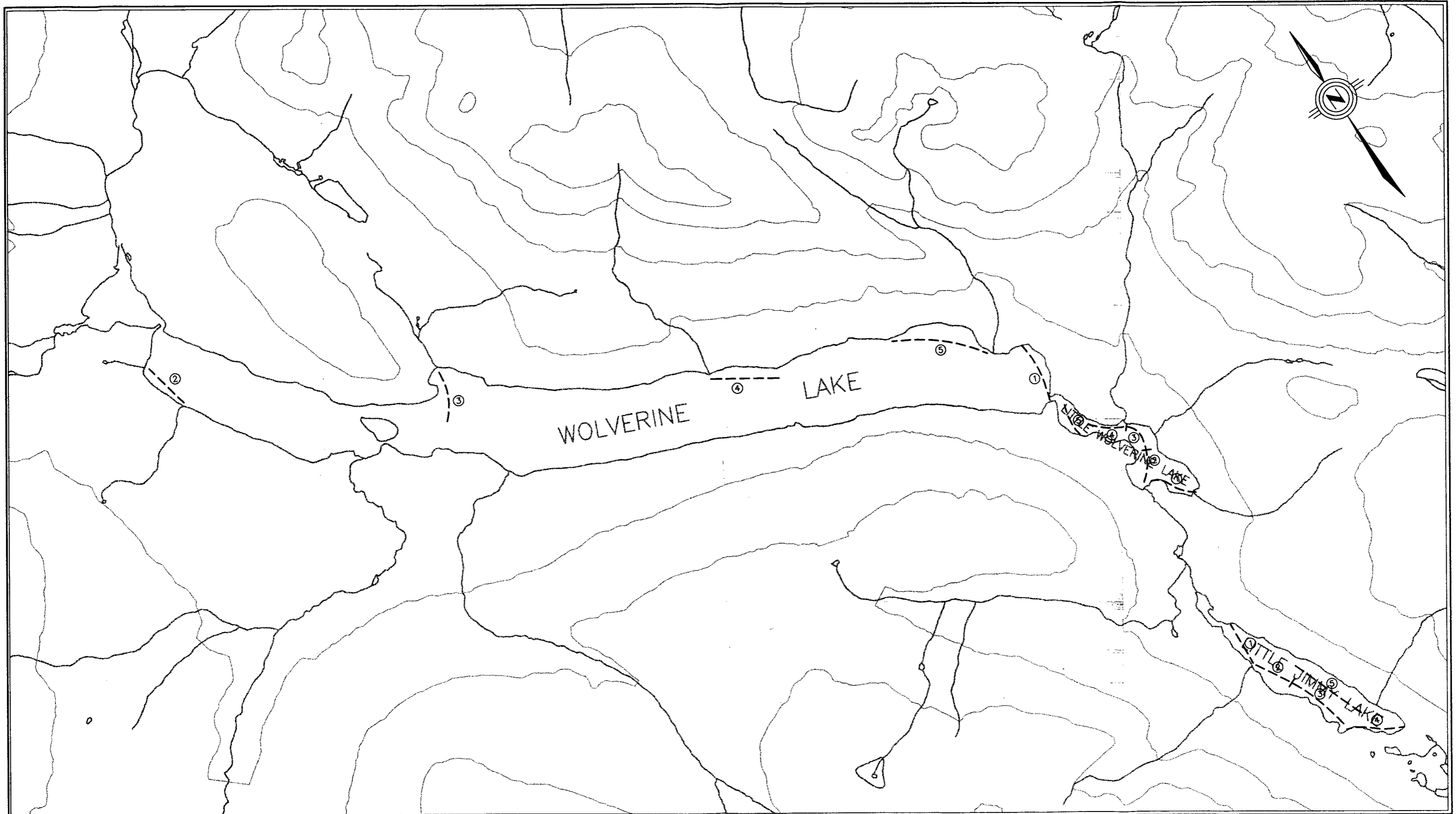
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM

BENTHOS MONITORING STATIONS
FINLAYSON PROJECT AREA

PREPARED BY: ACCESS MINING CONSULTANTS LTD.

SCALE: 1:250,000 | DATE: 11/14/00 | FILE: FIN-3_68

FIG. 3.68



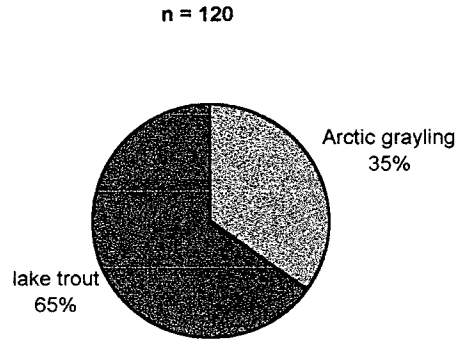
LEGEND: ① PLANKTON HAUL TRANSECT

EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
PLANKTON HAUL SITES			
WOLVERINE AREA			
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.		
SCALE: 1:40,000	DATE: 11/14/00	FILE:	FIN-3_69

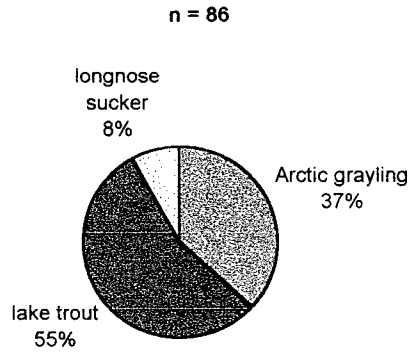
FIG. 3.69

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

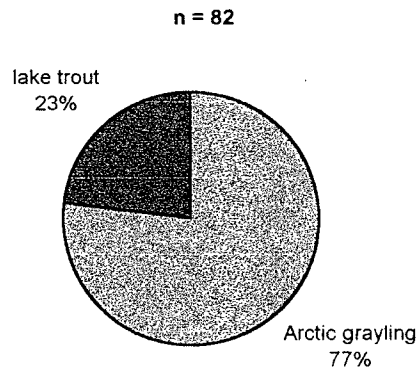
Figure 3.70
Species Composition by Weight for Fish in Lakes in the Wolverine Area



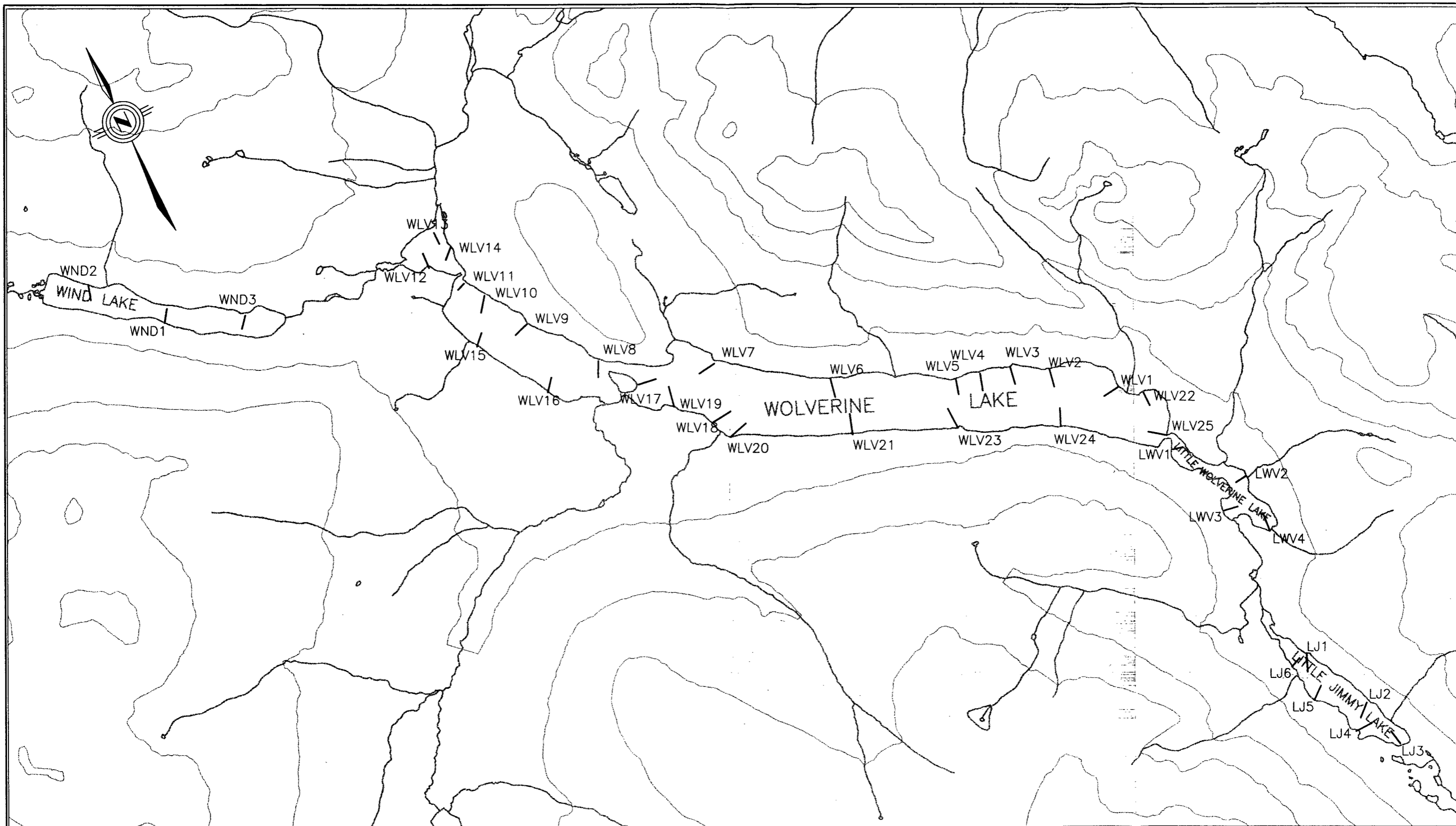
Species composition by weight as determined from index gillnets, Wolverine Lake, 1996.



Species composition by weight as determined from index gillnets, Little Wolverine Lake, 1996.



Species composition by weight as determined from index gillnets, Little Jimmy Lake, 1996.



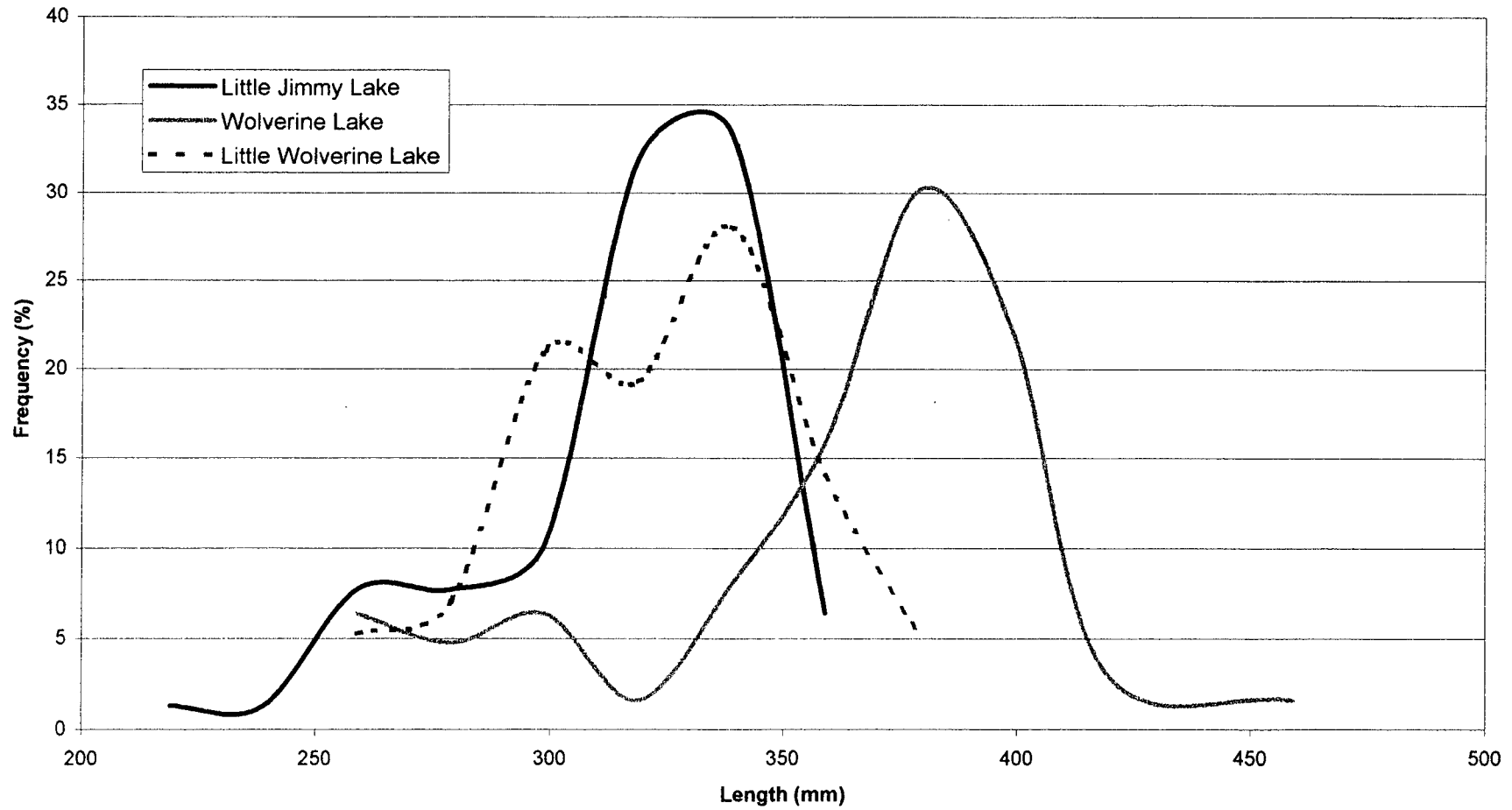

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 Resources Ltd.

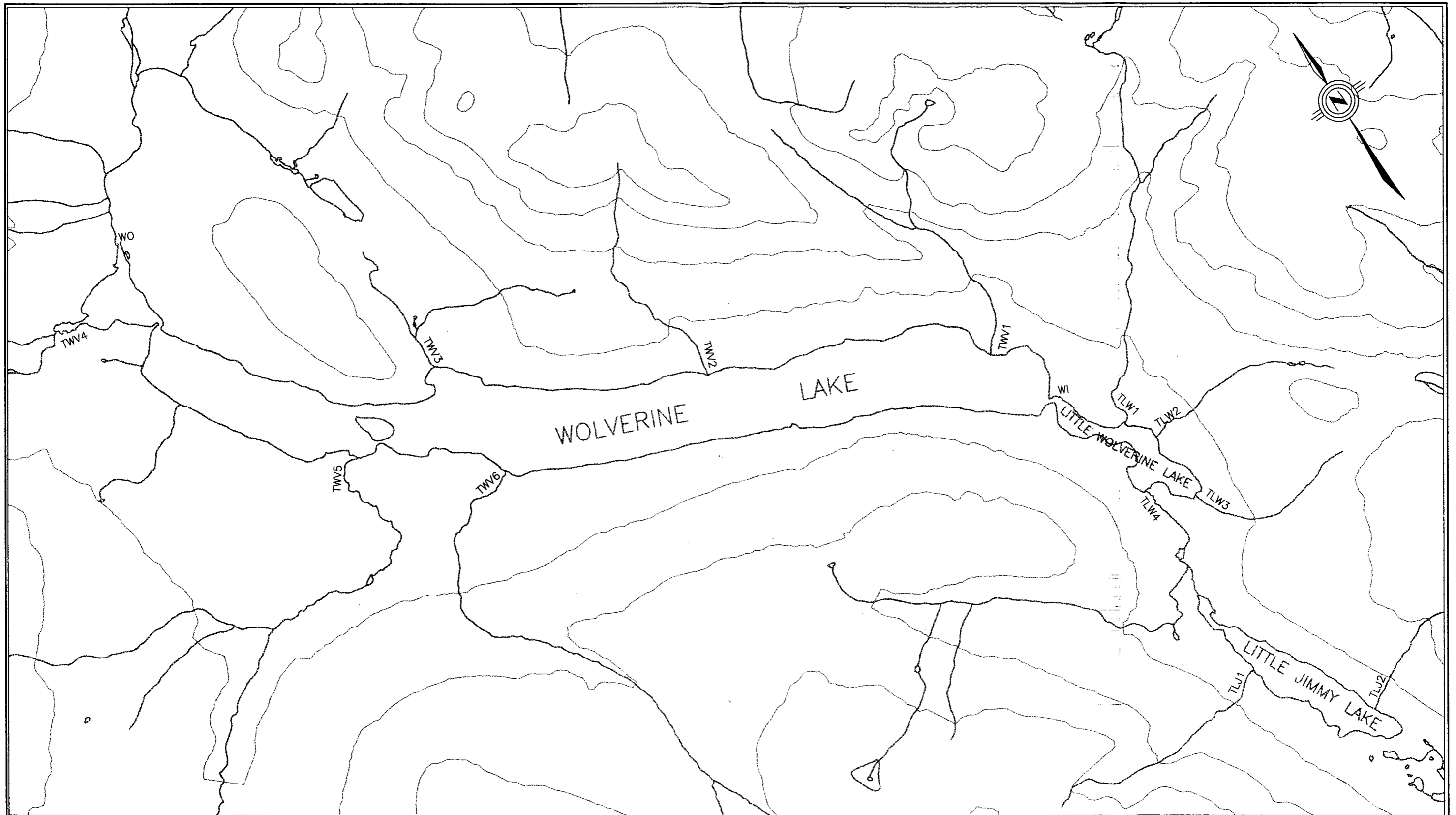
EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
LOCATIONS OF NON-DESTRUCTIVE GILLNET SETS			
WOLVERINE AREA			
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.		
SCALE: 1:50,000	DATE: 11/14/00	FILE:	FIN-3 71

FIG. 3.71

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.72
Length-Frequency Data for Arctic Grayling in Lakes in the Wolverine Area





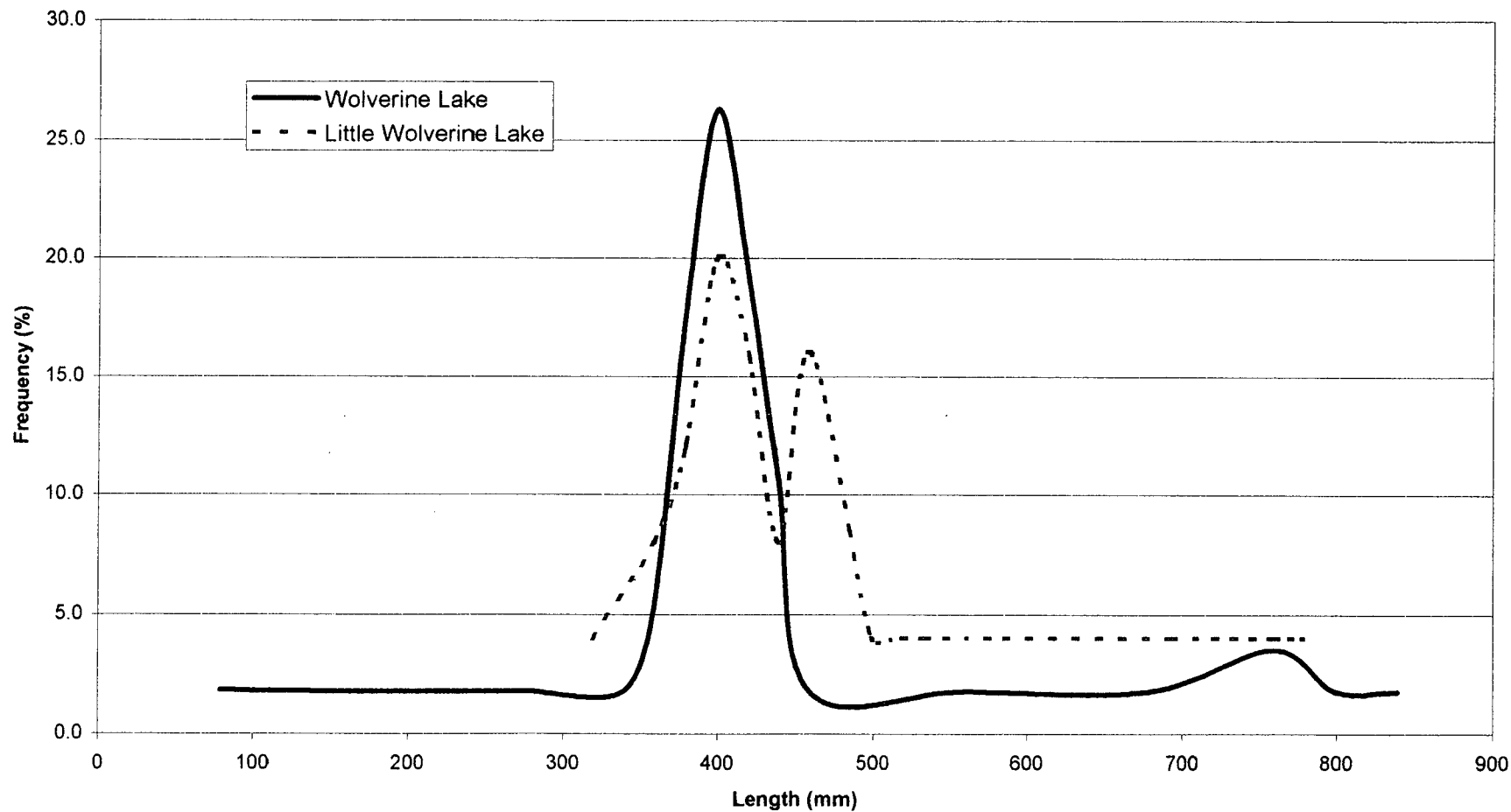

 Expatriate
 Resources Ltd.

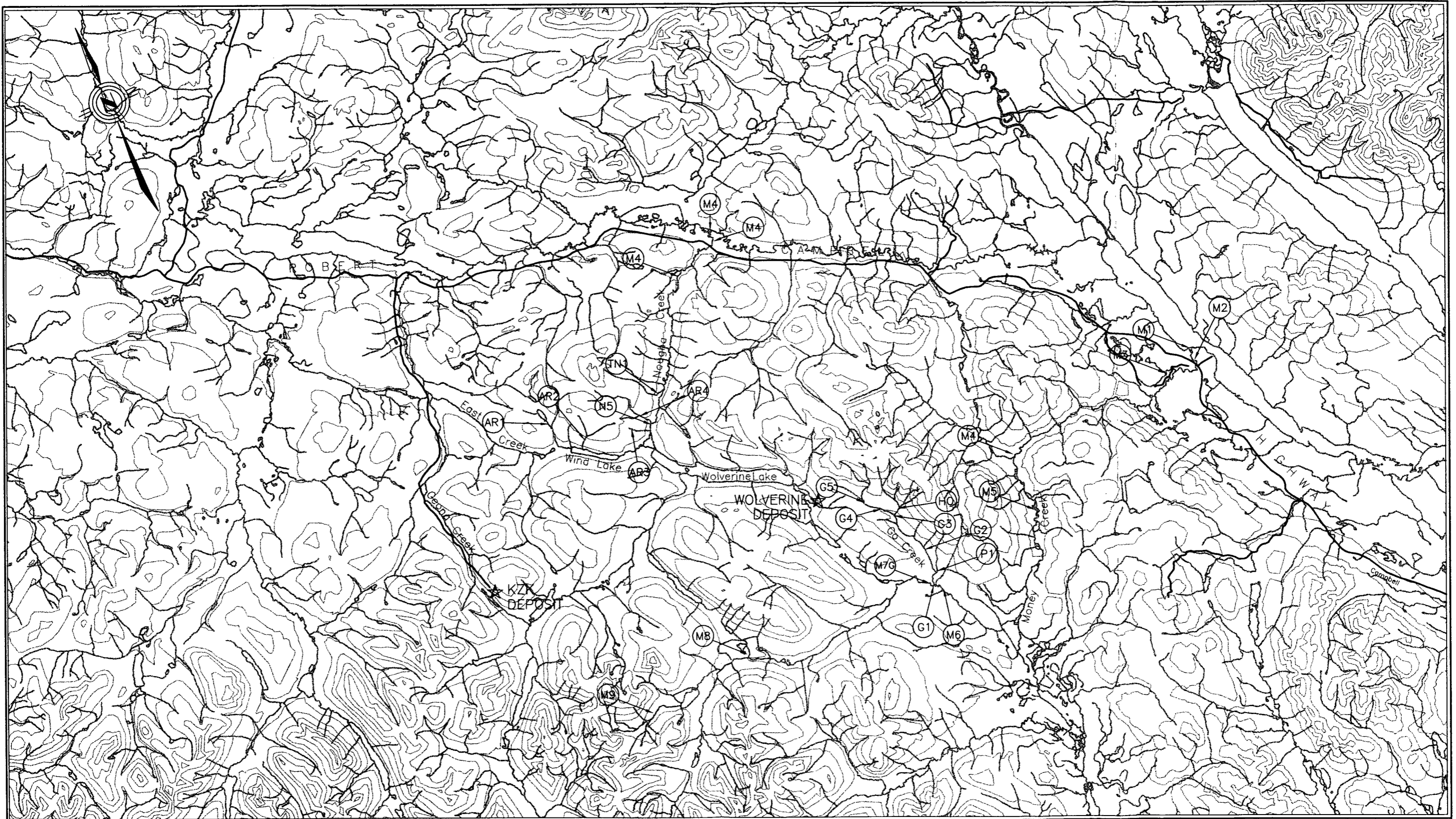
EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
LOCATIONS AND TITLES OF LAKE TRIBUTARIES, INLETS AND OUTLETS			
SAMPLED DURING THE FISHERIES INVESTIGATION - WOLVERINE AREA			
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.		
SCALE: 1:40,000	DATE: 11/14/00	FILE:	FIN-3_73

FIG. 3.73

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.74
Length-Frequency Data for Lake Trout in Lakes in the Wolverine Area






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 Resources Ltd.

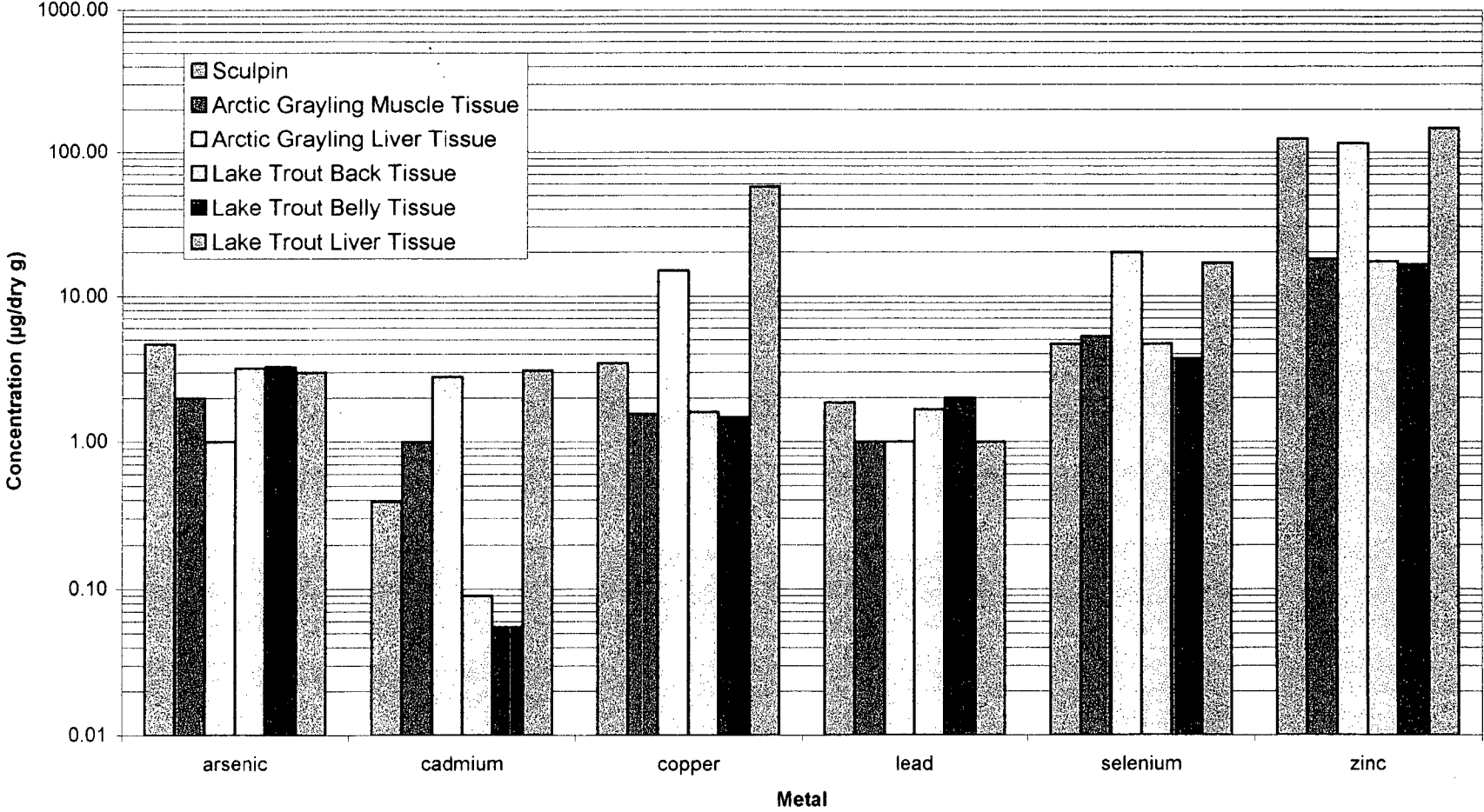
LEGEND: (I) → CREEK SAMPLE SITES

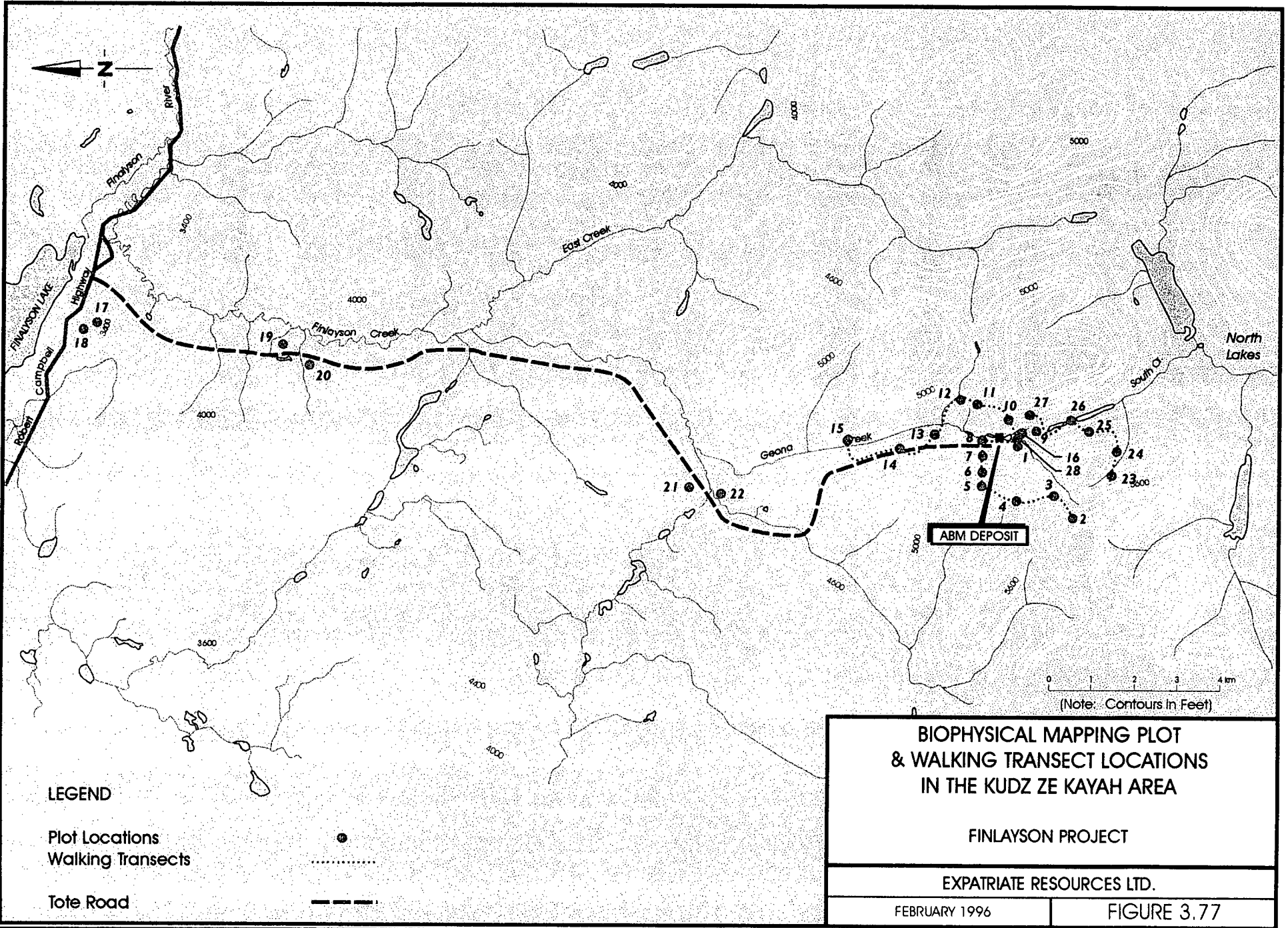
EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
LOCATIONS AND TITLES OF CREEK SAMPLING SITES			
WOLVERINE FISHERIES INVESTIGATIONS			
PREPARED BY:		ACCESS MINING CONSULTANTS LTD.	
SCALE: 1:250,000	DATE: 11/14/00	FILE:	FIN-3_75

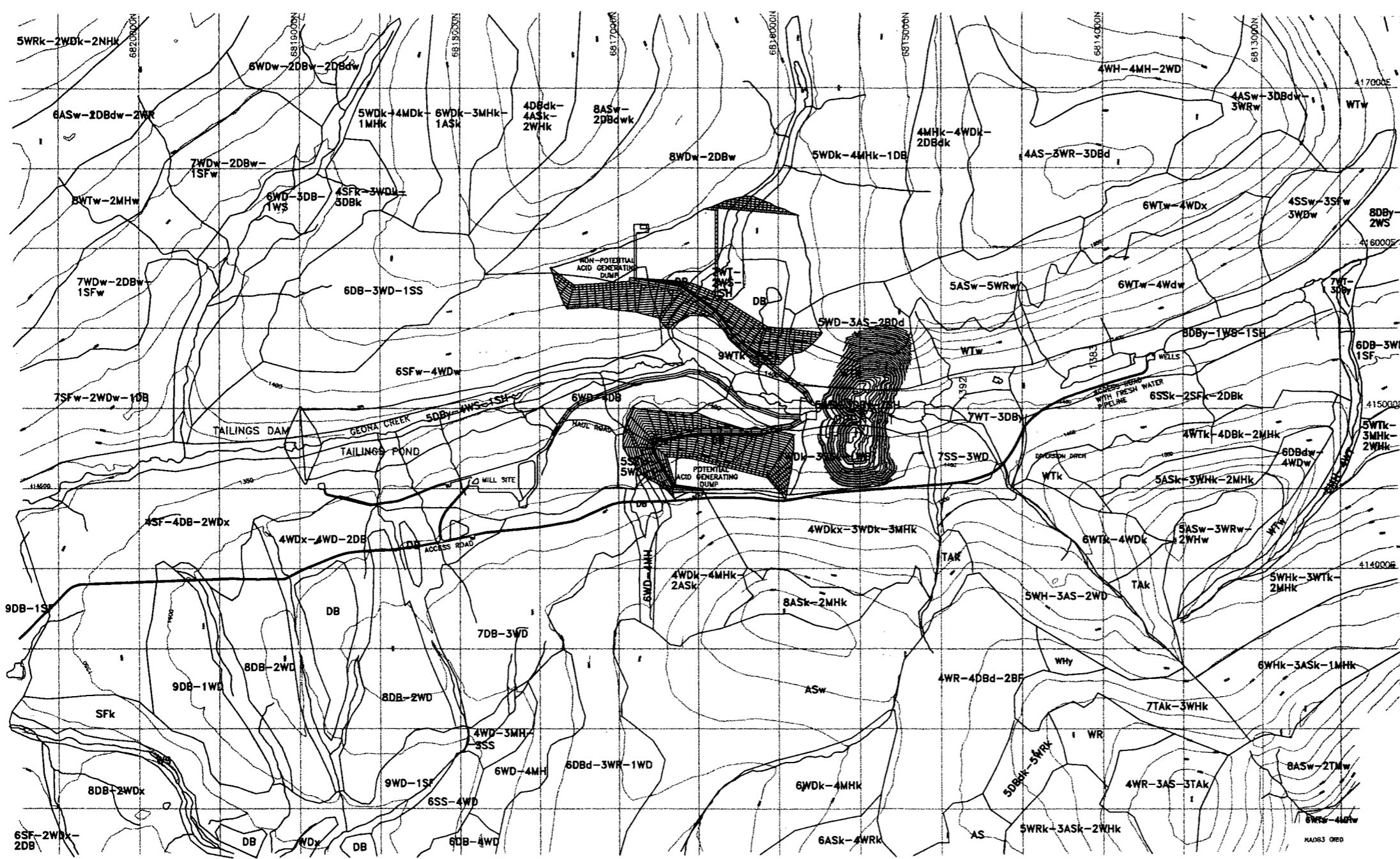
FIG. 3.75

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Figure 3.76
Metals in Fish Tissue - Wolverine Area

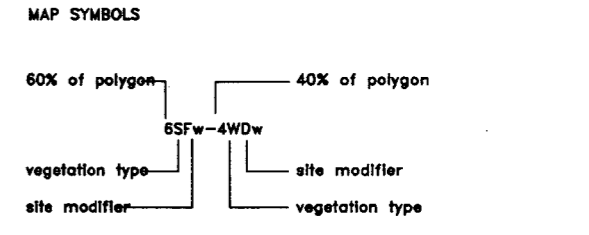






- VEGETATION TYPES**
- TM Trembling Aspen Forest
 - SF Open Canopy Subalpine Fir Forest
 - BSp Open Canopy Black Spruce Forest: mineral soil
 - PC Open Canopy White Spruce Forest: organic soil
 - DB Dwarf Birch Tall Shrub: herb poor, moss rich
 - DBy Dwarf Birch Tall Shrub: wet phase
 - WT Willow Tall Shrub
 - WS Willow Tall Shrub: wetland (riparian)
 - WD Willow - Dwarf Birch Tall Shrub: herb rich
 - WDx Willow - Dwarf Birch Tall Shrub: dry, herb poor
 - DBd Dwarf Birch Dwarf Shrub
 - WH Willow Dwarf Shrub
 - WHy Will Dwarf Shrub: wet
 - SS Subalpine Fir Tall Shrub
 - AS Alpine Dwarf Shrub (misc.)
 - WR Dry Wood-rush herb
 - SH Wet Sedge Herb: lowland (riparian)
 - MH Mesic Mixed Herb
 - BF Blockfield
 - TA Talus/Rock
 - RO Rock

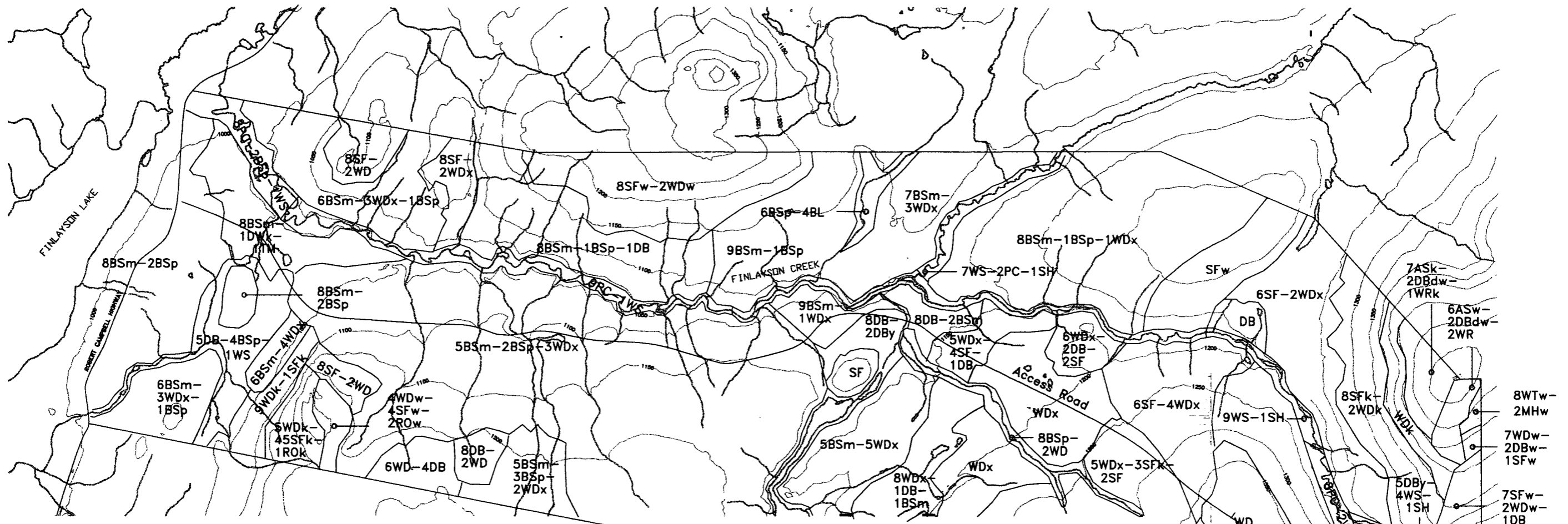
- MODIFIERS**
- k cool aspect (slopes >25%, aspect 285 to 135 degrees)
 - w warm aspect (slopes >25%, aspect 135 to 285 degrees)
 - x drier phase
 - y wetter phase



SCALE 1:30 000
metres
0 260 520 780 1040

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY
 1996 BASELINE BIOPHYSICAL SURVEY PROGRAM
 VEGETATION MAPPING IN THE VICINITY OF THE PROPOSED
 KUDZ ZE KAYAH OPERATIONS
 PREPARED BY: NORECOL, DAMES & MOORE INC.
 SCALE: 1:30,000 | DATE: 11/14/00 | FILE: FIN-3_78 | FIG.3.78





VEGETATION TYPES

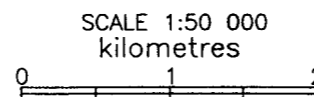
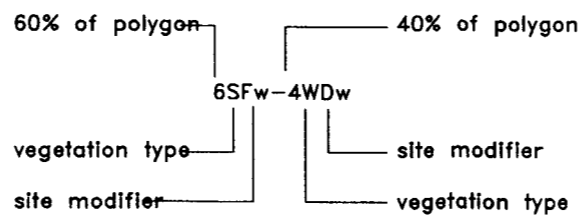
- TM Trembling Aspen Forest
- SF Open Canopy Subalpine Fir Forest
- BSp Open Canopy Black Spruce Forest: mineral soil
- BSp Open Canopy Black Spruce Forest: organic soil
- PC Open Canopy White Spruce Forest
- DB Dwarf Birch Tall Shrub: herb poor, moss rich
- DBy Dwarf Birch Tall Shrub: wet phase
- WT Willow Tall Shrub
- WS Willow Tall Shrub: wetland (riparian)

- WD Willow - Dwarf Birch Tall Shrub: herb rich
- WDx Willow - Dwarf Birch Tall Shrub: dry, herb poor
- DBd Dwarf Birch Dwarf Shrub
- WH Willow Dwarf Shrub
- WHy Will Dwarf Shrub: wet
- SS Subalpine Fir Tall Shrub
- AS Alpine Dwarf Shrub (misc.)
- WR Dry Wood rush herb
- SH Wet Sedge Herb: lowland (riparian)
- MH Mesic Mixed Herb
- BF Blockfield
- TA Talus/Rock
- RO Rock

MODIFIERS

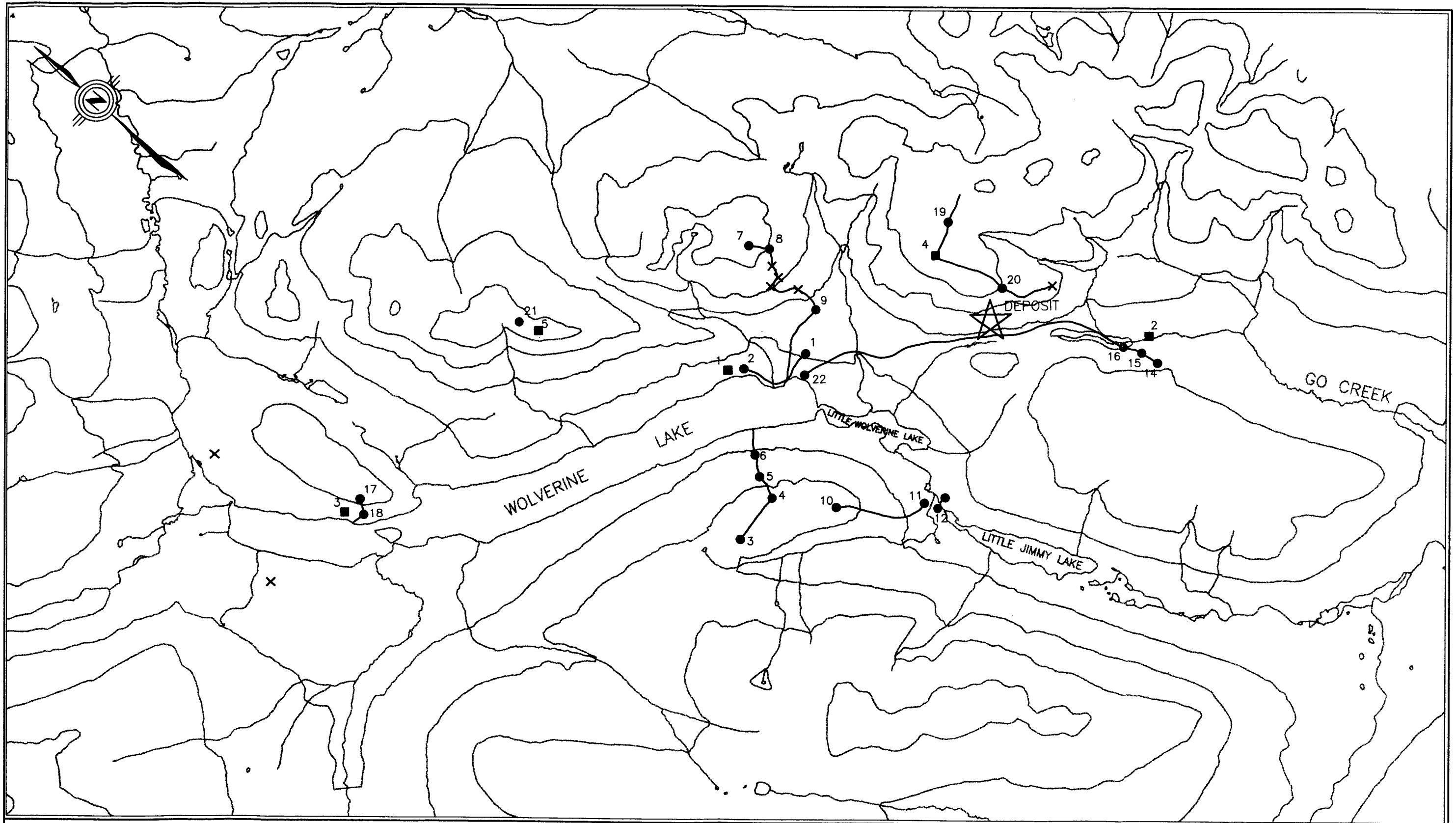
- k cool aspect (slopes >25%, aspect 285 to 135 degrees)
- w warm aspect (slopes >25%, aspect 135 to 285 degrees)
- x drier phase
- y wetter phase

MAP SYMBOLS



EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY
 1996 BASELINE BIOPHYSICAL SURVEY PROGRAM
 VEGETATION MAPPING IN THE VICINITY OF THE TOTE ROAD
 KUDZ ZE KAYAH
 PREPARED BY: NORECOL, DAMES & MOORE INC.
 SCALE: 1:50,000 | DATE: 11/14/00 | FILE: FIN-3_79



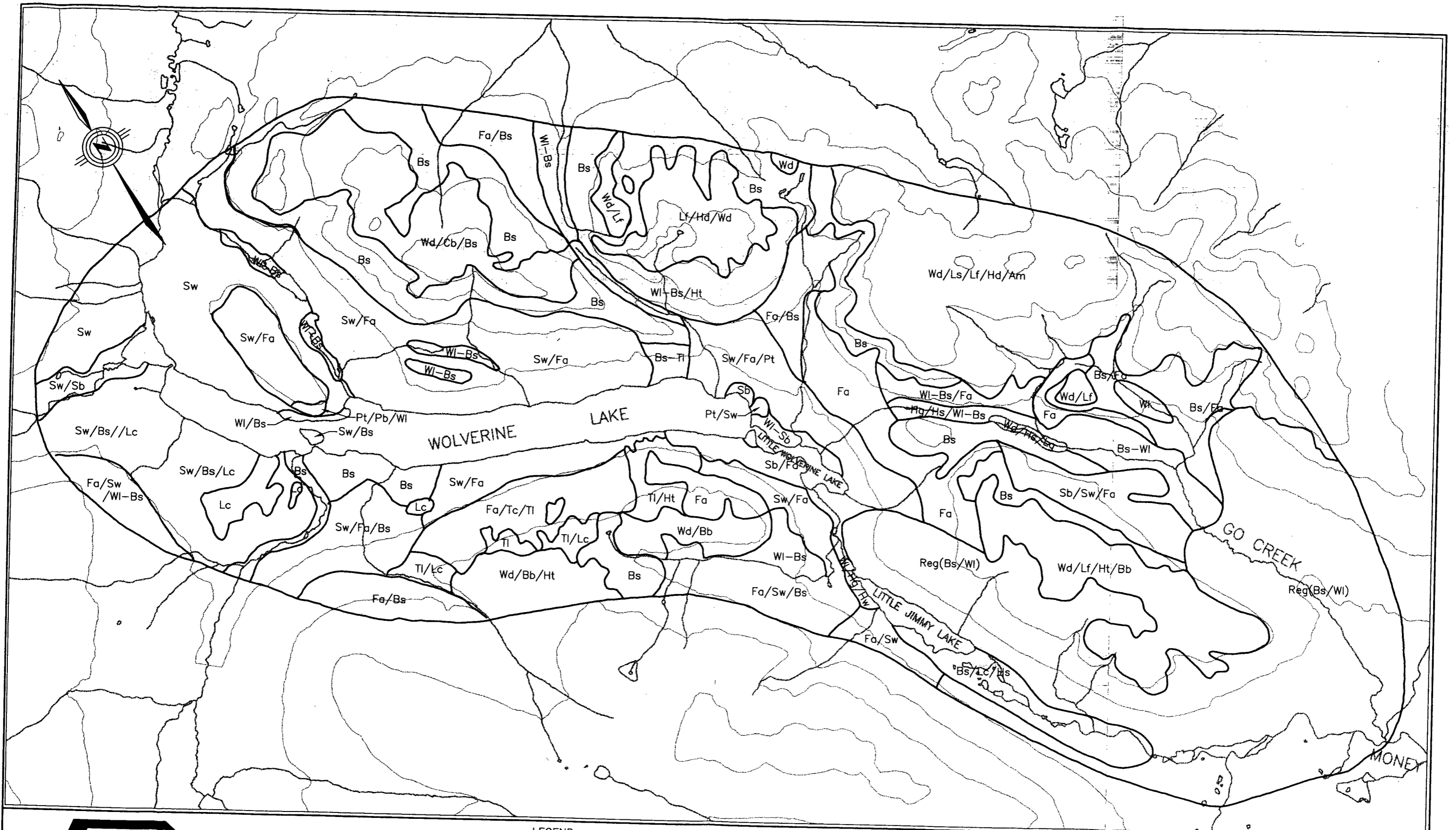



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- LEGEND: X SURVEY SITES (WITH VEGETATION KEYS)
 ■ SAMPLING SITES (WITH METAL ANALYSIS)
 ● VEGETATION SURVEY PLOTS
 --- WALKING TRANSECTS

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM	
VEGETATION SAMPLING PLOTS AND TRANSECT LOCATIONS	
WOLVERINE AREA	
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.
SCALE: 1:60,000	DATE: 11/14/00 FILE: FIN-3_80

FIG. 3.80




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 Resources Ltd.

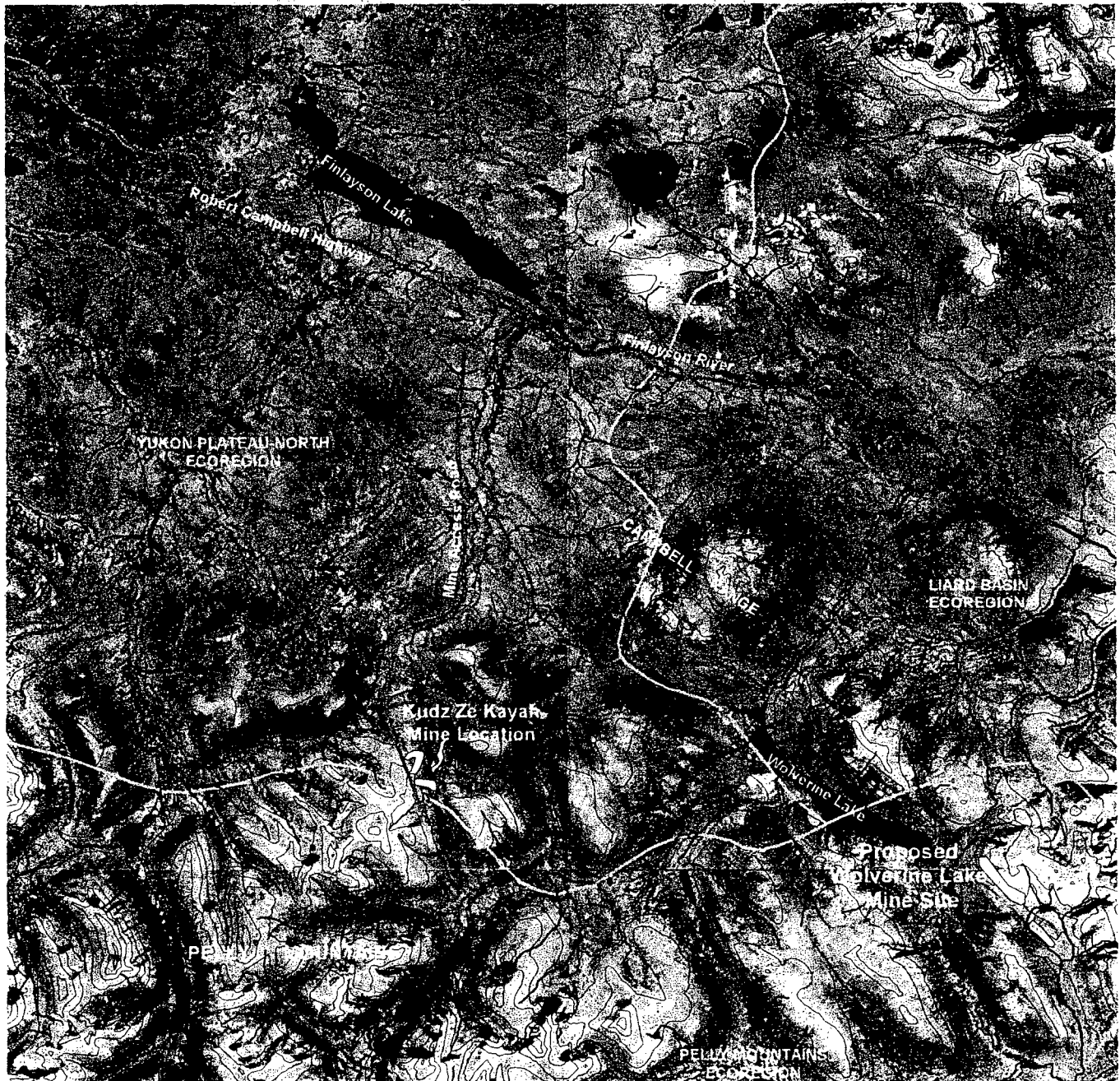
LEGEND:

Sw	White Spruce	Bs-Tl	Shrub Birch - Labrador Tea	Am	Mountain Aven
Sb	Black Spruce	Wl	Willow(Low)	Hs	Sedge Herb
Fa	Alpine Fir	Wl-Bs	Willow - Shrub Birch	Hg	Grass Herb
Pt	Trembling Aspen	Wd	Willow(Dwarf)	Hm	Mesic Mixed Herb
Pb	Balsam Poplar	Bb	Alpine Bearberry	Hw	Wet Mixed Herb
Bs	Shrub Birch	Cb	Lowbush Cranberry	Ls	Crustose - Fruticose lichen
Tl	Labrador Tea	Ht	White Heather	Lf	Cetraria - Alectoria - Fruticose Lichen
Lc	Cladina Lichen	Reg	Regeneration (Following 1994 Fire)		

EXPATRIATE RESOURCES LIMITED WOLVERINE LAKE PROPERTY
 1996 BASELINE BIOPHYSICAL SURVEY PROGRAM
 REGIONAL VEGETATION COMMUNITIES
 WOLVERINE AREA
 PREPARED BY: ACCESS MINING CONSULTANTS LTD.
 SCALE: 1:60,000 DATE: 11/14/00 FILE: FIN-3_81

FIG. 3.81

Finlayson Project: Ecoregions



DATA SOURCES:

Kudz Ze Kayah Mine location, access road and vegetation mapping based on 1996 Environmental Assessment Report. Proposed Wolverine Lake mine site and vegetation mapping based on 1996 Baseline Biophysical Survey Program report.

Ecoregions developed by 1995 Ecological Stratification Working Group as part of "A National Ecological Framework for Canada" by Agriculture and Agri-Food Canada at 1:1,000,000

Finlayson Lake Area Spot Panchromatic over Landsat TM Bands 731. Satellite image produced by Resource GIS and Imaging (RGI) at 1:100,000. Landsat TM image from September 14, 1985 and Spot image from July 23, 1994.

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at 1:250,000. Reproduced under license from Her Majesty the Queen in Right of Canada, with permission of Natural Resources Canada.



Scale 1:200,000
Projection: UTM NAD27, Zone 9

4 0 4 8 Kilometers

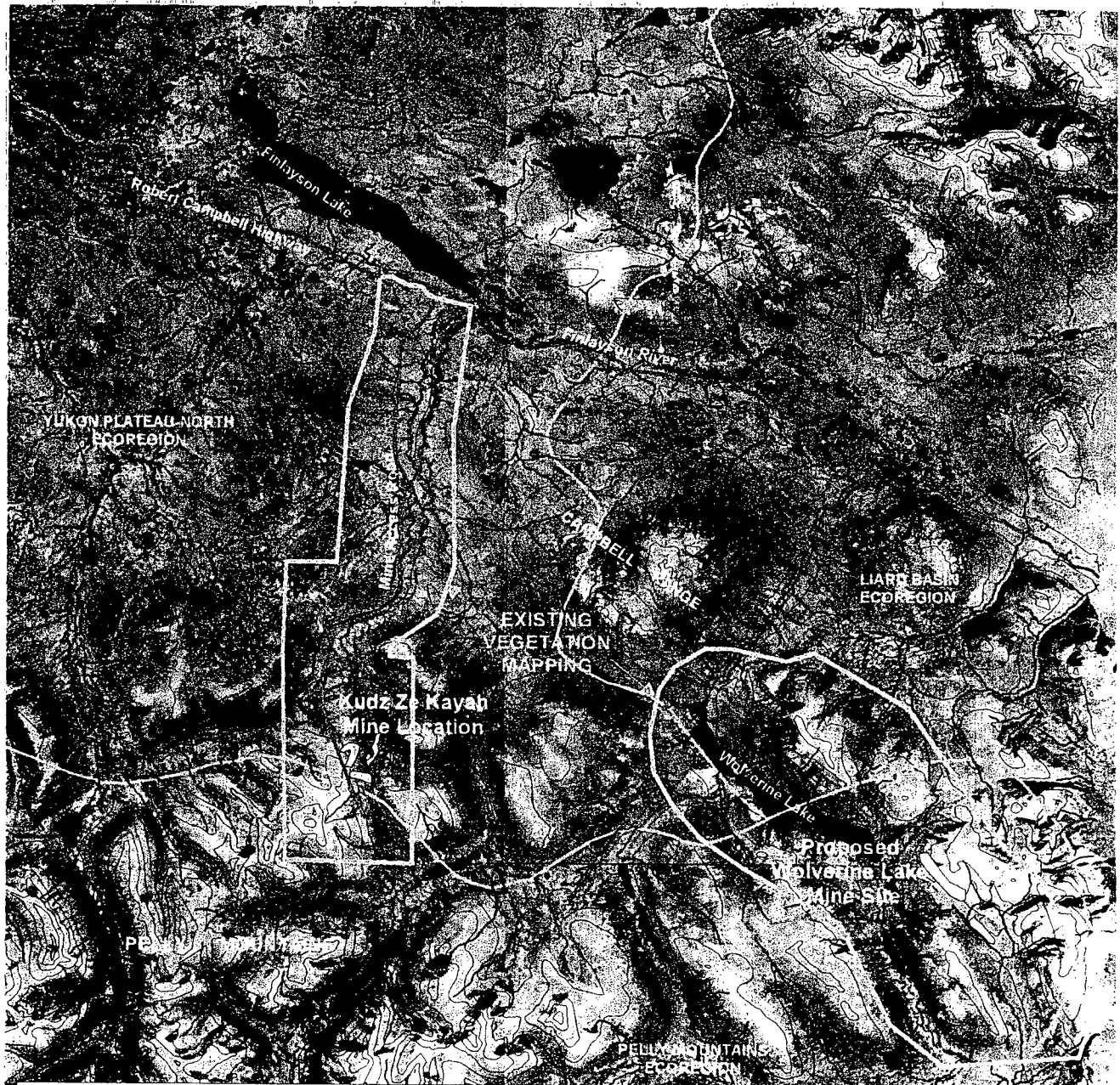
Map Compiled By:
N. Steffen and N. Guy
Applied Ecosystem Management Ltd
www.AEMLtd.ca

10 November 2000



Figure 3.82

Finlayson Project: Extent of Vegetation Mapping



DATA SOURCES:

Kudz Ze Kayah Mine location, access road and vegetation mapping based on 1996 Environmental Assessment Report. Proposed Wolverine Lake mine site and vegetation mapping based on 1996 Baseline Biophysical Survey Program report.

Ecoregions developed by 1995 Ecological Stratification Working Group as part of "A National Ecological Framework for Canada" by Agriculture and Agri-Food Canada at 1:1,000,000

Finlayson Lake Area Spot Panchromatic over Landsat TM Bands 731. Satellite image produced by Resource GIS and Imaging (RGI) at 1:100,000. Landsat TM image from September 14, 1985 and Spot image from July 23, 1994.

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at 1:250,000. Reproduced under license from Her Majesty the Queen in Right of Canada, with permission of Natural Resources Canada



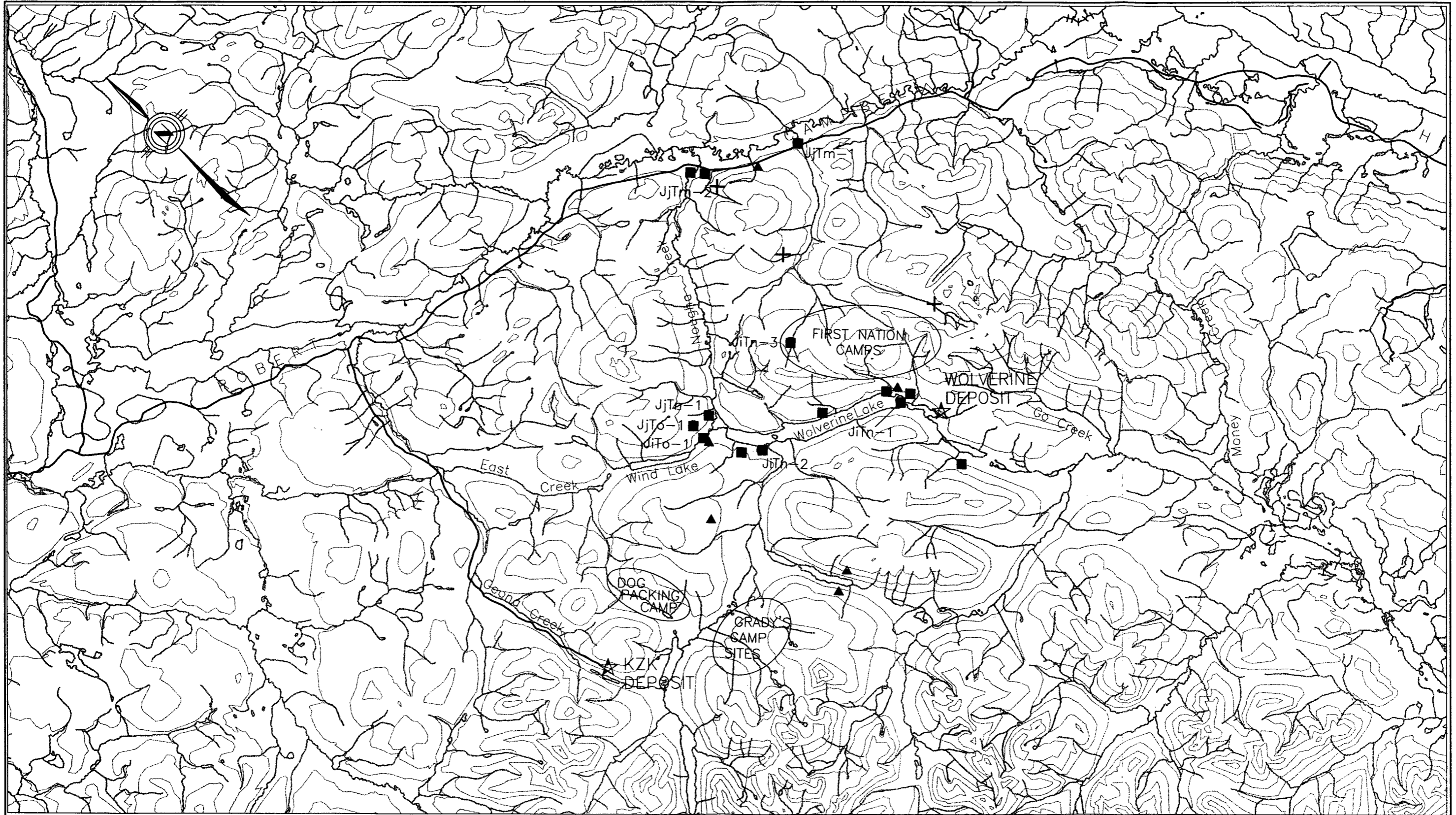
Scale 1:200,000
Projection: UTM NAD27, Zone 9
4 0 4 8 Kilometers

Map Compiled By:
N. Steffen and N. Guy
Applied Ecosystem Management Ltd
www.AEMLtd.ca

10 November 2000



Figure 3.83

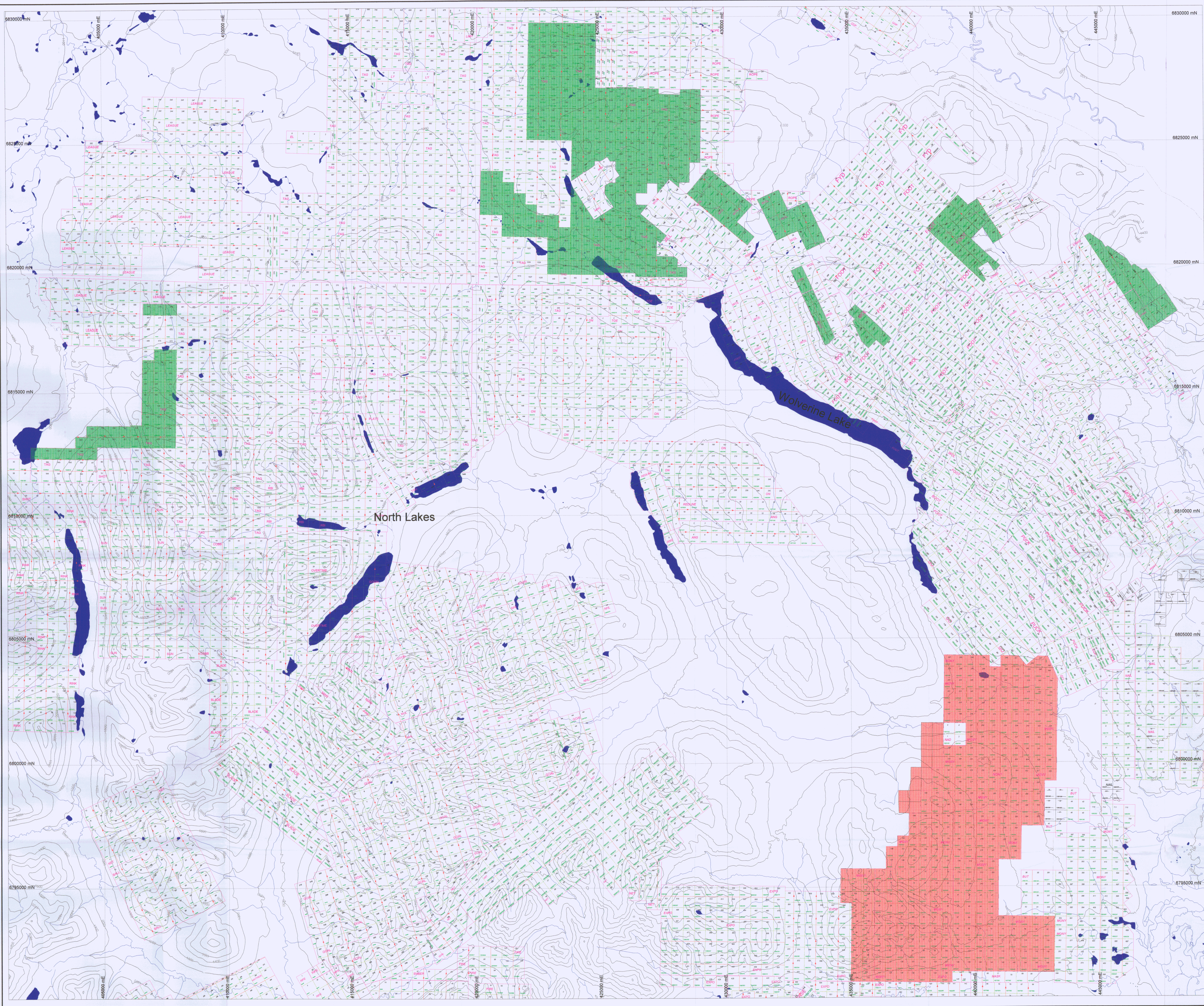



 Expatriate
 Resources Ltd.

LEGEND: ▲ CAMP SITE
 ■ CABIN
 + GRAVE SITE

EXPATRIATE RESOURCES LIMITED		WOLVERINE LAKE PROPERTY	
1996 BASELINE BIOPHYSICAL SURVEY PROGRAM			
ARCHAEOLOGICAL SITES IN THE WOLVERINE AREA			
PREPARED BY:	ACCESS MINING CONSULTANTS LTD.		
SCALE: 1:250,000	DATE: 11/14/00	FILE:	FIN-3_84

FIG. 3.84



094236

- Legend**
- Area One Claims
 - Area Two Claims

Expatriate Resources Ltd.

Fig. 1
 Date: 23/03/2011
 Author: R. Duncan
 Office: Vancouver

**Finlayson Project
 Description Report**

Scale: 1:50,000 Projection: UTM Zone 9 (NAD 27 for Canada)
 Scale: 1:50,000

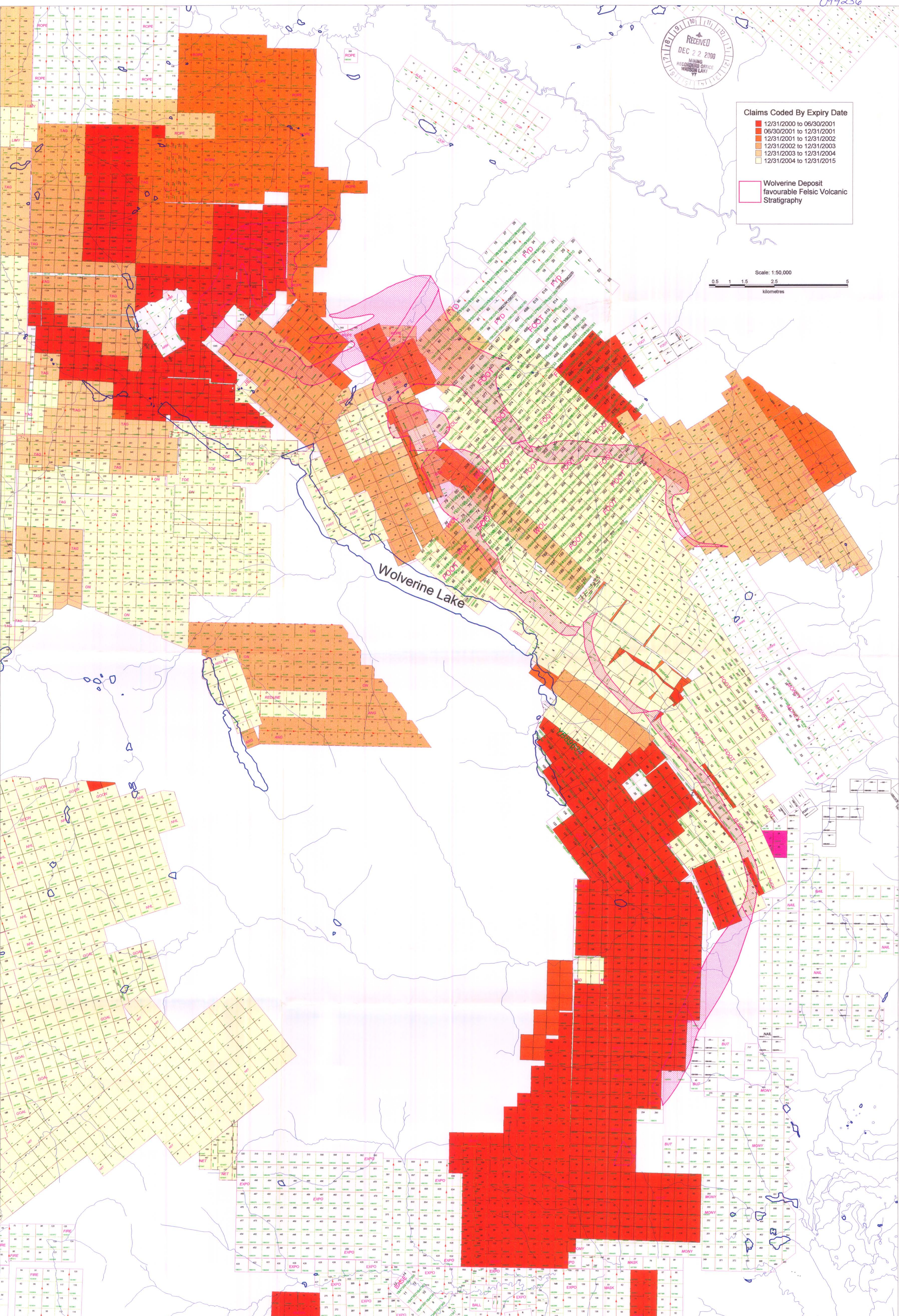
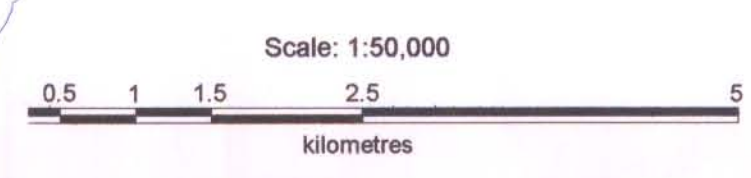
0 0.5 1 1.5 2.5 5
 Kilometres



Claims Coded By Expiry Date

- 12/31/2000 to 06/30/2001
- 06/30/2001 to 12/31/2001
- 12/31/2001 to 12/31/2002
- 12/31/2002 to 12/31/2003
- 12/31/2003 to 12/31/2004
- 12/31/2004 to 12/31/2015

Wolverine Deposit favourable Felsic Volcanic Stratigraphy



FINLAYSON



PROJECT DESCRIPTION REPORT

APPENDICES

November 2000

094236

**APPENDIX 1A
SUMMARY OF INFORMATION PRESENTED
IN THIS REPORT; INDICATION OF NEW INFORMATION
AND PREVIOUSLY REVIEWED INFORMATION**



094236

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

Section	Title	Comment
1	Introduction	A general introduction to: <ul style="list-style-type: none"> • project proponent; • project history; • regulatory context; and • project and assessment scope Information not previously presented during previous project consultation and review.
2	Project Description	
2.1	Wolverine	Information not previously presented during previous project consultation and review.
2.2	Ore Haul Road	Information not previously presented during previous project consultation and review.
2.3	Kudz Ze Kayah	
2.3.1	Exploration and Data Collection	Summarized from previously presented data.
2.3.2	Ore Outline and Block Model Development	Minor updates to the Kudz Ze Kayah Project as proposed by Cominco in their Water Licence Application.
2.3.3	Resource and Reserve Summary and Classification	Minor updates to the Kudz Ze Kayah Project as proposed by Cominco in their Water Licence Application..
2.3.4	Mine Ore Reserves and Open Pit Design	Minor updates to ore reserves. No change to open pit design.
2.3.5	Production Plan	No change from Kudz Ze Kayah Water Licence Application.
2.3.6	Description of Operation	No change from Kudz Ze Kayah Water Licence Application.
2.3.7	Process	Process updated to allow larger throughput. Flotation process follows flowsheet prepared by Cominco for the Kudz Ze Kayah Project.
2.3.8	Infrastructure	As presented in the Kudz Ze Kayah Water Licence Application.
2.3.8.3	Fuel Supply and Storage	Updated to reflect the larger power requirements.
2.3.8.4	Fresh Water Distribution and Fire Protection	No change from Kudz Ze Kayah Water Licence Application.
2.3.8.5	Communications	No change from Kudz Ze Kayah Water Licence Application.
2.3.8.6	Ancillary Buildings	No change from Kudz Ze Kayah Water Licence Application.
2.3.9	Power Generation	Updated to reflect the larger power requirements.
2.3.9.1	Site Access	No change from Kudz Ze Kayah Water Licence Application.

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

2.3.10	Manpower Requirement	Minor updates to reflect changes in mill staffing
2.3.11	Concentrate Shipping	No change from Kudz Ze Kayah Water Licence Application.
2.4	Wolverine - Waste and Water Management	Information not previously presented during consultation or review process.
2.5	Kudz Ze Kayah- Waste and Water Management	Waste and Water Management plans are the same as presented in the Kudz Ze Kayah Water Licence Application. There has been a minor modification to the volume of WPAG waste rock expected from the operations. This section is a summary of waste and water management plans presented in the Kudz Ze Kayah Water Licence Application. Management plans for solid wastes are based on the "Solid Waste Management Plan" presented to the YTWB in October, 2000.
2.6	Reclamation and Closure Plans	Reclamation and closure plans for the Finlayson Project are the same as proposed in the Kudz Ze Kayah Water Licence Application for the area of the Kudz Ze Kayah operations and the Kudz Ze Kayah access road. Closure plans at Wolverine operations and ore haul road have not been presented during previous consultations or review process.
2.7	Project Opportunities	Presents opportunities for project optimization under consideration by the Company. Not presented during previous consultations or review process.
2.8	Project Schedule	Schedule considered for development of the Finlayson Project. Information not presented during previous consultations or review.

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

3	Environmental and Socioeconomic Conditions	
3.1	Physical Environment	
3.1.1	Climate	Regional analysis summarized from Kudz Ze Kayah Water Licence Application. Information not presented during previous consultation or review process includes: <ul style="list-style-type: none"> • 1996 data from Kudz Ze Kayah weather stations; and • Data from Wolverine weather station
3.1.2	Geology	
3.1.2.1	Regional Geology	Summarized from Kudz Ze Kayah reports (IEE and Water Licence Application) and expanded with geology reports developed by Expatriate Resources.
3.1.2.2	Kudz Ze Kayah Geology	Summarized from Kudz Ze Kayah Water Licence Application.
3.1.2.3	Wolverine Geology	Not presented in previous consultations or review process.
3.1.3	Physiography	Summarized from Kudz Ze Kayah Water Licence Application and expanded with information developed for the Wolverine Project. Some information not reviewed during previous consultations and review.
3.1.4	Soils and Surficial Geology	
3.1.4.1	Kudz Ze Kayah	Presented in Kudz Ze Kayah Water Licence Application.
3.1.4.2	Wolverine	Has not been previously presented during consultations or the review process.
3.1.5	Water Resources	
3.1.5.1	Surface Hydrology	Regional analysis summarized from Kudz Ze Kayah Water Licence Application. Site data from Kudz Ze Kayah summarized from Water Licence Application. Site data from Wolverine has not been presented during previous consultation or review process.
3.1.5.2	Limnology	Summary of lake studies conducted at Wolverine. Not previously presented during consultation or review process.

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

3.1.5.3	Hydrogeology	Hydrogeology information from Kudz Ze Kayah, summarized from the Water Licence Application. <i>Wolverine hydrogeology information has not been presented during previous consultation or review process.</i>
3.1.5.4	Surface Water Quality	Summary of water quality data from Kudz Ze Kayah summarized from the Water Licence Application. <i>Surface water quality from Wolverine; has not previously presented during consultation or review process.</i>
3.1.5.5	Groundwater Quality	Groundwater quality from Kudz Ze Kayah summarized from the Water Licence Application. <i>Groundwater quality from Wolverine; has not previously presented during consultation or review process.</i>
3.1.5.6	Sediments	Sediment quality data summarized from Kudz Ze Kayah Water Licence Application. <i>Sediment quality for Wolverine, not previously presented during consultation or review process.</i>
3.2	Biological Environment	
3.2.1	Aquatic Environment and Fisheries Resources	Aquatic environment and fisheries information summarized from Kudz Ze Kayah Water Licence Application. <i>Aquatic environment and fisheries information from Wolverine that has not previously been presented during consultation or review process.</i>
3.2.2	Vegetation	Vegetation information summarized from Kudz Ze Kayah Water Licence Application. <i>Vegetation information from Wolverine that has not previously been presented during consultation or review process.</i>
3.2.3	Ecosystems and Wildlife	Summary of wildlife and ecosystem information from the Finlayson area, based on information gathered for the Kudz Ze Kayah and Wolverine Projects. <i>Partially based on information not previously presented during consultation or review process.</i>

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

3.3	Heritage Resources	Heritage resources and archaeology information summarized from Kudz Ze Kayah Water Licence Application. Heritage resources information from Wolverine that has not previously been presented during consultation or review process.
3.4	Socioeconomic Conditions	Social and economic conditions in local communities. Updated the Kudz Ze Kayah Water Licence Application write-up with recent information. Not previously presented during consultation or review process.
3.5	Valuable Ecological and Cultural Components (VECC)	VECC's selected based on the Kudz Ze Kayah review process and comments from stakeholders and reviewers.
3.6	Additional Studies and Analysis	Additional studies proposed for completion of the Finlayson Project Environmental Assessment Report. Not previously presented during consultation or review process.
4	Environmental Effects Assessment	
4.1	Assessment Process	Description of environmental assessment process proposed for the Finlayson Project. Not previously presented during consultation or review process.
4.2	Cumulative Environmental Effects	Description of approach to cumulative effects assessment for the Finlayson Project. Not previously presented during consultation or review process.
4.3	Environmental Health and Safety and Accidents and Malfunctions	Description of approach to assessing the environmental effects of accidents and malfunctions and potential mitigation. Not previously presented during consultation or review process.
4.4	Follow-up Programs	Discussion of development guidelines for follow-up programs. Not previously presented during consultation or review process.
4.5	Preliminary Environmental Assessment and Potential Mitigation Measures	
4.5.1	Air Quality	Qualitative description of potential air quality effects from the project. Not previously presented during consultation or review process.

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

4.5.2	Topography and Landscape Appearance	Qualitative description of effects to landscape from the project. Not previously presented during consultation or review process.
4.5.3	Hydrogeology	Qualitative description of potential effects to hydrogeology from the project. Not previously presented during consultation or review process.
4.5.4	Groundwater Quality	Qualitative description of potential effects to groundwater quality from the project. Not previously presented during consultation or review process.
4.5.5	Surface Hydrology	Qualitative description of potential effects to surface hydrology from the project. Not previously presented during consultation or review process.
4.4.6	Surface Water Quality	Description of water quality effects from the project. Summary water quality modelling results presented in the Kudz Ze Kayah Water Licence Application.
4.4.7	Aquatic Resources	Description of potential effects to aquatic resources; summarized from the Kudz Ze Kayah Water Licence Application.
4.5.8	Vegetation	Description of effects to vegetation from the project. The Kudz Ze Kayah IEE did not directly consider effects to vegetation. Not previously presented during consultation or review process.
4.5.9	Wildlife	
4.5.9.1	Kudz Ze Kayah	Description of effects to wildlife from Kudz Ze Kayah and access road, summarized from the Kudz Ze Kayah Water Licence Application.
4.5.9.2	Wolverine Operations and Ore Haul Route	Qualitative description of potential effects from the Wolverine operations and ore haul route; not previously presented in consultation or review process.
4.5.10	Socio-economic Conditions	Description of potential socio-economic effects from the project. Summarized from the Kudz Ze Kayah Water Licence Application, updated with new information from the Finlayson Project Prefeasibility study. Not previously presented during

APPENDIX 1A - SUMMARY OF INFORMATION PRESENTED IN THIS REPORT;
INDICATION OF NEW INFORMATION AND PREVIOUSLY REVIEWED INFORMATION

		consultation or review process.
4.5.11	Heritage Resources	Summary of potential effects to heritage resources. Kudz Ze Kayah summarized from the Water Licence Application. Potential effects to Heritage Resources at Wolverine; not presented during previous consultation or review process.
4.5.12	Land Use	Summarized from the Kudz Ze Kayah Water Licence Application
4.5.13	Human Health	There are no potential effects to human health directly related to the project.
5	Public Consultation	
5.1	Kudz Ze Kayah, 1994-98	Summary of consultation activities carried out for the Kudz Ze Kayah Project during CEAA screening and Water Licence Application. Expanded from the Kudz Ze Kayah CEAA Screening Report
5.2	Wolverine 1996-97	Summary of consultation activities carried out for the Wolverine Project. Not previously presented during consultation or review process.
5.3	Finlayson, 2000	Consultation plans for the Finlayson Project. Not previously presented during consultation or review process.

APPENDIX 1B

**PERMITS AND AGREEMENTS PERTAINING TO THE
KUDZ ZE KAYAH PROJECT**

YUKON TERRITORY WATER BOARD

Pursuant to the Yukon Waters Act and Regulations, the Yukon Territory Water Board hereby grants a Type A Water Use Licence for a quartz mining undertaking to:

Cominco Ltd.
500 - 200 Burrard Street
Vancouver, British Columbia V6C 3L7

LICENCE NUMBER: QZ97-026

LICENCE TYPE: A

UNDERTAKING: QUARTZ MINING

WATER SOURCE: Geona Creek

QUANTITY OF WATER: 7,400 m³ per day

EFFECTIVE DATE: The date upon which the signature of the Minister of Indian and Northern Affairs Canada is affixed

EXPIRY DATE: September 28, 2018

This Licence shall be subject to the restrictions and conditions contained herein and to the restrictions and conditions contained in the Yukon Waters Act and the Regulations made thereunder. Where there is a discrepancy between the application and the terms of this Licence, the terms of this Licence shall prevail.

Dated this 17 day of

YUKON TERRITORY WATER BOARD

December, 1998

[Signature]
Witness

Ron W. Johnson
Ron Johnson, Chairperson

Dated this 2nd day of

November, 1999.
A. Wheeler
Witness

[Signature]
Minister of Indian and Northern
Affairs Canada

TERMS AND CONDITIONS OF WATER USE LICENCE QZ97-026

PART A - GENERAL CONDITIONS

1. Definitions

- (a) "Act" means Yukon Waters Act and any amendments thereto.
- (b) "Regulations" means the Regulations made under the Act.
- (c) "Board" means the Yukon Territory Water Board.
- (d) "Application" and "Water Use Application" mean Water Use Application QZ97-026, including any additional submissions and/or revisions, submitted to the Board by the Licensee.
- (e) "Deleterious Substance" means deleterious substance as defined in Section 34(1) of the Fisheries Act.
- (f) "Strongly Potentially Acid Generating (SPAG)" means material which has an AP (acid potential) $>2.9\%$ sulphur or an NP (neutralization potential) $<18\text{kg/t CaCO}_3$.
- (g) "Weakly Potentially Acid Generating (WPAG)" means material that has an AP $<2.9\%$ sulphur and an NP $>18\text{ kg/t CaCO}_3$ and an NP/AP ratio <1.7 .
- (h) "Potentially Acid Consuming (PAC)" means material which is not SPAG and which has an NP/AP ratio >1.7 .
- (i) "Surrogate Analysis " means a site-specific Acid-Base Accounting analytical procedure using ICP analysis for calcium and magnesium and XRF analysis for sulphur.
- (j) "Commencement of Construction" means the time at which existing vegetation is first removed or the natural ground surface is first disturbed, whichever comes first, as a part of the construction activities for any particular portion of the project.
- (k) "Mill Start Up Date " means the time at which the mill first processes ore from the mine.
- (l) "Active Working Zone" means an above-water area no larger than $4,000\text{ m}^2$ in contiguous areal extent in which SPAG material is being actively deposited into the tailings impoundment.
- (m) "Temporary Closure" means any closure, except Permanent Closure, within the term of this licence.
- (n) "Permanent Closure" means a closure which results in the relocation of WPAG waste rock into the mine pit.

Representations, Warranties and Undertakings

2. The Board has relied on the representations, warranties and undertakings provided by the applicant in the material filed as Application QZ97-026. Such representations, warranties and undertakings are considered by the Board to be a part of the licence, but shall be subject to, and may be modified by the terms and conditions of the licence.

Other Laws

3. No term of this licence limits the application of any other Federal, Territorial or First Nation Law.

Correspondence

4. Where any direction, notice, order, or report under this licence is required to be in writing, it shall be given:

(a) To the Licensee, if left at, faxed to, or mailed by registered mail to the following address:

Cominco Ltd.
500-200 Burrard Street
Vancouver, British Columbia V6C 3L7
Fax: (604) 685-3019

and shall be deemed to have been given to the Licensee on the day it was left or faxed, or seven (7) days after the day it was mailed, as the case may be.

(b) To the Board, if left at, faxed to, or sent by registered mail to the following address:

Yukon Territory Water Board
Suite 106, 419 Range Road
Whitehorse, Yukon Y1A 3V1
Fax: (867) 668-3628

and shall be deemed to have been given to the Board on the day it was left or faxed, or seven (7) days after the day it was mailed, as the case may be.

Fees

5. The Licensee shall pay the water use fees prescribed in the Regulations annually, in advance, on the anniversary of the issuance of this licence.

Non-Compliance

6. In the event that the Licensee fails to comply with any provision or condition of this licence, the Board may, with the approval of the Minister and subject to the Act, cancel the licence.

Waste Discharge Standards

7. This licence is issued to the Licensee, subject to the conditions contained herein, with respect to the use or return of water, or the depositing or permitting the deposit of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposit of such waste may enter any waters. However, it is also a condition of granting of this licence to the Licensee that, whenever future Regulations are made by the Governor in Council under the Yukon Waters Act, or any other statute imposing conditions relating to the quantity and types of waste that may be deposited that are more stringent than any conditions included in this licence, this licence shall be deemed, upon prescription of such Regulations, to be automatically amended to conform with such Regulations.

Deleterious Substances

8. Subject to the provisions of this licence, deleterious substances shall be used, transported, stored and disposed of in such a manner that they are not deposited in, or allowed to be deposited in, any waters.

Reports

9. Unless otherwise specified in this licence, all reports shall be submitted to the Board in an unbound form that is reproducible by standard photocopier and shall be accompanied by five (5) copies.
10. All monitoring data and reports shall be submitted in printed form and on computer diskette in an IBM compatible format using commonly available software.

Annual Reports

11. The Licensee shall submit annual reports to the Board. The initial report shall be from the effective date of this licence to December 31, 1999 and shall be submitted to the Board on or before February 28, 2000. Subsequent reports shall be from January 1 to December 31 of each calendar year and shall be submitted to the Board on or before February 28 of the year following the year reported.

12. Annual Reports shall include the information required by this licence and by the Regulations, including, but not necessarily limited to:
- (a) all water quantities used during the year with a summary and an interpretation of any trends or variations in the data; and
 - (b) summaries of all data generated as a result of the monitoring requirements of this licence, including analysis and interpretation of the summaries by a qualified individual or firm and a discussion of any variances from base line conditions, or from anticipated conditions, or from previous years' data; and
 - (c) results of annual inspections of the physical structures associated with the project, including a detailed record of any major maintenance work carried out on any structure, or facility, or any other aspect of the works on the property which may have an impact on water; and
 - (d) an updated Closure Status Report that includes a discussion of planned future operations; and
 - (e) any other reports which are required by this licence or by the Regulations.

Spills and Unauthorized Discharges

13. The Licensee shall immediately contact the 24-hour Yukon Spill Report telephone number (867) 667-7244, should a spill or an unauthorized discharge occur. A detailed written report on any such event, including but not limited to, dates, quantities, parameters, causes and other relevant details and explanations, shall be submitted to the Board not later than fifteen (15) days after its occurrence.

Hazardous Materials Storage

14. The Licensee shall maintain a complete inventory of chemicals, oils and other hazardous materials, including but not limited to mill process reagents, fuels and lubricants, explosives and ore concentrates, and their locations. A current spill contingency plan suitable for each material shall be developed and submitted to the Board before the mill start up date.

Term of Licence

15. The term of this licence is for the period from the effective date to September 28, 2018.

PART B - SECURITY

16. The Licensee shall provide security in the total amount of twenty-four million and nine hundred thousand dollars (\$24,900,000).
17. The schedule for payment of security shall be as follows:
 - (a) \$220,000. (two hundred and twenty thousand dollars) within thirty days of the effective date of this licence;
 - (b) \$3,000,000. (three million dollars) within one year of the commencement of construction of the mill or the beginning of the stripping of the ore body, whichever comes first;
 - (c) \$6,000,000. (six million dollars) within thirty days of the mill start up date;
 - (d) \$13,000,000. (thirteen million dollars) to be paid in twenty quarterly installments of \$650,000. (six hundred and fifty thousand dollars). The first payment shall be made on or before the first day of the quarter beginning no later than three months after the mill start up date and subsequent payments shall be made quarterly thereafter;
 - (e) \$1,200,000. (one million two hundred thousand dollars) to be paid in the fourth and fifth years after the mill start up date in quarterly installments of \$150,000. (one hundred and fifty thousand dollars). The first payment shall be made on or before the first day of the quarter beginning no later than three months after the fourth anniversary of the mill start up date and subsequent payments shall be made quarterly thereafter;
 - (f) \$1,100,000. (one million one hundred thousand dollars) to be paid in the sixth year after the mill start up date in quarterly installments of \$275,000. (two hundred and seventy thousand dollars). The first payment shall be made on or before the first day of the quarter beginning no later than three months after the sixth anniversary of the mill start up date and subsequent payments shall be made quarterly thereafter;
 - (g) \$380,000. (three hundred and eighty thousand dollars) to be paid in the seventh year after the mill start up date in quarterly installments of \$95,000. (ninety five thousand dollars). The first payment shall be made on or before the first day of the quarter beginning within three months after the seventh anniversary of the mill start up date and subsequent payments shall be made quarterly thereafter; and
 - (h) for the purposes of the above payments, quarters shall be considered to begin on January 1, April 1, July 1, and October 1 of any year.

18. The Licensee shall inform the Board, in writing, of the commencement of construction or of the commencement of stripping and of the Mill Start Up Date, within thirty days of the commencement of any of these activities.
19. The security required by this licence shall be calculated and paid in Canadian Dollars indexed from the Mill Start Up Date.
20. On the 1st day of the 27th month following the Mill Start Up Date, and every 2 years thereafter (the "Adjustment Date"), the security and required payments shall be adjusted by applying the Bank of Canada Gross Domestic Product At Market Value ("GDP Market Value") index prevailing for the previous quarterly period (the "Adjusted Security") and "Adjusted payments").
21. On the Adjustment Date, the Licensee shall pay an amount equal to the difference between the Adjusted Payments and the total of all payments made by the Licensee from the Mill Start Up Date to the Adjustment Date.
22. The form of security required by this licence shall be in accordance with the requirements of the Regulations.

PART C - DESIGN AND CONSTRUCTION

23. The design of all structures and facilities associated with the project shall be carried out using sound engineering practices and shall be completed by a Professional Engineer licenced to practice in Yukon.
24. All instream earthworks, diversions, ditches, spillways and any other water related structures, except the tailings dam and spillway, shall be designed and constructed to accommodate the peak instantaneous 200-year return period flood.
25. The Licensee shall submit to the Board final detailed design drawings, construction plans and specifications for all proposed structures and facilities associated with the project at least 90 (ninety) days prior to the proposed date of commencement of construction of each proposed structure or facility. Structures and facilities shall include, but not be limited to, waste rock dumps, dams, coffer dams, impoundments, drainage works, diversions, spillways, waste storage facilities, water supply systems, wastewater transportation systems, wastewater treatment facilities, and any other structure or facility relevant to the conditions of this licence or to the Regulations. All drawings and specifications submitted to the Board shall be sealed by a Professional Engineer licenced to practice in Yukon.

26. All construction shall be carried out in accordance with the designs and drawings submitted to the Board except that, should the Board notify the Licensee prior to the date of commencement of construction that a public hearing will be held to review the design, then the Licensee shall not proceed with construction of that structure or facility until such time as the public hearing has been convened and the Board has concluded deliberations.
27. The Licensee shall notify the Board, in advance, of the details of any modifications or variations from the designs previously submitted. The notice shall include an explanation of the reasons for the change and an assessment of the potential impact.
28. At least 20 (twenty) days prior to the proposed date of commencement of construction of any structure or facility, the Licensee shall submit to the Board a written notification, together with a detailed construction schedule and the name and contact number(s) of the construction superintendent.
29. The Licensee shall submit final as-constructed (record) drawings of all structures and facilities within 90 (ninety) days of completion. The drawings shall be submitted as transparencies which are reproducible by standard photocopier and shall be accompanied by five (5) copies. All drawings shall be sealed by a Professional Engineer licenced to practice in Yukon.

Tailings Dam

30. The Licensee shall submit to the Board, at least 90 (ninety) days prior to the proposed date of commencement of construction, a Tailings Dam Final Design Report that details the results of a foundation investigation program completed in accordance with the requirements of the Construction Quality Assurance/Quality Control Manual that was included as exhibit 1.5.15 of the Application. The report shall provide data from the foundation investigation together with details of required foundation remediation programs, and final design details for the tailings dam based on the results of the investigation.
31. The tailings dam shall be designed and constructed in such a manner as to provide:
 - (a) sufficient storage for all SPAG waste rock, tailings and sludge with a minimum of 2 metres of water cover;
 - (b) sufficient storage to accommodate all flows during the non-discharge period of 01 October to 30 April; and
 - (c) adequate wastewater retention time to meet the effluent quality standards of this licence.

32. The tailings dam shall be designed to have a minimum factor of safety under static conditions of 1.66 in the centre section and 1.30 in the west abutment section; and under the Maximum Credible Earthquake, 1.25 for the centre section and 1.10 for the west abutment section.
33. The tailings dam spillway shall be designed to accommodate the Maximum Probable Flood.
34. The Licensee shall not place SPAG material in the tailings dam embankment. The Licensee shall not place WPAG material in the tailings dam embankment, except in the upstream face such that it will remain no less than two metres below the design water level elevation for that particular raise of the dam.
35. The Licensee shall incorporate a temporary frost protection cap into each raise of the tailings dam embankment and a permanent frost protection cap into the final raise. Each temporary frost protection cap shall be removed immediately prior to the construction of the subsequent raise of the dam. The Licensee shall submit to the Board details of the frost protection caps at least 90 (ninety) days prior to the proposed date of commencement of construction.

PAC Waste Rock Dump

36. The Licensee shall carry out a foundation investigation program for the PAC waste rock dump site as proposed in the PAC Waste Dump Design Criteria and Stability Analyses document (Exhibit 1.5.2 of the Application) and the Construction Quality Assurance/Quality Control Manual (Exhibit 1.5.15 of the Application). The objective of the investigation shall be to identify and delineate materials that are acceptable as foundation for the PAC waste rock dump.
37. The Licensee shall submit to the Board, at least 90 (ninety) days prior to the proposed date of commencement of construction, a PAC Dump Design Report which details:
 - (a) the results of the foundation investigation program;
 - (b) details of any actions proposed to be taken to remediate unacceptable foundation conditions;
 - (c) confirmation that the foundation conditions for the proposed dump are acceptable either without or after remediation; and
 - (d) final designs incorporating any design modifications resulting from the foundation investigation.

38. The PAC waste rock dump shall be designed and constructed such that:
- (a) a minimum 50 metre horizontal setback is maintained between the toe of the dump and the edge of Geona Creek, after a 150 m section of the creek is straightened;
 - (b) the surface of the dump is no steeper than 3H:1V; and
 - (c) the dump will be stable when subjected to the Maximum Credible Earthquake.
39. The Licensee shall design and construct a flow-through drain along the existing ephemeral stream channel beneath the PAC waste rock dump site. The Licensee shall submit design details of the drain at least 90 (ninety) days prior to the proposed date of commencement of construction.

PART D - OPERATION

40. During the term of this licence, including any period of temporary closure, the Licensee shall maintain all works on the property in good order in accordance with sound engineering and environmental practices.

Water Use and Storage

41. The Licensee is hereby authorised to :
- (a) store the entire flow of Geona Creek behind a tailings dam and to withdraw water at a maximum rate of 6,300 m³/day;
 - (b) withdraw water from wells located between the two South Lakes at a maximum rate of 1,100 m³/day;
 - (c) use said water for quartz mining undertakings and for camp use;
 - (d) construct a tailings impoundment on Geona Creek, as described in the Water Use Application and subject to this licence, and to store water within that facility; and
 - (e) construct a polishing pond on Geona Creek, as described in the Water Use Application and subject to this licence, and to store water within that facility.

Diversion

42. The Licensee is hereby authorised to:

- (a) temporarily divert Geona Creek during construction of a tailings dam trench as described in the Water Use Application;
- (b) divert Fault Creek and Pit Creek flows to the South Lakes watershed during the operating life of the project and to return the flows to the Geona Creek watershed upon permanent closure of the project;
- (c) divert water collected in sumps located immediately adjacent to and/or in the mine pit to the tailings impoundment located on Geona Creek; and
- (d) divert water collected in the West Ditch as described in the Water Use Application.

Dewatering

43. The Licensee is hereby authorized to:

- (a) dewater the Geona Lakes by pumping water out of the lakes into Geona Creek;
- (b) dewater overburden and bedrock in the mine pit area during construction and discharge the water to Geona Creek; and
- (c) dewater the tailings dam trench excavation and discharge the water to Geona Creek.

Waste Deposit

44. The Licensee is hereby authorised to:

- (a) discharge mill wastewater into the tailings impoundment located on Geona Creek as indicated in the Water Use Application;
- (b) discharge treated domestic wastewater into the tailings impoundment;
- (c) deposit sludge removed from the domestic wastewater treatment facility into containment pits located adjacent to the tailings impoundment;
- (d) discharge sludge removed from sumps located immediately adjacent to and/or in the mine pit to the tailings impoundment, subject to the Licensee ensuring that the sludge is deposited at least 2 metres under the water surface of the impoundment;

- (e) discharge water from the tailings impoundment, via a polishing pond, into Geona Creek between 01 May and 30 September at a rate which provides a minimum dilution ratio of 3:1 (minimum flow at KZ15 over the preceding week:the discharge at KZ8); and
- (f) discharge surface water runoff and groundwater from solid waste disposal site(s), subject to any water whose quality is impacted or potentially impacted by the solid waste disposal being directed to the tailings impoundment.

Wastewater Treatment

- 45. The Licensee shall design, construct, operate and maintain wastewater treatment facilities to meet the requirements of this licence.
- 46. The Licensee shall design, construct, operate and maintain a pilot wetland polishing treatment project generally as described in the Water Use Application and subject to the following:
 - (a) the pilot project shall evaluate the speciation of metals, sulphur and selenium as a function of redox potential, sulphate and organic content;
 - (b) operation of the pilot project shall commence no later than one year after the first placement of tailings into the tailings impoundment;
 - (c) the Licensee shall submit details of the proposed pilot project to the Board at least 90 (ninety) days prior to the proposed date of commencement of construction and shall advise the Board of the proposed date of commencement of operation of the pilot project; and
 - (d) the Licensee shall submit to the Board a report documenting, analysing and evaluating the results of the pilot project no later than four (4) years after commencement of operation of the pilot project.

Waste Rock Identification and Segregation

- 47. The Licensee shall characterize and segregate SPAG, WPAG and PAC waste rock according to the procedures described in the Operation Quality Assurance/Quality Control Manual (Exhibit 1.5.16 of the Application).
- 48. Identification of SPAG waste rock may be made by visual assessment.
- 49. PAC and WPAG waste rock shall be identified by the shift geologist on the basis of pre-blast

modelling of rock zones and surrogate acid-base accounting analysis of drill cuttings as described in the Operation Quality Assurance/Quality Control Manual (Exhibit 1.5.16 of the Application).

50. Sampling to confirm modelling for PAC and WPAG waste rock shall be completed on no less than 10% of all drill holes and no less than 5 holes per blast in areas where pre-blast modelling has identified non-acid generating rock. Sampling for segregation purposes shall be completed on no less than every third row of north-south blast holes in areas where modelling is not adequate to define rock types or where WPAG material is present.
51. The Licensee shall summarise and submit to the Board monthly the results of all waste rock characterization and testing work.
52. The Licensee shall carry out no less than 1 conventional Acid-Base Accounting (ABA) test for every 100 surrogate tests for the purpose of confirming the ABA correlation factors used for waste rock segregation by the surrogate analysis. The results of this confirmation testing shall be submitted in the annual report.
53. The Licensee shall maintain waste rock haul records for the purposes of tracking the types, quantities and disposal locations of waste rock. The records shall be specific and shall document the source of the waste rock, the type of waste rock, the date hauled, the volume hauled, and the location of placement in the applicable waste rock dump. The records shall be tied to the analytical test results. The Licensee shall submit the records to the Board on a monthly basis.
54. The Licensee shall exercise diligence in segregating waste rock so as to ensure that no more than 1% of the SPAG material is placed into the WPAG waste dump and no more than 12% of the WPAG material is placed into the PAC waste dump. The Licensee shall do all things necessary to meet this requirement, including removing and relocating misplaced waste rock.

SPAG Waste Rock Disposal

55. Except as otherwise authorized by this section of this licence, the Licensee shall at all times maintain a minimum of two (2) metres of water cover over the upper surface of all SPAG material, tailings material and sludges in the tailings impoundment. *how do you place this material*
56. Within an Active Working Zone, as defined in this licence, nominal amounts of SPAG material may remain with less than two (2) metres of water cover for a period of no more than six (6) months from the time of original deposition of the oldest-placed material within the Active Working Zone. For the purposes of this clause, no more than two (2) Active Working Zones may exist concurrently. *ok - holes*

Detailed Spill Contingency and Emergency Response Plan

57. The Licensee shall prepare and submit to the Board not later than six (6) months prior to the date of any Commencement of Construction, a Detailed Spill Contingency and Emergency Response Plan

which in general conformance with the draft plan contained in Exhibit 1.4.2 of the Application.

58. The Licensee shall revise and resubmit the Detailed Spill Contingency and Emergency Response Plan to the Board within thirty (30) days of the effective date of any applicable new or revised regulatory requirements.
59. The first Detailed Spill Contingency and Emergency Response Plan submitted to the Board, and each revised plan, shall be accompanied by a report identifying the differences from the draft plan or previous plan, as the case may be.

PART E - EFFLUENT QUALITY STANDARDS

60. All effluent, including dewatering flows, that is discharged from the project during construction, operation, temporary closure or after permanent closure shall meet the following effluent quality criteria at all points of compliance: *— does this mean at end of pipe or @ discharge point*

PARAMETER	MAXIMUM ALLOWABLE LIMIT
Suspended Solids	15 mg/l
pH	6.5 - 9.0
Oil & Grease	none visible
BOD	45 mg/l
Faecal Coliforms	600 counts per 100 ml
Arsenic (dissolved)	50 µg/l
Copper (total)	15 µg/l
Cadmium (total)	7 µg/l
Lead (total)	26 µg/l
Selenium (total)	15 µg/l
Zinc (total)	110 µg/l
CN (total)	50 µg/l
CN (wad)	20 µg/l
Ammonia (as total N)	2500 µg/l

61. All effluent that is discharged from the project, during construction, operation, temporary closure or after permanent closure shall meet the non-toxicity requirement defined by the LT₅₀ rainbow trout

static bioassay, 96 hours at 100%, pH non-adjusted.

62. The points of compliance for effluent discharge standards that are required by this licence, during construction, operation, temporary closure and permanent closure, shall be:
- (a) When there is surface flow from the Polishing Pond, then the points of compliance shall be at both Stations KZ8 and KZ7;
 - (b) When there is no surface flow from the Polishing Pond, then the point of compliance shall be at Station KZ7; and
 - (c) Prior to and during construction of the Tailings Dam, the point of compliance shall be at Station KZ7.

PART F - MONITORING AND SURVEILLANCE

Surveillance Network, Sampling and Analysis

at start of construction

63. (a) The surveillance network, sampling frequencies and analytical requirements of this licence are:

STATION NO.	STATION DESCRIPTION	SAMPLING FREQUENCY	FLOW MONITORING FREQUENCY	ANALYTICAL SUITE ¹
KZ1	South Creek between two headwater lakes	M		A,B
KZ2	Fault Creek at discharge to South Creek headwater lake	M	Q	A,B
KZ3	WPAG dump runoff	M	M	A,B
KZ5	Tailings Impoundment discharge (or tailings impoundment itself if no discharge)	M	M _{level}	A,B
KZ6	PAC dump runoff	M		A,B
KZ7	Geona Creek 100 m downstream of toe of polishing pond embankment ¹	M ²	M ²	A,B,C,D,E
KZ8	Polishing Pond discharge (or pond itself if no discharge)	W/M	W	A,B,C,D ¹ ,E ¹
KZ9	Geona Creek downstream of KZ10 near 61.15 N 180.606667W (decimal degrees)	T		A,B,C
KZ10	Tailings Impoundment seepage	M	M	A,B,C
KZ12	Mine Water Treatment Plant discharge to Tailings impoundment (when flowing)	W _{comp}		A,B
KZ13	Lower South Creek near 61.430667N 130565667W (decimal degrees)	Q	Q	A,B,F
KZ14	North River downstream of South Creek	SP		A,B,F
KZ15	Finlayson Creek 100 m downstream of Geona Creek	W/M	C ⁴	A,B,C,F
KZ16	Finlayson Creek immediately upstream of Geona Creek	M		A,B
KZ17	Geona Creek at mouth	W/M	M	A,B,C,F
KZ21	East Creek at mouth	Q		A,B
KZ22	Finlayson Creek 100 m downstream of East Creek	M	Q	A,B,C,F
KZ26	Finlayson Creek, at Robert Campbell Highway	Q		A,B,C
KZ27	North River below Upper North Lake and upstream of South Lake	SP		A,B
KZGW	Groundwater wells below Tailings Dam	Q	Q _{level}	A,C

(b) Surveillance Network Definitions:

External Suite A: Physical Parameters, ICP Metals Scan - Dissolved Metals, Ammonia, Nitrate, Nitrite

External Suite B: ICP Metals Scan - Total Metals

External Suite C: CN (tot), CN (wad), cyanate, thiocyanate

External Suite D: BOD, coliforms (total and fecal), oil & grease

External Suite E: LT₅₀ static bioassay, 96 hours at 100%, pH non-adjusted

External Suite F: Dissolved Organic Carbon

Physical Parameters: pH, temperature, conductivity, sulphate, alkalinity, acidity, hardness

ICP Metals Scan: All scanned metals/metalloids shall be reported and shall include, but not be limited to all metals/metalloids for which effluent standards are specified in this licence

SP: Water Quality only at same time as sediment program

W = weekly

Q = quarterly

M = monthly

T = every two years

C = continuous

w_{comp}: Weekly composite of daily samples

W/M: weekly while discharging at KZ8, otherwise monthly

M_{TV}: Total volume of effluent treated that month

Level: static water level in impoundment or well instead of flow

(c) Surveillance Network Notes:

1. Prior to construction of the polishing pond, Station KZ 7 is located 100 m downstream of the polishing pond location proposed in the Water Use Application.
 2. Only sampled when no discharge at KZ8
 3. Frequency for this suite at this station = once/month
 4. During the period of April 15 to September 30.
 5. Parameters for which effluent standards apply shall have analytical detection limits not higher than one-tenth of their effluent standard
-
64. The Licensee shall compile data relating to the surveillance network program into a monthly report. The report shall be submitted to the Board within thirty (30) days of the end of each month for which the report is compiled.
 65. Unless otherwise specified in a quality assurance/quality control program, all analyses shall be conducted in accordance with the current edition of "Standard Methods for the Examination of Water and Waste Water", prepared and published jointly by the American Water Works Association and the Water Pollution Control Federation.

66. The Licensee may use an internal lab providing that a quality assurance/quality control program has first been submitted to the Board. The objective of the quality assurance/quality control program shall be to validate data and provide quality assurance.

Physical Monitoring Program

67. The Licensee shall implement and comply with the Physical Monitoring Program described in Appendix 1.

Finlayson Creek Selenium Study

68. The Licensee shall complete a program of studies relating to selenium as described in Appendix 5.2c of Exhibit 1.5.36 of the Water Use Application, and shall submit to the Board not later than four years after the Mill Start Up Date, a report which presents:
- (a) a recommendation for a selenium water quality objective and the rationale; and
 - (b) an assessment of the results of the Finlayson Creek complexing capacity for zinc and copper.

Benthic Invertebrate Monitoring Program

69. The Licensee shall carry out a benthic invertebrate monitoring program every two years during July/August, beginning the first year after the effective date of the licence, as follows:
- (a) three replicate samples shall be taken by a circular Hess sampler (0.0934 m²) or waters and Knapp sampler (0.089 m²) equipped with a 250 µm mesh net;
 - (b) samples shall be preserved with 10% formalin solution and identified to the lowest possible taxon (usually genus) and counted. The company shall provide data analysis with the raw data;
 - (c) stream information collected at the time of benthos collection shall include: velocity, depth, temperature, substrate conditions and riparian conditions;
 - (d) routine water quality sampling shall be carried out during the benthic invertebrate sampling program; and
 - (e) the sampling stations shall be stations KZ9, KZ15, KZ16, KZ17, KZ21, KZ26, and KZ27.

70. The Licensee shall carry out a benthic invertebrate metal tissue program every two years during July/August, beginning the first year after the effective date of the licence, as follows:
- (a) one composite sample shall be collected of sufficient size to allow low detection limits in invertebrate tissues for heavy metals and selenium. Collection equipment shall use artificial substrate, or any other suitable field equipment;
 - (b) samples shall be preserved with 10 % formalin, but no dye shall be used.
 - (c) the sampling locations shall be stations KZ15, KZ16, and KZ26.

Sediment Monitoring Program

71. The Licensee shall carry out a sediment monitoring program every two years during July/August, beginning the first year after the effective date of the licence, as follows:
- (a) sediment shall be collected and analysed as follows:
 - 1. three replicate samples of fine sediment shall be taken from within the active channel of the stream, using an aluminum or Teflon scoop or a glass sampling jar;
 - 2. the samples shall be dried and screened, using sieve sizes at ASTM mesh numbers 10, 20, 40, 60, 100, 140 and 270 (ASTM E11-61), and the fraction weights recorded;
 - 3. a sub-sample, composed of material which passes through the 230 mesh sieve, shall be analysed for metals by a 33 element ICP scan and total organic carbon (TOC);
 - 4. a routine water quality sample shall be taken at the same time as the sediment sampling is carried out.
 - (b) the sediment sampling locations shall be at sites: KZ7, KZ9, KZ15, KZ16, KZ17, KZ21, KZ26, and KZ27.

Fish Monitoring Program

72. The Licensee shall develop and carry out a sculpin fish tissue sampling program addressing heavy metals and selenium.
73. The Licensee shall carry out the sampling every two years during July/August, beginning the first year after the effective date of the licence, at stations KZ15, KZ16 and KZ26 and shall submit the results of the program to the Board in the annual report for the year.

74. The Licensee shall submit a detailed plan for the sampling program to the Board by April 1, 1999.

Tailings Impoundment Groundwater Monitoring Program

75. Not later than three months after commencing construction work on the tailings dam foundation, the Licensee shall submit to the Board a detailed plan for the monitoring of the impact of the tailings impoundment on groundwater quality. The primary objective of the plan shall be the early detection of emerging groundwater impacts. The Licensee shall implement the plan prior to starting the placement of tailings or waste rock or dewatering flows into the impoundment, whichever comes first.

PART G - CLOSURE

Decommissioning and Reclamation Plan

76. The Licensee shall, no later than six (6) months prior to the proposed date of Commencement of Construction of the starter raise of the tailings dam, submit to the Board a Detailed Decommissioning and Reclamation Plan which includes, but is not limited to, detailed plans for the following:

- (a) long-term chemical and physical stability of the site;
- (b) rehandling of the WPAG waste rock into the mine pit;
- (c) re-location of Fault Creek and Pit Creek into the mine pit;
- (d) maintenance of mine pit pH during filling at adequate levels to precipitate metals in place;
- (e) permanent water cover for all potentially acid generating materials;
- (f) maintenance of a water treatment plant at least until the mine pit fills with water;
- (g) water treatment, as necessary, to comply with effluent standards and protect downstream aquatic resources;
- (h) construction of any necessary upgrades to all closure structures, including the frost protection cap for the tailings dam, to ensure that the structures can withstand natural events with a probability of occurrence equal to the Probable Maximum Flood (PMF) and the Maximum Credible Earthquake (MCE), based on data available at the time;

- (i) construction of a permanent spillway into any raise of the tailings dam;
- (j) removal of SPAG waste from the pit walls;
- (k) progressive reclamation during the active mining stage;
- (l) research and monitoring programs to be undertaken in support of reclamation and closure proposals, including research programs to evaluate WPAG chemical stability (acid generation and metal leaching), dump performance, WPAG rehandling water quality implications (soluble metal loading to the pit and expected release rates), and to identify effective revegetation methods; and
- (m) a schedule for ongoing post closure monitoring and maintenance activities after the expiry of this licence.

77. The Licensee shall, either no later than ninety (90) days prior to the proposed date of Commencement of Construction of each raise of the tailings dam, except for the starter raise, or every three years after submission of the first Detailed Decommissioning and Reclamation Plan, whichever comes first, submit to the Board an updated Detailed Decommissioning and Reclamation Plan.

Spillway

78. The Licensee shall, as part of the Detailed Decommissioning and Reclamation Plan, submit a detailed design for the tailings dam spillway, including flow routing downstream of the rockfill apron.

79. The spillway shall be designed to withstand flows from a conservative estimate of the Probable Maximum Flood including flows from the Fault Creek and Pit Creek catchments and flows resulting from a failure of the West Diversion Ditch.

80. The Licensee shall construct the closure spillway concurrently with the third raise of the tailings dam.

Temporary Closure

81. All discharges from the project during Temporary Closure shall comply with the effluent standards specified in Part E of this licence

82. The Licensee shall maintain all treatment and monitoring systems in good repair during any Temporary Closure and shall continue to carry out all monitoring, sampling and reporting as required by this licence.

Permanent Closure

83. The Licensee shall provide a minimum of six (6) months notice to the Board of its intention to implement a Permanent Closure of the project.
84. The Licensee shall implement the then current Detailed Decommissioning and Reclamation Plan as part of the Permanent Closure.
85. In the event that closure occurs before the Detailed Decommissioning and Reclamation Plan is completed, the Licensee shall implement the conceptual plan as described in the Water Use Application.

APPENDIX 1
PHYSICAL MONITORING PROGRAM DURING OPERATIONS

Daily Visual Inspections

1. The Licensee shall conduct daily visual inspections of the Tailings Dam, the WPAG Waste Dump and the PAC Waste Dump.
2. Daily Visual Inspections shall include inspections for cracks, subsidence or other irregularities, sloughing of slopes and abnormal flow or ponding of water.
3. Daily Visual Inspections of the WPAG and PAC Waste Dumps shall include visual inspections for misplaced rock.
4. A summary of the Daily Visual Inspections shall be included as a component of the annual report that is required by this licence.

Weekly Inspections

5. Weekly inspections shall be carried out by qualified personnel in accordance with the following criteria:

Facility	Weekly Inspection Activity
Tailings Dam	Inspect for cracks or subsidence of crest, slope movement, and erosion. Measure and record water level. Inspect for seepage, and measure and record flows, if any.
SPAG	Inspect for required water cover over SPAG rock and record.
Polishing Pond	Inspect dikes and embankments for cracks, subsidence, slope movement and erosion. Measure and record water level. Inspect for seepage, and measure and record flows, if any.
WPAG Waste Dump	Inspect for signs of movement. Inspect for incorrectly placed material.
PAC Waste Dump	Inspect for signs of movement. Inspect for incorrectly placed material.
Fault Creek Dam	Inspect for signs of movement or erosion. Inspect for and remove accumulated debris.
Access Road	Inspect drainage works for proper operation.

- The Licensee shall include a summary of the weekly inspections as a component of the annual report that is required by this Licence.

Quarterly Inspections

- The Licensee shall design and install an instrumentation network for use during operations.
- The instrumentation network shall include, as a minimum, multiple piezometers at various elevations in all dams and dam foundations and at the toe of each waste rock dump, and multiple thermistor strings in all dams and dam foundations.
- Monitoring of the instrumentation shall be carried out quarterly.
- The Licensee shall compile the data from the instrumentation monitoring, and shall submit it to the Board with the annual report, together with information on any actions either taken or recommended based on the results of the monitoring.

Semi-Annual Inspections

- The Licensee shall conduct semi-annual hub surveying of the Open Pit, the Tailings Dam, the WPAG Waste Dump, and the PAC Waste Dump.

Annual Inspections

- The Licensee shall carry out an Annual Inspection before the first day of July of each year that this licence is in effect, in accordance with the following criteria:

Facility	Annual Inspection Activity
Open Pit	Inspect and assess pit wall stability and mining methods.
Tailings Dam	Inspect for cracks or subsidence of crest, slope movement and erosion. Measure and record water level. Inspect for seepage and measure and record flows, if any.
SPAG	Inspect for required water cover over SPAG rock, and record.
Polishing Pond	Inspect dikes and embankments for cracks, subsidence, slope movement and erosion. Measure and record water level. Inspect for seepage, and measure and record flows, if any.
WPAG Waste Dump	Inspect for signs of movement. Inspect for seepage, and measure and record flows, if any.
PAC Waste Dump	Inspect for signs of movement. Inspect for seepage, and measure and record flows, if any.
Fault Creek Dam	Inspect for signs of movement or erosion.
Access Road	Inspect drainage works for proper operation. Inspect and assess performance of erosion protection works.

COPY

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INDIAN AND NORTHERN AFFAIRS / AFFAIRS INDIENNES ET DU NORD

PARCEL IDENTIFIER: 105G07-002

THIS LEASE is made this ^{2nd} day of November, 2000

BETWEEN

Her Majesty the Queen in right of Canada,

hereinafter called "Her Majesty"
OF THE FIRST PART

AND

Cominco Ltd., an extra-territorial company, incorporated under the laws of Canada, with its Head Office located in the City of Vancouver, in the Province of British Columbia,

hereinafter called "the Lessee"
OF THE SECOND PART

WITNESSETH that in consideration of the rents, covenants and agreements herein reserved and contained on the part of the Lessee to be paid, observed and performed, and subject to the TERRITORIAL LANDS ACT and the TERRITORIAL LANDS REGULATIONS, Her Majesty demises and leases unto the Lessee all that parcel(s) or tract(s) of land comprised of 1180 hectares, more or less, on Geona Creek south of Finlayson Lake, in Quad 105 G/07, in the Yukon Territory, as shown outlined in red on the sketch annexed hereto and forming part of this description;

61° 28' N
130° 32' W

hereinafter called "the land" SUBJECT TO the following reservations:

- (a) all mines and of all minerals whether solid, liquid or gaseous which may be found to exist within, upon, or under the land together with the full powers to work the same and for that purpose to enter upon, use and occupy the land or so much thereof and to such an extent as may be necessary for the effectual working and extracting of the said minerals;
- (b) the rights of the recorded holders of mineral claims and any other claims or permits affecting the land;
- (c) all timber that may be on the land;
- (d) the right to enter upon, work and remove any rock outcrop required for public purposes;
- (e) such right or rights of way and of entry as may be required under regulations in force in connection with the construction, maintenance and use of works for the conveyance of water for the use in mining operations; and
- (f) the right to enter upon the land for the purpose of installing and maintaining any public utility.

IN THIS LEASE:

1.0 DEFINITIONS

- 1.1* "Minister" means the Minister of Indian Affairs and Northern Development, and any person authorized to act on his behalf;
- 1.2 "facilities" means all physical structures or appurtenances placed in or upon the land;
- 1.3 "construction" means all manner of disturbance of the natural state of the surface of the land, including the sub-surface and sub-strata;
- 1.4 "Surveyor General" means the Surveyor General as defined in the Canada Lands Surveys Act;
- 1.5 "body of water" means any lake, river, stream, swamp, marsh, channel, gully, coulee or draw that continuously or intermittently contains water;
- 1.6 "mine site" means all buildings and equipment necessary for the extraction of minerals and all other associated facilities;
- 1.11 "Forest Officer" means an officer appointed pursuant to the Yukon Forest Protection Regulations under the Territorial Lands Act.
- 1.12 "Land Agent" means a land agent pursuant to the Territorial Lands Act.

2.0 TERM, RENT AND TAXES

- 2.1* **TO HAVE AND TO HOLD** for and during the term of twenty-one (21) years commencing on the first day of May, 2000;
YIELDING AND PAYING THEREFORE yearly and every year in advance a rental of forty thousand five hundred (\$40,500.00) dollars, or such other rental as may be fixed by the Minister pursuant to Clause 2.5 hereunder.
- 2.2* The Lessee will, during the said term, pay the said rental and all taxes, rates and assessments charged upon the land or upon the Lessee in respect thereof.
- 2.3* Where any portion of the rental herein reserved is unpaid for more than thirty days after it becomes due, whether formally demanded or not, the Minister may, by notice in writing, terminate this lease and on the day following the mailing of the notice, this lease is terminated.

2.4* Termination of this lease will not prejudice Her Majesty's right to unpaid rental or any other right with respect to a breach of any covenant or agreement herein contained.

2.5 The Minister may, not less than three months before the first day of ^{November} May in each of the years 2005, 2010, 2015, and 2020, give to the Lessee notice in writing of a variation in the amount of the rent reserved based on the fair appraised value at the time of such notification, but without taking into account the value of any improvements owned by the Lessee, which shall be payable for the next following period or, if there is no subsequent notification by the Minister, for the balance of the term and at the beginning of such period the Lessee may:

- a) pay the rent reserved as varied by the Minister,
or
- b) vacate the premises and surrender this lease.

3.0 RENEWAL

3.1 Subject to the Lessee having performed and observed all the covenants and conditions on the part of the Lessee to be performed and observed, and upon a renewal being requested by the Lessee, in writing, at least ninety (90) days prior to the date of expiry of this lease, Her Majesty may grant to the Lessee a renewal of this lease for a further term of twenty-one (21) years upon essentially the same terms and conditions as are herein contained except as to rent and this right of renewal.

4.0 OPTION TO PURCHASE

4.1 If the Lessee is not in default of the covenants of this lease, he shall have the option to purchase the said land in accordance with the Regulations at and for the amount to be determined by the Minister.

4.2 Subject to the Lessee exercising the option to purchase as outlined in Clause 4.1, the Lessee will be responsible for all appraisal costs incurred to determine the land sale value.

5.0 USE

5.1* The Lessee will use the said land for industrial mine site purposes only and will not permit the land, or any portion thereof, to be used or occupied for any other purpose.

6.0 SUBLETTING OR ASSIGNMENTS

6.1* The Lessee shall not sublet the land or assign or transfer this lease or any portion thereof without the consent of the Minister in writing, which consent shall not be unreasonably withheld.

6.2 No sublease, assignment or transfer of this lease to any party will receive the consent of the Minister unless lease number 105G07-001 is sublet, assigned or transferred to the same party.

6.6 Where at any time during the term of this lease the Lessee is permitted by Her Majesty to sublet, transfer or assign the leased premises or any part thereof for the remainder or any part of the said term, all conditions and agreements herein will extend to and bind the sub-lessee, transferee, assignee or his executors, administrators or assigns respectively and a breach thereof by any of them has the same effect as against the Lessee as if he had made the breach.

7.0 SECURITY DEPOSITS

7.1 The Minister may, at any time, require that the Lessee deposit with the Minister a security deposit in such amount as may be specified from time to time in the Territorial Lands Act or Regulations.

The security deposit provided by the Lessee must be in the form of:

- (a) a promissory note guaranteed by a chartered bank and payable to the Receiver General for Canada;
- (b) a certified cheque drawn on a chartered bank of Canada and payable to the Receiver General for Canada;
- (c) bearer bonds issued or guaranteed by the Government of Canada;
- (d) a combination of the securities described in paragraphs (a) to (c); or
- (e) any other guaranteed security approved by the Minister.

7.2 Where the Lessee has not complied with all of the terms and conditions of this lease, the Minister may retain such part of the security deposit as required to fulfil the said terms and conditions.

7.3 Where the Minister retains all or part of the said security deposit, the Minister shall use the amount retained to remedy any damage or default, or to carry out any restoration necessary resulting from the Lessee's non-compliance, and shall refund any excess to the Lessee.

7.4 Within one (1) year of the commencement of construction of the facilities authorized herein the Lessee shall provide a reclamation plan as set out hereinafter, including cost estimates, which plan shall be utilized in establishing a reasonable security amount to be deposited with the Minister within two years of the said date of commencement of construction. Said security amount will cover reclamation of those facilities not specifically addressed by the security provisions of the Water Licence QZ97-026 dated December 17, 1998, or any renewal, replacement or amendment to the said Water Licence.

8.0 BREACH

8.1* Where the Lessee breaches or fails to perform or observe any of the covenants, terms, conditions or agreements herein contained, other than the covenant to pay rent, the Minister may so advise the Lessee by written notice and if the Lessee fails to remedy the breach or non-performance within a reasonable time thereafter or within the time granted in the said notice, the Minister may, by notice in writing, terminate this lease and on the day following the mailing of such notice, this lease is cancelled.

8.2* Unless a waiver is given in writing by the Minister, Her Majesty will not be deemed to have waived any breach by the Lessee of any of the covenants or agreements herein contained, and a waiver relates only to the specific breach to which it refers.

8.3* If this lease has been secured by misrepresentation as to any material facts, it may be summarily cancelled by the Minister.

9.0 TERMINATION

9.1* Upon the termination or expiration of this lease, the Lessee shall deliver up possession of the land in a condition satisfactory to the Minister.

9.2* Termination of this lease will not prejudice Her Majesty's right to unpaid rental or any other right with respect to a breach or non-performance of any covenant, term, condition

or agreement herein contained nor will the Lessee be relieved of any obligation contained herein.

- 9.3* On the termination of this lease, the Lessee will sever and remove from the land all structures, fixtures and improvements which, during the said term, were affixed or placed at his expense on the land.
- 9.6 Upon the termination or expiration of this lease, the Lessee shall deliver up possession of the land in a restored condition as prescribed by the latest approved plan of reclamation.
- 9.8 Where the Lessee fails to restore the land as required and within the time allowed by the Regulations or by the Minister, the Minister may order the restoration of all or any part of such land and any expenses thus incurred by the Minister shall be recoverable from the Lessee as a debt due to Her Majesty.
- 9.12 In the event the lessee decides to terminate its operations on the land during the term of this lease, the lessee will provide the Minister with written notice at least six (6) months prior to the date of termination.

10.0 RECLAMATION

10.1 The Lessee shall, within one year of the commencement of construction of the facilities authorized herein, deliver to the Minister for his review and approval a plan of reclamation which, where applicable, shall include but is not limited to the following:

- (a) buildings and other structures;
- (b) roads and airstrips;
- (c) water supply facilities;
- (d) tailings disposal facilities;
- (e) waste rock disposal sites;
- (f) petroleum and chemical storage areas and facilities;
- (g) garbage, sewage and waste storage or disposal sites and facilities;
- (h) pipelines and electrical transmission installations;
- (i) site drainage systems, granular material deposits and open pit areas;
- (j) other facilities or sites utilized during the operation;
- (k) revegetation
- (l) the land generally;

and such plan shall be prepared with the objective of reclaiming the land as near as possible to its original state, including the removal of all improvements, or such alternate objectives as may be approved by the Minister.

- 10.2 The Minister may, at any time during the term of the lease, request the Lessee to review update the approved plan of reclamation and, upon receipt in writing of such a request, the Lessee shall submit to the Minister, for his approval and within the time specified, an updated plan of reclamation.
- 10.3 Within six (6) months of the receipt of any plan from the Lessee including an updated plan of reclamation, the Minister shall notify the Lessee whether or not the plan has been approved.

10.4 Upon the receipt of any plan, including updated or revised plan of reclamation, the Minister may:

- (i) approve the plan submitted;
- (ii) reject the plan or any portion thereof and return the plan to the Lessee for revision, stating the reasons for the rejection; or
- (iii) require the Lessee to include in the plan provisions that, in his opinion, are necessary to meet the objectives in Clause 10.1;

and the Lessee will be advised accordingly in writing.

10.5 Where the Minister notifies the Lessee of the rejection of any plan or any portion thereof, the Lessee shall, within six (6) months of receipt of such notification, deliver to the Minister a revised plan for approval.

10.6 The Lessee shall undertake ongoing reclamation during the term of the lease for any land or improvements which are no longer required for the Lessee's operations on the land.

10.8 Where the Lessee fails to restore the land as required and within the time allowed by the Territorial Lands Regulations or by the Minister, the Minister may order the reclamation of all or any part of such land and any expenses thus incurred by the Minister shall be recoverable from the Lessee as a debt due to Her Majesty.

10.9 When this lease expires or is terminated, the Lessee at its own expense shall within one (1) years thereof remove all buildings, equipment, or appurtenances owned by him that may be on the land and reclaim the land as provided hereinafter. The said one (1) year period is subject to payment of an annual rental at the rate in effect in the year previous to the date the lease expired or was terminated.

11.0 WASTE DISPOSAL

11.1* The Lessee will control the quality of effluent or overflow discharged from the said lands in such a manner as to maintain standards of water quality to the satisfaction of all applicable Acts and Regulations.

11.2* The Lessee shall, prior to installation of any sewage disposal facilities on the said land, make application and receive approval to the designs from Environmental Health Services, Health and Social Services, Yukon Territorial Government.

11.3* The Lessee shall dispose of all combustible garbage and debris by burning in an incinerator approved by the Land Agent and remove all noncombustible garbage and debris to an authorized dumping site.

11.4 The Lessee shall not discharge or deposit any refuse substance or other waste materials in any body of water, or the banks thereof, which will, in the opinion of the Minister, impair the quality of the waters or the natural environment and any areas designated for waste disposal shall not be located within thirty point forty-eight (30.48) metres of the ordinary high water mark of any body of water, unless otherwise authorized by the Minister.

11.5 The Lessee shall collect and dispose of all waste hydrocarbon products, including but not limited to lubricating oils, grease and hydraulic fluids in a manner acceptable to the Minister.

11.6 The Lessee shall remove all scrap metal, discarded machinery and parts, barrels, kegs, buildings and building materials from the land.

12.0 ENVIRONMENTAL

12.1* The Lessee shall at all times keep the land in a condition satisfactory to the Minister.

- 12.2* The Lessee will not light or permit to be lighted any fire without first having obtained, in writing, permission from a Forest Officer, and, if fire occurs on the said land, the Lessee shall forthwith make every effort to extinguish such fire.
- 12.3* The Lessee shall ensure that all activities are conducted in such a manner that mitigate any significant adverse environmental effects.
- 12.7 The Lessee shall not unduly interfere with the natural drainage pattern of the land, except with the permission of the Minister.
- 12.8 In the event that the Lessee is conducting operations which are, in the opinion of the Minister, whose opinion will be reasonably exercised, causing irreparable damage to the environment, the Minister may require that the operations of the Lessee hereunder be suspended and the operations shall be suspended until such time as the situation has been satisfactorily remedied.
- 12.10 The Lessee shall undertake such corrective measures as may be specified by the Minister in the event of any spill on the land, or water or wind erosion of the land, resulting from the Lessee's operations, and shall demonstrate to the satisfaction of the Minister that the Lessee has the ability, including the necessary equipment, to undertake the corrective measures.
- 12.11 If the Lessee, by its operations on the land, has contributed to any detrimental environmental change, the Lessee shall pay its proportionate share of any costs of remedial action which may be considered necessary, as determined by the Minister.
- 12.12 The Lessee will take all reasonable precautions to prevent any fire occurring or spreading on the said land and will pay all firefighting costs of such fire caused by or attributable to the Lessee.

13.0 FUEL AND HAZARDOUS CHEMICALS

- 13.3 The Lessee shall take all reasonable precautions to prevent the migration of petroleum products into bodies of water.
- 13.5 The Lessee shall mark with flags, posts or similar devices, all petroleum fuel storage facilities, including fill and distribution lines, such that they are clearly visible at all times.
- 13.6 The Lessee shall immediately report all spills of petroleum and hazardous chemicals to Environmental Protection Service at Whitehorse, Yukon, phone (867) 667-7244.
- 13.7 The Lessee shall handle, store, dispose and keep records of all hazardous and toxic chemicals in accordance with the law.
- 13.8 The Lessee shall ensure that fuel storage containers are not located within thirty point forty-eight (30.48) metres of the ordinary high water mark of any body of water unless otherwise authorized by the Minister.
- 13.9 The Lessee shall establish and maintain fuel storage and dispensing facilities in accordance with applicable Acts, Regulations, Ordinances and By-laws. No spilled or leaked fuel shall be allowed to spread to surrounding lands or into any waters. Liquid-tight containers or sumps shall be placed below each tap, valve and nozzle used to dispense fuel.
- 13.10 The Lessee shall prevent the possibility or migration of spilled fuel over the ground surface or through seepage in the ground.
- 13.13 The fuel storage facilities of the Lessee, including all tanks, bladders, hoses, pumps, fuel transfer lines and associated mechanical connections and valves shall be installed and maintained to the satisfaction of the Minister and the Lessee agrees to make such reasonable modification and improvements as are deemed necessary by the Minister.

-8-

13.14 The Lessee shall line the dyke and area enclosed by the dyke with an impermeable liner that meets the following criteria:

- 1) consist of material that is inert to or Compatible (chemically resistant) with the material being stored,
- 2) a permeability of 10-6 cm/s or less (e.g. a minimum of 30 mil geomembrane liner or current accepted standards),
- 3) durable and appropriate for the operating and ambient conditions, and
- 4) cover the dyke and the area within the dyke (including the area beneath the tanks) and be keyed into the dyke walls.

13.15 The Lessee shall dispose of all combustible waste petroleum products as per the Special Waste Regulations of the Yukon Environment Act.

14.0 BOUNDARIES/SURVEY

14.1* Her Majesty is not responsible for the establishment on the ground of the boundaries of the land.

14.2* The boundaries of the land are subject to such adjustment and alteration as may be shown to be necessary by survey.

14.3 The Lessee hereby agrees that upon exercising clause 4.1 in addition to the payment of the purchase money and interest under the Agreement of Sale he will, before the issue of Letters Patent, have the said land surveyed by a Canada Lands Surveyor and will pay the full cost of such survey. ^{— prior to purchase} It is further understood and agreed that no survey will be carried out without the prior written approval of the Head, Land Dispositions, Yukon Region, Northern Affairs Program, Whitehorse, Yukon Territory.

15.0 IMPROVEMENTS

15.1* The Lessee is responsible for insuring that all structures or improvements made on the land are contained within the boundaries of the land.

15.2* The Lessee will not erect on the said land any building or structures, except fencing, nearer than a distance of two (2) metres from any boundary of the land.

15.3 The Lessee shall not construct any facilities within thirty point four eight (30.48) metres of the ordinary high water mark of any body of water without the written approval of the Minister.

15.8 The Lessee will, before the first day of November, 2005, commence construction upon the said land of a concentrator and main service complex, airstrip, accommodation complex, fuel storage compound, open pit mine, waste dumps, tailings impoundment and appurtenances thereto permanently affixed to the and valued in the opinion of the Minister at not less than one million (\$1,000,000.00) dollars, conforming to all applicable federal, territorial or local regulations, ordinances or by-laws. Other expenditures of monies or labour on such items as land clearing, fencing, roads or power lines are not accepted as building improvements towards the above stated one million (\$1,000,000.00) dollars.

16.0 ACCESS

16.1* It shall be lawful for Her Majesty or any person duly authorized at all reasonable times to enter upon the land for the purpose of examining the condition thereof.

16.2* Her Majesty assumes no responsibility, expressed or implied, to provide access or municipal services to the land.

16.8 The Lessee shall construct only one access road to the land, the said access road to meet the standards and conditions specified by Community and Transportation Services, Transportation Division and the said road to be constructed at the Lessee's expense.

16.9 Her Majesty assumes no liability, expressed or implied, to provide access, road maintenance, school bus service, fire protection or related services to the said land.

16.24 The Lessee may install and maintain a gate on accesses within the lease boundaries.

18.0 INDEMNIFICATION

18.1* The Lessee will at all times indemnify and save harmless Her Majesty from and against all actions, claims, demands, costs and damages whatsoever that may be brought, made or sustained against Her Majesty by reason of anything done or omitted to be done by the Lessee, his agents, servants or workmen, arising out of or connected with the granting of this lease.

18.2 The Lessee will not be entitled to compensation from Her Majesty by reason of the land or any portion thereof being submerged, damaged by erosion, or otherwise affected by flooding.

18.3 Her Majesty will not be liable for damages caused by vandalism or interference by others with the Lessee's facilities and equipment.

18.8 Her Majesty assumes no liability express or implied to provide compensation for any archaeological site or burial ground unearthed or otherwise discovered within the land. Her Majesty or any person duly authorized by Her Majesty may at all times enter upon the land for the purpose of examining, excavating or preserving any archaeological site or burial ground found therein.

18.10 The Lessee will save harmless Her Majesty from all claims damages or losses whatsoever arising from any landslides, mud-slides or rock-slides that may occur on or affect the said land.

19.0 NOTICES

19.1* Any notice, consent, demand, waiver, or any communication to the Lessee shall be deemed to be effectively given if mailed to the Lessee at his last known address.

19.2* No notice of default given herein by Her Majesty shall be valid or of any effect unless it is also given to any mortgagee of the Lessee, in respect of the leased lands, of whom Her Majesty shall have received written notice.

19.3* Any notice affecting this lease which Her Majesty may desire to serve upon the Lessee, or any notice which the Lessee may desire to serve upon Her Majesty shall, unless otherwise stipulated herein, be sufficiently served if posted by registered mail to the last known address of the opposite party as follows:

To Her Majesty: Director, Yukon Region
Northern Affairs Program
Department of Indian Affairs and
Northern Development
345-300 Main Street
Whitehorse, Yukon
Y1A 2B5

Attn: Head, Land Dispositions

-10-

To the Lessee: Cominco Ltd.
700-406 Granville Street
Vancouver, British Columbia
V6C 1T2

Either party may change its address for service during the term of this lease by notifying the other party in writing.

19.4* All written notices respecting the land or the covenants, terms, conditions or agreements contained in this lease shall, unless otherwise stipulated herein, be deemed to have been received by the Lessee ten (10) days after the mailing thereof or, if hand delivered, on the day of delivery.

20.0 GENERAL

20.1* The Lessee will comply with the said Act and Regulations.

20.2* The Lessee will at all times conform to all applicable federal, territorial or local regulations, ordinances or by-laws.

20.3* This lease ensures to the benefit of and is binding upon Her Majesty, Her Heirs and Successors and the Lessee, his heirs, executors, administrators and assigns.

20.4* No implied covenant or implied liability on the part of Her Majesty is created by the use of the words "demises" and "leases" herein.

20.5* Wherever the singular or masculine is used in this lease, the same shall be deemed to include the plural or the feminine, or body politic or corporate, also the heirs, executors, administrators, successors, and assigns of the parties hereto and each of them where the context or the parties so require.

20.9 The Lessee shall not fence the land, or any part thereof, except as may be reasonably required for security or safety purposes.

20.10 Subject to the reservations, conditions, covenants and agreements herein contained, the Lessee, its successors and permitted assigns, having performed and observed all the stipulations, provisos and conditions on its part to be observed and performed, will be entitled to the quiet enjoyment of the lands herein leased without hindrance, molestation or interruption on the part of Her Majesty or any person claiming by, through or under Her.

23.0 TRAP LINE

* 23.1 This lease and the said land are subject to the trapping rights of the holder or holders of a registered trapline within the said lands.

25.0 MINE SITE

25.1 The Lessee will at all times conform to all applicable federal, territorial or local laws, regulations, ordinances or by-laws and, without limiting the generality of the foregoing, will in particular comply with the Yukon Quartz Mining Act, the Yukon Placer Act and the Mine Safety Regulations, and regulations and all orders made thereunder.

25.2 The Lessee shall during the term of this lease abide by the terms and conditions of the Water Licence QZ97-026 issued December 17 on 1998.

25.3 On termination of this lease, restoration of the site will also include cleanup removal of debris, levelling and re-sloping of waste rock.

- 25.5 The Lessee shall impound or otherwise contain tailings or any other product of the mining operation and will construct and maintain all waste dumps in a manner satisfactory to the Mining Inspector duly appointed by or under authority of the Minister.
- 25.6 The Lessee shall not fence the land, or any part thereof, except as may be reasonably required for security of safety purposes or as required by the Canada Mining Regulation or any other applicable law.
- 25.7 For the purpose of Section 76, subsection 1(a) of the Yukon Quartz Mining Act R.S. Ch. Y-4, the Minister of Indian Affairs and Northern Development hereby certifies such entry, use and occupation of the said land by the Lessee to be necessary for the efficient and miner like operation of the mines and minerals contained in any mineral claim owned by the Lessee located within the said lands. _____

IN WITNESS WHEREOF

Director, Renewable Resources, Yukon Region, Northern Affairs Program, Department of Indian Affairs and Northern Development, has hereunto set his hand and seal on behalf of Her Majesty the Queen in right of Canada, Cominco Ltd. has hereunto affixed its corporate seal attested to by its proper officers duly authorized in that behalf.

SIGNED SEALED AND DELIVERED on behalf of Her Majesty by Director, Renewable Resources Yukon Region Northern Affairs Program Department of Indian Affairs and Northern Development, in the presence of

Witness

Director, Renewable Resources

SEALED, ATTESTED TO AND DELIVERED

by the

[Handwritten Signature]

and the

GENERAL COUNSEL & SECRETARY

of Cominco Ltd.

TO JEFF HEIDEN
MSY 27/98

PARCEL IDENTIFIER: 105G07-0000-00001

THIS LEASE made this 15th

day of March 1998
* needs to be reworked April 2000
* requires consent for transfer

BETWEEN

Her Majesty the Queen in right of Canada, * request a copy of restoration form pursuant to para 12.0
hereinafter called "Her Majesty"

OF THE FIRST PART

AND

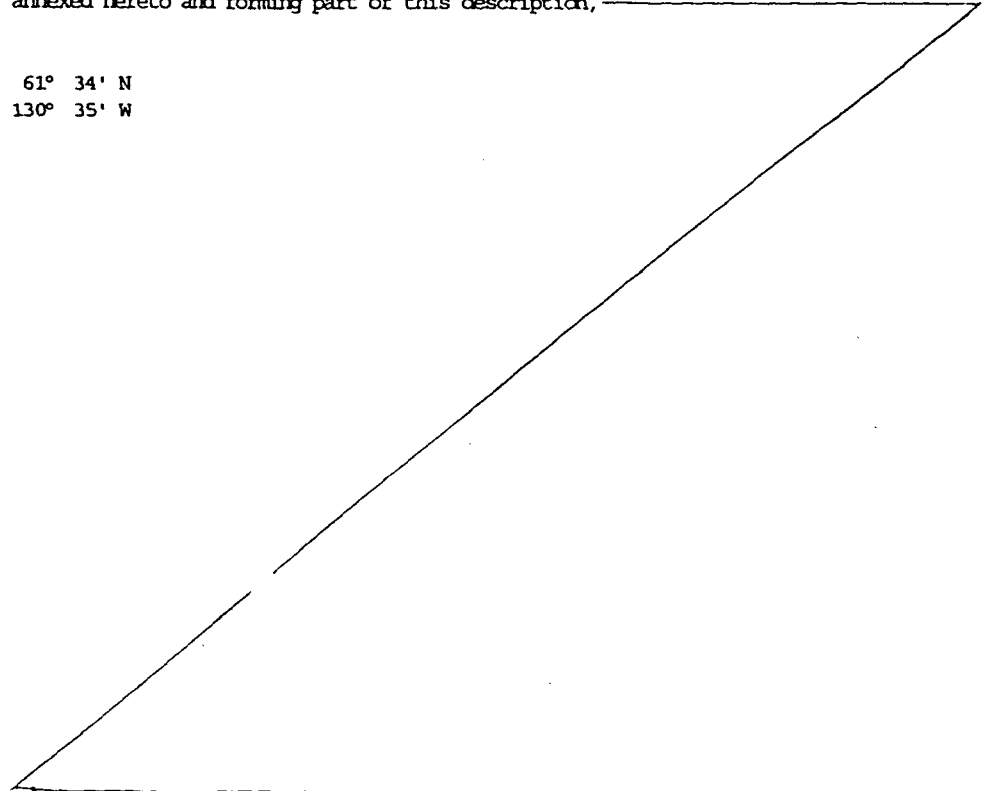
Cominco Ltd., an extraterritorial company, incorporated under the laws of Canada, with its Head Office located at 500-200 Burrard Street, Vancouver, British Columbia,

hereinafter called "the lessee"

OF THE SECOND PART

WITNESSETH that in consideration of the rents, covenants and agreements herein reserved and contained on the part of the lessee to be paid, observed and performed, and subject to the Territorial Lands Act and the Territorial Lands Regulations, Her Majesty demises and leases unto the lessee all that certain parcel(s) or tract(s) of land situate, lying and being comprised of 47.0 hectares, more or less, located in Quads 105 G/7 and 105 G/10, in the Yukon Territory, as shown outlined in red on the sketch annexed hereto and forming part of this description,

61° 34' N
130° 35' W



hereinafter called "the land," SUBJECT TO the following reservations:

- (a) all mines and of all minerals whether solid, liquid or gaseous which may be found to exist within, upon, or under such lands together with the full powers to work the same and for that purpose to enter upon, use and occupy the lands or so much thereof and to such an extent as may be necessary for the effectual working and extracting of the said minerals;
- (b) the rights of the recorded holders of mineral claims and any other claims or permits affecting the lands;
- (c) all timber that may be on the lands;
- (d) the right to enter upon, work and remove any rock outcrop required for public purposes;
- (e) such right or rights of way and of entry as may be required under regulations in force in connection with the construction, maintenance and use of works for the conveyance of water for use in mining operations; and
- (f) the right to enter upon the land for the purpose of installing and maintaining any public utility.

THE PARTIES COVENANT AND AGREE AS FOLLOWS:

1.0 DEFINITIONS:

In this lease:

- 1.1 "Minister" means the Minister of Indian Affairs and Northern Development and any person authorized by him in writing to act on his behalf;
- 1.2 "facilities" means all physical structures or appurtenances placed in or upon the land;
- 1.3 "construction" means all manner of disturbance of the natural state of the surface of the land, including the sub-surface and sub-strata;
- 1.4 "Surveyor General" means the Surveyor General as defined in the Canada Lands Surveys Act;
- 1.5 "body of water" means any lake, river, stream, swamp, marsh, channel, gully, coulee or draw that continuously or intermittently contains water;
- 1.6 "mine site" means all buildings and equipment necessary for the extraction of minerals and all other associated facilities;

2.0 TERM:

2.1 The term of this lease shall be for a period of five (5) years commencing on the first day of May, 1995 and terminating on the thirtieth day of April, 2000.

3.0 RENT AND TAXES:

- 3.1 The lessee shall pay to Her Majesty yearly and every year in advance a rental of one thousand six hundred and forty-five (\$1,645.00) dollars or such other rental as may be fixed by the Minister pursuant to Clause 3.4. rental
- 3.2 The lessee shall during the said term, pay the said rental and all taxes, rates and assessments charged upon the land or upon the lessee in respect thereof.
- 3.3 Where any portion of the rental herein reserved is unpaid for more than thirty (30) days after it becomes due, whether formally demanded or not, or when the lessee fails to perform or observe any of the covenants or agreements herein

contained, subject to the provisions in Clause 10, the Minister may by notice in writing terminate this lease and on the day following the mailing of the notice this lease is terminated.

4.0 RENEWAL:

4.1 Subject to the lessee having performed and observed all of the covenants and conditions on the part of the lessee to be performed and observed and, upon the lessee submitting a written request for renewal at least ninety (90) days prior to the expiry of this lease, Her Majesty will grant to the lessee a renewal of this lease for a further term of five (5) years upon essentially the same terms and conditions as are herein contained except as to rent.

5.0 Extension - not applicable

6.0 Option to Purchase - not applicable

7.0 USE:

7.1 The lessee will use the said land for access road (Kudz Ze Keyah access road) and gatehouse purposes only and will not permit the land, or any portion thereof, to be used or occupied for any other purpose.

7.2 The said land is leased only and will not be considered for sale or title.

7.3 This lease is given on the understanding that the land is to be used only as an access road. No tailings or liquid or other discharges are to be deposited on the said land.

8.0 SUBLETTING OR ASSIGNMENTS:

8.1 The lessee shall not sublet the land or assign or transfer this lease or any portion thereof without the consent of the Minister in writing, which consent shall not be unreasonably withheld.

9.0 SECURITY DEPOSITS:

9.1 The lessee shall deposit with the Minister a security deposit in the amount of two hundred and twenty thousand (\$220,000.00) dollars, or such other amount as may be specified from time to time in the Territorial Lands Act and Regulations thereto. *

9.2 The security deposit provided by the lessee must be in the form of:

- (a) a promissory note guaranteed by a chartered bank and payable to the Receiver General for Canada;
- (b) a certified cheque drawn on a chartered bank in Canada and payable to the Receiver General for Canada;
- (c) bearer bonds issued or guaranteed by the Government of Canada;
- (d) a letter of credit;
- (e) a combination of the securities described in paragraphs (a) to d); or
- (f) any other guaranteed security approved by the Minister.

9.3 Where the lessee has not complied with all of the terms and conditions of this lease, the Minister may retain such part of the security deposit as required to fulfil the said terms and conditions.

9.4 Where the Minister retains all or part of the said security deposit, the Minister shall use the amount retained to remedy any damage or default, or to carry out any restoration necessary resulting from the lessee's non-compliance, and shall refund any excess to the lessee.

10.0 BREACH:

10.1 If this lease has been secured by intentional or negligent misrepresentation as to any material facts, it may be summarily cancelled by the Minister,

10.2 Where the lessee breaches or fails to perform or observe any of the covenants, terms, conditions or agreements herein contained, other than the covenant to pay rent, the Minister may so advise the lessee by written notice and if the lessee fails to remedy the breach or non-performance within 60 days or such reasonable time thereafter as granted in the said notice, the Minister may, by notice in writing, terminate this lease and on the day following the mailing of such notice, this lease is cancelled.

10.3 Unless a waiver is given in writing by the Minister, Her Majesty will not be deemed to have waived any breach or non-performance by the lessee of any of the covenants, terms, conditions or agreements herein contained and a waiver affects only the specific breach to which it refers.

11.0 TERMINATION:

11.1 In the event the lessee decides to terminate its operations on the land during the term of this lease, the lessee will provide the Minister with written notice at least six (6) months prior to the date of termination.

11.2 Upon the termination or expiration of this lease, the lessee shall deliver up possession of the land in a restored condition or in such condition approved by the Minister and, where there are no arrears of rent or taxes, the lessee may, within three (3) months after the termination or expiration, remove any buildings or other structures owned by him that may be on the land.

11.3 Termination or expiration of this lease will not prejudice Her Majesty's right to unpaid rental or any other right with respect to a breach or non-performance of any covenant, term, condition or agreement herein contained nor will the lessee be relieved of any obligation contained herein.

12.0 RESTORATION:

12.1 The lessee shall, within one (1) year of the execution of this lease, deliver to the Minister for his review and approval a plan of restoration which, where applicable, shall include but not be limited to the following:

- (a) identify the type, location, and extent of the surface disturbance;
- (b) surface conditions following disturbance and proposed mitigation;
- (c) soil handling procedures;
- (d) drainage and erosion control;
- (e) revegetation plans; and
- (f) reclamation schedule,

and such plan shall be prepared with the objective of restoring the land as near as possible to its original state, including the removal of all improvements, or such alternate objective as may be approved by the Minister.

- 12.2 Upon the termination or expiration of this lease, the lessee shall deliver up possession of the land in a condition satisfactory to the Minister.
- 12.3 Where the lessee fails to restore the land as required and within the time allowed by the Regulations or by the Minister, the Minister may order the restoration of all or any part of such land and any expenses thus incurred by the Minister shall be recoverable from the lessee as a debt due to Her Majesty.
- 12.4 When this lease expires or is terminated, the lessee at its own expense shall within one (1) year thereof remove all buildings, equipment, or appurtenances owned by him that may be on the land and restore the land as provided hereinafter. The said one (1) year period is subject to payment of an annual rental at the rate in effect in the year previous to the date the lease expired or was terminated.
- 12.5 The lessee shall within one year or such longer period as the Minister in his discretion may allow:
- (i) commence and foster revegetation of all cleared areas, road shoulders and side slopes in areas of cut or fill, and all other areas disturbed during construction of the facilities;
 - (ii) ensure that any areas not to be revegetated shall be given a cover of at least five (5) centimetre thickness of gravel or other good granular material;
 - (iii) prevent surface erosion or loss of surface material by wind or water by such method or methods which receive the prior written approval of the Minister.
- 12.6 The Minister may at any time during the term of the lease request the lessee to review and update the approved plan of restoration and upon receipt in writing of such a request, the lessee shall submit to the Minister, for his approval and within the time specified, an updated plan of restoration.
- 12.7 Within three (3) months of the receipt of any plan from the lessee including an updated plan of restoration the Minister shall notify the lessee whether or not the plan has been approved.
- 12.8 Upon the receipt of any plan, including updated or revised plan of restoration, the Minister may:
- (i) approve the plan submitted;
 - (ii) reject the plan or any portion thereof and return the plan to the lessee for revision, stating the reasons for the rejection; or
 - (iii) require the lessee to include in the plan provisions that, in his opinion, are necessary to meet the objectives in Clause 12.1;
- and the lessee will be advised accordingly in writing.
- 12.9 Where the Minister notifies the lessee of the rejection of any plan or any portion thereof, the lessee shall, within three (3) months of receipt of such notification, deliver to the Minister a revised plan for approval.
- 12.10 The lessee shall undertake ongoing restoration during the term of the lease for any land or improvements which are no longer required for the lessee's operations on the land. *what restoration has been done*
- 12.11 The lessee shall file annually a progress report for the preceding year, outlining the ongoing restoration completed in conformance with the approved plan of restoration.
- 12.12 The lessee shall notify the Minister of its intention to permanently cease operations on the site, not less than six (6) months before cessation. At that time, if not before the above mentioned abandonment and restoration plan must be submitted for approval by the Minister.

13.0 WASTE DISPOSAL:

- 13.1 The lessee will control the quality of effluent or overflow discharged from the said lands in such a manner as to maintain standard of water quality to the satisfaction of the Minister in such streams, rivers or other bodies of water in which such effluent or overflow may find its way.
- 13.2 The lessee shall dispose of all combustible garbage and debris by burning in an incinerator approved by the Land Agent and remove all noncombustible garbage and debris to an authorized dumping site.
- 13.3 The lessee shall dispose of human waste in a manner satisfactory to the Minister.
- 13.4 The lessee shall not discharge or deposit any refuse substances or other waste materials in any body of water, or the banks thereof, which will, in the opinion of the Minister, impair the quality of the waters or the natural environment.
- 13.5 The lessee shall dispose of all scrap metal, discarded vehicles, machinery and parts thereof, barrels and kegs by burial within the lease area beneath not less than ninety (90) centimetres of good granular material or soil, or by removal to an approved dumping place.

14.0 ENVIRONMENTAL:

- 14.1 The lessee shall at all times keep the land in a condition satisfactory to the Minister.
- 14.2 The lessee shall not do anything which will cause erosion of the banks of any body of water on or adjacent to the land, and shall provide necessary controls to prevent such erosion.
- 14.3 The lessee shall incorporate accepted erosion control practices into the design and construction of the access road.
- 14.4 The lessee shall not disturb the insulating capability of natural vegetation and organic soil in such a manner as to cause permanent subsidence or erosion of the land surface and shall, if subsidence occurs as a result of construction or maintenance of the facilities, restore the land to design grade at the expense of the lessee, to the satisfaction of the Minister.
- 14.5 The lessee shall not unduly interfere with the natural drainage pattern of the land, except with the permission of the Minister.
- 14.6 In the event that the lessee is conducting operations which are, in the opinion of the Minister, whose opinion will be reasonably exercised, causing irreparable damage to the environment, the Minister may require that the operations of the lessee hereunder be suspended and the operations shall be suspended until such time as the situation has been satisfactorily remedied.
- 14.7 The lessee shall undertake such corrective measures as may be specified by the Minister in the event of any spill on the land, or water or wind erosion of the land, resulting from the lessee's operations, and shall demonstrate to the satisfaction of the Minister that the lessee has the ability, including the necessary equipment, to undertake the corrective measures.
- 14.8 If the lessee, by its operations on the land, has contributed to any detrimental environmental change, the lessee shall pay its proportionate share of any costs of remedial action which may be considered necessary, as determined by the Minister, acting reasonably.

- 14.9 The lessee shall during the term of this lease maintain in good standing Water Licence MS94-017 issued on April 11, 1995.
- 14.10 The lessee will take all reasonable precautions to prevent any fire from occurring or spreading on the lands and will pay all fire fighting costs of such fire caused by or attributable to the lessee.
- 14.11 If any archaeological site is discovered within the land, the lessee shall immediately advise the Minister in writing of such discovery and shall take all reasonable precautions necessary to prevent any further disturbance or destruction of such site.
- 14.12 The lessee will meet with the Department of Fisheries and Oceans to discuss the construction practices to be employed in the installation of final culverts. Streaming crossing techniques will be employed that do not significantly alter the width or slope of the natural stream channel or impede fish passage. The lessee shall conduct in stream works between the period of June 15 and August 31.
- 14.13 (i) The lessee will minimize the potential for disturbance to caribou during sensitive life cycle activities by avoiding those areas that are used for calving, post-calving and rutting, and by ensuring the access road does not conflict with such areas used by caribou and other migratory wildlife. (i.e. moose)
- (ii) Encounters with wildlife are to be avoided. If caribou or moose are encountered on the access road, the equipment and or activity is to be halted immediately until the wildlife has left the immediate area.
- (iii) The Lessee shall develop a reporting mechanism with YTG Renewable Resources for the reporting of wildlife fatalities that occur along the access road.

15.0 FUEL AND HAZARDOUS CHEMICALS:

- 15.1 The lessee shall take all reasonable precautions to prevent the possibility of migration of spilled petroleum fuel over the ground surface or through seepage in the ground by:
- (i) constructing a dyke around any stationary petroleum fuel container where the container has a capacity exceeding four thousand (4,000) litres; and
 - (ii) ensuring that the dyke(s) and the area enclosed by the dyke(s) is impermeable to petroleum products at all times; and
 - (iii) ensuring that the volumetric capacity of the dyked area shall, at all times, be equal to the capacity of the largest petroleum fuel container plus ten (10) percent of the total displacement of all petroleum fuel containers placed therein; or
- such other alternate specifications submitted by the lessee that may be approved, in writing, by the Minister.
- 15.2 The lessee shall ensure that fuel storage containers are not located within thirty point four eight (30.48) feet of the ordinary high water mark of any body of water unless otherwise authorized by the Minister.
- 15.3 The lessee shall mark with flags, posts or similar devices all petroleum fuel storage facilities, including fill and distribution lines, such that they are clearly visible at all times.
- 15.4 The lessee shall immediately report all spills of petroleum and hazardous chemicals in accordance with the Government of the Yukon Territory Spill Report and any amendments thereto, or in a manner satisfactory to the Minister. The

lessee shall report all petroleum spills immediately to the Environmental Protection 24 hour emergency spill report line (403) 667-7244 and a Yukon Waters Act Inspector.

- 15.5 The lessee shall handle, store, dispose and keep records of all hazardous and toxic chemicals in a manner satisfactory to the Minister.
- 15.6 The lessee shall prevent the possibility of migration of spilled fuel over the ground surface or through seepage in the ground or into bodies of water.
- 15.7 The fuel storage facilities of the lessee, including all tanks, bladders, hoses, pumps, fuel transfer lines and associated mechanical connections and valves shall be installed and maintained to the satisfaction of the Minister and the lessee agrees to make such reasonable modifications and improvements as are deemed necessary by the Minister.
- 15.8 The lessee shall take all reasonable precautions to prevent the migration of petroleum products into bodies of water.
- 15.9 The lessee shall establish and maintain fuel storage and dispensing facilities in accordance with applicable Acts, Regulations, Ordinances and By-laws. Liquid-tight containers or surps shall be placed below each tap, valve and nozzle used to dispense fuel.
- 16.0 **BOUNDARIES/SURVEY:**
- 16.1 Her Majesty is not responsible for the establishment on the ground of the boundaries of the land.
- 16.2 The boundaries of the land are subject to such adjustment and alteration as may be shown to be necessary by survey. It is further understood and agreed that no such survey shall be carried out without the prior written approval of the Regional Manager, Land Resources, Whitehorse, Yukon Territory.
- 17.0 **IMPROVEMENTS:**
- 17.1 The lessee shall, before the first day of May, 1996, complete construction upon the land of a mine access road and gatehouse, valued in the opinion of the Minister at not less than five hundred thousand (\$500,000.00) dollars, and shall maintain the said improvements, or any similar improvements which may be constructed, in a manner and condition satisfactory to the Minister.
- 17.2 The lessee is responsible for ensuring that all structures or improvements made on the land are contained within the boundaries of the land.
- 17.3 The lessee shall not erect any building or structure nearer than a distance of three (3) metres from any boundary of the land.
- 17.4 The lessee shall not construct any facilities within thirty point four eight (30.48) metres of the ordinary high water mark of any body of water unless otherwise authorized by the Minister.
- 17.5 The lessee shall not fence the land, or any part thereof, except as may be reasonably required for security or safety purposes.
- 17.6 The lessee will submit for approval detailed construction plans for the access road construction. These plans should include typical road cross sections including cuts and fills of significant volumes; plans for permafrost areas and stabilization contingencies; and, plans for drainage management which is to

include the location and placement of culverts and minor bridges. The road construction plans are to be approved by the Regional Manager of Land Resources prior to construction and shall conform to the standards for low volume roads.

- 17.7 The lessee will submit as-build plans for the access road with six months of completion of construction.
- 18.0 ACCESS:
- 18.1 Her Majesty assumes no responsibility or liability, express or implied, to provide access or municipal services to the land.
- 18.2 It shall be lawful for Her Majesty or any person duly authorized at all reasonable times to enter upon the land for the purpose of examining the condition thereof.
- 18.3 The Minister may, subject to the approval of the lessee, which approval shall not be unreasonably withheld, grant to such persons as he may consider fit, access across, through, under or over all or any portion of the land for any purpose whatsoever, but such access will not unreasonably interfere with the rights granted to the lessee hereunder, or with any improvements made by the lessee on the land.
- 18.4 This lease and the said land are subject to the trapping rights of the holder or holders of a registered trapline within the said lands.
- 18.5 The Minister may grant, at the full risk and expense of persons so authorized, or access across, through, under or over all or any portion of the land affected by this lease for aboriginal subsistence use purpose whatsoever, but such or access must not unreasonably interfere with the rights granted to the lessee or with any improvements made by the lessee on the land.
- 18.6 Any agreement entered into by the lessee for shared use or maintenance of the access road is subject to review and consent of the Minister, in writing, which shall not be unreasonably withheld. The lessee may assess reasonable charges for use of the access road to assist in the maintenance costs.
- 18.7 Notwithstanding any other provision of this lease, the lessee at all times shall permit any vehicle owned by or under contract to any Department of the Government of Canada or the Government of Yukon to use the access road free of any charges or fees whatsoever.
- 19.0 PUBLIC UTILITIES: - not applicable
- 20.0 INDEMNIFICATION:
- 20.1 The lessee shall at all times hereafter indemnify and keep Her Majesty indemnified against all claims, demands, actions or other legal proceedings by whomsoever made or brought against Her Majesty by reason of anything done or omitted to be done by the lessee, his officers, servants, agents or employees arising out of or connected with the granting of this lease.
- 20.2 The lessee will not be entitled to compensation from Her Majesty by reason of the land or any portion thereof being submerged, damaged by erosion, or otherwise affected by flooding.
- 20.3 Her Majesty will not be liable for damages caused by vandalism or interference by others with the lessee's facilities and equipment.

20.4 The lessee shall not be entitled to compensation from Her Majesty for damages suffered by the lessee, or any person claiming through or under him, by reason of the land or any portion thereof being submerged or otherwise affected by the exercise of the rights granted to any operation under any licence issued under the Dominion Water Powers Act and affecting the land.

20.5 The lessee shall save harmless Her Majesty from all claims, damages or loss whatsoever arising from any landslides, mud-slides or rock-slides that may occur on, or affect the land.

20.6 Her Majesty assumes no liability express or implied to provide compensation for any archaeological site or burial ground unearthed or otherwise discovered within the land. Her Majesty or any person duly authorized by Her Majesty may at all times enter upon the land for the purpose of examining, excavating or preserving any archaeological site or burial ground found therein.

21.0 REVIEW:

21.1 At the request of the lessee, any decision of the Minister will be reviewable by the Trial Division of the Federal Court of Canada; costs of such review are the responsibility of the lessee unless otherwise ordered by the Court.

22.0 NOTICES:

22.1 Any notice affecting this lease which Her Majesty may desire to serve upon the lessee, or any notice which the lessee may desire to serve upon Her Majesty shall, unless otherwise stipulated herein, be sufficiently served if posted by registered mail to the last known address of the opposite party as follows:

To Her Majesty: Director, Renewable Resources
Yukon Region
Northern Affairs Program
Department of Indian Affairs & Northern Development
345-300 Main Street
Whitehorse, Yukon
Y1A 2B5

To the Lessee: Cominco Ltd.
500-200 Burrard Street
Vancouver, BC
V6C 3L7

Either party may change its address for service during the term of this lease by notifying the other party in writing.

22.2 No notice of breach or default given herein by Her Majesty shall be valid or of any effect unless it is also given to any mortgagee of the lessee, in respect of the leased lands, of which Her Majesty shall have received written notice.

22.3 Any notice, consent, demand, waiver, or any communication to the Lessee shall be deemed to be effectively given if mailed to the Lessee at his last known address.

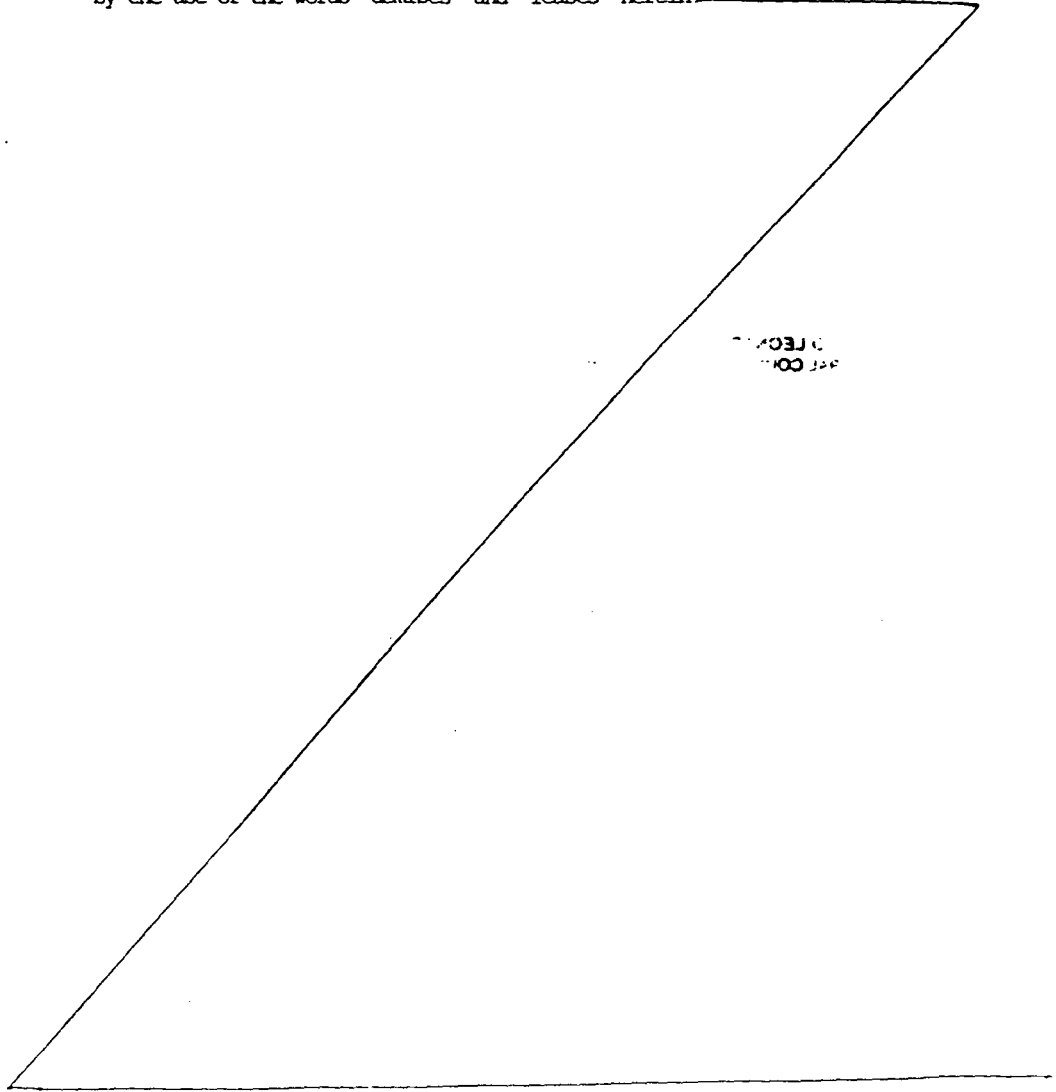
23.0 GENERAL:

23.1 The lessee must comply with the said Act and Regulations.

23.2 The lessee will at all times conform to all applicable federal, territorial or local laws, regulations, ordinances or by-laws and, without limiting the

generality of the foregoing, will in particular comply with the Yukon Quartz Mining Act, the Yukon Placer Mining Act and the Mine Safety Ordinance, the Timber Regulations and the Yukon Forest Protection Ordinance and Regulations and all orders made thereunder.

- 23.3 For the purpose of Section 76, subsection 1 (a) of the Yukon Quartz Mining Act R.S. Ch. Y-4, the Minister of Indian Affairs and Northern Development hereby certifies such entry, use and occupancy of the lands by the lessee to be necessary for the efficient and miner like operation of the mines and minerals contained in any mineral claim owned by the lessee located within the lands.
- 23.4 Wherever the singular or masculine is used in this lease, the same shall be deemed to include the plural or the feminine, or body politic or corporate; also the heirs, executors, administrators, successors, and assigns of the parties hereto and each of them where the context or the parties so require.
- 23.5 This lease enures to the benefit of and is binding upon Her Majesty, Her Heirs and Successors and the lessee, its successors and assigns.
- 23.6 No implied covenant or implied liability on the part of Her Majesty is created by the use of the words "demises" and "leases" herein.





July 29, 1999

Department of Indian Affairs and Northern Development
Yukon Region
Government of Canada
345 - 300 Main Street
Whitehorse, Yukon
Y1A 2B5

Attention: Carol Corrothers

AND

Environmental Protection and Assessment Branch (R8)
Department of Renewable Resources
Yukon Territorial Government
P.O. Box 2703
Whitehorse, Yukon
Y1A 2C6

Attention: Jon Bowen

Dear Sirs:

Re: Kudz Ze Kayah Project - Wildlife Protection

This letter is further to the Screening Report of the Environmental Assessment of the Kudz Ze Kayah project, dated November 13, 1997 and prepared by the Department of Indian Affairs and Northern Development (DIAND) and Fisheries & Oceans, Canada pursuant to the *Canadian Environmental Assessment Act*. The purpose of this letter is to set out provisions for mitigation of potential impacts on wildlife not otherwise specifically addressed in a proposed amendment (see attached) to the Surface Lease granted to Cominco Ltd. by DIAND, the 15th day of March, 1996, (parcel identifier 105G07-0000-00001).

The following provisions will come into force upon the effective date of the amendment to the Surface Lease:

Wildlife Protection Policy - Upon request of Cominco, the Department of Renewable Resources, Yukon Territorial Government (YTG-RR) will provide assistance in reviewing Wildlife Protection Policies and providing educational programs on environmental training to mine employees and contractors.

Wildlife Monitoring – Commencing upon mine construction, representatives of Cominco, DIAND, YTG-RR, affected First Nations and other resource users in the areas will be invited to meet annually to discuss matters related to wildlife protection, monitoring and surveys, and review of incidents involving wildlife encounters. Cominco will provide notice of its desire to hold a meeting within 60 days of a determination to proceed with construction. Thereafter, Cominco will arrange a time and place for the annual meeting prior to March 31st of each year throughout the life of the mine and during the period of mine closure and reclamation.

Cominco will be invited to participate in YTG-RR post-calving and rut surveys for caribou, which will also include moose observations for the project area. Initially, in those years when surveys are conducted, Cominco will contribute toward the cost of these surveys up to an annual maximum amount of \$7,500.

The provisions set out in this letter are subject to change from time to time as agreed upon by the parties identified below. The commitments made by Cominco herein may be assigned subject to the consent of DIAND and YTG-RR, which consent shall not be unreasonably withheld.

Please indicate acceptance of these provisions by your respective departments by having an appropriate official from your department execute this letter where indicated below and return all signed copies to Cominco Ltd. c/o David Parker. A fully executed copy will be returned to you in due course. In the meantime, if you have any questions or concerns, please do not hesitate to contact the undersigned.

Yours truly,

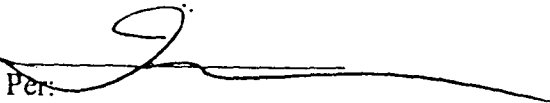
Cominco Ltd.



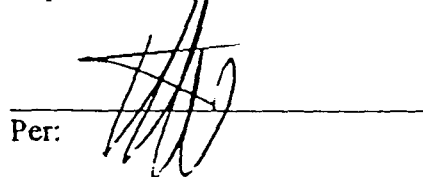
David R. Parker
Manager, Regulatory and Public Affairs

We hereby acknowledge and accept the terms set out in this letter.

Government of Canada,
Department of Indian Affairs
and Northern Development

Per: 

Yukon Territorial Government,
Department of Renewable Resources

Per: 

**PROPOSED AMENDMENT To
Surface Lease 105G07-0000-00001,
Her Majesty the Queen in right of Canada
And
Cominco Ltd.**

FINAL

Abstract

This surface lease applies to lands upon which the Kudz Ze Kayah Mine Project tote road is located. The tote road will become the Mine Haul Road if a decision is made to proceed with the project. The purpose of this amendment is to incorporate into the lease wildlife mitigation measures recommended in the *Screening Report of the Environmental Assessment of the Kudz Ze Kayah Project, Cominco Ltd. Prepared by The Department of Indian Affairs and Northern Development and Fisheries and Oceans Canada*, dated November 13, 1997. These provisions will come into effect should Cominco or its assignee choose to proceed with the mine project reviewed in the Screening Report.

- 9.1 Amend Security provision to increase by \$10,000.
- 14.14 The lessee shall, during the term of this lease, carry out the wildlife protection, monitoring, facilities management, and consultation provisions as set out in Schedule 2, attached hereto and in accordance with the provisions of the letter agreement, dated January XX, 1999, entered into between the lessor, lessee, and the Department of Renewable Resources, Yukon Territory.

SCHEDULE 2

WILDLIFE PROTECTION AND MONITORING

1.0 WILDLIFE PROTECTION POLICY

- 1.1 Prior to commencement of construction of the project, the lessee shall establish Wildlife Protection Policies to encourage wildlife awareness and avoid disturbance effects. The Wildlife Protection Policies shall include the following:
- (i) environmental training for all mine employees and contractors, pursuant to which the lessee will implement an education and awareness program with respect to wildlife and habitat protection needs of wildlife. One objective of this program will be to educate mine employees and contractors about potential wildlife issues and the commitments made by the lessee regarding wildlife mitigation. This program shall be presented in conjunction with site orientation and training and shall be made available in written form as part of the overall environmental program at the mine. Upon request by the lessee, the Yukon Territorial Government

Renewable Resources (YTG RR) will provide assistance in reviewing program materials and making related presentations to mine personnel;

- (ii) a "No hunting/No Fishing Policy" applicable to all mine employees and contractors. The objective of this policy will be to prohibit hunting and fishing in the general vicinity of the project mine site or haul road to the Robert Campbell Highway. This policy shall be in effect throughout the life of the project from construction through to closure and reclamation and shall apply to all mine employees and contractors. The lessee shall notify the lessor of any reported infringement of this policy;
- (iii) a policy prohibiting recreational use by employees and contractors of all-terrain vehicles and snowmobiles. The lessee shall prohibit access and use of ATVs and snowmobiles for recreational purposes on the mine haul road and the mine site; and,
- (iv) a wildlife and incident reporting log in accordance with Section 2.0, Wildlife Monitoring.

2.0 WILDLIFE MONITORING

2.1 Wildlife activities in the project area are to be monitored to identify changes in wildlife migration, distribution, and abundance, to evaluate causal relationships between observed changes and project-related activities and to obtain information for the planning of mitigation. Monitoring of caribou and moose shall be used as indicators for the Valued Ecosystem Components. Monitoring shall be used to detect changes beyond baseline conditions or specific values for Valued Ecosystem Components.

2.2 The parameters for Valued Ecosystem Components monitoring shall be as follows:

- (i) frequency of surveys should be established in two year periods, commencing upon mine construction, subject to review at annual meetings of the Lessor, the Lessee, YTG RR, affected First Nations, and other resource users in the area, including, but not limited to representatives of outfitters and trappers groups (the "Interested Parties"). The period for which surveys are required should be for the life of the mine, unless otherwise determined by the parties;
- (ii) survey area definition should be as completed in accordance with the original baseline survey for the project as shown in the map attached as Schedule 3 [see appendix 5 of IEE];
- (iii) survey methodology shall include participation in annual YTG post-calving and rut surveys for caribou in conjunction with YTG RR survey schedules. Moose observations for the project area should be included in

these surveys. Methodology, including participation, should be determined annually through discussions with the YTG RR regional biologist (the "Regional Biologist");

- (iv) survey reporting shall be made by December 31 of each year for review in a annual meetings of the Interested Parties.
- (v) survey follow-up should include review and discussion with Interested Parties of survey data in conjunction with YTG as well as additional mitigation based on the findings of effects monitoring. Reformatting of the wildlife monitoring design may also be required to reflect changing conditions.

2.3 The lessee shall maintain a written log of wildlife observations and incidents for the mine property and access road. The Wildlife Log shall include time and date, species, location of observation, and other relevant information such as mortality of wildlife and birds. The Wildlife Log shall be maintained for the life of the mine until there are no longer employees on site. The area definition should include the mine property and access road, as well as relevant portions of the Robert Campbell Highway. The Wildlife Log shall be in written form, including maps.

The Wildlife Log shall be reviewed annually each January with the Regional Biologist for the area. Wildlife collisions and mortalities should be reported immediately to the local YTG RR conservation office.

2.4 Wildlife observations, monitoring programs, and incidents may be required to be followed up with additional mitigation as determined by the lessor, in consultation with the lessee, YTG RR and affected First Nations.

3.0 METAL ACCUMULATION MONITORING IN FORAGE PLANTS

3.1 Within two years of mine start up, the lessee shall establish a metal monitoring program in consultation with the parties and affected First Nations.

4.0 FACILITIES MANAGEMENT

4.1 Commencing upon construction of the project, the lessee shall manage company-directed activities and transportation along the Mine Haul Road to avoid wildlife mortality and to eliminate movement barriers from wildlife access routes. Areas of concern shall include the Mine Haul Road and portions of Robert Campbell Highway and other highway routes used, if applicable. The lessee shall consult with the YTG, RR and Department of Transportation to implement appropriate wildlife protection measures, which may include, but are not limited to maintenance guidelines for winter, speed reduction zones, signs at crossings, radio equipped trucks, reporting of wildlife on roads.

- 4.2 Aircraft use shall be carried out to minimize non-essential flight activities and to avoid wildlife calving and rutting areas during sensitive lifecycle periods. Avoidance periods are subject to change from time to time in accordance with results from wildlife survey and Wildlife Log observations and consultation with the Regional Biologist.
- 4.3 The lessee, in consultation with the Regional Biologist, shall establish appropriate measures to carry out blasting activities at the mine in a manner that avoids disturbance of wildlife during critical lifecycle activities, particularly caribou calving and sheep lambing periods.
- 4.4 The lessee, in consultation with the Regional Biologist, shall establish appropriate measures to prevent bear attraction into the project area, including the mine, camp, and Mine Haul Road, and elimination of problem wildlife incidents for all species. Bear avoidance measures shall include fencing the dump and kitchen areas with electric fences, storage of waste in bear-proof containers, and daily incineration of waste in a Canadian Standards Association approved fuel-fired incinerator. All bear incidents are to be reported to the local Conservation Officer within 24 hours of the incident or as directed by a Conservation Officer in writing.
- 4.5 The lessee shall implement progressive reclamation plans with the objective of minimizing impacts and duration of habitat loss associated with disturbed areas that are no longer required for mine-related activities. The lessee shall report annually on the extent of surface disturbances and reclaimed areas.

5.0 CONSULTATION

- 5.1 The lessee shall provide opportunities to meet at least once each year with Interested Parties to report on and review the wildlife protection and monitoring provisions contemplated in this schedule. A primary objective of the annual meetings shall be to provide advance notice of anticipated project activities and plans for the upcoming year and to avoid unnecessary conflicts with other resource users.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

Authorization issued to:

Name: Cominco Ltd. ("Cominco")
Address: 600-200 Burrard Street, Vancouver, B.C. V6C 3L7

Telephone No.: (604) 682-0611

Location of Project

The upper end of the Geona Creek Valley and South Creek near Ross River in Southeastern Yukon.

Valid Authorization Period

The valid authorization period for the draining of the Upper Geona Creek habitat and the diversion of Fault Creek both associated with the development of the Kudz Ze Kayah Mine is from June 1, 1998 to November 30, 2001; the valid authorization periods for the other conditions of this Authorization are as set out below.

Description of Works or Undertakings

The harmful alteration hereby authorized is the draining of beaver ponds and stream habitat in the Upper Geona Creek Valley (4.7 hectares of pond habitat and 2.0 hectares of stream habitat) and the diversion of approximately 1,000m² of lower Fault Creek into the South Creek drainage system, during the operation of the Kudz Ze Kayah Mine and redirection of Fault Creek into Geona Creek after the mine life; all of which alterations are more specifically described in the attached Appendix 1 "Fish habitat compensation and biophysical monitoring measures to be completed by Cominco Ltd. to ensure no net loss of fish production in the area of the proposed Kudz Ze Kayah Base Metal Mine Project in Yukon".

Conditions of Authorization

1. Cominco confirms that all plans and specifications relating to this Authorization have been duly prepared and reviewed by appropriate professionals working on behalf of Cominco. Cominco acknowledges that it is solely responsible for all design, safety and workmanship aspects of all of the works associated with this Authorization.
2. Cominco will do a complete fish salvage on Upper Geona Creek and the ponds from just below the downstream edge of the proposed tailings impoundment structure to the lowermost reach of Fault Creek. All fish will be live transported to one or more of the barren target lakes for immediate introduction to the new lake and stream habitat. This work will all be completed upon the terms and as more fully described in the attached Appendix 1.
3. Cominco will create new stream habitat including Arctic Grayling spawning area in the upper South Creek drainage where Fault Creek will be diverted, from upper Geona Creek to the uppermost lake in the South Creek system, all as more fully described in Appendix 1.

4. Once the water upstream of the tailings dam reaches an acceptable water quality to sustain aquatic life, Cominco will re-introduce Arctic Grayling into areas upstream of the tailings dam and ensure that these populations are viable.
5. Cominco shall carry out a monitoring program (the "Monitoring Program"), described in the Environmental Monitoring section of Appendix 1 which includes the following:
 - During construction, a qualified Environmental Monitor will be onsite to supervise the construction of all compensation components;
 - Inspection of the sites to which the fish from upper Geona Creek and ponds were transported, to confirm survival 2 and 4 years after the fish salvage operation;
 - Photographic assessment and site inspection by a qualified fisheries biologist of the created habitat in the upper South Creek and Fault Creek diversion in the first, second and fifth year following completion of the habitat creation to ensure they are functioning as designed;
 - Provide to DFO a written summary of all monitoring activities identified in Appendix 1 by December 31 of each year in which the monitoring and assessment was undertaken; and
 - after re-introduction of fish into the area upstream of the tailings dam, undertake assessment of survivals 2 and 4 years after introduction.
6. Cominco shall ensure that the compensatory habitat created in the South Creek drainage is functioning as designed until Fault Creek is returned to its original drainage upon reclamation of the minesite.
7. If the results of the stability analysis to be undertaken for the PAC dump site indicate that there is a significant risk of failure and the dump will be relocated, and if the relocation would interfere with any of the conditions of this Authorization, Cominco acknowledges that no PAC dump work will be undertaken that will impact the conditions of this Authorization without the prior written approval from DFO.
8. If at any time in the future Cominco becomes aware that any of the compensatory habitat is not functioning as intended, for example by reason of natural erosion, Cominco shall carry out any works which are necessary to enable the compensatory habitat to function as intended.
9. After the compensatory habitat is functioning as intended, Cominco shall not carry out any work or undertaking that will adversely disturb or impact the compensatory habitat without obtaining the consent of DFO.
10. Cominco shall forthwith deliver to DFO a performance bond or a letter of credit from a Canadian bank in the sum of \$110,000, valid until post-closure monitoring is completed. This security shall be in a form approved by DFO, and the amount of the security may be reduced with the approval of DFO based upon progressive completion of compensatory works.

The holder of this authorization is hereby authorized under the authority of section 35(2) of the Fisheries Act, R.S.C., 1985, c. F. 14, to carry out the work or undertaking described herein.

This authorization is valid only with respect to fish habitat and for no other purposes. It does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies or with any requirements of the Navigable Waters Protection Act.

Failure to comply with any condition of this authorization may result in charges under the Fisheries Act.

This authorization form should be held on site and work crews should be made familiar with the conditions attached.

Date of issuance: _____, 1997

Approved by: _____
Gail Faulkner

Title: Chief, Habitat and Enhancement Branch, Yukon Area DFO

Cominco Ltd. acknowledges that DFO has consulted with it regarding the terms of this Authorization, and confirms that it has reviewed and understands the terms of this Authorization, and it will comply with them.

Executed on behalf of Cominco Ltd. on)
the 3RD day of December, 1997 in the)
presence of:)

Cominco Ltd.

[Signature])
Witness (signature))

Per. [Signature]

David R. Parker)
(print name))

APPENDIX 1:
FISH HABITAT COMPENSATION AND BIOPHYSICAL MONITORING
MEASURES TO BE COMPLETED BY COMINCO LTD.
TO ENSURE NO NET LOSS OF FISH PRODUCTION
IN THE AREA OF THE PROPOSED
KUDZ ZE KAYAH BASE METAL MINE PROJECT IN YUKON

The proposed Kudz Ze Kayah base metal mine/mill near Ross River in the Yukon Territory will result in some unavoidable and unmitigable (residual) losses of fish habitat in upper Geona Creek, a tributary of Finlayson Creek, which joins Finlayson River just downstream of Finlayson Lake, Yukon (Figure 1). The proponent of the project - Cominco Ltd. - is committed to ensuring no net loss of fish production in the area by implementing habitat compensation measures as outlined below. Further below are the proposed habitat (physical and biological) monitoring measures proposed for the construction, operation and closure phases of the mine/mill project.

HABITAT COMPENSATION

The key fish habitat compensation measures proposed by Cominco to offset the residual adverse impacts of the proposed KZK project on fishery resources include:

stocking of two barren lakes in the local area with all of the fish (primarily Arctic grayling *Thymallus arcticus*) from Geona Creek and ponds by means of a fish salvage, live transport and stocking in the lakes; and

creation of new stream habitat including spawning area in the upper South Creek drainage where Fault Creek will be diverted from upper Geona Creek to the uppermost lake in the South Creek system (Figure 1). Similar work will be completed in the lowermost section of Fault Creek before it is diverted back to Geona Creek upon project abandonment.

The proposed target lakes to receive the fish from upper Geona Creek include two (2) potentially suitable lakes (1 relatively deep lake and 1 large beaver pond) with no existing fish fauna, each with considerably more pond and stream habitat area than the pond and creek habitat to be displaced by the proposed KZK mine and tailings areas. The proposal to transfer the fish from the upper Geona Creek system to one or more of these lakes/ponds will result in significantly increased fish production in the local area and more than offset the anticipated loss of habitat to the mine development. The principal of "no net loss" of fish production capacity will be exceeded with the proposed mitigation and compensation measures.

Geona Creek and Ponds

The ponds and upper creek contain Arctic grayling and slimy sculpins in all seasons, including winter. The ponds are approximately 150 m long by 50 m wide and up to 3 m deep, with soft silt substrates over scattered boulders. Geona Creek below the beaver ponds at the KZK site shows a mix of habitat types from wide (35 m) rocky floodplain to narrow (1-2 m) incised watercourse with gravel, silt and boulder substrate in different sections. No large areas of typical grayling spawning habitat were found in Geona Creek and few small areas of riffle/gravel habitat were found. The area of fish-bearing habitat in the affected area includes approximately 4.7 ha in 3 inactive beaver ponds and 2.0 ha of the mainstem Geona Creek, a total of 6.7 ha.

Fault Creek provides some potential spawning habitat for the Geona ponds fish in its alluvial fan area, but is otherwise relatively steep and bouldery providing little, if any, potential fish habitat upstream. The grayling in the ponds were all age 2+ in 1995 and will be adults and ready to begin spawning by the spring of 1998, or 1999. Fault Creek would be diverted away from Geona Creek into the South Creek drainage during the life of the mine, but would be redirected back to Geona Creek as part of site reclamation. Old drainage courses indicate that Fault Creek may have drained to South Creek before a natural shift occurred to move it into the Geona Creek drainage, probably hundreds, or thousands, of years ago. A reasonably well defined channel exists where Fault Creek once flowed to South Creek. Arctic grayling, including full-size mature fish, and burbot were found in the headwater lakes (large beaver ponds) in South Creek, which flows to the North Lakes system. This system supports numerous fish species.

A complete fish salvage will be conducted on Geona Creek from just below the downstream edge of the proposed tailings impoundment structure to the lowermost reach of Fault Creek and including the beaver ponds at the mine site. The fish salvage will be completed during maximum fish utilization in early summer after the hatch and emergence of any young-of-the-year fry that may be in the creek area. The beaver dams controlling the pond levels will be removed (by hand) at that time to facilitate pond drainage and the fish salvage. The salvage will be conducted in low water conditions with electrofishing gear, dip nets and, possibly, seine nets. Stop nets will be set at the pond outlets. Several members of the Ross River Dena will be employed to assist in the fish salvage. The complete salvage and transport process will require approximately 2-4 days in the mid-summer period.

The fish salvaged from Geona Creek will be live-transported by air in an aerated fish transport bag (as used by hatcheries) to two barren target lakes (see below) for immediate introduction to the new lake and stream habitat. Each lake will be monitored from the stocking date to check for any significant mortality. Test sampling and/or diving surveys will be completed on each lake 2 and 4 years after the salvage and transplant operation to determine if the population has stabilized.

"Cirque Lake" (see Figure 1), the primary target lake to receive the fish from Geona Creek/ponds, receives water from a steep headwater creek with two smaller upstream lakes on the east face of the mountain overlooking east North Lake, and is part of the headwaters of the North River system. The cirque lake is approximately 200 m long by up to 80 m wide with a surface area of 6.2 ha and up to 8 m deep, based on a diver survey. The substrate is comprised of rock scree from the adjacent talus and bedrock slope, and fine-grain sediments at depth in both the main and secondary (3 m deep) basins. The outlet from the lake is a single cobble/boulder creek channel that eventually drains to the easternmost North Lake. A permanent fish migration block in the form of a gradient barrier (chutes) occurs approximately 400 m downstream of the cirque lake. Below the gradient barrier, the creek has several large beaver dams and steep (but passable) sections. The stream area above the barrier contains approximately 800 m² of riffle/cobble habitat. The inlet creek is small and steep and has little available spawning habitat. The lake volume and depth are considerably greater than those of the ponds to be displaced in Geona Creek. Migrants from a newly stocked population of grayling in this lake will become recruits to the North Lakes grayling populations, while those that remain will maintain a resident population.

The secondary target lake is a large beaver pond in upper East Creek that is approximately 8.0 ha in area and up to 3 m deep, and is barren of fish, as is the creek and several other ponds downstream. The large, uppermost pond has a very soft silty bottom (as do parts of the Geona Creek ponds), a high degree of shoreline irregularity with undercut banks, and abundant plankton and invertebrate life. Cominco is proposing to utilize both Cirque Lake and the uppermost pond in East Creek as target lakes to ensure that the fish transplant has a good chance for success. It is Cominco's desire not to put all of the fish in one lake, as the possibility that the fish might not "take" to the lake could result in the loss of all of the salvaged fish. It is preferred to use at least two (2) target lakes to ensure success in maintaining local fish production.

Fault Creek Diversion

The proposed diversion of Fault Creek into South Creek will result in the temporary loss of Fault Creek flows to Geona Creek downstream of the mine and tailings impoundment area. The creek must be diverted to keep water out of the proposed open pit mine and downstream tailings area as much as possible. The area of creek displaced for the diversion will be approximately 1000 m² in lower Fault Creek. This will be immediately replaced by at least as much habitat of superior quality when the creek is diverted to South Creek (see below).

With the diversion of Fault Creek, and the discharge of overburden drainage from south of the open pit to South Creek, flows in the South Creek drainage will increase by approximately 37% on average (0.13 m³/sec to 0.18 m³/sec). This will cause higher water levels in the large beaver ponds and in the creek downstream. This will not result in any significant adverse effects on the South Creek system, and will increase productivity in that drainage. The increased flows in South Creek may cause some displacement of the existing beaver dams; however, the dams and lodges on the lakes and in the creek are active, and would likely be rebuilt by the beavers. Some erosion

and sedimentation of the creek banks may also occur; however, as Fault Creek once drained to South Creek, the existing channel and floodplain will accommodate the increased flows. The floodplain is also well vegetated with grasses and willow, which will resist erosion and prevent significant erosion of the soils.

Sediment control measures proposed for the diversion of Fault Creek include preparation of the new channel, including excavation of old deposits in some areas to ensure the channel is stable and has adequate capacity for flood flows, and lining of the new channel. Clean gravels will be placed in the new channel to provide a gravel/cobble substrate. As part of the habitat compensation plan, large boulders and large woody debris will be placed in the new channel and anchored securely. This material and substrate contouring will provide habitat complexity (pools, riffles, runs, cover) and increased fish production capacity. Bank vegetation will be left in place along both sides of the new channel and new riparian growth including grasses and shrubs will be planted where necessary to ensure a productive riparian zone. The key fish populations for which this new habitat will be created are the existing Arctic grayling and burbot stocks in the lakes/ponds in upper South Creek. The new habitat will provide water, nutrients, spawning and rearing habitat for the fish in the upper South Creek system.

The diversion of Fault Creek into upper South Creek, where it has apparently flowed in the past, offers a particularly effective opportunity for fish habitat creation, as spawning habitat appears to be very limited in the lakes of upper South Creek. As noted above, the new channel for Fault Creek to South Creek will be excavated and lined before the water is diverted into the channel. Habitat complexing with boulders and large woody debris (LWD), and riparian seeding and planting will also be completed in this section of creek. The LWD will be properly anchored by cables to buried anchors. These measures will add approximately 800 m² of stream habitat to the South Creek/Lakes system which contains relatively large Arctic grayling, burbot and possibly other species, and appears to be limited in terms of fish production by a lack of spawning area.

Habitat creation in the new (diversion) section of Fault Creek can largely be completed at any time of year, provided plugs are left in place between the new channel and the creek and lake. The plugs will be removed during the low flow period (August-September) and the plug areas lined with clean rock and gravels. Steel ditch plates may be used to reduce the width of the plugs to allow for channel lining in those areas in the dry. As currently planned, the new channel will be excavated and complexed during the summer months and the plugs removed as noted above. The plugs will be removed in the order: downstream plug first, followed by the upstream plug, to limit erosion and sediment transport.

The created habitat described above will be lost when Fault Creek is redirected back to Geona Creek upon project decommissioning in approximately 20 years. However, at that time, additional habitat will be created upstream of the tailings dam, which will consist of a small lake with a permanent spillway. Arctic grayling from Finlayson Creek or the large natural lake in the East Creek system will be live-transported under permit

to the new pond when water of acceptable quality to support aquatic life is achieved. This area will then be monitored 2 and 4 years after the fish have been re-introduced to that area to ensure the population is surviving. The fish will be able to utilize the lowermost reach of Fault Creek for spawning. Clean spawning-size gravels will be placed in that area for that purpose as part of the reclamation and abandonment process. If it is possible to maintain some flows to the South Creek system as well, it would be of continued benefit to the fish in that system. This will also be discussed with DFO at the time of the re-diversion at the end of mine life.

Summary of Habitat Compensation

The total area of stream and lake habitat displaced by the proposed KZK mine and tailings containment area includes 4.7 ha of pond habitat and 2.0 ha of stream habitat.

The total area of new direct-use habitat that will be created by the proposed stocking of the Cirque Lake and the large beaver pond in the upper East Creek will include 14.2 ha of lake habitat and 2.15 ha of stream habitat. Following mine closure, there will be introduction of fish into the area above the tailings dam which will add additional habitat.

This degree of habitat compensation will more than offset the losses due to the project and ensure no net loss of fish production in the area.

ENVIRONMENTAL MONITORING

Cominco will monitor several components of the physical and biological environment in the vicinity of the proposed KZK project, including:

Construction Monitoring

Retain a qualified and experienced environmental monitor to supervise the implementation of the recommended mitigation measures. The monitor should be on site during all instream and near-stream construction work to ensure that all practical means are used to minimize erosion and sedimentation to the streams. He/she should provide direction to construction personnel on the placement of silt fencing, sump pumps, fuel containment areas and other environmental protection techniques;

Develop a relationship (regression equation) between total suspended solids (TSS) and turbidity. Monitor turbidity in the creeks downstream of the project during the construction period to determine whether TSS levels are within the acceptable range. If the levels generated by the construction work are higher than the acceptable level, the environmental monitor will direct immediate remedial action to maintain control of suspended sediments; and

Monitor sediment accumulation downstream of the construction site. Sediment levels can be measured in terms of the amounts that may build up on the creek bottoms in sediment deposition areas, several of which were sampled in the

baseline work. A staff gauge will be installed in a known depositional area in Geona Creek downstream of the construction site as an indicator of sediment build up. Sediment accumulation at the staff gauge will be checked daily. If significant deposition is found during the construction period, remedial actions will be taken.

Operatlons Monitoring

The monitoring program proposed for the operational phase of the KZK project will include:

Monitoring of the target lakes for the fish salvage and transplant will also be conducted, under licence from DFO, during the operational phase of the project. Dive surveys and/or non-lethal sampling will be used to determine the survival of the fish and success of that component of the overall compensation plan. Dive surveys will likely suffice to determine the degree to which the fish survive in the target lakes. Both lakes were diver surveyed in the baseline work, clarity was excellent, and the numbers and sizes (adult/juvenile) of fish can be readily observed with this method. In particular, the presence of young-of-the-year (y-o-y) grayling will indicate that the fish have successfully spawned in the creeks associated with the lakes and are therefore becoming self-sustaining populations. If, at the request of DFO and/or YTG, fish lengths, weights, condition factors and/or growth rates are deemed necessary, non-lethal capture methods will be used, under permit, to catch and measure fish in the target lakes. A comparison of condition factors (length:weight relationships) and growth rates (size-at-age) will show whether they are growing at acceptable rates compared to the fish from the baseline sampling and from other areas in the Yukon as described in the literature. Monitoring of these transplanted fish populations will be conducted at 2 and 4 years after transplant during the life of the mine, at closure, and when fish are placed in the lake created by the open pit (see below).

Post-Closure Monitoring

The monitoring program proposed for the post-decommissioning phase of the KZK project will include the following:

As noted above, the fish salvaged from upper Geona Creek and transplanted to existing barren lakes/ponds will be monitored during the life of the mine and at closure to determine the success of the salvage/transplant measures. These lakes will also be checked again after mine closure at the time that fish are moved to the new area above the tailings dam (one to several years after closure), and again two (2) years later, and

When the water quality in the area above the tailings dam is of acceptable quality to support fish and other aquatic life, fish will be transplanted there, under permit from DFO, from the lower Finlayson Creek, or East Creek, system(s). The fish in the area above the tailings dam will be monitored 2 and 4 years after they are placed in the new area. The fish will be monitored for survival, evidence of successful reproduction and, if necessary, condition and growth factors. The timing of the transplant of fish to the area above the tailings dam will depend on water quality and evidence of invertebrate life in the lake, and will likely occur from one to several years after mine closure.

COSTS

Measures which will form the basis for the habitat compensation agreement in time sequence are as follows:

- stream channel construction work to provide good stream fish habitat in the proposed channel to upper South Lake from the point of diversion of Fault Creek. Fish habitat creation will include the placement (anchored) of large woody debris (LWD), such as log cut-banks and root wads, boulder clusters, gravels, pools and riffle areas in the new channel, and riparian planting along both banks. The work directed specifically towards fish habitat creation can be completed with a bull-dozer (1-2 days), back-hoe (3-5 days) and a small crew of 3-4 workers. A fisheries biologist, or technician, with experience in the creation of acceptable new fish habitat, will monitor and supervise the work. The main costs will include the heavy equipment and crew, and a fisheries consultant (5-6 days, including letter report). Supplies will include 1/4" steel cable, clean gravels, large rocks, shrubs/trees for planting, grass seed, silt fencing, filter cloth, logs & root wads, much of which can be obtained locally;
- fish salvage and transfer using helicopter support from the headwaters of Geona Creek to one or more barren lakes in the area. The fish salvage will involve a fisheries biologist, a field technician and 3-4 assistants (Ross River Dena), electro-fishing, trapping and seine netting gear, as well as a proper fish live-transport system (available from Whitehorse Hatchery) that operates from a helicopter. The fish salvage and transplant will require approximately 3 field days to ensure that all fish are removed from Geona Creek from the headwaters down to the proposed location of the tailings dam. Stop-nets will be deployed to ensure no fish can access the project area after the fish salvage. The salvaged fish (all species) will be air lifted to "Cirque Lake" and the uppermost pond in East Creek for stocking;
- surveys to confirm that the fish population has stabilized in the previously barren lakes 2 and 4 years after stocking and 1 after mine decommissioning. This can be accomplished in 1 full day on site for each monitoring event. The monitoring will be completed by a qualified fisheries biologist and diver using helicopter support. If samples are required for fish condition, or growth, assessments, the

field time would be approximately 2 days and would not significantly change the cost;

- stocking the area above the tailings dam with Arctic grayling when the water quality is acceptable following mine closure. This can be done by live-capturing fish from lower Finlayson and/or East Creeks, under permit, for transplant to the flooded tailings pond; and

surveys to confirm that the Arctic grayling population in the tailings pond has stabilized (two surveys 2 and 4 years after the transplant). This can be accomplished in 1 full day on site for each monitoring event. The monitoring will be completed by a qualified fisheries biologist and diver using helicopter support.

The costs for the above measures are estimated in Table 1, attached.

TABLE 1: COSTS FOR HABITAT COMPENSATION MEASURES

	RATES (\$/hr)	DAYS	COSTS
HABITAT CREATION IN SOUTH CREEK			
MANPOWER	\$105	5	\$5,250
	\$30	4	\$1,200
HEAVY EQUIPMENT	\$450	8	\$28,800
MATERIALS			\$2,500
DISBURSEMENTS			\$3,000
SUB-TOTAL			\$40,750
FISH SALVAGE/TRANSPORT			
MANPOWER	\$105	4	\$4,200
	\$30	12	\$3,600
HELICOPTER	\$750	3	\$4,500
DISBURSEMENTS			\$3,500
SUB-TOTAL			\$15,800
LAKE SURVEYS			
MANPOWER	\$30	10	\$3,000
HELICOPTER	\$750	8	\$9,000
DISBURSEMENTS			\$2,500
SUB-TOTAL			\$14,500
TAILINGS POND STOCKING			
MANPOWER	\$105	4	\$4,200
	\$30	3	\$900
HELICOPTER	\$750	2	\$3,000
DISBURSEMENTS			\$2,500
SUB-TOTAL			\$10,600
TAILINGS POND SURVEYS			
MANPOWER	\$30	10	\$3,000
HELICOPTER	\$750	4	\$9,000
DISBURSEMENTS			\$3,500
SUB-TOTAL			\$15,500
TOTAL			\$97,150
GST			\$8,801
GRAND TOTAL			\$105,951

**APPENDIX 2A
ACID ROCK CHARACTERIZATION DATA
FOR THE WOLVERINE PROPERTY**

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC1

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-63 Hanging Wall Composite (Comp 1)

Starting Date: July 15, 1997

Sample weight: 1 kg

Page: 1 of 3

Flush volume: 500 mL

Element	Unit	Cycle										
		0	1	2	3	4	5	6	7	8	9	10
Al	mg/L	0.18			0.11			0.08			0.10	
Sb	mg/L	<0.05			<0.05			<0.05			<0.05	
As	mg/L	<0.03			<0.03			<0.03			<0.03	
Ba	mg/L	0.063			0.028			0.021			0.018	
Be	mg/L	<0.001			<0.001			<0.001			<0.001	
Bi	mg/L	<0.1			<0.1			<0.1			<0.1	
B	mg/L	0.24			0.30			0.26			0.36	
Cd	mg/L	<0.005			<0.005			<0.005			<0.005	
Ca	mg/L	37.79			26.72			21.54			19.17	
Cr	mg/L	<0.01			<0.01			<0.01			<0.01	
Co	mg/L	<0.01			<0.01			<0.01			<0.01	
Cu	mg/L	<0.01			<0.01			0.02			0.02	
Fe	mg/L	<0.01			<0.01			<0.01			<0.01	
Pb	mg/L	<0.05			<0.05			<0.05			<0.05	
Li	mg/L	<0.02			<0.02			<0.02			<0.02	
Mg	mg/L	2.8			1.8			1.7			1.6	
Mn	mg/L	0.404			0.574			0.673			0.681	
Hg	mg/L	<0.02			<0.02			<0.02			<0.02	
Mo	mg/L	<0.01			<0.01			<0.01			<0.01	
Ni	mg/L	0.16			0.05			0.05			0.06	
P	mg/L	<0.1			<0.1			<0.1			<0.1	
K	mg/L	3			<2			<2			<2	
Se	mg/L	<0.05			<0.05			<0.05			<0.05	
Si	mg/L	0.46			0.18			0.12			0.28	
Ag	mg/L	<0.02			<0.02			<0.02			<0.02	
Na	mg/L	6			1.5			1.0			1.0	
Sr	mg/L	0.221			0.162			0.127			0.112	
Tl	mg/L	<0.2			<0.2			<0.2			<0.2	
Sn	mg/L	<0.1			<0.1			<0.1			<0.1	
Ti	mg/L	<0.01			<0.01			<0.01			<0.01	
W	mg/L	<0.1			<0.1			<0.1			<0.1	
V	mg/L	<0.01			<0.01			<0.01			<0.01	
Zn	mg/L	0.084			0.100			0.103			0.107	
Leachate Vol	mL	462	410	487	480	477	487	458	470	465	472	474
pH		7.4	7.1	6.8	7.3	6.7	7.1	6.9	6.8	6.7	6.9	6.9
Conductivity	µS	263	167	155	160	140	151	124	109	124	111	112
ORP	mV	120	117	119	90	120	93	103	106	118	114	270
Acidity	mg CaCO ₃ /L	4.6	3.8	3.6	4.0	4.7	2.3	2.7	2.8	3.7	3.3	3.0
Alkalinity	mg CaCO ₃ /L	2.5	11.4	10.5	12.9	11.5	8.8	8.6	6.4	9.5	8.4	7.9
Sulphate	mg/L	95	69	61	66	52	55	49	40	44	45	43
Cum. Sulphate	mg/kg	44	72	102	134	158	185	208	226	247	268	288

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC1

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-63 Hanging Wall Composite (Comp 1)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 2 of 3

Element	Unit	Cycle										
		11	12	13	14	15	16	17	18	19	20	21
Al	mg/L		0.06			0.12			0.07	0.05	<0.05	0.11
Sb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
As	mg/L		<0.03			<0.03			<0.03	<0.03	<0.03	<0.03
Ba	mg/L		0.017			0.016			0.013	0.013	0.012	0.011
Be	mg/L		<0.001			<0.001			<0.001	<0.001	<0.001	0.001
Bi	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
B	mg/L		0.35			0.39			0.28	0.28	0.38	0.31
Cd	mg/L		<0.005			<0.005			<0.005	<0.005	<0.005	<0.005
Ca	mg/L		17.63			17.08			14.25	14.47	13.52	13.13
Cr	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Co	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Cu	mg/L		0.02			0.02			0.01	<0.01	<0.01	0.02
Fe	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	0.11
Pb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Li	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mg	mg/L		1.5			1.5			1.7	1.6	1.2	0.9
Mn	mg/L		0.695			0.643			0.549	0.497	0.396	0.380
Hg	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mo	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Ni	mg/L		0.05			0.04			0.02	0.02	<0.01	0.03
P	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
K	mg/L		<2			<2			<2	<2	<2	<2
Se	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Si	mg/L		0.09			0.22			0.12	0.11	0.10	0.11
Ag	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Na	mg/L		1.0			0.9			1.0	0.7	0.9	1.4
Sr	mg/L		0.105			0.101			0.094	0.088	0.079	0.073
Tl	mg/L		<0.2			<0.2			<0.2	<0.2	<0.2	<0.2
Sn	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
Ti	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
W	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
V	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Zn	mg/L		0.097			0.114			0.067	0.063	0.057	0.075
Leachate Vol	mL	470	466	465	467	474	472	492	471	461	488	470
pH		6.9	7.0	6.7	6.7	7.0	6.9	6.7	6.9	6.6	6.9	6.5
Conductivity	µS	112	97	107	101	100	85	91	93	88	81	69
ORP	mV	290	235	244	212	193	206	257	223	205	221	150
Acidity	mg CaCO ₃ /L	3.5	2.3	4.2	3.3	2.5	3.7	1.8	2.7	3.9	3.2	4.6
Alkalinity	mg CaCO ₃ /L	11.0	9.3	10.2	8.0	6.4	8.0	5.8	9.1	9.5	9.1	6.4
Sulphate	mg/L	40	34	40	36	30	30	39	33	30	29	29
Cum. Sulphate	mg/kg	307	323	342	359	373	387	406	422	435	450	463

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC1

Reporting Date: January 29, 1998
 Project: 96-121

Sample id: DDH-WV96-63 Hanging Wall Composite (Comp 1)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 3 of 3

Element	Unit	Cycle										
		22	23	24	25	26	27	28	29	30	31	32
Al	mg/L	0.15	0.12	0.07	0.12	0.12						
Sb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
As	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03						
Ba	mg/L	0.012	0.011	0.008	0.011	0.010						
Be	mg/L	0.002	<0.001	<0.001	<0.001	<0.001						
Bi	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
B	mg/L	0.41	0.30	0.34	0.22	0.36						
Cd	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005						
Ca	mg/L	13.50	14.21	9.64	12.79	11.78						
Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Cu	mg/L	0.06	0.02	0.06	0.05	<0.01						
Fe	mg/L	0.17	<0.01	0.05	0.02	<0.01						
Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Li	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mg	mg/L	1.3	1.4	1.0	0.9	0.9						
Mn	mg/L	0.439	0.444	0.282	0.328	0.277						
Hg	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mo	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Ni	mg/L	0.03	0.02	0.01	0.02	0.01						
P	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
K	mg/L	<2	<2	<2	<2	<2						
Se	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Si	mg/L	0.29	0.22	0.17	0.20	0.25						
Ag	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Na	mg/L	0.6	<0.2	1.2	0.4	0.6						
Sr	mg/L	0.081	0.081	0.046	0.073	0.067						
Tl	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2						
Sn	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
Ti	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
W	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
V	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Zn	mg/L	0.064	0.057	0.065	0.053	0.022						
Leachate Vol	mL	470	474	495	470	485						
pH		6.6	6.4	6.7	6.7	6.4						
Conductivity	µS	69	69	53	66	59						
ORP	mV	178	179	244	336	277						
Acidity	mg CaCO ₃ /L	4.6	3.7	3.8	4.0	4.4						
Alkalinity	mg CaCO ₃ /L	7.1	8.2	4.6	8.6	7.1						
Sulphate	mg/L	31	30	22	26	28						
Cum. Sulphate	mg/kg	478	492	503	515	529						

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC2

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-60 Foot Wall Composite (Comp 2)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 1 of 3

Element	Unit	Cycle										
		0	1	2	3	4	5	6	7	8	9	10
Al	mg/L	0.17			0.11			0.10			0.07	
Sb	mg/L	0.13			0.10			0.05			<0.05	
As	mg/L	<0.03			<0.03			<0.03			<0.03	
Ba	mg/L	0.052			0.021			0.019			0.015	
Be	mg/L	<0.001			<0.001			<0.001			<0.001	
Bi	mg/L	<0.1			<0.1			<0.1			<0.1	
B	mg/L	0.26			0.34			0.38			0.31	
Cd	mg/L	0.011			0.006			0.014			0.018	
Ca	mg/L	21.97			20.38			17.40			18.63	
Cr	mg/L	<0.01			<0.01			<0.01			<0.01	
Co	mg/L	<0.01			<0.01			<0.01			<0.01	
Cu	mg/L	0.03			0.02			0.06			0.02	
Fe	mg/L	0.02			<0.01			0.03			0.11	
Pb	mg/L	<0.05			<0.05			<0.05			<0.05	
Li	mg/L	<0.02			<0.02			<0.02			<0.02	
Mg	mg/L	2.9			2.2			1.8			1.7	
Mn	mg/L	0.083			0.066			0.080			0.100	
Hg	mg/L	<0.02			<0.02			<0.02			<0.02	
Mo	mg/L	<0.01			<0.01			<0.01			<0.01	
Ni	mg/L	0.11			0.02			0.12			0.07	
P	mg/L	<0.1			<0.1			<0.1			<0.1	
K	mg/L	18			8			3			<2	
Se	mg/L	0.13			<0.05			<0.05			<0.05	
Si	mg/L	0.55			0.25			0.27			0.15	
Ag	mg/L	<0.02			<0.02			<0.02			<0.02	
Na	mg/L	32.2			7.9			2.3			1.3	
Sr	mg/L	0.086			0.081			0.067			0.068	
Tl	mg/L	<0.2			<0.2			<0.2			<0.2	
Sn	mg/L	<0.1			<0.1			<0.1			<0.1	
Ti	mg/L	<0.01			<0.01			<0.01			<0.01	
W	mg/L	<0.1			<0.1			<0.1			<0.1	
V	mg/L	<0.01			<0.01			<0.01			<0.01	
Zn	mg/L	0.37			0.300			0.875			1.101	
Leachate Vol	mL	422	430	458	482	458	456	456	456	470	456	454
pH		7.3	7.0	6.6	6.9	6.7	6.7	6.7	6.7	6.6	6.5	6.6
Conductivity	µS	29	166	14	174	14	147	122	126	134	114	119
ORP	mV	111	157	128	90	136	96	121	117	125	123	276
Acidity	mg CaCO ₃ /L	6.3	4.0	3.4	4.0	2.8	4.2	3.6	3.9	3.9	3.7	3.9
Alkalinity	mg CaCO ₃ /L	18.0	5.5	5.9	7.3	6.4	4.4	3.8	3.8	3.8	3.9	4.9
Sulphate	mg/L	125	58	56	67	57	57	47	47	54	51	51
Cum. Sulphate	mg/kg	53	78	103	136	162	188	209	231	256	279	302

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC2

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-60 Foot Wall Composite (Comp 2)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 2 of 3

Element	Unit	Cycle										
		11	12	13	14	15	16	17	18	19	20	21
Al	mg/L		0.07			0.06			<0.05	<0.05	<0.05	0.1
Sb	mg/L		<0.05			<0.05			<0.05	<0.05	0.05	<0.05
As	mg/L		<0.03			<0.03			<0.03	<0.03	<0.03	<0.03
Ba	mg/L		0.011			0.010			0.011	0.011	0.011	0.009
Be	mg/L		<0.001			<0.001			<0.001	<0.001	<0.001	<0.001
Bi	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
B	mg/L		0.34			0.3			0.26	0.36	0.35	0.25
Cd	mg/L		0.019			0.013			0.007	0.008	0.012	0.013
Ca	mg/L		17.94			14.70			13.44	15.23	13.83	18.84
Cr	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Co	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Cu	mg/L		0.01			0.04			<0.01	<0.01	0.02	<0.01
Fe	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	0.02
Pb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Li	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mg	mg/L		1.5			1.3			1.2	1.2	1.1	1.4
Mn	mg/L		0.108			0.093			0.078	0.085	0.074	0.093
Hg	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mo	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Ni	mg/L		0.06			0.04			0.02	0.02	0.01	0.03
P	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
K	mg/L		<2			<2			<2	<2	<2	<2
Se	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Si	mg/L		0.13			0.12			0.15	0.18	0.16	0.15
Ag	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Na	mg/L		1.2			0.9			0.9	0.9	0.9	1.4
Sr	mg/L		0.064			0.053			0.056	0.058	0.053	0.069
Tl	mg/L		<0.2			<0.2			<0.2	<0.2	<0.2	<0.2
Sn	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
Ti	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
W	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
V	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Zn	mg/L		1.112			0.764			0.356	0.463	0.454	0.597
Leachate Vol	mL	440	447	445	460	458	467	499	493	478	496	484
pH		6.7	6.8	6.5	6.6	6.7	6.7	6.7	6.8	6.8	6.7	6.6
Conductivity	µS	116	103	104		94	72	83	88	91	84	96
ORP	mV	202	240	245	226	201	213	265	237	213	238	177
Acidity	mg CaCO ₃ /L	3.9	3.5	5.4	4.4	3.5	2.8	2.3	3.2	2.5	3.2	4.6
Alkalinity	mg CaCO ₃ /L	6.9	6.4	7.1	6.2	4.9	4.4	5.8	6.4	8.0	9.3	5.5
Sulphate	mg/L	45	45	42	37	34	29	35	33	33	31	46
Cum. Sulphate	mg/kg	322	342	361	378	394	407	425	441	457	472	494

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC2

Reporting Date: January 29, 1998
 Project: 96-121

Sample id: DDH-WV96-60 Foot Wall Composite (Comp 2)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 3 of 3

Element	Unit	Cycle										
		22	23	24	25	26	27	28	29	30	31	32
Al	mg/L	0.11	0.11	0.09	0.10	0.10						
Sb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
As	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03						
Ba	mg/L	0.008	0.009	0.011	0.010	0.010						
Be	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001						
Bi	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
B	mg/L	0.33	0.27	0.30	0.20	0.31						
Cd	mg/L	0.009	0.011	0.009	0.011	0.010						
Ca	mg/L	14.11	13.71	11.79	10.51	11.32						
Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Cu	mg/L	0.03	<0.01	0.08	0.03	0.01						
Fe	mg/L	0.02	<0.01	<0.01	<0.01	<0.01						
Pb	mg/L	<0.05	<0.05	0.06	<0.05	<0.05						
Li	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mg	mg/L	1.0	1.0	0.8	0.7	0.8						
Mn	mg/L	0.076	0.069	0.087	0.058	0.054						
Hg	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mo	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Ni	mg/L	0.02	0.03	0.03	0.02	0.02						
P	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
K	mg/L	<2	<2	<2	<2	<2						
Se	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Si	mg/L	0.18	0.20	0.23	0.20	0.28						
Ag	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Na	mg/L	0.5	<0.2	1.2	<0.2	0.5						
Sr	mg/L	0.051	0.049	0.035	0.039	0.040						
Tl	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2						
Sn	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
Ti	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
W	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
V	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Zn	mg/L	0.413	0.455	0.525	0.395	0.392						
Leachate Vol	mL	490	490	496	491	485						
pH		6.4	6.6	6.5	6.5	6.4						
Conductivity	µS	74	67	60	55	57						
ORP	mV	197	184	249	340	276						
Acidity	mg CaCO ₃ /L	4.5	3.6	3.7	4.2	4.4						
Alkalinity	mg CaCO ₃ /L	6.6	7.3	6.4	7.1	6.6						
Sulphate	mg/L	33	29	20	21	29						
Cum. Sulphate	mg/kg	510	525	535	545	559						

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC3

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-58 Foot Wall Composite (Comp 3)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 1 of 3

Element	Unit	Cycle										
		0	1	2	3	4	5	6	7	8	9	10
Al	mg/L	0.8			0.23			0.37			0.37	
Sb	mg/L	<0.05			<0.05			<0.05			<0.05	
As	mg/L	<0.03			<0.03			<0.03			<0.03	
Ba	mg/L	0.133			0.041			0.021			0.014	
Be	mg/L	<0.001			<0.001			<0.001			<0.001	
Bi	mg/L	<0.1			<0.1			<0.1			<0.1	
B	mg/L	0.24			0.26			0.39			0.35	
Cd	mg/L	<0.005			<0.005			<0.005			<0.005	
Ca	mg/L	31.92			38.14			22.64			20.65	
Cr	mg/L	<0.01			<0.01			<0.01			<0.01	
Co	mg/L	0.04			0.03			0.02			0.03	
Cu	mg/L	0.12			0.07			0.12			0.14	
Fe	mg/L	6.5			1.60			5.09			6.48	
Pb	mg/L	<0.05			<0.05			<0.05			<0.05	
Li	mg/L	<0.02			<0.02			<0.02			<0.02	
Mg	mg/L	5.7			5.3			5.1			6.3	
Mn	mg/L	0.698			0.891			0.999			1.174	
Hg	mg/L	<0.02			<0.02			<0.02			<0.02	
Mo	mg/L	<0.01			<0.01			<0.01			<0.01	
Ni	mg/L	0.8			0.31			0.30			0.31	
P	mg/L	<0.1			<0.1			<0.1			<0.1	
K	mg/L	3			<2			<2			<2	
Se	mg/L	<0.05			<0.05			<0.05			<0.05	
Si	mg/L	0.55			0.38			0.36			0.21	
Ag	mg/L	<0.02			<0.02			<0.02			<0.02	
Na	mg/L	8.9			1.9			1.1			1.1	
Sr	mg/L	0.1			0.093			0.061			0.055	
Tl	mg/L	<0.2			<0.2			<0.2			<0.2	
Sn	mg/L	<0.1			<0.1			<0.1			<0.1	
Ti	mg/L	<0.01			<0.01			<0.01			<0.01	
W	mg/L	<0.1			<0.1			<0.1			<0.1	
V	mg/L	<0.01			<0.01			<0.01			<0.01	
Zn	mg/L	0.788			0.563			0.610			0.697	
Leachate Vol	mL	467	420	490	420	407	449	430	458	452	446	451
pH		4.8	4.5	4.5	4.8	4.8	4.5	4.4	4.3	4.2	4.1	4.3
Conductivity	µS	308	444	358	246	224	140	186	164	220	190	260
ORP	mV	183	204	190	134	146	165	227	166	195	186	293
Acidity	mg CaCO ₃ /L	23.5	101.8	59.4	10.7	10.3	10.5	18.3	17.0	25.0	24.9	27.0
Alkalinity	mg CaCO ₃ /L	--	--	--	--	--	--	--	--	--	--	--
Sulphate	mg/L	140	225	180	110	95	60	90	75	95	95	100
Cum. Sulphate	mg/kg	65	160	248	294	333	360	399	433	476	518	563

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC3

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-58 Foot Wall Composite (Comp 3)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 2 of 3

Element	Unit	Cycle										
		11	12	13	14	15	16	17	18	19	20	21
Al	mg/L		0.22			0.09			0.16	0.09	0.08	0.15
Sb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
As	mg/L		<0.03			<0.03			<0.03	<0.03	<0.03	<0.03
Ba	mg/L		0.011			0.010			0.011	0.011	0.01	0.006
Be	mg/L		<0.001			<0.001			<0.001	<0.001	<0.001	<0.001
Bi	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
B	mg/L		0.42			0.42			0.27	0.35	0.39	0.31
Cd	mg/L		<0.005			<0.005			<0.005	<0.005	<0.005	<0.005
Ca	mg/L		15.25			14.23			11.04	12.36	11.75	16.63
Cr	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Co	mg/L		0.02			<0.01			<0.01	<0.01	<0.01	<0.01
Cu	mg/L		0.13			0.06			0.08	0.05	0.07	0.07
Fe	mg/L		3.10			0.21			0.50	0.43	0.42	0.55
Pb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Li	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mg	mg/L		6.2			4.1			2.4	2.8	2.5	3.3
Mn	mg/L		1.159			0.654			0.343	0.393	0.366	0.480
Hg	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mo	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Ni	mg/L		0.24			0.11			0.05	0.06	0.05	0.07
P	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
K	mg/L		<2			<2			<2	<2	<2	<2
Se	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Si	mg/L		0.34			0.22			0.19	0.20	0.30	0.32
Ag	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Na	mg/L		1.0			1.0			0.9	0.8	0.8	1.4
Sr	mg/L		0.045			0.040			0.035	0.035	0.033	0.046
Tl	mg/L		<0.2			<0.2			<0.2	<0.2	<0.2	<0.2
Sn	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
Ti	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
W	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
V	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Zn	mg/L		0.559			0.235			0.148	0.135	0.130	0.143
Leachate Vol	mL	437	449	480	460	464	476	463	466	476	470	470
pH		4.3	4.6	4.6	4.8	4.9	4.9	5.2	5.1	5.3	5.3	5.2
Conductivity	µS	164	140	195	154	118	113	85	85	89	89	105
ORP	mV	291	263	288	239	235	196	157	147	171	176	240
Acidity	mg CaCO ₃ /L	16.0	14.0	14.0	8.4	5.1	6.0	5.8	4.6	5.7	6.2	7.6
Alkalinity	mg CaCO ₃ /L	--	--	--	--	--	--	0.4	--	0.4	0.2	--
Sulphate	mg/L	85	75	95	73	50	56	41	40	40	40	58
Cum. Sulphate	mg/kg	600	634	680	713	737	763	782	801	820	839	866

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC3

Reporting Date: January 29, 1998
 Project: 96-121

Sample id: DDH-WV96-58 Foot Wall Composite (Comp 3)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 3 of 3

Element	Unit	Cycle										
		22	23	24	25	26	27	28	29	30	31	32
Al	mg/L	0.15	0.15	0.11	0.12	0.12						
Sb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
As	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03						
Ba	mg/L	0.007	0.008	0.008	0.008	0.007						
Be	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001						
Bi	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
B	mg/L	0.40	0.29	0.30	0.19	0.31						
Cd	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005						
Ca	mg/L	11.54	11.97	11.19	11.34	10.69						
Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Cu	mg/L	0.08	0.07	0.12	0.09	0.04						
Fe	mg/L	0.56	0.52	0.42	0.52	0.43						
Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Li	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mg	mg/L	2.5	2.6	2.3	2.1	1.9						
Mn	mg/L	0.400	0.403	0.363	0.336	0.290						
Hg	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mo	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Ni	mg/L	0.07	0.07	0.06	0.05	0.03						
P	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
K	mg/L	<2	<2	<2	<2	<2						
Se	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Si	mg/L	0.35	0.30	0.18	0.28	0.40						
Ag	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Na	mg/L	0.6	<0.2	1.2	<0.2	0.5						
Sr	mg/L	0.034	0.033	0.027	0.031	0.029						
Tl	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2						
Sn	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
Ti	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
W	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
V	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Zn	mg/L	0.129	0.127	0.124	0.107	0.075						
Leachate Vol	mL	465	474	484	468	470						
pH		4.8	5.0	5.3	5.5	5.4						
Conductivity	µS	78	75	75	70	67						
ORP	mV	210	193	200	253	216						
Acidity	mg CaCO ₃ /L	8.0	5.3	5.2	6.3	5.98						
Alkalinity	mg CaCO ₃ /L	--	--	1	0.2	0.2						
Sulphate	mg/L	40	42	34	35	40						
Cum. Sulphate	mg/kg	885	904	921	937	956						

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)

Reporting Date: December 31, 1997

Test: HC4

Project: 96-121

Sample id: DDH-WV96-72 Hanging Wall Composite (Comp 4)

Starting Date: July 15, 1997

Sample weight: 1 kg

Page: 1 of 3

Flush volume: 500 mL

Element	Unit	Cycle										
		0	1	2	3	4	5	6	7	8	9	10
Al	mg/L	0.17			0.12			0.11			0.12	
Sb	mg/L	<0.05			<0.05			<0.05			<0.05	
As	mg/L	<0.03			<0.03			<0.03			<0.03	
Ba	mg/L	0.067			0.036			0.033			0.025	
Be	mg/L	<0.001			<0.001			<0.001			<0.001	
Bi	mg/L	<0.1			<0.1			<0.1			<0.1	
B	mg/L	0.24			0.34			0.29			0.34	
Cd	mg/L	0.017			0.008			0.017			0.012	
Ca	mg/L	55.69			25.81			32.99			25.58	
Cr	mg/L	<0.01			<0.01			<0.01			<0.01	
Co	mg/L	0.01			<0.01			<0.01			<0.01	
Cu	mg/L	0.01			<0.01			0.04			0.03	
Fe	mg/L	<0.01			<0.01			<0.01			0.03	
Pb	mg/L	<0.05			<0.05			<0.05			<0.05	
Li	mg/L	<0.02			<0.02			<0.02			<0.02	
Mg	mg/L	9.8			4.0			6.9			4.8	
Mn	mg/L	1.033			0.323			0.514			0.366	
Hg	mg/L	<0.02			<0.02			<0.02			<0.02	
Mo	mg/L	<0.01			<0.01			<0.01			<0.01	
Ni	mg/L	0.14			0.01			0.02			<0.01	
P	mg/L	<0.1			<0.1			<0.1			<0.1	
K	mg/L	5			<2			<2			<2	
Se	mg/L	0.1			<0.05			0.07			<0.05	
Si	mg/L	0.62			0.27			0.25			0.28	
Ag	mg/L	<0.02			<0.02			<0.02			<0.02	
Na	mg/L	14.5			2.0			1.3			1.1	
Sr	mg/L	0.311			0.175			0.191			0.140	
Tl	mg/L	<0.2			<0.2			<0.2			<0.2	
Sn	mg/L	<0.1			<0.1			<0.1			<0.1	
Ti	mg/L	<0.01			<0.01			<0.01			<0.01	
W	mg/L	<0.1			<0.1			<0.1			<0.1	
V	mg/L	<0.01			<0.01			<0.01			<0.01	
Zn	mg/L	1.426			0.622			1.292			0.836	
Leachate Vol	mL	417	415	483	458	440	425	452	451	467	452	467
pH		7.1	6.6	7.0	6.8	6.7	6.6	6.5	6.7	6.3	6.5	6.7
Conductivity	µS	456	241	398	175	225	211	220	210	210	163	150
ORP	mV	112	168	115	164	142	111	140	124	142	157	275
Acidity	mg CaCO ₃ /L	8.4	5.3	4.2	3.7	3.9	4.2	3.8	3.7	3.9	3.9	3.5
Alkalinity	mg CaCO ₃ /L	17.7	6.4	8.6	7.5	5.9	3.9	5.1	3.5	4.2	3.5	4.4
Sulphate	mg/L	175	105	180	90	95	95	95	90	95	90	78
Cum. Sulphate	mg/kg	73	117	203	245	287	327	370	410	455	495	532

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC4

Reporting Date: December 31, 1997
 Project: 96-121

Sample id: DDH-WV96-72 Hanging Wall Composite (Comp 4)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 2 of 3

Element	Unit	Cycle										
		11	12	13	14	15	16	17	18	19	20	21
Al	mg/L		0.06			0.08			<0.05	0.07	0.05	0.11
Sb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
As	mg/L		<0.03			<0.03			<0.03	<0.03	<0.03	<0.03
Ba	mg/L		0.023			0.021			0.016	0.014	0.018	0.013
Be	mg/L		<0.001			<0.001			<0.001	<0.001	<0.001	<0.001
Bi	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
B	mg/L		0.22			0.35			0.25	0.31	0.37	0.24
Cd	mg/L		0.009			0.009			0.006	0.006	0.011	0.010
Ca	mg/L		17.73			17.17			14.02	15.34	14.18	20.68
Cr	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Co	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Cu	mg/L		0.02			0.01			0.02	0.02	<0.01	<0.01
Fe	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	0.02
Pb	mg/L		<0.05			<0.05			<0.05	<0.05	<0.05	<0.05
Li	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mg	mg/L		3.9			3.7			3.0	3.4	3.1	4.1
Mn	mg/L		0.319			0.362			0.280	0.295	0.300	0.396
Hg	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Mo	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Ni	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
P	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
K	mg/L		<2			<2			<2	<2	<2	<2
Se	mg/L		<0.05			<0.05			<0.05	<0.05	0.05	<0.05
Si	mg/L		0.12			0.18			0.12	0.14	0.15	0.19
Ag	mg/L		<0.02			<0.02			<0.02	<0.02	<0.02	<0.02
Na	mg/L		0.9			0.8			0.8	0.8	0.9	1.4
Sr	mg/L		0.096			0.093			0.085	0.082	0.080	0.109
Tl	mg/L		<0.2			<0.2			<0.2	<0.2	<0.2	<0.2
Sn	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
Ti	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
W	mg/L		<0.1			<0.1			<0.1	<0.1	<0.1	<0.1
V	mg/L		<0.01			<0.01			<0.01	<0.01	<0.01	<0.01
Zn	mg/L		0.739			0.708			0.459	0.466	0.601	0.783
Leachate Vol	mL	455	456	460	459	459	482	474	479	483	482	480
pH		6.7	6.6	6.6	6.6	6.7	6.6	6.6	6.6	6.6	6.8	6.6
Conductivity	µS	159	117	133	129	130	104	110	106	108	102	122
ORP	mV	102	243	167	228	213	182	146	139	146	188	198
Acidity	mg CaCO ₃ /L	4.0	4.2	5.1	4.9	3.5	3.2	2.8	3.0	3.0	4.1	5.1
Alkalinity	mg CaCO ₃ /L	5.7	4.6	6.6	5.3	3.5	5.1	4.9	4.6	4.6	6.2	4.6
Sulphate	mg/L	75	57	60	64	50	45	45	41	45	40	66
Cum. Sulphate	mg/kg	566	592	620	649	672	694	715	735	756	776	807

HUMIDITY CELL TEST REPORT

Client: Westmin Resources Limited (Wolverine Lake Project)
 Test: HC4

Reporting Date: January 29, 1998
 Project: 96-121

Sample id: DDH-WV96-72 Hanging Wall Composite (Comp 4)
 Sample weight: 1 kg
 Flush volume: 500 mL

Starting Date: July 15, 1997
 Page: 3 of 3

Element	Unit	Cycle										
		22	23	24	25	26	27	28	29	30	31	32
Al	mg/L	0.14	0.07	0.08	0.10	0.12						
Sb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
As	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03						
Ba	mg/L	0.015	0.013	0.013	0.014	0.015						
Be	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001						
Bi	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
B	mg/L	0.42	0.23	0.34	0.19	0.33						
Cd	mg/L	0.009	0.007	0.008	0.008	0.008						
Ca	mg/L	14.90	13.82	11.61	12.08	11.33						
Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Cu	mg/L	<0.01	<0.01	0.05	0.03	<0.01						
Fe	mg/L	0.03	<0.01	<0.01	<0.01	<0.01						
Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Li	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mg	mg/L	3.4	3.0	2.6	2.6	2.5						
Mn	mg/L	0.342	0.300	0.273	0.283	0.251						
Hg	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Mo	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Ni	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
P	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
K	mg/L	<2	<2	<2	<2	<2						
Se	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05						
Si	mg/L	0.32	0.15	0.16	0.16	0.35						
Ag	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02						
Na	mg/L	0.7	<0.2	1.3	<0.2	0.5						
Sr	mg/L	0.080	0.073	0.054	0.067	0.062						
Tl	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2						
Sn	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
Ti	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
W	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1						
V	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01						
Zn	mg/L	0.584	0.537	0.545	0.575	0.513						
Leachate Vol	mL	480	486	492	478	478						
pH		6.4	6.4	6.6	6.2	6.4						
Conductivity	µS	94	82	75	75	70						
ORP	mV	172	160	172	259	195						
Acidity	mg CaCO ₃ /L	5.3	4.2	4.1	5.1	4.6						
Alkalinity	mg CaCO ₃ /L	6.6	6.6	6.0	6.9	6.6						
Sulphate	mg/L	43	37	31	33	38						
Cum. Sulphate	mg/kg	828	846	861	877	895						

Sample	% Total	% Sulfate	Paste	Acid	Neutralization Potential (NP)		
	Sulfur	Sulfur	pH	Potential	Actual	Ratio	Net
WV96-58 Hanging wall	3.29	0.01	8	103	142	1.39	40
WV96-58 Foot wall	1.77	0.01	7.9	55	22.3	0.4	-33
WV96-72 Hanging wall	5.59	0.04	7.9	174.7	38.5	0.22	-136.2
WV96-72 Foot wall	1.09	<0.01	8.4	34.1	196	5.76	162
WV96 - 72 Hanging/foot	2.7	<0.01	7.5	84.4	33.7	0.4	-50.7
WV96-39 Hanging wall	3.44	<0.01	7.7	108	82.8	0.77	-25
WV96-39 Foot wall	0.28	<0.01	8.8	9	49.5	5.66	40.8
WV96-63 Hanging wall	1.57	<0.01	8.1	49.1	161	3.29	112
WV96-63 Foot wall	1.24	<0.01	8	38.8	91.5	2.36	52.8
WV96-60 Foot wall	2.11	<0.01	8	65.9	60.8	0.92	-5.2
Massive Sulphide Comp 3							
Massive Sulphide Comp 2							
Massive Sulphide Comp 1							
WV96-72 Foot wall (D)	1.07	<0.01	8.4	33.4	198	5.92	165
WV96-72 Hanging wall (D)					44.3		
WV96 - 72 Hanging/foot (D)	2.81	<0.01	7.4	87.8	34.9	0.4	-53

Results of QA/QC Samples

Date:

Duplicate samples were sent to Process Research Associates (PRA) and the BC Research (BCR).

Data from:

Sample	% Total Sulfur	% Sulfate Sulfur	Paste pH	Acid Potential	Neutralization Potential (NP)		
					Actual	Ratio	Net
105226 + 105213	9.77	0.06	6.4	3.03	29.4	0.1	-27.4
					28		
105777	2.15	<0.01	8.2	67.2	21.5	0.32	-45.7
					23.6		
105777 (BCR)	2.13		8.6	66.6	18.3	0.27	-48.3
105809	0.79	0.02	7.4	24.1	14.1	0.59	-10
					12		
105812	2.14	<0.01	7.7	66.9	24.3	0.36	-42.6
105812 (BCR)	2.06		8.3	64.4	21.6	0.33	-42.9
105831	3.31	0.01	7.7	103	17.8	0.17	-85.3
105831 (BCR)	3.52		7.6	110	12.1	0.11	-97.9
105938 + 105939	6.83	<0.01	7.6	213	200	0.94	-13.4
					202		
172344	1.72	<0.01	8.1	53.8	16.9	0.31	-36.9
172344 (BCR)	1.84		8.4	57.5	15.4	0.27	-42.1
172348	45.6	0.02	6.3	1424	10.4	0.01	-141.4
172410	0.56	<0.01	8.3	17.5	227	13	209
172420	2.08	<0.01	7.9	65	28.2	0.43	-36.8
172420 (BCR)	2.09		8.2	66.3	20.8	0.32	-44.7
172454	2.64	<0.01	7.1	82.5	5.1	0.06	-77.4
172454 (BCR)	2.76		7.4	86.2	6.7	0.08	-79.5

APPENDIX 3A

**CLIMATE DATA FROM KUDZ ZE KAYAH AND
WOLVERINE WEATHER STATIONS**

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Summary of Temperature Data From Kudz Ze Kayah Low Elevation Weather Station (°C)

1995															
	May			June			July			August			September		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	
1									6.9	10.7	4.6	4.7	8.5	1.8	
2						11.9	14.5	8.9	9.0	13.8	4.7	7.3	9.5	4.2	
3						10.5	13.9	8.2	9.9	13.7	6.6	5.6	7.8	3.4	
4						9.6	11.0	8.1	7.4	9.0	6.0				
5						10.1	16.2	5.3	6.4	9.4	4.5				
6						9.4	13.9	3.6	6.2	10.4	3.5				
7						9.8	16.0	4.4	7.2	12.0	3.2				
8						12.5	19.2	3.6	8.5	14.7	1.8				
9						12.9	18.3	6.9	8.7	16.6	0.5				
10						11.4	14.0	8.0	9.5	16.6	1.2				
11						11.5	16.3	6.9	9.6	15.6	4.5				
12						12.1	17.7	3.5	10.5	16.9	3.4				
13						11.1	13.7	8.6	11.2	14.7	6.2				
14						11.6	16.3	6.3	7.9	11.0	5.1				
15						11.8	15.2	9.2	7.5	12.7	-0.5				
16						10.6	14.1	6.4	9.0	12.2	5.7				
17						12.4	17.0	7.0	7.2	12.3	2.8				
18						12.2	17.3	6.8	6.3	11.8	0.9				
19						13.4	18.4	7.4	6.1	10.9	2.0				
20						11.5	15.0	7.5	7.1	12.1	1.3				
21									7.6	13.6	3.3				
22									6.1	11.1	2.4				
23									6.7	11.1	3.5				
24						8.5	11.3	5.4	5.9	10.3	1.1				
25						7.6	9.9	5.8	5.3	10.4	1.1				
26						8.3	11.5	6.2	5.2	9.2	1.4				
27						7.9	11.3	5.1	3.5	7.5	-0.2				
28						5.2	6.8	3.3	4.5	8.9	-1.2				
29						5.2	8.7	2.1	3.2	6.7	0.2				
30						7.1	11.4	2.7	5.8	9.5	-0.6				
31						6.8	9.7	4.9	8.0	11.6	3.8				
Avg						10.1	14.0	6.0	7.2	11.8	2.7				
Max						13.4	19.2	9.2	11.2	16.9	6.6				
Min						5.2	6.8	2.1	3.2	6.7	-1.2				

1996															
	May			June			July			August			September		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	
1			8.1	12.5	1.0	5.1	7.7	2.9							
2			6.1	8.5	0.2	7.3	11.0	1.5							
3			4.5	8.9	-2.2	7.9	13.4	3.8							
4	-4.6	-14.8	2.8	6.2	-0.7	9.7	13.9	5.5							
5	-3.3	-17.4	5.7	10.9	-3.1	10.1	15.0	6.6							
6	-2.1	-13.5	8.1	12.1	2.9	11.5	15.8	5.1							
7	-1.4	-10.1	6.7	10.4	3.1	11.3	17.1	4.5							
8	1.6	-12.9	5.8	10.1	3.2	8.5	10.0	7.4							
9	5.6	-7.2	4.9	8.7	1.1	9.8	13.8	6.8							
10	3.8	-3.1	5.2	9.5	1.8	7.9	10.7	4.1							
11	5.3	-4.5	5.4	9.3	0.9	4.9	7.0	2.8							
12	5.4	-3.5	3.9	6.9	0.0	9.1	14.9	4.4							
13	4.9	-2.8	4.0	8.5	-1.7	10.4	16.5	2.4							
14	3.6	-3.1	6.7	11.0	0.9	10.3	13.9	2.8							
15	3.1	-2.3	8.5	15.1	-0.1	12.3	17.6	7.2							
16	5.4	-2.7	10.7	15.2	1.6	13.6	19.4	5.4							
17	8.8	-3.5	11.7	18.0	1.8	12.9	17.7	8.4							
18	8.6	-1.0	12.6	18.5	3.1	9.6	13.2	3.6							
19	9.2	0.2	12.5	18.3	2.3	9.1	12.4	5.8							
20	11.4	-1.4	12.2	18.1	5.4	11.2	15.6	5.1							
21	10.8	-1.3	12.7	18.3	3.6	13.6	19.5	6.6							
22	11.1	0.2	13.9	19.5	5.5	14.9	21.0	7.3							
23	7.8	2.2	14.6	20.2	4.1	14.2	20.6	6.2							
24	6.3	0.1	12.8	16.4	6.2	15.7	23.8	5.0							
25	5.6	0.2	10.4	13.7	5.5										
26	8.4	1.0	9.9	14.4	5.2										
27	9.4	2.1	7.7	10.7	5.3										
28	7.5	0.0	7.2	10.9	2.8										
29	11.8	-2.6	6.5	10.6	3.1										
30	14.2	-0.1	4.4	7.6	0.8										
31	12.6	1.3													
Avg	6.1	-3.6	8.2	12.6	2.1	10.5	15.1	5.0							
Max	14.2	2.2	14.6	20.2	6.2	15.7	23.8	8.4							
Min	-4.6	-17.4	2.8	6.2	-3.1	4.9	7.0	1.5							

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Summary of Temperature Data From Kudz Ze Kayah High Elevation Weather Station (°C)

1995																					
March			April			May			June			July			August			September			
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1													10.9	12.6	7.8	7.4	11.3	4.4	5.4	7.3	3.2
2													8.8	11.5	7.5	8.0	11.6	4.7	4.2	6.0	2.4
3													7.9	8.9	7.2	5.4	6.9	4.1			
4													9.0	14.1	6.4	4.4	6.7	2.8			
5													8.1	11.0	4.6	5.1	8.2	3.6			
6													9.5	14.3	5.3	6.4	9.7	3.4			
7													12.7	17.0	8.2	8.7	12.6	4.8			
8													12.6	16.0	8.8	9.6	14.2	4.8			
9													9.4	11.8	6.5	10.6	13.7	6.8			
10													9.9	14.2	6.4	9.0	12.9	6.2			
11													11.4	15.6	6.7	10.2	14.7	5.6			
12													9.3	11.3	7.9	9.7	12.2	6.8			
13													10.3	14.0	7.3	6.3	8.8	4.8			
14													9.6	12.1	7.5	7.0	10.0	3.9			
15													9.3	12.4	6.0	7.8	10.7	5.1			
16													10.9	14.9	7.7	6.9	9.5	4.2			
17													11.5	14.7	9.1	6.5	9.7	4.0			
18													13.1	16.2	9.9	5.9	9.1	4.3			
19													10.4	12.6	8.7	7.2	9.7	5.1			
20													10.4	13.0	7.3	7.1	10.8	5.0			
21										15.3	18.2	11.7	8.8	10.2	7.8	5.6	8.8	4.0			
22										8.5	18.2	1.9	7.3	9.1	5.5	5.5	9.8	3.5			
23										3.1	7.7	-0.1	6.7	8.8	4.5	5.2	8.3	3.5			
24										3.8	6.2	1.6	5.6	7.5	4.0	5.1	8.4	2.4			
25										6.5	9.5	4.8	6.4	9.3	4.5	4.1	6.8	1.1			
26										8.7	13.2	4.8	6.7	9.2	3.6	2.7	5.6	0.8			
27										10.7	14.7	8.7	3.8	5.1	2.8	3.6	6.4	0.8			
28										12.5	16.2	8.7	4.4	7.0	2.4	1.8	4.0	-0.2			
29													6.8	10.1	4.0	4.0	7.2	-0.6			
30													4.8	7.1	3.3	5.9	8.8	3.8			
31													5.2	8.6	3.3	3.3	6.9	0.5			
Ave										8.7	13.0	5.3	8.7	11.6	6.2	6.3	9.5	3.7	4.8	6.7	2.8
Max										15.3	18.2	11.7	13.1	17.0	9.9	10.6	14.7	6.8	5.4	7.3	3.2
Min										3.1	6.2	0.1	3.8	5.1	2.4	1.8	4.0	-0.6	4.2	6.0	2.4

1996																					
March			April			May			June			July			August			September			
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1				-24.3	-21.9	-26.7	-0.6	2.1	-3.0	6.6	9.5	3.5	2.9	5.7	0.6	5.7	14.8	-0.5			
2				-21.8	-17.7	-26.2	-1.4	1.1	-3.9	6.7	9.5	4.7	3.4	5.6	1.4	12.4	16.3	8.8			
3				-13.8	-9.6	-20.0	-4.8	-3.1	-7.3	4.2	6.2	1.6	6.0	8.6	2.8	12.7	16.0	9.1			
4				-6.6	-2.3	-10.8	-7.3	-4.8	-12.2	3.8	6.4	1.0	6.7	11.2	3.9	12.1	15.5	9.3			
5				-3.0	-1.6	-4.6	-11.2	-7.6	-15.3	1.7	3.9	-0.5	8.2	11.3	5.4	11.9	15.0	8.3			
6				-5.1	-3.2	-8.0	-9.6	-5.4	-14.4	5.1	8.2	1.7	8.8	12.3	6.4	12.9	16.8	7.8			
7				-8.6	-7.2	-10.4	-7.3	-4.5	-8.6	5.7	9.2	3.1	11.0	13.8	7.8						
8				-9.3	-6.4	-11.4	-7.7	-4.5	-11.1	4.2	7.0	1.7	11.6	14.4	9.6						
9				-9.6	-7.0	-11.6	-4.2	-0.9	-8.1	3.1	7.4	0.9	7.0	8.9	5.6						
10				-9.3	-7.9	-11.7	-0.2	3.2	-4.1	2.5	5.3	-0.3	5.6	8.6	3.0						
11				-10.8	-8.8	-12.8	-0.7	1.5	-2.9	2.8	6.1	-0.5	8.3	11.5	5.5						
12				-9.7	-7.6	-12.1	0.5	3.0	-2.0	3.3	6.2	0.3	9.4	13.3	6.8						
13				-7.4	-5.3	-10.1	-0.4	2.8	-2.8	2.4	4.4	0.1	7.6	11.8	4.9						
14				-3.9	-1.4	-6.0	-1.5	1.3	-5.0	2.8	6.2	-0.7	5.9	8.2	2.9						
15				-1.8	-0.4	-3.1	-1.8	1.7	-4.6	4.9	8.3	2.3	3.3	4.8	1.5						
16				-1.2	1.3	-3.1	-1.7	1.6	-4.2	7.9	12.0	3.1	8.2	12.4	3.8						
17				-2.2	-0.8	-3.6	0.1	2.4	-2.6	8.8	12.9	5.5	10.4	13.7	7.8						
18				-1.8	1.1	-3.9	3.4	5.9	0.6	11.1	15.1	6.5	9.1	11.5	5.7						
19				-1.2	1.1	-2.7	3.1	5.1	1.0	12.4	16.3	8.8	11.3	14.9	7.5						
20				-1.6	-0.4	-3.3	3.1	5.8	1.1	12.7	16.0	9.1	13.5	16.6	10.5						
21				-2.1	0.2	-4.3	5.0	9.1	2.1	12.1	15.5	9.6	12.2	15.0	7.9						
22	-16.0	-14.0	-17.7	-1.0	1.9	-4.0	4.3	7.5	2.5	11.9	15.0	8.3	8.5	10.7	6.2						
23	-14.1	-8.9	-17.5	-1.1	1.4	-2.9	3.6	7.3	1.1	12.8	16.8	7.8	7.8	10.5	5.9						
24	-7.4	-4.5	-10.3	-0.9	1.6	-2.5	2.2	4.7	0.3	14.7	17.4	11.7	10.8	14.0	7.9						
25	-9.7	-7.8	-11.1	-1.6	1.4	-4.3	0.9	2.8	-0.9	11.5	13.8	7.7									
26	-8.9	-6.0	-11.9	-1.2	1.1	-2.9	0.7	3.0	-2.1	8.4	11.4	5.5									
27	-7.9	-5.6	-13.7	-2.8	-1.0	-5.1	2.1	4.8	-0.5	8.0	11.9	4.7									
28	-14.1	-11.6	-16.6	-3.8	-0.9	-6.7	3.3	6.0	0.9	5.3	7.9	3.0									
29	-15.3	-12.7	-17.3	-1.9	0.5	-4.3	1.8	4.8	0.3	4.8	8.4	0.8	2.2	4.7	0.3						
30	-17.6	-13.3	-20.4	-1.5	0.8	-3.2	5.3	8.8	1.6	4.0	8.4	1.3	0.8	2.8	-0.9						
31	-19.7	-17.2	-24.1				8.4	11.5	5.6				0.8	3.0	-2.1						
Ave	-13.1	-10.2	-16.1	-5.7	-3.3	-8.1	-0.4	2.5	-3.2	6.9	10.1	3.7	7.5	10.4	4.8						
Max	-7.4	-4.5	-10.3	-0.9	1.9	-2.5	8.4	11.5	5.6	14.7	17.4	11.7	13.5	16.6	10.5						
Min	-19.7	-17.2	-24.1	-24.3	-21.9	-26.7	-11.2	-7.6	-15.3	1.7	3.9	-0.7	0.8	2.8	-2.1						

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Summary of Temperature Data from the Wolverine Camp (°C)

1996																		
	March			April			May			June			July			August		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1				-23.0			3.0			10.0	19.0	1.0	8.5	11.0	6.0	11.0	19.0	3.0
2				-21.0			-0.5			8.5	18.0	-1.0	7.5	11.0	4.0	10.0	17.0	3.0
3				-15.0						11.0	18.0	4.0	9.0	18.0	0.0	8.5	12.0	5.0
4				-8.0			-2.0			5.0	13.0	-3.0	9.0	14.0	4.0	3.0	6.0	0.0
5				-5.5			-3.5			7.0	12.0	2.0	11.0	17.0	5.0	6.0	9.0	3.0
6				-3.0			-11.5			5.5	15.0	-4.0	13.5	20.0	7.0	6.5	11.0	2.0
7				-6.0			-8.5			8.5	17.0	0.0	15.0	23.0	7.0	7.5	14.0	1.0
8				-14.0			1.0			10.5	17.0	4.0	13.5	22.0	5.0	6.0	14.0	-2.0
9				-17.0			-1.0			7.5	15.0	0.0	14.0	20.0	8.0	9.5	15.0	4.0
10				-15.5			-11.0			7.0	16.0	-2.0	8.5	11.0	6.0	9.5	19.0	0.0
11				-15.0						7.0	14.0	0.0	12.0	17.0	7.0	7.0	15.0	-1.0
12				-16.0			-4.0			7.5	17.0	-2.0	11.5	20.0	3.0	9.5	15.0	4.0
13				-14.0			1.0			7.0	14.0	0.0	11.5	18.0	5.0	7.5	14.0	1.0
14				-23.0			2.5			5.5	13.0	-2.0	12.5	19.0	6.0	7.5	16.0	-1.0
16				-1.0			1.0			7.0	14.0	0.0	7.5	11.0	4.0	9.5	20.0	-1.0
16				-5.5			2.5			9.5	20.0	-1.0	11.0	20.0	2.0	11.0	19.0	3.0
17				0.0			8.0			12.0	21.0	3.0	12.5	22.0	3.0	9.5	19.0	0.0
18				3.5			6.5			11.5	23.0	0.0	8.0	12.0	4.0	9.0	15.0	3.0
19				-2.5			6.5			16.5	25.0	8.0	14.0	22.0	6.0	5.5	11.0	0.0
20				-2.0			2.5			16.0	24.0	8.0	17.5	26.0	9.0	7.5	13.0	2.0
21				-6.0			5.0			15.5	24.0	7.0	15.0	20.0	10.0	7.0	12.0	2.0
22				-8.5			5.0			14.0	24.0	4.0	9.5	14.0	5.0	9.0	14.0	4.0
23				-3.5			5.0			15.0	25.0	5.0		16.0		9.5	15.0	4.0
24				0.0			4.5			16.5	28.0	5.0	13.5	23.0	4.0	10.0	16.0	4.0
26							3.0			17.5	28.0	7.0	14.5	21.0	8.0	10.5	18.0	3.0
26				2.0						12.5	21.0	4.0	16.0	26.0	6.0	9.0	15.0	3.0
27				-0.5						12.5	21.0	4.0	16.0	27.0	5.0			
28				-0.5						13.5	21.0	6.0	17.5	29.0	6.0			
29				1.5						10.0	16.0	4.0	21.0	30.0	12.0			
30	-27			3.5						11.5	18.0	5.0	13.5	22.0	5.0			
31	-25.5												13.5	21.0	6.0			
Ave	-26.3			-7.4			0.7			10.6	19.0	2.2	12.6	19.5	5.6	8.3	14.7	1.9
Max	-25.5			3.5			8.0			17.5	28.0	8.0	21.0	30.0	12.0	11.0	20.0	5.0
Min	-27.0			-23.0			-11.5			5.0	12.0	-4.0	7.5	11.0	0.0	3.0	6.0	-2.0

1997																		
	March			April			May			June			July			August		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1										6.5	14.0	-1.0	10.5	21.0	0.0	10.5	19.0	2.0
2										-4.0	17.0	-2.5	19.0	25.0	13.0	10.0	20.0	0.0
3										8.0	19.0	-3.0	15.5	25.0	6.0	12.5	20.0	5.0
4										12.5	19.0	6.0	16.5	25.0	8.0	13.5	25.0	2.0
5										5.0	11.0	-1.0	13.5	22.0	5.0	17.0	28.0	6.0
6										6.5	13.0	0.0	14.5	25.0	4.0	16.0	28.0	4.0
7										7.5	17.0	-2.0	15.0	24.0	6.0	15.0	22.0	8.0
8										7.0	15.0	-1.0	12.5	17.0	8.0	13.0	21.0	5.0
9										8.0	17.0	-1.0	11.0	15.0	7.0	14.5	21.0	8.0
10							1.5	10.0	-7.0	7.5	19.0	-4.0	20.0	23.0	17.0	13.0	19.0	7.0
11							3.0	6.0	0.0	12.0	26.0	-2.0	14.5	24.0	5.0	11.5	14.0	9.0
12							9.0	17.0	1.0	10.0	16.0	4.0	14.5	22.0	7.0	12.5	19.0	6.0
13							9.0	16.0	2.0	11.0	17.0	5.0	14.5	23.0	6.0	12.5	16.0	9.0
14							6.0	12.0	0.0	15.0	26.0	4.0	14.0	23.0	5.0	10.0	15.0	5.0
15							5.5	13.0	-2.0	9.0	19.0	-1.0	12.0	17.0	7.0	11.0	20.0	2.0
16							3.5	8.0	-1.0	10.0	16.0	4.0	11.5	15.0	8.0	2.0	2.0	2.0
17							5.5	15.0	-4.0	10.5	15.0	6.0	12.0	15.0	9.0	4.5	8.0	1.0
18							2.0	2.0	2.0	12.0	19.0	5.0	13.0	20.0	6.0	7.0	10.0	4.0
19							2.0	7.0	-3.0	13.0	22.0	4.0	13.5	21.0	6.0	6.5	11.0	2.0
20							6.5	17.0	-4.0	12.0	20.0	4.0	8.0	14.0	2.0	9.0	18.0	0.0
21							8.5	13.0	4.0	12.5	19.0	6.0	13.5	22.0	5.0	11.0	20.0	2.0
22							11.0	18.0	4.0	16.0	27.0	5.0	5.5	11.0	0.0	12.0	20.0	4.0
23							10.5	18.0	3.0	13.0	21.0	5.0	8.0	10.0	6.0	8.0	11.0	5.0
24							5.0	11.0	-1.0	12.5	20.0	5.0	10.5	15.0	6.0	7.0	12.0	2.0
25							3.0	9.0	-3.0	13.0	21.0	5.0	15.5	24.0	7.0	6.5	10.0	3.0
26							0.5	5.0	-4.0	14.5	20.0	9.0	14.5	23.0	6.0	12.0	20.0	4.0
27							1.0	5.0	-3.0	11.0	20.0	2.0	16.5	27.0	6.0			
28							3.5	14.0	-7.0	10.5	18.0	3.0	16.5	27.0	6.0			
29							10.0	20.0	0.0	11.0	18.0	4.0	15.0	26.0	4.0			
30							9.0	20.0	-2.0	7.5	12.0	3.0	14.0	21.0	7.0	13.5	20.0	7.0
31							8.0	19.0	-3.0				14.0	21.0	7.0			
Ave							5.6	12.5	-1.3	10.0	18.4	2.4	13.5	20.7	6.3	10.8	17.4	4.2
Max							11.0	20.0	4.0	16.0	27.0	9.0	20.0	27.0	17.0	17.0	28.0	9.0
Min							0.5	2.0	-7.0	-4.0	11.0	-4.0	5.5	10.0	0.0	2.0	2.0	0.0

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Summary of Humidity Data From Kudz Ze Kayah Low Elevation Weather Station (%)

1995												
	May			June			July			August		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1							83	95	71	79	94	61
2							91	98	76	66	89	50
3							95	100	88	81	97	74
4							81	98	55	75	85	66
5							77	97	55	86	95	65
6							78	94	57	87	100	66
7							69	92	42	72	95	43
8							70	85	48	69	92	42
9							79	95	62	70	95	42
10							73	96	49	79	95	57
11							67	95	43	67	91	46
12							71	82	62	68	83	59
13							73	91	52	75	95	57
14							67	80	53	77	95	56
15							63	76	55	89	100	76
16							58	72	40	87	98	65
17							67	85	53	80	94	58
18							63	80	38	85	95	71
19							76	91	58	81	96	59
20							87	100	75	80	91	56
21										87	97	63
22										87	97	65
23										83	100	58
24							78	93	65	78	93	55
25							86	100	73	81	93	65
26							82	97	64	76	91	51
27							94	100	87	67	87	45
28							92	99	79	86	95	73
29							83	95	64	62	79	51
30							83	92	71	62	74	52
31							88	98	75	83	93	68
Avg							78	92	61	78	93	59
Max							95	100	88	89	100	76
Min							58	72	38	62	74	42

1996												
	May			June			July			August		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1				63	93	43	94	100	84			
2				62	94	42	77	98	57			
3				48	76	32	80	95	53			
4	42	59	32	87	98	59	80	99	61			
5	39	53	29	61	87	40	89	100	65			
6	54	75	37	60	81	38	77	100	51			
7	49	73	35	54	70	41	73	91	48			
8	42	60	27	53	65	35	92	100	74			
9	43	60	30	58	77	43	69	91	52			
10	74	92	55	54	67	38						
11	57	76	45	55	71	42						
12	48	69	29	66	81	50						
13	61	68	53	61	86	44	71	95	56			
14	78	98	55	60	84	40	96	100	91			
15	87	98	73	49	84	30	76	100	46			
16	59	80	41	39	60	27	70	93	48			
17	49	70	32	40	73	19	71	96	57			
18	62	93	48	36	64	16	73	94	55			
19	70	93	49	43	71	29	58	80	40			
20	65	89	39	51	75	31	68	90	51			
21	71	90	51	50	84	31	74	96	56			
22	78	99	52	41	67	25	94	100	86			
23	71	89	57	41	71	27	83	100	65			
24	76	99	60	49	67	39	73	95	44			
25	66	74	60	57	69	48	59	89	35			
26	79	93	60	58	72	45	57	82	40			
27	65	96	38	57	71	42	55	90	29			
28	79	91	56	50	68	34						
29	65	91	40	69	82	49						
30	56	82	38	84	95	71						
31	71	92	49									
Avg	63	82	45	55	77	38	75	95	56			
Max	87	99	73	87	98	71	96	100	91			
Min	39	53	27	36	60	16	55	80	29			

**EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT**

Summary of Humidity Data from the Wolverine Camp (%)

1996				
	June	July	August	
1	67	93	67	
2	52	95	58	
3	44	86	94	
4	43	92	93	
5	75	94	93	
6	44	74	94	
7	59	73	58	
8	43	67	75	
9	44	94	80	
10	35	90	59	
11	43	89	90	
12	55	82	94	
13	57	73	49	
14	56	84	63	
15	55	85	73	
16	45	75	60	
17	38	54	85	
18	35	58	94	
19	28	29	90	
20	32	64	82	
21	54	81	84	
22	46	60	86	
23	55		87	
24	34	66	72	
25	50	66	67	
26	48	42	70	
27	43	44		
28	52	68		
29	49	77		
30	78	60		
31		75		
Ave	48.6	72.8	77.4	
Max	78.0	95.3	94.0	
Min	28.3	28.5	48.5	

1997				
	May	June	July	August
1		56.0	51.0	64.0
2		98.0	24.0	68.0
3		41.0	46.0	78.0
4		95.0	95.0	61.0
5		78.0	90.0	41.0
6		68.0	47.0	58.0
7		94.0	65.0	89.0
8		74.0	94.0	67.0
9		68.0	94.0	91.0
10	60	68.0	94.0	78.0
11	95	17.0	56.0	56.0
12	47	78.0	58.0	90.0
13	73	50.0	60.0	99.0
14	93	49.0	72.0	94.0
15	88	24.0	94.0	81.0
16	93	69.0	75.0	94.0
17	88	89.0	95.0	87.0
18	92	50.0	69.0	88.0
19	93	70.0	68.0	94.0
20	73	72.0	95.0	95.0
21	56	56.0	58.0	55.0
22	56	19.0	95.0	88.0
23	87	51.0	83.0	94.0
24	93	49.0	81.0	78.0
25	93	55.0	98.0	94.0
26	85	30.0	69.0	88.0
27	83	39.0	48.0	
28	79	88.0	44.0	
29	50	65.0	78.0	
30	58	77.0	68.0	
31	78		71.0	
Ave	77.9	61.2	72.1	79.6
Max	95.0	98.0	98.0	99.0
Min	47.0	17.0	24.0	41.0

APPENDIX 3B

WOLVERINE AREA – WATER QUALITY BY STATION

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W1

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	87	19	135	67	17	17
Hardness CaCO3	67.2	12.2	101.0	51.2	16	16
pH	7.77	0.35	8.57	7.25	17	17
Total Suspended Solids	4	4	16	1	11	9
Turbidity (NTU)	0.9	0.5	2.0	0.4	16	16
Alkalinity-Total CaCO3	62	13	91	45	17	17
Chloride Cl	0.5	0.1	0.9	0.5	16	4
Fluoride F	0.17	0.22	1.00	0.08	16	15
Sulphate SO4	10	2	16	7	17	17
Ammonia Nitrogen N	0.078	0.082	0.170	0.013	3	2
Nitrate Nitrogen N	0.015	0.026	0.100	0.005	17	5
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	8
Nitrite/Nitrate Nitrogen N	0.011	0.018	0.061	0.005	10	3
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.020	0.015	0.057	0.005	16	14
Antimony T-Sb	0.07755	0.09818	0.20000	0.00006	16	7
Arsenic T-As	0.00389	0.00608	0.02000	0.00091	17	15
Barium T-Ba	0.0353	0.0070	0.0500	0.0269	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.054	0.051	0.100	0.001	15	2
Cadmium T-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium T-Ca	18.0	3.7	26.2	13.2	17	17
Chromium T-Cr	0.0010	0.0023	0.0100	0.0001	17	10
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper T-Cu	0.001	0.001	0.006	0.001	17	15
Iron T-Fe	0.09	0.05	0.25	0.03	17	17
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	4
Lithium T-Li	0.022	0.069	0.290	0.001	17	8
Magnesium T-Mg	5.77	1.29	8.64	4.13	17	17
Manganese T-Mn	0.01566	0.00747	0.03400	0.00800	17	17
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	0
Molybdenum T-Mo	0.01339	0.01439	0.03000	0.00081	17	8
Nickel T-Ni	0.0091	0.0094	0.0200	0.0010	17	8
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	0	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	15	1
Silicon T-Si	1.98	0.78	3.94	1.23	16	16
Silver T-Ag	0.00014	0.00033	0.00100	0.00001	17	1
Sodium T-Na	2	0	2	1	17	3
Strontium T-Sr	0.0614	0.0148	0.0950	0.0435	16	16
Thallium T-Tl	0.0404	0.0504	0.1000	0.0001	15	1
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	16	1
Titanium T-Ti	0.01	0.00	0.01	0.00	16	0
Uranium T-U	0.0106	0.0231	0.0600	0.0006	12	10
Vanadium T-V	0.015	0.015	0.030	0.001	17	2
Zinc T-Zn	0.004	0.002	0.007	0.001	17	9

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.026	0.047	0.200	0.004	17	13
Antimony D-Sb	0.07756	0.09817	0.20000	0.00006	16	7
Arsenic D-As	0.00378	0.00612	0.02000	0.00080	17	15
Barium D-Ba	0.0408	0.0158	0.0792	0.0200	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.057	0.048	0.100	0.001	15	4
Cadmium D-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium D-Ca	18.1	3.6	26.3	13.6	17	17
Chromium D-Cr	0.0011	0.0023	0.0100	0.0001	17	11
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper D-Cu	0.001	0.001	0.003	0.001	17	15
Iron D-Fe	0.06	0.09	0.40	0.00	17	15
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	3
Lithium D-Li	0.011	0.021	0.090	0.001	17	8
Magnesium D-Mg	5.80	1.23	8.52	4.17	17	17
Manganese D-Mn	0.00981	0.00897	0.03200	0.00060	17	14
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01338	0.01439	0.03000	0.00081	17	8
Nickel D-Ni	0.0091	0.0094	0.0200	0.0010	17	8
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	0	2	1	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	0
Silicon D-Si	1.97	0.73	3.88	1.25	16	16
Silver D-Ag	0.00014	0.00033	0.00100	0.00001	17	0
Sodium D-Na	2	0	2	1	17	3
Strontium D-Sr	0.0610	0.0139	0.0910	0.0437	16	16
Thallium D-Tl	0.0404	0.0504	0.1000	0.0001	15	1
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	16	1
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0106	0.0231	0.0600	0.0006	12	10
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.005	0.004	0.020	0.001	17	9

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W2

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	278	72	379	159	6	6
Hardness CaCO3	223.3	58.8	277.0	113.0	6	6
pH	7.73	0.27	8.10	7.42	6	6
Total Suspended Solids	7	8	16	1	3	2
Turbidity (NTU)	1.6	2.2	6.0	0.3	6	6
Alkalinity-Total CaCO3	160	38	195	-87	6	6
Chloride Cl	0.6	0.2	1.0	0.5	5	1
Fluoride F	0.47	0.09	0.53	0.32	5	5
Sulphate SO4	70	24	97	28	6	6
Ammonia Nitrogen N	0.042	0.033	0.070	0.005	3	1
Nitrate Nitrogen N	0.101	0.196	0.500	0.005	6	4
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.022	0.011	0.031	0.005	5	4
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.052	0.057	0.161	0.014	6	6
Antimony T-Sb	0.04410	0.08757	0.20000	0.00013	5	3
Arsenic T-As	0.00457	0.00757	0.02000	0.00111	6	5
Barium T-Ba	0.1008	0.1580	0.4230	0.0243	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	3
Cadmium T-Cd	0.00019	0.00017	0.00050	0.00006	6	4
Calcium T-Ca	50.3	13.1	64.6	26.8	6	6
Chromium T-Cr	0.0006	0.0004	0.0010	0.0001	6	3
Cobalt T-Co	0.0063	0.0082	0.0200	0.0001	6	1
Copper T-Cu	0.003	0.003	0.009	0.001	6	6
Iron T-Fe	0.19	0.17	0.54	0.09	6	6
Lead T-Pb	0.0003	0.0004	0.0010	0.0001	5	2
Lithium T-Li	0.007	0.007	0.020	0.002	6	3
Magnesium T-Mg	22.58	6.39	30.40	11.80	6	6
Manganese T-Mn	0.07228	0.03051	0.11900	0.03800	6	6
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01130	0.01458	0.03000	0.00058	6	3
Nickel T-Ni	0.0107	0.0074	0.0200	0.0040	6	4
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	0	2	2	5	1
Selenium T-Se	0.0016	0.0005	0.0020	0.0010	5	5
Silicon T-Si	5.20	1.02	6.50	3.69	5	5
Silver T-Ag	0.00019	0.00040	0.00100	0.00001	6	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.1970	0.0517	0.2440	0.1110	5	5
Thallium T-Tl	0.0011	0.0022	0.0050	0.0001	5	1
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	2
Uranium T-U	0.0140	0.0257	0.0600	0.0008	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.031	0.044	0.120	0.006	6	6

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.014	0.009	0.030	0.005	6	6
Antimony D-Sb	0.04409	0.08758	0.20000	0.00013	5	3
Arsenic D-As	0.00440	0.00764	0.02000	0.00103	6	5
Barium D-Ba	0.0392	0.0083	0.0489	0.0237	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.043	0.052	0.100	0.001	5	3
Cadmium D-Cd	0.00016	0.00017	0.00050	0.00005	6	3
Calcium D-Ca	51.4	13.1	62.4	26.3	6	6
Chromium D-Cr	0.0006	0.0004	0.0010	0.0001	6	3
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.002	0.003	0.008	0.001	6	6
Iron D-Fe	0.07	0.03	0.10	0.01	6	6
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	1
Lithium D-Li	0.007	0.007	0.020	0.002	6	3
Magnesium D-Mg	23.07	6.31	29.40	11.80	6	6
Manganese D-Mn	0.05993	0.02254	0.09370	0.04000	6	6
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01129	0.01458	0.03000	0.00057	6	3
Nickel D-Ni	0.0098	0.0080	0.0200	0.0020	6	4
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	0	2	1	5	1
Selenium D-Se	0.0018	0.0004	0.0020	0.0010	5	5
Silicon D-Si	5.13	0.99	6.32	3.61	5	5
Silver D-Ag	0.00019	0.00040	0.00100	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.2016	0.0531	0.2380	0.1100	5	5
Thallium D-Tl	0.0011	0.0022	0.0050	0.0001	5	1
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0140	0.0257	0.0600	0.0009	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	1
Zinc D-Zn	0.010	0.003	0.014	0.006	6	6

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT
WATER QUALITY AT STATION W3

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	75	10	88	64	4	4
Hardness CaCO3	54.5	3.3	56.9	49.5	4	4
pH	7.80	0.31	8.05	7.34	4	4
Total Suspended Solids	2	0	2	2	2	2
Turbidity (NTU)	0.5	0.4	1.0	0.2	4	4
Alkalinity-Total CaCO3	49	3	54	47	4	4
Chloride Cl	0.5	0.0	0.5	0.5	3	0
Fluoride F	0.11	0.01	0.12	0.10	3	3
Sulphate SO4	10	1	10	9	4	4
Ammonia Nitrogen N	0.045	0.007	0.050	0.040	2	1
Nitrate Nitrogen N	0.029	0.048	0.100	0.005	4	0
Nitrite Nitrogen N	0.002	0.001	0.003	0.001	4	1
Nitrite/Nitrate Nitrogen N	0.005	0.000	0.005	0.005	3	0
Total Cyanide CN	0.005	#DIV/0!	0.005	0.005	1	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.015	0.011	0.030	0.005	4	4
Antimony T-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic T-As	0.00561	0.00959	0.02000	0.00080	4	3
Barium T-Ba	0.0306	0.0010	0.0317	0.0296	4	4
Beryllium T-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth T-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron T-B	0.034	0.057	0.100	0.001	3	1
Cadmium T-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium T-Ca	15.4	0.4	15.7	14.8	4	4
Chromium T-Cr	0.0007	0.0004	0.0010	0.0002	4	2
Cobalt T-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper T-Cu	0.002	0.002	0.004	0.001	4	3
Iron T-Fe	0.05	0.07	0.15	0.01	4	2
Lead T-Pb	0.0004	0.0005	0.0010	0.0001	3	0
Lithium T-Li	0.006	0.009	0.020	0.001	4	1
Magnesium T-Mg	4.32	0.21	4.53	4.04	4	4
Manganese T-Mn	5.50191	10.99873	22.00000	0.00021	4	3
Mercury T-Hg	0.00029	0.00048	0.00100	0.00005	4	0
Molybdenum T-Mo	0.00919	0.01401	0.03000	0.00074	4	2
Nickel T-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus T-P	0.2	0.1	0.3	0.1	3	0
Potassium T-K	2	1	2	1	3	1
Selenium T-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon T-Si	1.76	0.30	2.10	1.55	3	3
Silver T-Ag	0.00028	0.00048	0.00100	0.00001	4	0
Sodium T-Na	2	1	2	1	4	1
Strontium T-Sr	0.0461	0.0010	0.0469	0.0450	3	3
Thallium T-Tl	0.0017	0.0028	0.0050	0.0001	3	1
Tin T-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium T-Ti	0.01	0.01	0.01	0.00	3	0
Uranium T-U	0.0203	0.0344	0.0600	0.0003	3	2
Vanadium T-V	0.009	0.014	0.030	0.001	4	0
Zinc T-Zn	0.004	0.003	0.008	0.001	4	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.010	0.006	0.019	0.006	4	3
Antimony D-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic D-As	0.00558	0.00962	0.02000	0.00075	4	3
Barium D-Ba	0.0321	0.0033	0.0368	0.0298	4	4
Beryllium D-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth D-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron D-B	0.037	0.055	0.100	0.001	3	1
Cadmium D-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium D-Ca	14.9	0.8	15.3	13.7	4	4
Chromium D-Cr	0.0006	0.0005	0.0010	0.0001	4	2
Cobalt D-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper D-Cu	0.002	0.002	0.004	0.001	4	3
Iron D-Fe	0.01	0.01	0.03	0.00	4	0
Lead D-Pb	0.0015	0.0024	0.0050	0.0001	4	0
Lithium D-Li	0.006	0.009	0.020	0.001	4	1
Magnesium D-Mg	4.19	0.33	4.50	3.73	4	4
Manganese D-Mn	0.00162	0.00225	0.00500	0.00034	4	3
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	3	0
Molybdenum D-Mo	0.00916	0.01403	0.03000	0.00080	4	2
Nickel D-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus D-P	0.2	0.1	0.3	0.1	3	0
Potassium D-K	2	1	2	1	3	1
Selenium D-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon D-Si	1.68	0.30	2.03	1.48	3	3
Silver D-Ag	0.00028	0.00048	0.00100	0.00001	4	0
Sodium D-Na	2	1	2	1	4	1
Strontium D-Sr	0.0444	0.0030	0.0463	0.0410	3	3
Thallium D-Tl	0.0017	0.0028	0.0050	0.0001	3	1
Tin D-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium D-Ti	0.01	0.01	0.01	0.00	3	0
Uranium D-U	0.0204	0.0343	0.0600	0.0005	3	2
Vanadium D-V	0.009	0.014	0.030	0.001	4	0
Zinc D-Zn	0.004	0.002	0.007	0.002	4	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W4

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	197	27	232	153	6	6
Hardness CaCO3	155.3	15.0	164.0	125.0	6	6
pH	7.90	0.23	8.20	7.63	6	6
Total Suspended Solids	6	4	10	4	3	3
Turbidity (NTU)	1.1	1.1	3.1	0.1	6	5
Alkalinity-Total CaCO3	112	9	124	97	6	6
Chloride Cl	0.5	0.0	0.6	0.5	5	1
Fluoride F	0.27	0.03	0.29	0.23	5	5
Sulphate SO4	49	9	55	30	6	6
Ammonia Nitrogen N	0.028	0.023	0.050	0.005	3	1
Nitrate Nitrogen N	0.066	0.045	0.112	0.005	6	4
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.076	0.043	0.113	0.005	5	4
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.041	0.026	0.075	0.013	6	6
Antimony T-Sb	0.04413	0.08756	0.20000	0.00019	5	3
Arsenic T-As	0.00362	0.00803	0.02000	0.00028	6	5
Barium T-Ba	0.1241	0.0244	0.1580	0.0928	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	2
Cadmium T-Cd	0.00024	0.00014	0.00050	0.00009	6	4
Calcium T-Ca	36.6	4.2	40.6	29.2	6	6
Chromium T-Cr	0.0006	0.0004	0.0010	0.0001	6	3
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper T-Cu	0.002	0.001	0.003	0.001	6	5
Iron T-Fe	0.09	0.06	0.18	0.03	6	4
Lead T-Pb	0.0003	0.0004	0.0010	0.0001	5	4
Lithium T-Li	0.006	0.008	0.020	0.001	6	1
Magnesium T-Mg	14.77	1.18	16.10	12.70	6	6
Manganese T-Mn	0.00946	0.00480	0.01600	0.00500	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01163	0.01429	0.03000	0.00148	6	3
Nickel T-Ni	0.0088	0.0087	0.0200	0.0020	6	4
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0029	0.0007	0.0040	0.0020	5	5
Silicon T-Si	4.43	0.61	5.21	3.55	5	5
Silver T-Ag	0.00019	0.00040	0.00100	0.00001	6	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.1274	0.0137	0.1380	0.1040	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0129	0.0263	0.0600	0.0010	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.017	0.007	0.026	0.009	6	6

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.009	0.006	0.020	0.003	6	6
Antimony D-Sb	0.04412	0.08756	0.20000	0.00019	5	3
Arsenic D-As	0.00356	0.00805	0.02000	0.00020	6	5
Barium D-Ba	0.1212	0.0199	0.1460	0.0882	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.042	0.053	0.100	0.001	5	1
Cadmium D-Cd	0.00021	0.00015	0.00050	0.00006	6	4
Calcium D-Ca	37.5	4.0	39.9	29.4	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0001	6	3
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	1
Copper D-Cu	0.002	0.001	0.003	0.001	6	5
Iron D-Fe	0.02	0.02	0.05	0.00	6	1
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	1
Magnesium D-Mg	15.03	1.19	16.10	12.70	6	6
Manganese D-Mn	0.00378	0.00387	0.01040	0.00023	6	4
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01165	0.01427	0.03000	0.00161	6	3
Nickel D-Ni	0.0084	0.0090	0.0200	0.0020	6	3
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0029	0.0012	0.0040	0.0013	5	5
Silicon D-Si	4.42	0.61	5.17	3.52	5	5
Silver D-Ag	0.00019	0.00040	0.00100	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.1290	0.0153	0.1440	0.1040	5	5
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	1
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0129	0.0263	0.0600	0.0010	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.013	0.005	0.021	0.007	6	6

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W5

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	72	9	86	66	4	4
Hardness CaCO3	55.4	1.7	57.7	53.7	4	4
pH	7.81	0.26	8.04	7.45	4	4
Total Suspended Solids	2	0	2	1	2	2
Turbidity (NTU)	0.6	0.4	1.0	0.2	4	4
Alkalinity-Total CaCO3	46	4	49	40	4	4
Chloride Cl	0.5	0.0	0.5	0.5	3	0
Fluoride F	0.13	0.04	0.17	0.10	3	3
Sulphate SO4	9	0	10	9	4	4
Ammonia Nitrogen N	0.035	0.021	0.050	0.020	2	1
Nitrate Nitrogen N	0.029	0.048	0.100	0.005	4	0
Nitrite Nitrogen N	0.002	0.001	0.003	0.001	4	0
Nitrite/Nitrate Nitrogen N	0.005	0.000	0.005	0.005	3	0
Total Cyanide CN	0.005	#DIV/0!	0.005	0.005	1	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.014	0.011	0.030	0.007	4	4
Antimony T-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic T-As	0.00560	0.00980	0.02000	0.00077	4	3
Barium T-Ba	0.0312	0.0017	0.0327	0.0295	4	4
Beryllium T-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth T-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron T-B	0.034	0.057	0.100	0.001	3	1
Cadmium T-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium T-Ca	15.4	0.4	16.0	15.1	4	4
Chromium T-Cr	0.0006	0.0005	0.0010	0.0001	4	2
Cobalt T-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper T-Cu	0.002	0.003	0.007	0.001	4	3
Iron T-Fe	0.02	0.01	0.03	0.01	4	1
Lead T-Pb	0.0004	0.0005	0.0010	0.0001	3	1
Lithium T-Li	0.006	0.009	0.020	0.001	4	1
Magnesium T-Mg	4.26	0.12	4.42	4.13	4	4
Manganese T-Mn	0.00282	0.00146	0.00500	0.00192	4	3
Mercury T-Hg	0.00029	0.00048	0.00100	0.00005	4	0
Molybdenum T-Mo	0.00915	0.01404	0.03000	0.00076	4	2
Nickel T-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus T-P	0.2	0.1	0.3	0.1	3	0
Potassium T-K	2	1	2	1	3	1
Selenium T-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon T-Si	1.71	0.42	2.20	1.47	3	3
Silver T-Ag	0.00028	0.00048	0.00100	0.00001	4	0
Sodium T-Na	2	0	2	1	4	1
Strontium T-Sr	0.0469	0.0012	0.0480	0.0457	3	3
Thallium T-Tl	1.0334	1.7898	3.1000	0.0001	3	2
Tin T-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium T-Ti	0.01	0.01	0.01	0.00	3	0
Uranium T-U	0.0204	0.0343	0.0600	0.0005	3	2
Vanadium T-V	0.009	0.014	0.030	0.001	4	0
Zinc T-Zn	0.004	0.002	0.006	0.002	4	3

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.008	0.002	0.010	0.006	4	4
Antimony D-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic D-As	0.00559	0.00981	0.02000	0.00075	4	3
Barium D-Ba	0.0324	0.0025	0.0358	0.0300	4	4
Beryllium D-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth D-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron D-B	0.037	0.055	0.100	0.001	3	1
Cadmium D-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium D-Ca	15.2	0.5	15.9	14.8	4	4
Chromium D-Cr	0.0006	0.0005	0.0010	0.0001	4	2
Cobalt D-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper D-Cu	0.002	0.002	0.005	0.001	4	3
Iron D-Fe	0.01	0.01	0.03	0.00	4	1
Lead D-Pb	0.0015	0.0024	0.0050	0.0001	4	0
Lithium D-Li	0.006	0.009	0.020	0.001	4	1
Magnesium D-Mg	4.24	0.15	4.36	4.05	4	4
Manganese D-Mn	0.00159	0.00228	0.00500	0.00026	4	3
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	3	0
Molybdenum D-Mo	0.00914	0.01405	0.03000	0.00075	4	2
Nickel D-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus D-P	0.2	0.1	0.3	0.1	3	0
Potassium D-K	2	1	2	1	3	1
Selenium D-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon D-Si	1.67	0.38	2.11	1.45	3	3
Silver D-Ag	0.00028	0.00048	0.00100	0.00001	4	0
Sodium D-Na	2	0	2	1	4	1
Strontium D-Sr	0.0467	0.0008	0.0472	0.0458	3	3
Thallium D-Tl	0.0017	0.0029	0.0050	0.0001	3	0
Tin D-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium D-Ti	0.01	0.01	0.01	0.00	3	0
Uranium D-U	0.0204	0.0343	0.0600	0.0005	3	2
Vanadium D-V	0.009	0.014	0.030	0.001	4	0
Zinc D-Zn	0.004	0.003	0.007	0.001	4	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT
WATER QUALITY AT STATION W6

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	107	23	139	72	6	6
Hardness CaCO3	86.3	17.8	99.7	52.3	6	6
pH	7.80	0.32	8.21	7.34	6	6
Total Suspended Solids	10	15	28	1	3	3
Turbidity (NTU)	1.1	1.8	4.7	0.1	6	4
Alkalinity-Total CaCO3	75	15	89	48	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.05	0.02	0.06	0.02	5	5
Sulphate SO4	15	5	20	7	6	6
Ammonia Nitrogen N	0.028	0.023	0.050	0.005	3	1
Nitrate Nitrogen N	0.070	0.018	0.100	0.047	6	6
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	2
Nitrite/Nitrate Nitrogen N	0.085	0.012	0.079	0.048	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.089	0.117	0.273	0.007	6	5
Antimony T-Sb	0.04404	0.08761	0.20000	0.00005	5	2
Arsenic T-As	0.00349	0.00809	0.02000	0.00005	6	4
Barium T-Ba	0.0794	0.0312	0.1070	0.0200	6	5
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00020	0.00019	0.00050	0.00005	6	1
Calcium T-Ca	28.9	5.6	33.3	18.1	6	6
Chromium T-Cr	0.0022	0.0039	0.0100	0.0002	6	3
Cobalt T-Co	0.0053	0.0082	0.0200	0.0001	6	1
Copper T-Cu	0.002	0.002	0.005	0.001	6	5
Iron T-Fe	0.07	0.13	0.33	0.01	6	2
Lead T-Pb	0.0003	0.0004	0.0010	0.0001	5	1
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	3.69	0.70	4.27	2.33	6	6
Manganese T-Mn	0.01742	0.03526	0.08930	0.00122	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01108	0.01476	0.03000	0.00037	6	3
Nickel T-Ni	0.0077	0.0096	0.0200	0.0003	6	3
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.89	0.35	3.21	2.30	5	5
Silver T-Ag	0.00019	0.00040	0.00100	0.00001	6	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0972	0.0217	0.1170	0.0619	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0155	0.0297	0.0800	0.0006	4	3
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.005	0.005	0.014	0.002	6	4

Dissolved	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum	0.044	0.077	0.200	0.005	6	5
Antimony	0.04404	0.08761	0.20000	0.00005	5	2
Arsenic	0.00349	0.00810	0.02000	0.00010	6	5
Barium	0.0884	0.0186	0.1070	0.0531	6	6
Beryllium	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth	0.0243	0.0432	0.1000	0.0005	5	0
Boron	0.042	0.053	0.100	0.001	5	1
Cadmium	0.00015	0.00018	0.00050	0.00005	6	0
Calcium	28.5	5.9	33.1	17.2	6	6
Chromium	0.0021	0.0039	0.0100	0.0001	6	3
Cobalt	0.0053	0.0082	0.0200	0.0001	6	1
Copper	0.002	0.001	0.004	0.001	6	6
Iron	0.02	0.01	0.03	0.00	6	1
Lead	0.0010	0.0020	0.0050	0.0001	6	1
Lithium	0.006	0.008	0.020	0.001	6	0
Magnesium	3.69	0.75	4.27	2.28	6	6
Manganese	0.00280	0.00193	0.00500	0.00080	6	4
Mercury	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum	0.01110	0.01474	0.03000	0.00047	6	3
Nickel	0.0073	0.0099	0.0200	0.0003	6	3
Phosphorus	0.3	0.1	0.3	0.1	5	0
Potassium	2	1	2	0	5	1
Selenium	0.0009	0.0002	0.0010	0.0005	5	0
Silicon	2.86	0.34	3.08	2.11	5	5
Silver	0.00169	0.00407	0.01000	0.00001	6	0
Sodium	2	0	2	1	6	1
Strontium	0.0968	0.0215	0.1160	0.0611	5	5
Thallium	0.0010	0.0022	0.0050	0.0001	5	0
Tin	0.0071	0.0130	0.0300	0.0001	5	0
Titanium	0.01	0.00	0.01	0.00	5	0
Uranium	0.0154	0.0297	0.0800	0.0003	4	3
Vanadium	0.011	0.015	0.030	0.001	6	0
Zinc	0.004	0.002	0.008	0.001	6	4

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W7

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	73	11	89	65	4	4
Hardness CaCO3	54.9	2.9	57.8	50.9	4	4
pH	7.81	0.26	7.99	7.42	4	4
Total Suspended Solids	2	0	2	2	2	2
Turbidity (NTU)	0.5	0.4	1.0	0.2	4	4
Alkalinity-Total CaCO3	49	3	54	47	4	4
Chloride Cl	0.5	0.0	0.5	0.5	3	0
Fluoride F	0.10	0.02	0.12	0.09	3	3
Sulphate SO4	10	0	10	9	4	4
Ammonia Nitrogen N	0.035	0.021	0.050	0.020	2	1
Nitrate Nitrogen N	0.006	0.003	0.010	0.005	4	0
Nitrite Nitrogen N	0.002	0.001	0.003	0.001	4	0
Nitrite/Nitrate Nitrogen N	0.005	0.000	0.005	0.005	3	0
Total Cyanide CN	0.005	#DIV/0!	0.005	0.005	1	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.009	0.001	0.010	0.007	4	3
Antimony T-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic T-As	0.00562	0.00959	0.02000	0.00077	4	3
Barium T-Ba	0.0311	0.0010	0.0324	0.0300	4	4
Beryllium T-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth T-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron T-B	0.034	0.057	0.100	0.001	3	1
Cadmium T-Cd	0.00010	0.00009	0.00020	0.00005	3	0
Calcium T-Ca	15.5	0.5	16.2	15.2	4	4
Chromium T-Cr	0.0006	0.0005	0.0010	0.0001	4	2
Cobalt T-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper T-Cu	0.002	0.002	0.005	0.001	4	3
Iron T-Fe	0.02	0.01	0.03	0.01	4	1
Lead T-Pb	0.0004	0.0005	0.0010	0.0001	3	0
Lithium T-Li	0.006	0.009	0.020	0.001	4	3
Magnesium T-Mg	4.27	0.12	4.44	4.18	4	4
Manganese T-Mn	0.00282	0.00146	0.00500	0.00186	4	3
Mercury T-Hg	0.00029	0.00048	0.00100	0.00005	4	0
Molybdenum T-Mo	0.00914	0.01405	0.03000	0.00072	4	2
Nickel T-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus T-P	0.2	0.1	0.3	0.1	3	0
Potassium T-K	2	1	2	1	3	1
Selenium T-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon T-Si	1.71	0.41	2.19	1.47	3	3
Silver T-Ag	0.00053	0.00098	0.00200	0.00001	4	1
Sodium T-Na	2	0	2	1	4	1
Strontium T-Sr	0.0472	0.0015	0.0487	0.0458	3	3
Thallium T-Tl	0.0017	0.0029	0.0050	0.0001	3	0
Tin T-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium T-Ti	0.01	0.01	0.01	0.00	3	0
Uranium T-U	0.0203	0.0343	0.0600	0.0005	3	2
Vanadium T-V	0.009	0.014	0.030	0.001	4	1
Zinc T-Zn	0.003	0.001	0.005	0.002	4	3

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.007	0.002	0.010	0.005	4	2
Antimony D-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic D-As	0.00559	0.00961	0.02000	0.00074	4	3
Barium D-Ba	0.0321	0.0027	0.0361	0.0300	4	4
Beryllium D-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth D-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron D-B	0.036	0.055	0.100	0.001	3	1
Cadmium D-Cd	0.00133	0.00245	0.00500	0.00005	4	0
Calcium D-Ca	15.1	0.7	15.9	14.1	4	4
Chromium D-Cr	0.0006	0.0005	0.0010	0.0001	4	0
Cobalt D-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper D-Cu	0.002	0.002	0.004	0.001	4	3
Iron D-Fe	0.01	0.01	0.03	0.00	4	0
Lead D-Pb	0.0015	0.0024	0.0050	0.0001	4	0
Lithium D-Li	0.006	0.009	0.020	0.001	4	2
Magnesium D-Mg	4.20	0.27	4.40	3.82	4	4
Manganese D-Mn	0.00158	0.00228	0.00500	0.00032	4	2
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	3	0
Molybdenum D-Mo	0.00915	0.01404	0.03000	0.00078	4	2
Nickel D-Ni	0.0060	0.0093	0.0200	0.0010	4	2
Phosphorus D-P	0.2	0.1	0.3	0.1	3	0
Potassium D-K	2	1	2	1	3	1
Selenium D-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon D-Si	1.68	0.39	2.13	1.45	3	3
Silver D-Ag	0.00028	0.00048	0.00100	0.00001	4	0
Sodium D-Na	2	1	2	1	4	1
Strontium D-Sr	0.0457	0.0017	0.0473	0.0440	3	3
Thallium D-Tl	0.0017	0.0029	0.0050	0.0001	3	0
Tin D-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium D-Ti	0.01	0.01	0.01	0.00	3	0
Uranium D-U	0.0204	0.0343	0.0600	0.0005	3	2
Vanadium D-V	0.009	0.014	0.030	0.001	4	0
Zinc D-Zn	0.004	0.001	0.005	0.002	4	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W8

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	94	16	121	78	6	6
Hardness CaCO3	78.6	6.0	87.3	71.5	6	6
pH	7.69	0.27	8.00	7.38	6	6
Total Suspended Solids	1	0	1	1	3	0
Turbidity (NTU)	0.4	0.4	1.0	0.1	6	6
Alkalinity-Total CaCO3	65	4	71	61	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.04	0.01	0.05	0.03	5	5
Sulphate SO4	13	3	19	10	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.073	0.026	0.107	0.045	6	6
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	2
Nitrite/Nitrate Nitrogen N	0.068	0.029	0.108	0.045	4	4
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.021	0.016	0.050	0.007	6	6
Antimony T-Sb	0.04405	0.08761	0.20000	0.00005	5	2
Arsenic T-As	0.00348	0.00810	0.02000	0.00012	6	5
Barium T-Ba	0.1165	0.1782	0.4800	0.0379	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00008	0.00007	0.00020	0.00005	5	0
Calcium T-Ca	26.6	2.0	29.9	24.5	6	6
Chromium T-Cr	0.0005	0.0004	0.0010	0.0002	6	5
Cobalt T-Co	0.0054	0.0081	0.0200	0.0001	6	1
Copper T-Cu	0.002	0.002	0.007	0.001	6	5
Iron T-Fe	0.03	0.02	0.07	0.01	6	2
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	1
Lithium T-Li	0.006	0.008	0.020	0.001	6	1
Magnesium T-Mg	3.16	0.32	3.58	2.78	6	6
Manganese T-Mn	0.00348	0.00240	0.00662	0.00071	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01106	0.01478	0.03000	0.00038	6	3
Nickel T-Ni	0.0075	0.0097	0.0200	0.0007	6	3
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	0	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.70	0.33	3.26	2.41	5	5
Silver T-Ag	0.00036	0.00081	0.00200	0.00001	6	1
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0569	0.0065	0.0650	0.0491	5	5
Thallium T-Tl	0.0212	0.0441	0.1000	0.0001	5	1
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	1
Uranium T-U	0.0124	0.0266	0.0600	0.0003	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.006	0.002	0.010	0.004	6	5

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.013	0.007	0.022	0.006	6	6
Antimony D-Sb	0.04404	0.08761	0.20000	0.00005	5	3
Arsenic D-As	0.00347	0.00810	0.02000	0.00010	6	5
Barium D-Ba	0.0451	0.0046	0.0502	0.0400	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.041	0.054	0.100	0.001	5	1
Cadmium D-Cd	0.00090	0.00201	0.00500	0.00005	6	0
Calcium D-Ca	26.2	2.0	29.2	24.2	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0001	6	4
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	1
Copper D-Cu	0.002	0.002	0.006	0.001	6	6
Iron D-Fe	0.02	0.01	0.03	0.01	6	2
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	3.20	0.27	3.46	2.71	6	6
Manganese D-Mn	0.00239	0.00206	0.00500	0.00035	6	4
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01107	0.01477	0.03000	0.00040	6	3
Nickel D-Ni	0.0075	0.0097	0.0200	0.0006	6	3
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	2.65	0.29	3.13	2.40	5	5
Silver D-Ag	0.00019	0.00040	0.00100	0.00001	6	2
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0562	0.0060	0.0630	0.0488	5	5
Thallium D-Tl	0.0210	0.0442	0.1000	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0124	0.0266	0.0600	0.0003	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.006	0.001	0.007	0.004	6	6

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W9

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	137	18	173	97	16	16
Hardness CaCO3	106.2	30.5	133.0	8.5	15	15
pH	7.75	0.24	8.20	7.38	16	16
Total Suspended Solids	2	1	6	1	10	6
Turbidity (NTU)	1.4	3.4	13.5	0.1	15	14
Alkalinity-Total CaCO3	94	14	113	56	16	16
Chloride Cl	0.5	0.1	1.0	0.5	15	2
Fluoride F	0.17	0.23	1.00	0.09	15	14
Sulphate SO4	26	4	35	16	16	16
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.116	0.069	0.300	0.046	16	15
Nitrite Nitrogen N	0.037	0.125	0.500	0.001	16	5
Nitrite/Nitrate Nitrogen N	0.085	0.040	0.153	0.047	9	9
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.021	0.017	0.060	0.002	15	14
Antimony T-Sb	0.06943	0.09580	0.20000	0.00018	15	8
Arsenic T-As	0.00272	0.00675	0.02000	0.00018	16	14
Barium T-Ba	0.1146	0.0132	0.1330	0.0800	16	16
Beryllium T-Be	0.0024	0.0023	0.0050	0.0002	16	0
Bismuth T-Bi	0.0429	0.0487	0.1000	0.0005	15	0
Boron T-B	0.051	0.051	0.100	0.001	14	1
Cadmium T-Cd	0.00132	0.00023	0.00184	0.00085	16	16
Calcium T-Ca	34.2	4.4	40.3	21.3	16	16
Chromium T-Cr	0.0011	0.0024	0.0100	0.0001	16	8
Cobalt T-Co	0.0052	0.0071	0.0200	0.0001	16	0
Copper T-Cu	0.002	0.001	0.006	0.001	16	14
Iron T-Fe	0.05	0.07	0.29	0.01	16	12
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	14	7
Lithium T-Li	0.007	0.007	0.020	0.001	16	1
Magnesium T-Mg	7.39	1.24	9.74	4.64	16	16
Manganese T-Mn	0.00683	0.01053	0.04200	0.00011	16	12
Mercury T-Hg	0.00012	0.00024	0.00100	0.00005	15	1
Molybdenum T-Mo	0.01225	0.01427	0.03000	0.00062	16	7
Nickel T-Ni	0.0097	0.0083	0.0200	0.0020	16	9
Phosphorus T-P	0.3	0.1	0.3	0.1	15	0
Potassium T-K	2	0	2	1	15	3
Selenium T-Se	0.0032	0.0006	0.0040	0.0020	14	14
Silicon T-Si	3.03	0.38	3.75	2.11	15	15
Silver T-Ag	0.00009	0.00025	0.00100	0.00001	15	2
Sodium T-Na	2	0	2	1	16	3
Strontium T-Sr	0.1033	0.0153	0.1280	0.0680	15	15
Thallium T-Tl	0.0361	0.0494	0.1000	0.0001	14	0
Tin T-Sn	0.0127	0.0147	0.0300	0.0001	15	0
Titanium T-Ti	0.01	0.00	0.01	0.00	15	0
Uranium T-U	0.0109	0.0229	0.0600	0.0005	12	10
Vanadium T-V	0.014	0.015	0.030	0.001	16	1
Zinc T-Zn	0.134	0.031	0.198	0.055	16	15

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.022	0.048	0.200	0.001	16	12
Antimony D-Sb	0.06945	0.09579	0.20000	0.00010	15	8
Arsenic D-As	0.00268	0.00676	0.02000	0.00010	16	14
Barium D-Ba	0.1164	0.0132	0.1320	0.0800	16	16
Beryllium D-Be	0.0024	0.0023	0.0050	0.0002	16	0
Bismuth D-Bi	0.0429	0.0487	0.1000	0.0005	15	0
Boron D-B	0.054	0.048	0.100	0.001	14	4
Cadmium D-Cd	0.00118	0.00014	0.00140	0.00082	16	15
Calcium D-Ca	34.0	4.2	39.8	21.3	16	16
Chromium D-Cr	0.0011	0.0024	0.0100	0.0001	16	7
Cobalt D-Co	0.0052	0.0071	0.0200	0.0001	16	0
Copper D-Cu	0.002	0.001	0.004	0.001	16	14
Iron D-Fe	0.03	0.04	0.12	0.00	16	4
Lead D-Pb	0.0008	0.0017	0.0050	0.0001	16	5
Lithium D-Li	0.006	0.007	0.020	0.001	16	0
Magnesium D-Mg	7.39	1.22	9.88	4.61	16	16
Manganese D-Mn	0.00307	0.00315	0.00900	0.00009	16	12
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	14	0
Molybdenum D-Mo	0.01223	0.01428	0.03000	0.00050	16	7
Nickel D-Ni	0.0094	0.0085	0.0200	0.0020	16	9
Phosphorus D-P	0.3	0.1	0.3	0.1	15	0
Potassium D-K	2	1	2	1	15	3
Selenium D-Se	0.0032	0.0007	0.0040	0.0020	14	14
Silicon D-Si	2.99	0.34	3.65	2.06	15	15
Silver D-Ag	0.00071	0.00249	0.01000	0.00001	16	0
Sodium D-Na	2	0	2	1	16	3
Strontium D-Sr	0.1019	0.0164	0.1270	0.0680	15	15
Thallium D-Tl	0.0361	0.0494	0.1000	0.0001	14	0
Tin D-Sn	0.0127	0.0147	0.0300	0.0001	15	2
Titanium D-Ti	0.01	0.00	0.01	0.00	15	0
Uranium D-U	0.0109	0.0229	0.0600	0.0006	12	10
Vanadium D-V	0.014	0.015	0.030	0.001	16	0
Zinc D-Zn	0.123	0.029	0.175	0.054	16	16

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W10

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	71	16	93	56	4	4
Hardness CaCO3	51.4	5.4	55.7	43.6	4	4
pH	7.63	0.27	7.88	7.28	4	4
Total Suspended Solids	2	0	2	2	2	2
Turbidity (NTU)	0.8	0.2	1.0	0.5	4	4
Alkalinity-Total CaCO3	45	3	48	41	4	4
Chloride Cl	0.5	0.0	0.5	0.5	3	0
Fluoride F	0.08	0.01	0.08	0.07	3	3
Sulphate SO4	9	1	10	7	4	4
Ammonia Nitrogen N	0.040	0.014	0.050	0.030	2	1
Nitrate Nitrogen N	0.006	0.003	0.010	0.005	4	0
Nitrite Nitrogen N	0.008	0.015	0.030	0.001	4	0
Nitrite/Nitrate Nitrogen N	0.005	0.000	0.005	0.005	3	0
Total Cyanide CN	0.005	#DIV/0!	0.005	0.005	1	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.021	0.013	0.040	0.011	4	4
Antimony T-Sb	0.00670	0.01152	0.02000	0.00005	3	1
Arsenic T-As	0.00589	0.00941	0.02000	0.00113	4	3
Barium T-Ba	0.0456	0.0058	0.0500	0.0372	4	4
Beryllium T-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth T-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron T-B	0.034	0.057	0.100	0.001	3	0
Cadmium T-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium T-Ca	15.7	1.7	16.8	13.2	4	4
Chromium T-Cr	0.0006	0.0005	0.0010	0.0001	4	1
Cobalt T-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper T-Cu	0.002	0.002	0.005	0.001	4	3
Iron T-Fe	0.04	0.02	0.07	0.03	4	4
Lead T-Pb	0.0004	0.0005	0.0010	0.0001	3	0
Lithium T-Li	0.006	0.009	0.020	0.001	4	0
Magnesium T-Mg	3.27	0.32	3.52	2.79	4	4
Manganese T-Mn	0.01440	0.00836	0.02650	0.00741	4	4
Mercury T-Hg	0.00029	0.00048	0.00100	0.00005	4	0
Molybdenum T-Mo	0.00921	0.01399	0.03000	0.00089	4	2
Nickel T-Ni	0.0058	0.0095	0.0200	0.0005	4	2
Phosphorus T-P	0.2	0.1	0.3	0.1	3	0
Potassium T-K	2	1	2	1	3	1
Selenium T-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon T-Si	2.63	0.37	3.05	2.34	3	3
Silver T-Ag	0.00004	0.00005	0.00010	0.00001	3	0
Sodium T-Na	2	1	2	1	4	1
Strontium T-Sr	0.0388	0.0058	0.0430	0.0321	3	3
Thallium T-Tl	0.0017	0.0029	0.0050	0.0001	3	0
Tin T-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium T-Ti	0.01	0.01	0.01	0.00	3	0
Uranium T-U	0.0203	0.0344	0.0600	0.0004	3	2
Vanadium T-V	0.009	0.014	0.030	0.001	4	0
Zinc T-Zn	0.005	0.000	0.005	0.005	4	3

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.011	0.004	0.017	0.007	4	3
Antimony D-Sb	0.00670	0.01152	0.02000	0.00005	3	0
Arsenic D-As	0.00584	0.00944	0.02000	0.00110	4	3
Barium D-Ba	0.0474	0.0077	0.0580	0.0400	4	4
Beryllium D-Be	0.0016	0.0023	0.0050	0.0002	4	0
Bismuth D-Bi	0.0070	0.0113	0.0200	0.0005	3	0
Boron D-B	0.038	0.054	0.100	0.001	3	1
Cadmium D-Cd	0.00020	0.00021	0.00050	0.00005	4	0
Calcium D-Ca	15.3	1.6	16.4	12.9	4	4
Chromium D-Cr	0.0006	0.0005	0.0010	0.0001	4	1
Cobalt D-Co	0.0053	0.0098	0.0200	0.0001	4	0
Copper D-Cu	0.001	0.001	0.002	0.001	4	3
Iron D-Fe	0.02	0.01	0.03	0.01	4	1
Lead D-Pb	0.0015	0.0024	0.0050	0.0001	4	0
Lithium D-Li	0.006	0.009	0.020	0.001	4	0
Magnesium D-Mg	3.22	0.35	3.57	2.75	4	4
Manganese D-Mn	0.00238	0.00189	0.00500	0.00062	4	3
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	3	0
Molybdenum D-Mo	0.00921	0.01400	0.03000	0.00090	4	2
Nickel D-Ni	0.0057	0.0096	0.0200	0.0004	4	2
Phosphorus D-P	0.2	0.1	0.3	0.1	3	0
Potassium D-K	2	1	2	1	3	1
Selenium D-Se	0.0008	0.0003	0.0010	0.0005	3	0
Silicon D-Si	2.59	0.33	2.96	2.31	3	3
Silver D-Ag	0.00253	0.00498	0.01000	0.00001	4	0
Sodium D-Na	2	1	2	1	4	1
Strontium D-Sr	0.0383	0.0036	0.0407	0.0341	3	3
Thallium D-Tl	0.0017	0.0029	0.0050	0.0001	3	0
Tin D-Sn	0.0017	0.0028	0.0050	0.0001	3	0
Titanium D-Ti	0.01	0.01	0.01	0.00	3	0
Uranium D-U	0.0203	0.0344	0.0600	0.0004	3	2
Vanadium D-V	0.009	0.014	0.030	0.001	4	0
Zinc D-Zn	0.007	0.007	0.017	0.001	4	2

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W11

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	62	15	105	47	17	17
Hardness CaCO3	42.3	10.5	66.1	20.7	16	16
pH	7.45	0.29	7.99	7.03	17	17
Total Suspended Solids	2	2	8	1	11	8
Turbidity (NTU)	0.7	0.4	1.4	0.2	16	15
Alkalinity-Total CaCO3	36	11	59	17	17	17
Chloride Cl	0.5	0.1	0.8	0.5	16	3
Fluoride F	0.14	0.23	1.00	0.06	16	15
Sulphate SO4	12	3	17	5	17	17
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.057	0.081	0.258	0.005	17	14
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	7
Nitrite/Nitrate Nitrogen N	0.033	0.076	0.261	0.005	11	9
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.043	0.023	0.100	0.010	15	15
Antimony T-Sb	0.07753	0.09819	0.20000	0.00005	16	0
Arsenic T-As	0.00250	0.00659	0.02000	0.00005	17	13
Barium T-Ba	0.0319	0.0140	0.0700	0.0200	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.054	0.051	0.100	0.001	15	2
Cadmium T-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium T-Ca	11.7	3.2	18.4	5.6	17	17
Chromium T-Cr	0.0017	0.0031	0.0100	0.0002	17	9
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper T-Cu	0.001	0.001	0.004	0.001	17	14
Iron T-Fe	0.14	0.11	0.42	0.03	17	17
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	6
Lithium T-Li	0.007	0.006	0.020	0.001	17	8
Magnesium T-Mg	3.59	0.98	5.53	1.73	17	17
Manganese T-Mn	0.01714	0.01796	0.07480	0.00628	17	17
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	1
Molybdenum T-Mo	0.01313	0.01463	0.03000	0.00026	17	7
Nickel T-Ni	0.0089	0.0095	0.0200	0.0007	17	7
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	0	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	15	1
Silicon T-Si	3.25	1.10	5.73	1.90	16	16
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	0
Sodium T-Na	2	0	2	1	17	4
Strontium T-Sr	0.0399	0.0099	0.0590	0.0230	16	16
Thallium T-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	16	0
Titanium T-Ti	0.01	0.00	0.01	0.00	16	0
Uranium T-U	0.0116	0.0239	0.0600	0.0007	11	9
Vanadium T-V	0.015	0.015	0.030	0.001	17	0
Zinc T-Zn	0.004	0.003	0.012	0.001	17	8

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.040	0.061	0.200	0.005	17	11
Antimony D-Sb	0.07754	0.09818	0.20000	0.00005	16	3
Arsenic D-As	0.00249	0.00659	0.02000	0.00005	17	13
Barium D-Ba	0.0367	0.0194	0.0729	0.0100	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.057	0.048	0.100	0.001	15	4
Cadmium D-Cd	0.00012	0.00015	0.00050	0.00005	17	2
Calcium D-Ca	11.6	3.2	18.4	5.5	17	17
Chromium D-Cr	0.0017	0.0032	0.0100	0.0001	17	8
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper D-Cu	0.001	0.001	0.002	0.000	17	13
Iron D-Fe	0.06	0.04	0.19	0.01	17	15
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	5
Lithium D-Li	0.007	0.006	0.020	0.001	17	7
Magnesium D-Mg	3.58	0.98	5.60	1.68	17	17
Manganese D-Mn	0.00685	0.00318	0.01500	0.00249	17	16
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01312	0.01463	0.03000	0.00024	17	7
Nickel D-Ni	0.0089	0.0096	0.0200	0.0005	17	7
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	1	2	1	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	0
Silicon D-Si	3.25	1.11	5.68	1.82	16	16
Silver D-Ag	0.00007	0.00024	0.01000	0.00001	17	0
Sodium D-Na	2	0	2	1	17	4
Strontium D-Sr	0.0394	0.0095	0.0590	0.0230	16	16
Thallium D-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	16	2
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0115	0.0240	0.0600	0.0006	11	9
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.007	0.008	0.026	0.001	17	8

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W12

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	79	15	111	56	17	17
Hardness CaCO3	61.0	11.8	81.2	36.1	16	16
pH	7.63	0.24	8.08	7.28	17	17
Total Suspended Solids	3	2	6	1	11	8
Turbidity (NTU)	0.9	0.6	2.2	0.2	16	15
Alkalinity-Total CaCO3	56	11	73	33	17	17
Chloride Cl	0.6	0.3	1.7	0.5	16	2
Fluoride F	0.12	0.24	1.00	0.03	16	15
Sulphate SO4	10	3	15	6	17	17
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.030	0.045	0.148	0.005	17	7
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	5
Nitrite/Nitrate Nitrogen N	0.020	0.043	0.150	0.005	11	3
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.022	0.015	0.050	0.005	15	13
Antimony T-Sb	0.07753	0.09819	0.20000	0.00005	16	5
Arsenic T-As	0.00257	0.00656	0.02000	0.00014	17	15
Barium T-Ba	0.0594	0.0118	0.0800	0.0400	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.054	0.051	0.100	0.001	15	1
Cadmium T-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium T-Ca	19.5	3.8	25.6	11.7	17	17
Chromium T-Cr	0.0016	0.0032	0.0100	0.0001	17	7
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	1
Copper T-Cu	0.001	0.001	0.004	0.000	17	14
Iron T-Fe	0.07	0.05	0.22	0.03	17	16
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	7
Lithium T-Li	0.007	0.007	0.020	0.001	17	0
Magnesium T-Mg	3.41	0.91	5.20	1.96	17	17
Manganese T-Mn	0.01192	0.00670	0.02700	0.00590	17	17
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	0
Molybdenum T-Mo	0.01315	0.01460	0.03000	0.00035	17	7
Nickel T-Ni	0.0086	0.0098	0.0200	0.0001	17	5
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	1	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0012	0.0005	15	3
Silicon T-Si	2.90	0.67	4.49	1.96	16	16
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	2	1	17	3
Strontium T-Sr	0.0404	0.0087	0.0560	0.0270	16	16
Thallium T-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	16	0
Titanium T-Ti	0.01	0.00	0.01	0.00	16	0
Uranium T-U	0.0110	0.0242	0.0600	0.0001	11	9
Vanadium T-V	0.015	0.015	0.030	0.001	17	1
Zinc T-Zn	0.003	0.002	0.005	0.001	17	5

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.035	0.063	0.200	0.004	17	11
Antimony D-Sb	0.07756	0.09817	0.20000	0.00005	16	6
Arsenic D-As	0.00255	0.00657	0.02000	0.00010	17	15
Barium D-Ba	0.0641	0.0188	0.0955	0.0300	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.057	0.048	0.100	0.001	15	4
Cadmium D-Cd	0.00013	0.00015	0.00050	0.00005	17	3
Calcium D-Ca	19.3	3.6	24.8	11.4	17	17
Chromium D-Cr	0.0016	0.0032	0.0100	0.0001	17	7
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper D-Cu	0.001	0.001	0.003	0.000	17	13
Iron D-Fe	0.04	0.03	0.10	0.01	17	15
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	6
Lithium D-Li	0.007	0.007	0.020	0.001	17	0
Magnesium D-Mg	3.41	0.87	5.09	1.86	17	17
Manganese D-Mn	0.00580	0.00410	0.02000	0.00180	17	14
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01315	0.01461	0.03000	0.00031	17	7
Nickel D-Ni	0.0086	0.0098	0.0200	0.0001	17	5
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	1	2	0	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	2
Silicon D-Si	2.89	0.66	4.39	1.85	16	16
Silver D-Ag	0.00067	0.00242	0.01000	0.00001	17	2
Sodium D-Na	2	0	2	1	17	3
Strontium D-Sr	0.0402	0.0086	0.0550	0.0250	16	16
Thallium D-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	16	1
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0110	0.0242	0.0600	0.0001	11	9
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.009	0.009	0.026	0.001	17	9

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W13

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	74	8	88	62	6	6
Hardness CaCO3	60.4	6.9	65.6	46.5	6	6
pH	7.65	0.31	8.10	7.33	6	6
Total Suspended Solids	2	1	3	1	3	2
Turbidity (NTU)	0.4	0.4	1.0	0.1	6	5
Alkalinity-Total CaCO3	60	7	66	47	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.04	0.01	0.06	0.02	5	5
Sulphate SO4	4	1	5	3	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.090	0.016	0.113	0.068	6	5
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	4
Nitrite/Nitrate Nitrogen N	0.089	0.017	0.114	0.069	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.029	0.032	0.070	0.004	5	4
Antimony T-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic T-As	0.00345	0.00811	0.02000	0.00005	6	4
Barium T-Ba	0.0680	0.0155	0.0856	0.0438	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium T-Ca	18.5	2.2	20.3	14.2	6	6
Chromium T-Cr	0.0021	0.0039	0.0100	0.0002	6	3
Cobalt T-Co	0.0054	0.0081	0.0200	0.0001	6	1
Copper T-Cu	0.001	0.001	0.004	0.001	6	5
Iron T-Fe	0.02	0.01	0.03	0.01	6	2
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	0
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	3.40	0.35	3.63	2.73	6	6
Manganese T-Mn	0.00246	0.00239	0.00500	0.00020	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01097	0.01486	0.03000	0.00020	6	3
Nickel T-Ni	0.0072	0.0099	0.0200	0.0003	6	3
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	4.03	0.42	4.76	3.72	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0275	0.0061	0.0320	0.0172	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0151	0.0299	0.0600	0.0001	4	3
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.003	0.002	0.005	0.001	6	2

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.051	0.076	0.200	0.002	6	5
Antimony D-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic D-As	0.00345	0.00811	0.02000	0.00005	6	4
Barium D-Ba	0.0688	0.0150	0.0859	0.0450	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.041	0.054	0.100	0.001	5	1
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	18.4	2.2	19.9	14.1	6	6
Chromium D-Cr	0.0021	0.0039	0.0100	0.0002	6	3
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.001	0.001	0.002	0.000	6	4
Iron D-Fe	0.04	0.05	0.13	0.01	6	2
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	3.45	0.39	3.84	2.72	6	6
Manganese D-Mn	0.00195	0.00241	0.00500	0.00006	6	4
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01097	0.01486	0.03000	0.00020	6	3
Nickel D-Ni	0.0072	0.0099	0.0200	0.0003	6	3
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	4.01	0.36	4.62	3.70	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0280	0.0067	0.0350	0.0171	5	5
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0151	0.0299	0.0600	0.0001	4	3
Vanadium D-V	0.011	0.015	0.030	0.001	6	1
Zinc D-Zn	0.003	0.002	0.005	0.001	6	2

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W14

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	71	17	102	50	17	17
Hardness CaCO3	48.5	12.0	72.1	25.7	16	16
pH	7.51	0.29	8.03	7.06	17	17
Total Suspended Solids	2	1	5	1	11	7
Turbidity (NTU)	0.6	0.3	1.2	0.3	16	16
Alkalinity-Total CaCO3	42	10	63	22	17	17
Chloride Cl	0.6	0.1	0.8	0.5	16	4
Fluoride F	0.13	0.23	1.00	0.02	16	14
Sulphate SO4	11	3	15	5	17	17
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.055	0.084	0.300	0.005	17	14
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	8
Nitrite/Nitrate Nitrogen N	0.028	0.055	0.191	0.005	11	9
Total Cyanide CN	0.005	#DIV/0!	0.005	0.005	1	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.028	0.015	0.060	0.005	15	13
Antimony T-Sb	0.07753	0.09819	0.20000	0.00005	16	2
Arsenic T-As	0.00250	0.00659	0.02000	0.00007	17	15
Barium T-Ba	0.0413	0.0147	0.0800	0.0200	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.054	0.051	0.100	0.001	15	2
Cadmium T-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium T-Ca	14.0	3.7	20.7	7.6	17	17
Chromium T-Cr	0.0016	0.0032	0.0100	0.0001	17	8
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	0
Copper T-Cu	0.001	0.001	0.005	0.000	17	14
Iron T-Fe	0.09	0.05	0.26	0.03	17	16
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	2
Lithium T-Li	0.007	0.006	0.020	0.001	17	8
Magnesium T-Mg	3.47	0.91	5.10	1.76	17	17
Manganese T-Mn	0.01090	0.00478	0.02180	0.00500	17	16
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	1
Molybdenum T-Mo	0.01313	0.01462	0.03000	0.00026	17	7
Nickel T-Ni	0.0095	0.0095	0.0200	0.0004	17	8
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	0	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	15	1
Silicon T-Si	3.18	0.95	5.51	1.98	16	16
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	2	1	17	3
Strontium T-Sr	0.0389	0.0093	0.0550	0.0230	16	16
Thallium T-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	18	0
Titanium T-Ti	0.01	0.00	0.01	0.00	16	1
Uranium T-U	0.0114	0.0240	0.0600	0.0008	11	9
Vanadium T-V	0.015	0.015	0.030	0.001	17	1
Zinc T-Zn	0.003	0.002	0.008	0.001	17	9

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.041	0.061	0.200	0.005	17	12
Antimony D-Sb	0.07755	0.09818	0.20000	0.00005	16	3
Arsenic D-As	0.00250	0.00659	0.02000	0.00005	17	15
Barium D-Ba	0.0481	0.0194	0.0800	0.0200	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.057	0.048	0.100	0.001	15	4
Cadmium D-Cd	0.00013	0.00015	0.00050	0.00005	17	2
Calcium D-Ca	14.0	3.6	20.6	7.5	17	17
Chromium D-Cr	0.0017	0.0032	0.0100	0.0001	17	10
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	1
Copper D-Cu	0.001	0.001	0.003	0.000	17	13
Iron D-Fe	0.06	0.03	0.14	0.01	17	15
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	3
Lithium D-Li	0.007	0.006	0.020	0.001	17	7
Magnesium D-Mg	3.48	0.85	5.05	1.73	17	17
Manganese D-Mn	0.00570	0.00244	0.01300	0.00230	17	14
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01312	0.01463	0.03000	0.00024	17	7
Nickel D-Ni	0.0088	0.0096	0.0200	0.0004	17	7
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	1	2	1	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	0
Silicon D-Si	3.19	0.94	5.51	1.87	16	16
Silver D-Ag	0.00067	0.00242	0.01000	0.00001	17	1
Sodium D-Na	2	0	2	1	17	4
Strontium D-Sr	0.0387	0.0089	0.0530	0.0230	16	16
Thallium D-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	18	1
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0114	0.0240	0.0600	0.0005	11	9
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.008	0.009	0.026	0.001	17	7

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W15

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	64	11	89	53	11	11
Hardness CaCO3	46.9	5.6	53.5	32.9	11	11
pH	7.49	0.33	7.97	6.92	11	11
Total Suspended Solids	5	9	24	1	7	4
Turbidity (NTU)	1.1	2.1	7.4	0.1	11	9
Alkalinity-Total CaCO3	43	6	48	28	11	11
Chloride Cl	0.5	0.0	0.5	0.5	10	0
Fluoride F	0.04	0.02	0.07	0.02	10	8
Sulphate SO4	7	1	9	5	11	11
Ammonia Nitrogen N	0.010	0.009	0.020	0.005	3	0
Nitrate Nitrogen N	0.058	0.049	0.173	0.018	11	10
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	11	6
Nitrite/Nitrate Nitrogen N	0.052	0.052	0.173	0.018	9	9
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.017	0.011	0.040	0.007	9	10
Antimony T-Sb	0.04204	0.08348	0.20000	0.00005	10	1
Arsenic T-As	0.00202	0.00597	0.02000	0.00010	11	9
Barium T-Ba	0.0224	0.0288	0.1090	0.0100	11	11
Beryllium T-Be	0.0017	0.0021	0.0050	0.0002	11	0
Bismuth T-Bi	0.0224	0.0414	0.1000	0.0005	10	0
Boron T-B	0.031	0.048	0.100	0.001	10	0
Cadmium T-Cd	0.00012	0.00014	0.00050	0.00005	11	1
Calcium T-Ca	16.9	2.2	19.7	11.9	11	11
Chromium T-Cr	0.0013	0.0029	0.0100	0.0001	11	6
Cobalt T-Co	0.0038	0.0066	0.0200	0.0001	11	2
Copper T-Cu	0.002	0.001	0.004	0.001	11	10
Iron T-Fe	0.06	0.15	0.52	0.01	11	6
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	9	1
Lithium T-Li	0.004	0.006	0.020	0.001	11	0
Magnesium T-Mg	1.15	0.29	1.94	0.78	11	11
Manganese T-Mn	0.00866	0.02198	0.07460	0.00036	11	8
Mercury T-Hg	0.00014	0.00029	0.00100	0.00005	11	1
Molybdenum T-Mo	0.00878	0.01371	0.03000	0.00014	11	7
Nickel T-Ni	0.0058	0.0091	0.0200	0.0001	11	2
Phosphorus T-P	0.3	0.1	0.3	0.1	10	0
Potassium T-K	2	0	2	1	10	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	9	0
Silicon T-Si	2.53	0.52	3.73	2.01	10	10
Silver T-Ag	0.00002	0.00003	0.00010	0.00001	10	0
Sodium T-Na	2	0	2	1	11	1
Strontium T-Sr	0.0276	0.0044	0.0377	0.0220	10	10
Thallium T-Tl	0.0105	0.0315	0.1000	0.0001	10	0
Tin T-Sn	0.0066	0.0124	0.0300	0.0001	10	0
Titanium T-Ti	0.01	0.00	0.01	0.00	10	0
Uranium T-U	0.0067	0.0200	0.0600	0.0000	9	8
Vanadium T-V	0.009	0.013	0.030	0.001	11	1
Zinc T-Zn	0.003	0.004	0.013	0.001	11	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.028	0.058	0.200	0.005	11	10
Antimony D-Sb	0.04208	0.08346	0.20000	0.00005	10	4
Arsenic D-As	0.00195	0.00599	0.02000	0.00009	11	10
Barium D-Ba	0.0334	0.0277	0.0843	0.0100	11	11
Beryllium D-Be	0.0017	0.0021	0.0050	0.0002	11	0
Bismuth D-Bi	0.0224	0.0414	0.1000	0.0005	10	0
Boron D-B	0.038	0.045	0.100	0.001	10	4
Cadmium D-Cd	0.00010	0.00014	0.00050	0.00005	11	0
Calcium D-Ca	16.8	2.1	19.4	11.9	11	11
Chromium D-Cr	0.0015	0.0029	0.0100	0.0001	11	7
Cobalt D-Co	0.0038	0.0067	0.0200	0.0001	11	0
Copper D-Cu	0.001	0.001	0.003	0.001	11	9
Iron D-Fe	0.02	0.02	0.05	0.00	11	2
Lead D-Pb	0.0014	0.0030	0.0092	0.0001	11	3
Lithium D-Li	0.004	0.006	0.020	0.001	11	0
Magnesium D-Mg	1.19	0.27	1.84	0.78	11	11
Manganese D-Mn	0.00306	0.00472	0.01580	0.00012	11	8
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	10	0
Molybdenum D-Mo	0.00878	0.01370	0.03000	0.00016	11	7
Nickel D-Ni	0.0058	0.0092	0.0200	0.0001	11	2
Phosphorus D-P	0.3	0.1	0.3	0.1	10	0
Potassium D-K	2	1	2	0	10	0
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	9	0
Silicon D-Si	2.50	0.42	3.52	2.01	10	10
Silver D-Ag	0.00093	0.00301	0.01000	0.00001	11	0
Sodium D-Na	2	0	2	1	11	1
Strontium D-Sr	0.0280	0.0046	0.0363	0.0220	10	10
Thallium D-Tl	0.0105	0.0315	0.1000	0.0001	10	0
Tin D-Sn	0.0066	0.0124	0.0300	0.0001	10	1
Titanium D-Ti	0.01	0.00	0.01	0.00	10	0
Uranium D-U	0.0067	0.0200	0.0600	0.0000	9	8
Vanadium D-V	0.009	0.013	0.030	0.001	11	0
Zinc D-Zn	0.009	0.009	0.025	0.001	11	6

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W16

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	77	10	88	61	6	6
Hardness CaCO3	61.4	9.2	68.3	43.0	6	6
pH	7.48	0.28	7.90	7.15	6	6
Total Suspended Solids	3	3	6	1	3	1
Turbidity (NTU)	0.5	0.4	1.0	0.1	6	5
Alkalinity-Total CaCO3	57	8	63	42	6	6
Chloride Cl	0.5	0.0	0.6	0.5	5	1
Fluoride F	0.04	0.01	0.05	0.03	5	5
Sulphate SO4	7	1	9	5	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.038	0.031	0.100	0.018	6	5
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.026	0.005	0.032	0.019	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.019	0.012	0.040	0.009	6	6
Antimony T-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic T-As	0.00344	0.00811	0.02000	0.00010	6	5
Barium T-Ba	0.0598	0.0073	0.0700	0.0475	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium T-Ca	20.4	3.3	22.9	13.9	6	6
Chromium T-Cr	0.0005	0.0004	0.0010	0.0001	6	3
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper T-Cu	0.002	0.001	0.004	0.001	6	5
Iron T-Fe	0.03	0.01	0.04	0.00	6	3
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	0
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	2.58	0.42	2.90	1.75	6	6
Manganese T-Mn	0.00722	0.00406	0.01510	0.00353	6	5
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01100	0.01483	0.03000	0.00030	6	3
Nickel T-Ni	0.0071	0.0100	0.0200	0.0002	6	3
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.68	0.35	3.04	2.22	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0389	0.0078	0.0470	0.0290	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0121	0.0268	0.0600	0.0001	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.004	0.001	0.005	0.002	6	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.013	0.007	0.021	0.006	6	6
Antimony D-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic D-As	0.00343	0.00812	0.02000	0.00008	6	5
Barium D-Ba	0.0574	0.0077	0.0664	0.0461	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.042	0.053	0.100	0.001	5	1
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	20.2	3.0	22.4	14.3	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0001	6	2
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.001	0.000	0.002	0.001	6	4
Iron D-Fe	0.02	0.01	0.03	0.00	6	2
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	2.64	0.47	3.08	1.78	6	6
Manganese D-Mn	0.00413	0.00124	0.00545	0.00244	6	5
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01100	0.01483	0.03000	0.00032	6	3
Nickel D-Ni	0.0071	0.0100	0.0200	0.0002	6	3
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	2.69	0.30	2.96	2.29	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0390	0.0095	0.0520	0.0258	5	5
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0121	0.0268	0.0600	0.0001	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.004	0.003	0.008	0.001	6	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W17

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	74	14	99	58	6	6
Hardness CaCO3	57.0	10.3	68.1	39.3	6	6
pH	7.74	0.30	8.09	7.30	6	6
Total Suspended Solids	1	0	1	1	3	0
Turbidity (NTU)	0.4	0.4	1.0	0.1	6	3
Alkalinity-Total CaCO3	53	8	61	38	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.03	0.01	0.03	0.02	5	4
Sulphate SO4	8	3	11	5	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.027	0.035	0.097	0.008	6	5
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.030	0.038	0.098	0.008	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.037	0.019	0.073	0.017	6	6
Antimony T-Sb	0.04403	0.08762	0.20000	0.00005	5	1
Arsenic T-As	0.00347	0.00810	0.02000	0.00013	6	5
Barium T-Ba	0.0105	0.0010	0.0125	0.0098	6	4
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium T-Ca	20.9	4.0	26.3	14.5	6	6
Chromium T-Cr	0.0005	0.0004	0.0010	0.0001	6	3
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper T-Cu	0.003	0.001	0.005	0.001	6	6
Iron T-Fe	0.02	0.01	0.03	0.01	6	2
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	0
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	1.32	0.24	1.66	0.95	6	6
Manganese T-Mn	0.00198	0.00236	0.00500	0.00006	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01094	0.01488	0.03000	0.00019	6	3
Nickel T-Ni	0.0071	0.0100	0.0200	0.0001	6	2
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.54	0.37	3.18	2.24	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0145	0.0038	0.0200	0.0098	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0120	0.0268	0.0600	0.0000	5	2
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.003	0.002	0.005	0.001	6	3

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.031	0.020	0.070	0.015	6	6
Antimony D-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic D-As	0.00346	0.00810	0.02000	0.00012	6	5
Barium D-Ba	0.0137	0.0058	0.0240	0.0098	6	4
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.042	0.053	0.100	0.001	5	2
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	20.6	3.7	24.7	14.2	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0001	6	2
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.002	0.001	0.004	0.001	5	5
Iron D-Fe	0.02	0.01	0.03	0.01	6	2
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	1.39	0.30	1.70	0.94	6	6
Manganese D-Mn	0.00193	0.00240	0.00500	0.00005	6	2
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01094	0.01488	0.03000	0.00018	6	3
Nickel D-Ni	0.0071	0.0100	0.0200	0.0001	6	1
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	2.46	0.21	2.75	2.24	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	1	2	0	6	1
Strontium D-Sr	0.0131	0.0070	0.0240	0.0050	5	4
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0120	0.0268	0.0600	0.0000	5	2
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.005	0.003	0.008	0.001	6	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W18

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	72	14	97	58	6	6
Hardness CaCO3	56.5	7.6	67.6	47.6	6	6
pH	7.75	0.31	8.10	7.37	6	6
Total Suspended Solids	2	1	2	1	3	2
Turbidity (NTU)	0.4	0.4	1.0	0.1	6	4
Alkalinity-Total CaCO3	52	5	58	46	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.02	0.00	0.02	0.02	5	1
Sulphate SO4	8	2	11	6	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	0
Nitrate Nitrogen N	0.084	0.061	0.200	0.032	6	6
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.081	0.068	0.201	0.033	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.024	0.021	0.060	0.008	6	6
Antimony T-Sb	0.04403	0.08762	0.20000	0.00005	5	1
Arsenic T-As	0.00351	0.00808	0.02000	0.00018	6	5
Barium T-Ba	0.0122	0.0022	0.0158	0.0100	6	4
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium T-Ca	21.3	2.9	26.2	17.9	6	6
Chromium T-Cr	0.0006	0.0004	0.0010	0.0002	6	3
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	1
Copper T-Cu	0.002	0.002	0.006	0.001	6	5
Iron T-Fe	0.02	0.01	0.03	0.01	6	2
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	1
Lithium T-Li	0.006	0.008	0.020	0.001	6	1
Magnesium T-Mg	0.93	0.12	1.14	0.79	6	6
Manganese T-Mn	0.00215	0.00229	0.00500	0.00005	6	3
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01098	0.01484	0.03000	0.00026	6	3
Nickel T-Ni	0.0071	0.0101	0.0200	0.0001	6	1
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.32	0.28	2.80	2.06	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0177	0.0031	0.0210	0.0145	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0120	0.0268	0.0600	0.0000	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.003	0.002	0.005	0.001	6	1

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.017	0.009	0.034	0.008	6	6
Antimony D-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic D-As	0.00351	0.00808	0.02000	0.00019	6	5
Barium D-Ba	0.0126	0.0029	0.0170	0.0100	5	4
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.041	0.054	0.100	0.001	5	1
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	21.0	2.8	25.3	17.7	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0002	6	3
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.002	0.001	0.003	0.001	6	5
Iron D-Fe	0.02	0.01	0.03	0.00	6	0
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	1.01	0.18	1.22	0.78	6	6
Manganese D-Mn	0.00197	0.00238	0.00500	0.00005	6	2
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01099	0.01484	0.03000	0.00027	6	3
Nickel D-Ni	0.0071	0.0100	0.0200	0.0001	6	1
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	2.31	0.26	2.75	2.12	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0173	0.0044	0.0250	0.0148	5	5
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0120	0.0268	0.0600	0.0000	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.004	0.002	0.006	0.001	6	2

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W19

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	67	8	80	57	6	6
Hardness CaCO3	55.0	7.3	62.8	42.0	6	6
pH	7.68	0.27	8.00	7.36	6	6
Total Suspended Solids	1	1	2	1	3	1
Turbidity (NTU)	0.3	0.3	1.0	0.1	6	4
Alkalinity-Total CaCO3	90	5	96	43	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.02	0.00	0.03	0.02	5	1
Sulphate SO4	8	2	11	5	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	1
Nitrate Nitrogen N	0.070	0.030	0.115	0.042	6	6
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.065	0.030	0.116	0.043	5	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.017	0.013	0.040	0.005	6	6
Antimony T-Sb	0.04403	0.08762	0.20000	0.00005	5	1
Arsenic T-As	0.00343	0.00812	0.02000	0.00010	6	5
Barium T-Ba	0.0113	0.0012	0.0131	0.0100	6	5
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium T-Ca	20.1	2.7	23.2	15.5	6	6
Chromium T-Cr	0.0005	0.0004	0.0010	0.0001	6	3
Cobalt T-Co	0.0053	0.0082	0.0200	0.0001	6	1
Copper T-Cu	0.002	0.002	0.006	0.001	6	5
Iron T-Fe	0.23	0.53	1.31	0.01	6	2
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	0
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	1.14	0.12	1.30	0.97	6	6
Manganese T-Mn	0.00407	0.00506	0.01330	0.00030	6	4
Mercury T-Hg	0.00021	0.00039	0.00100	0.00005	6	0
Molybdenum T-Mo	0.01094	0.01488	0.03000	0.00019	6	3
Nickel T-Ni	0.0071	0.0101	0.0200	0.0001	6	1
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	1	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon T-Si	2.39	0.29	2.86	2.12	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0207	0.0038	0.0250	0.0145	5	5
Thallium T-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0120	0.0268	0.0600	0.0000	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.003	0.002	0.005	0.001	6	2

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.011	0.007	0.024	0.005	6	6
Antimony D-Sb	0.04403	0.08762	0.20000	0.00005	5	0
Arsenic D-As	0.00343	0.00812	0.02000	0.00010	6	5
Barium D-Ba	0.0124	0.0032	0.0184	0.0100	6	5
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.041	0.054	0.100	0.001	5	1
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	20.0	2.7	23.1	15.3	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0002	6	3
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.001	0.001	0.002	0.001	6	4
Iron D-Fe	0.02	0.01	0.03	0.00	6	0
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	0
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	1.21	0.19	1.45	0.93	6	6
Manganese D-Mn	0.00188	0.00242	0.00500	0.00010	6	3
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01094	0.01488	0.03000	0.00018	6	3
Nickel D-Ni	0.0071	0.0101	0.0200	0.0001	6	1
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	0
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	0
Silicon D-Si	2.42	0.30	2.93	2.17	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0206	0.0049	0.0280	0.0147	5	5
Thallium D-Tl	0.0010	0.0022	0.0050	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0120	0.0268	0.0600	0.0000	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.004	0.003	0.008	0.001	6	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W20

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	97	17	126	77	6	6
Hardness CaCO3	75.4	15.1	95.6	50.8	6	6
pH	7.73	0.29	8.10	7.37	6	6
Total Suspended Solids	2	2	4	1	3	2
Turbidity (NTU)	0.7	0.5	1.3	0.1	6	5
Alkalinity-Total CaCO3	64	10	75	48	6	6
Chloride Cl	0.5	0.0	0.5	0.5	5	0
Fluoride F	0.07	0.01	0.08	0.06	5	5
Sulphate SO4	10	3	14	5	6	6
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	1
Nitrate Nitrogen N	0.042	0.032	0.100	0.005	6	4
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	6	4
Nitrite/Nitrate Nitrogen N	0.027	0.016	0.044	0.005	4	3
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.037	0.019	0.060	0.015	6	6
Antimony T-Sb	0.04404	0.08761	0.20000	0.00006	5	3
Arsenic T-As	0.00348	0.00809	0.02000	0.00017	6	5
Barium T-Ba	0.0396	0.0084	0.0508	0.0278	6	6
Beryllium T-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth T-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	0
Cadmium T-Cd	0.00015	0.00018	0.00050	0.00005	6	2
Calcium T-Ca	19.8	4.1	25.8	13.2	6	6
Chromium T-Cr	0.0005	0.0004	0.0010	0.0001	6	4
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper T-Cu	0.002	0.001	0.003	0.001	6	5
Iron T-Fe	0.03	0.01	0.05	0.02	6	4
Lead T-Pb	0.0002	0.0004	0.0010	0.0001	5	2
Lithium T-Li	0.006	0.008	0.020	0.001	6	0
Magnesium T-Mg	6.36	1.29	8.24	4.33	6	6
Manganese T-Mn	0.00229	0.00217	0.00500	0.00019	6	4
Mercury T-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum T-Mo	0.01124	0.01462	0.03000	0.00075	6	3
Nickel T-Ni	0.0075	0.0097	0.0200	0.0009	6	3
Phosphorus T-P	0.3	0.1	0.3	0.1	5	0
Potassium T-K	2	0	2	1	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0006	5	2
Silicon T-Si	3.71	0.74	4.70	2.66	5	5
Silver T-Ag	0.00169	0.00407	0.01000	0.00001	6	1
Sodium T-Na	2	0	2	1	6	1
Strontium T-Sr	0.0616	0.0141	0.0780	0.0416	5	5
Thallium T-Tl	0.0210	0.0442	0.1000	0.0001	5	0
Tin T-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.00	5	0
Uranium T-U	0.0131	0.0262	0.0600	0.0010	5	4
Vanadium T-V	0.011	0.015	0.030	0.001	6	1
Zinc T-Zn	0.004	0.001	0.005	0.002	6	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.027	0.014	0.052	0.015	6	6
Antimony D-Sb	0.04404	0.08761	0.20000	0.00005	5	3
Arsenic D-As	0.00347	0.00810	0.02000	0.00013	6	5
Barium D-Ba	0.0402	0.0072	0.0493	0.0276	6	6
Beryllium D-Be	0.0020	0.0024	0.0050	0.0002	6	0
Bismuth D-Bi	0.0243	0.0432	0.1000	0.0005	5	0
Boron D-B	0.041	0.054	0.100	0.001	5	1
Cadmium D-Cd	0.00015	0.00018	0.00050	0.00005	6	0
Calcium D-Ca	19.7	4.0	25.1	13.2	6	6
Chromium D-Cr	0.0005	0.0004	0.0010	0.0001	6	4
Cobalt D-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper D-Cu	0.001	0.000	0.002	0.001	6	5
Iron D-Fe	0.02	0.01	0.03	0.01	6	4
Lead D-Pb	0.0010	0.0020	0.0050	0.0001	6	1
Lithium D-Li	0.006	0.008	0.020	0.001	6	0
Magnesium D-Mg	6.35	1.26	7.97	4.30	6	6
Manganese D-Mn	0.00192	0.00240	0.00500	0.00012	6	4
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.01126	0.01461	0.03000	0.00080	6	3
Nickel D-Ni	0.0075	0.0097	0.0200	0.0007	6	3
Phosphorus D-P	0.3	0.1	0.3	0.1	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	5	1
Silicon D-Si	3.67	0.71	4.58	2.63	5	5
Silver D-Ag	0.00169	0.00407	0.01000	0.00001	6	0
Sodium D-Na	2	0	2	1	6	1
Strontium D-Sr	0.0610	0.0127	0.0710	0.0418	5	5
Thallium D-Tl	0.0210	0.0442	0.1000	0.0001	5	0
Tin D-Sn	0.0071	0.0130	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.00	5	0
Uranium D-U	0.0131	0.0262	0.0600	0.0010	5	4
Vanadium D-V	0.011	0.015	0.030	0.001	6	0
Zinc D-Zn	0.004	0.002	0.005	0.001	6	3

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W21

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	114	26	160	79	17	17
Hardness CaCO3	88.5	18.8	132.0	59.1	16	16
pH	7.81	0.24	8.30	7.42	17	17
Total Suspended Solids	6	6	20	1	11	10
Turbidity (NTU)	1.7	1.3	5.7	0.6	16	16
Alkalinity-Total CaCO3	81	16	115	55	17	17
Chloride Cl	0.5	0.1	0.8	0.5	16	5
Fluoride F	0.18	0.22	1.00	0.08	16	15
Sulphate SO4	16	6	31	8	17	17
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	2
Nitrate Nitrogen N	0.027	0.040	0.121	0.005	17	6
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	9
Nitrite/Nitrate Nitrogen N	0.018	0.037	0.123	0.005	10	3
Total Cyanide CN	0.005	0.000	0.005	0.005	2	1
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.036	0.037	0.158	0.009	16	15
Antimony T-Sb	0.07755	0.09818	0.20000	0.00007	16	8
Arsenic T-As	0.00369	0.00614	0.02000	0.00100	17	15
Barium T-Ba	0.0475	0.0153	0.1000	0.0334	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.056	0.049	0.100	0.003	15	7
Cadmium T-Cd	0.00013	0.00015	0.00050	0.00005	17	2
Calcium T-Ca	23.8	5.1	32.4	15.6	17	17
Chromium T-Cr	0.0011	0.0023	0.0100	0.0002	17	11
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	1
Copper T-Cu	0.002	0.001	0.004	0.001	17	14
Iron T-Fe	0.15	0.09	0.42	0.06	17	17
Lead T-Pb	0.0003	0.0003	0.0010	0.0001	15	11
Lithium T-Li	0.007	0.006	0.020	0.001	17	8
Magnesium T-Mg	8.30	2.13	12.20	5.25	17	17
Manganese T-Mn	0.02671	0.01439	0.06100	0.00820	17	17
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	1
Molybdenum T-Mo	0.01344	0.01434	0.03000	0.00085	17	8
Nickel T-Ni	0.0095	0.0090	0.0200	0.0018	17	8
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	0	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	15	2
Silicon T-Si	2.60	0.62	4.26	1.95	16	16
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	2	2	17	4
Strontium T-Sr	0.0889	0.0251	0.1500	0.0595	16	16
Thallium T-Tl	0.0404	0.0504	0.1000	0.0001	15	0
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	16	0
Titanium T-Ti	0.01	0.00	0.01	0.00	16	0
Uranium T-U	0.0106	0.0231	0.0600	0.0006	12	10
Vanadium T-V	0.015	0.015	0.030	0.001	17	1
Zinc T-Zn	0.005	0.006	0.028	0.002	17	12

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.024	0.047	0.200	0.004	17	13
Antimony D-Sb	0.07757	0.09816	0.20000	0.00007	16	8
Arsenic D-As	0.00355	0.00620	0.02000	0.00080	17	15
Barium D-Ba	0.0495	0.0153	0.0787	0.0300	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.060	0.045	0.100	0.003	15	7
Cadmium D-Cd	0.00012	0.00015	0.00050	0.00005	17	1
Calcium D-Ca	22.9	4.6	33.2	15.2	17	17
Chromium D-Cr	0.0012	0.0023	0.0100	0.0001	17	11
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	1
Copper D-Cu	0.001	0.001	0.003	0.001	17	14
Iron D-Fe	0.06	0.04	0.18	0.01	17	15
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	5
Lithium D-Li	0.007	0.007	0.020	0.001	17	7
Magnesium D-Mg	7.91	1.83	12.00	5.13	17	17
Manganese D-Mn	0.00828	0.00763	0.03200	0.00250	17	14
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01344	0.01434	0.03000	0.00090	17	8
Nickel D-Ni	0.0094	0.0092	0.0200	0.0015	17	8
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	0	2	1	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	0
Silicon D-Si	2.55	0.60	4.13	1.98	16	16
Silver D-Ag	0.00067	0.00242	0.01000	0.00001	17	0
Sodium D-Na	2	0	2	2	17	4
Strontium D-Sr	0.0832	0.0176	0.1230	0.0589	16	16
Thallium D-Tl	0.0404	0.0504	0.1000	0.0001	15	0
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	16	1
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0106	0.0231	0.0600	0.0006	12	10
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.007	0.005	0.020	0.001	17	12

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W22

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	106	40	187	57	17	17
Hardness CaCO3	82.3	32.2	173.0	42.6	16	16
pH	7.81	0.27	8.31	7.40	17	17
Total Suspended Solids	2	2	6	1	11	6
Turbidity (NTU)	0.9	1.0	4.4	0.1	16	16
Alkalinity-Total CaCO3	72	27	142	35	17	17
Chloride Cl	0.5	0.1	1.0	0.5	16	4
Fluoride F	0.15	0.23	1.00	0.06	16	15
Sulphate SO4	17	7	32	9	17	17
Ammonia Nitrogen N	0.025	0.023	0.050	0.005	3	1
Nitrate Nitrogen N	0.059	0.077	0.228	0.005	17	15
Nitrite Nitrogen N	0.031	0.121	0.500	0.001	17	11
Nitrite/Nitrate Nitrogen N	0.039	0.064	0.230	0.005	11	10
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.024	0.012	0.040	0.005	16	14
Antimony T-Sb	0.07754	0.09818	0.20000	0.00005	16	7
Arsenic T-As	0.00256	0.00656	0.02000	0.00018	17	15
Barium T-Ba	0.0548	0.0156	0.0900	0.0344	17	17
Beryllium T-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth T-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron T-B	0.055	0.050	0.100	0.002	15	7
Cadmium T-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium T-Ca	22.8	8.8	43.9	11.5	17	17
Chromium T-Cr	0.0011	0.0023	0.0100	0.0002	17	9
Cobalt T-Co	0.0055	0.0070	0.0200	0.0001	17	1
Copper T-Cu	0.0013	0.001	0.004	0.0003	17	14
Iron T-Fe	0.07	0.06	0.27	0.00	17	14
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	7
Lithium T-Li	0.007	0.008	0.020	0.001	17	8
Magnesium T-Mg	7.13	3.11	15.10	3.49	17	17
Manganese T-Mn	0.00775	0.00532	0.02400	0.00230	17	13
Mercury T-Hg	0.00011	0.00024	0.00100	0.00005	16	0
Molybdenum T-Mo	0.01319	0.01457	0.03000	0.00043	17	7
Nickel T-Ni	0.0090	0.0095	0.0200	0.0008	17	7
Phosphorus T-P	0.3	0.1	0.3	0.1	16	0
Potassium T-K	2	0	2	1	16	3
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	15	2
Silicon T-Si	3.42	0.88	5.31	2.37	16	16
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	3	2	17	4
Strontium T-Sr	0.0958	0.0456	0.2060	0.0480	16	16
Thallium T-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin T-Sn	0.0138	0.0148	0.0300	0.0001	16	0
Titanium T-Ti	0.01	0.00	0.01	0.00	16	0
Uranium T-U	0.0105	0.0231	0.0600	0.0005	12	10
Vanadium T-V	0.015	0.015	0.030	0.001	17	1
Zinc T-Zn	0.008	0.017	0.073	0.001	17	10

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.025	0.047	0.200	0.005	17	13
Antimony D-Sb	0.07756	0.09817	0.20000	0.00005	16	6
Arsenic D-As	0.00254	0.00657	0.02000	0.00016	17	15
Barium D-Ba	0.0589	0.0201	0.0962	0.0300	17	17
Beryllium D-Be	0.0026	0.0024	0.0050	0.0002	17	0
Bismuth D-Bi	0.0465	0.0492	0.1000	0.0005	16	0
Boron D-B	0.058	0.046	0.100	0.002	15	7
Cadmium D-Cd	0.00012	0.00015	0.00050	0.00005	17	0
Calcium D-Ca	22.5	8.5	44.5	11.4	17	17
Chromium D-Cr	0.0012	0.0023	0.0100	0.0002	17	11
Cobalt D-Co	0.0055	0.0070	0.0200	0.0001	17	2
Copper D-Cu	0.001	0.000	0.002	0.000	17	13
Iron D-Fe	0.03	0.03	0.12	0.00	17	12
Lead D-Pb	0.0008	0.0016	0.0050	0.0001	17	4
Lithium D-Li	0.007	0.006	0.020	0.001	17	7
Magnesium D-Mg	7.05	2.97	15.10	3.45	17	17
Manganese D-Mn	0.00334	0.00252	0.00800	0.00073	17	11
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01319	0.01457	0.03000	0.00038	17	7
Nickel D-Ni	0.0089	0.0096	0.0200	0.0007	17	7
Phosphorus D-P	0.3	0.1	0.3	0.1	16	0
Potassium D-K	2	0	2	1	16	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	15	1
Silicon D-Si	3.45	0.96	5.74	2.27	16	16
Silver D-Ag	0.00067	0.00242	0.01000	0.00001	17	1
Sodium D-Na	2	0	3	2	17	3
Strontium D-Sr	0.0940	0.0445	0.2080	0.0470	16	16
Thallium D-Tl	0.0337	0.0485	0.1000	0.0001	15	0
Tin D-Sn	0.0138	0.0148	0.0300	0.0001	16	0
Titanium D-Ti	0.01	0.00	0.01	0.00	16	0
Uranium D-U	0.0105	0.0231	0.0600	0.0005	12	10
Vanadium D-V	0.015	0.015	0.030	0.001	17	0
Zinc D-Zn	0.007	0.006	0.021	0.001	17	7

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W23

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	61	15	104	42	16	16
Hardness CaCO3	40.2	9.2	55.2	21.0	15	15
pH	7.48	0.30	7.99	7.07	16	16
Total Suspended Solids	1	1	4	1	11	1
Turbidity (NTU)	0.6	0.3	1.0	0.2	15	15
Alkalinity-Total CaCO3	33	9	53	16	16	16
Chloride Cl	0.5	0.0	0.6	0.5	16	2
Fluoride F	0.14	0.23	1.00	-0.06	16	15
Sulphate SO4	12	4	20	5	16	16
Ammonia Nitrogen N	0.013	0.011	0.020	0.005	2	0
Nitrate Nitrogen N	0.056	0.091	0.300	0.005	16	15
Nitrite Nitrogen N	0.033	0.125	0.500	0.001	16	8
Nitrite/Nitrate Nitrogen N	0.030	0.062	0.215	0.005	11	10
Total Cyanide CN	0.005	- 0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.033	0.014	0.070	0.010	14	14
Antimony T-Sb	0.08136	0.10039	0.20000	0.00005	15	0
Arsenic T-As	0.00132	0.00498	0.02000	0.00005	16	11
Barium T-Ba	0.0229	0.0048	0.0319	0.0178	16	16
Beryllium T-Be	0.0027	0.0023	0.0050	0.0002	16	0
Bismuth T-Bi	0.0482	0.0504	0.1000	0.0005	15	0
Boron T-B	0.054	0.051	0.100	0.001	15	3
Cadmium T-Cd	0.00010	0.00012	0.00050	0.00005	16	0
Calcium T-Ca	11.0	2.9	17.2	5.6	16	16
Chromium T-Cr	0.0018	0.0033	0.0100	0.0001	16	9
Cobalt T-Co	0.0058	0.0071	0.0200	0.0001	16	1
Copper T-Cu	0.001	0.001	0.003	0.001	16	13
Iron T-Fe	0.10	0.05	0.22	0.04	16	16
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	4
Lithium T-Li	0.007	0.006	0.020	0.001	16	8
Magnesium T-Mg	3.44	0.96	5.53	1.73	16	16
Manganese T-Mn	0.00751	0.00389	0.02000	0.00485	16	12
Mercury T-Hg	0.00005	0.00000	0.00006	0.00005	15	1
Molybdenum T-Mo	0.01359	0.01499	0.03000	0.00018	16	7
Nickel T-Ni	0.0094	0.0097	0.0200	0.0008	16	7
Phosphorus T-P	0.3	0.1	0.3	0.1	15	0
Potassium T-K	2	0	2	1	15	2
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	14	1
Silicon T-Si	3.19	1.02	5.67	1.94	15	15
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	2	2	16	2
Strontium T-Sr	0.0395	0.0107	0.0650	0.0240	15	15
Thallium T-Tl	0.0357	0.0497	0.1000	0.0001	14	0
Tin T-Sn	0.0144	0.0152	0.0300	0.0001	15	1
Titanium T-Ti	0.01	0.00	0.01	0.00	15	0
Uranium T-U	0.0068	0.0187	0.0600	0.0007	10	9
Vanadium T-V	0.016	0.015	0.030	0.001	16	0
Zinc T-Zn	0.004	0.003	0.012	0.001	16	5

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.045	0.062	0.200	0.006	16	13
Antimony D-Sb	0.08139	0.10037	0.20000	0.00005	15	3
Arsenic D-As	0.00132	0.00498	0.02000	0.00005	16	10
Barium D-Ba	0.0331	0.0194	0.0753	0.0175	16	16
Beryllium D-Be	0.0027	0.0023	0.0050	0.0002	16	0
Bismuth D-Bi	0.0482	0.0504	0.1000	0.0005	15	0
Boron D-B	0.058	0.047	0.100	0.001	15	4
Cadmium D-Cd	0.00010	0.00012	0.00050	0.00005	16	0
Calcium D-Ca	11.0	2.8	17.1	5.6	16	16
Chromium D-Cr	0.0017	0.0033	0.0100	0.0001	16	10
Cobalt D-Co	0.0058	0.0071	0.0200	0.0001	16	0
Copper D-Cu	0.001	0.000	0.002	0.000	16	13
Iron D-Fe	0.06	0.04	0.16	0.01	16	15
Lead D-Pb	0.0005	0.0012	0.0050	0.0001	16	4
Lithium D-Li	0.007	0.006	0.020	0.001	16	7
Magnesium D-Mg	3.45	0.93	5.42	1.72	16	16
Manganese D-Mn	0.00553	0.00324	0.01700	0.00210	16	11
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	1
Molybdenum D-Mo	0.01359	0.01499	0.03000	0.00019	16	7
Nickel D-Ni	0.0094	0.0097	0.0200	0.0007	16	7
Phosphorus D-P	0.3	0.1	0.3	0.1	15	0
Potassium D-K	2	0	2	1	15	2
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	14	0
Silicon D-Si	3.17	0.99	5.61	1.89	15	15
Silver D-Ag	0.00008	0.00025	0.00100	0.00001	16	0
Sodium D-Na	2	0	2	2	16	2
Strontium D-Sr	0.0399	0.0106	0.0640	0.0240	15	15
Thallium D-Tl	0.0357	0.0497	0.1000	0.0001	14	0
Tin D-Sn	0.0144	0.0152	0.0300	0.0001	15	2
Titanium D-Ti	0.01	0.00	0.01	0.00	15	0
Uranium D-U	0.0068	0.0187	0.0600	0.0007	10	9
Vanadium D-V	0.016	0.015	0.030	0.001	16	0
Zinc D-Zn	0.008	0.008	0.025	0.001	16	8

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W24

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	224	82	444	133	15	15
Hardness CaCO3	202.7	86.4	428.0	98.2	15	15
pH	7.63	0.40	8.06	6.68	15	15
Total Suspended Solids	11	26	89	1	11	10
Turbidity (NTU)	4.6	9.9	40.2	0.7	15	15
Alkalinity-Total CaCO3	185	85	411	87	15	15
Chloride Cl	0.6	0.1	0.9	0.5	15	5
Fluoride F	0.18	0.05	0.31	0.10	15	15
Sulphate SO4	28	9	43	13	15	15
Ammonia Nitrogen N	0.013	0.011	0.020	0.005	2	1
Nitrate Nitrogen N	0.028	0.061	0.203	0.005	15	4
Nitrite Nitrogen N	0.001	0.000	0.002	0.001	15	8
Nitrite/Nitrate Nitrogen N	0.025	0.063	0.205	0.005	10	2
Total Cyanide CN	0.007	0.002	0.008	0.005	2	1
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.091	0.200	0.790	0.005	15	13
Antimony T-Sb	0.08580	0.10264	0.20000	0.00010	14	7
Arsenic T-As	0.00232	0.00082	0.00379	0.00080	15	15
Barium T-Ba	0.0550	0.0147	0.0900	0.0300	15	15
Beryllium T-Be	0.0029	0.0023	0.0050	0.0005	15	0
Bismuth T-Bi	0.0503	0.0516	0.1000	0.0005	14	0
Boron T-B	0.054	0.051	0.100	0.001	15	7
Cadmium T-Cd	0.00008	0.00006	0.00020	0.00005	15	2
Calcium T-Ca	51.4	21.2	107.0	25.3	15	15
Chromium T-Cr	0.0013	0.0025	0.0100	0.0002	15	10
Cobalt T-Co	0.0062	0.0072	0.0200	0.0001	15	3
Copper T-Cu	0.001	0.001	0.006	0.001	15	13
Iron T-Fe	0.58	0.53	2.35	0.09	15	15
Lead T-Pb	0.0003	0.0006	0.0019	0.0001	15	8
Lithium T-Li	0.010	0.007	0.020	0.003	15	9
Magnesium T-Mg	18.36	8.70	42.40	8.96	15	15
Manganese T-Mn	0.07050	0.06477	0.28100	0.02880	15	15
Mercury T-Hg	0.00005	0.00000	0.00006	0.00005	15	1
Molybdenum T-Mo	0.01487	0.01484	0.03000	0.00066	15	8
Nickel T-Ni	0.0112	0.0087	0.0200	0.0020	15	8
Phosphorus T-P	0.3	0.0	0.3	0.3	14	0
Potassium T-K	2	0	3	2	14	2
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	14	2
Silicon T-Si	4.12	1.48	7.91	2.57	14	14
Silver T-Ag	0.00002	0.00003	0.00010	0.00001	15	1
Sodium T-Na	2	1	4	2	15	2
Strontium T-Sr	0.1570	0.0709	0.3410	0.0790	14	14
Thallium T-Tl	0.0429	0.0513	0.1000	0.0001	14	0
Tin T-Sn	0.0151	0.0155	0.0300	0.0001	14	1
Titanium T-Ti	0.01	0.00	0.02	0.01	14	1
Uranium T-U	0.0017	0.0003	0.0021	0.0013	10	10
Vanadium T-V	0.017	0.015	0.030	0.001	15	1
Zinc T-Zn	0.006	0.005	0.018	0.002	15	10

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.024	0.049	0.200	0.003	15	12
Antimony D-Sb	0.08583	0.10261	0.20000	0.00010	14	7
Arsenic D-As	0.00162	0.00062	0.00274	0.00029	15	15
Barium D-Ba	0.0599	0.0185	0.0917	0.0300	15	15
Beryllium D-Be	0.0029	0.0023	0.0050	0.0005	15	0
Bismuth D-Bi	0.0503	0.0516	0.1000	0.0005	14	0
Boron D-B	0.059	0.046	0.100	0.001	15	7
Cadmium D-Cd	0.00007	0.00005	0.00020	0.00005	15	2
Calcium D-Ca	51.1	20.8	104.0	24.9	15	15
Chromium D-Cr	0.0012	0.0025	0.0100	0.0002	15	11
Cobalt D-Co	0.0061	0.0073	0.0200	0.0001	15	1
Copper D-Cu	0.001	0.000	0.002	0.000	15	13
Iron D-Fe	0.22	0.11	0.41	0.02	15	14
Lead D-Pb	0.0002	0.0003	0.0010	0.0001	15	5
Lithium D-Li	0.010	0.007	0.020	0.002	15	9
Magnesium D-Mg	18.24	8.47	41.10	8.78	15	15
Manganese D-Mn	0.04759	0.06542	0.27100	0.01680	15	15
Mercury D-Hg	0.00005	0.00000	0.00006	0.00005	15	1
Molybdenum D-Mo	0.01471	0.01480	0.03000	0.00100	15	8
Nickel D-Ni	0.0107	0.0091	0.0200	0.0010	15	7
Phosphorus D-P	0.3	0.0	0.3	0.3	14	0
Potassium D-K	2	0	3	2	14	3
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	14	1
Silicon D-Si	4.03	1.45	7.60	2.46	14	14
Silver D-Ag	0.00002	0.00003	0.00010	0.00001	15	0
Sodium D-Na	2	1	4	2	15	2
Strontium D-Sr	0.1549	0.0683	0.3260	0.0770	14	14
Thallium D-Tl	0.0429	0.0513	0.1000	0.0001	14	0
Tin D-Sn	0.0151	0.0155	0.0300	0.0001	14	1
Titanium D-Ti	0.01	0.00	0.01	0.01	14	0
Uranium D-U	0.0016	0.0004	0.0022	0.0010	10	10
Vanadium D-V	0.016	0.015	0.030	0.001	15	0
Zinc D-Zn	0.011	0.009	0.037	0.002	15	11

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W25

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	49	10	70	38	11	11
Hardness CaCO3	34.2	7.7	51.4	26.5	10	10
pH	7.26	0.27	7.63	6.65	11	11
Total Suspended Solids	4	7	20	1	7	7
Turbidity (NTU)	1.6	2.2	7.8	0.4	10	10
Alkalinity-Total CaCO3	32	8	46	22	11	11
Chloride Cl	0.5	0.1	0.8	0.5	11	4
Fluoride F	0.17	0.28	1.00	0.07	11	10
Sulphate SO4	7	2	10	4	11	11
Ammonia Nitrogen N	0.016	0.006	0.020	0.011	2	2
Nitrate Nitrogen N	0.026	0.031	0.100	0.005	11	7
Nitrite Nitrogen N	0.047	0.150	0.500	0.001	11	6
Nitrite/Nitrate Nitrogen N	0.019	0.023	0.068	0.005	7	5
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.080	0.155	0.543	0.010	11	10
Antimony T-Sb	0.10203	0.10345	0.20000	0.00005	10	0
Arsenic T-As	0.00280	0.00573	0.02000	0.00069	11	10
Barium T-Ba	0.0484	0.0227	0.1100	0.0300	11	11
Beryllium T-Be	0.0033	0.0023	0.0050	0.0002	11	0
Bismuth T-Bi	0.0622	0.0492	0.1000	0.0005	10	0
Boron T-B	0.070	0.048	0.100	0.001	10	0
Cadmium T-Cd	0.00020	0.00028	0.00092	0.00005	11	1
Calcium T-Ca	10.2	2.2	13.9	8.2	11	11
Chromium T-Cr	0.0005	0.0004	0.0010	0.0001	11	3
Cobalt T-Co	0.0075	0.0077	0.0200	0.0001	11	0
Copper T-Cu	0.001	0.001	0.003	0.000	11	8
Iron T-Fe	0.14	0.25	0.88	0.04	11	11
Lead T-Pb	0.0007	0.0015	0.0050	0.0001	11	3
Lithium T-Li	0.009	0.007	0.020	0.001	11	0
Magnesium T-Mg	2.42	0.51	3.44	1.99	11	11
Manganese T-Mn	0.10127	0.23679	0.81300	0.00800	11	11
Mercury T-Hg	0.00005	0.00000	0.00005	0.00005	10	0
Molybdenum T-Mo	0.01718	0.01477	0.03000	0.00091	11	4
Nickel T-Ni	0.0113	0.0100	0.0200	0.0002	11	3
Phosphorus T-P	0.3	0.1	0.3	0.1	10	0
Potassium T-K	2	0	2	1	10	2
Selenium T-Se	0.0008	0.0003	0.0010	0.0005	10	0
Silicon T-Si	2.86	0.80	4.26	2.23	10	10
Silver T-Ag	0.00012	0.00030	0.00100	0.00001	11	1
Sodium T-Na	2	0	2	1	11	2
Strontium T-Sr	0.0272	0.0060	0.0360	0.0199	10	10
Thallium T-Tl	0.0445	0.0527	0.1000	0.0001	9	0
Tin T-Sn	0.0185	0.0149	0.0300	0.0001	10	0
Titanium T-Ti	0.01	0.00	0.01	0.00	10	0
Uranium T-U	0.0091	0.0225	0.0600	0.0002	7	6
Vanadium T-V	0.020	0.015	0.030	0.001	11	0
Zinc T-Zn	0.009	0.017	0.059	0.002	11	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.025	0.022	0.076	0.005	11	8
Antimony D-Sb	0.10203	0.10345	0.20000	0.00005	10	0
Arsenic D-As	0.00258	0.00578	0.02000	0.00065	11	10
Barium D-Ba	0.0415	0.0130	0.0700	0.0300	11	11
Beryllium D-Be	0.0033	0.0023	0.0050	0.0002	11	0
Bismuth D-Bi	0.0622	0.0492	0.1000	0.0005	10	0
Boron D-B	0.071	0.047	0.100	0.001	10	1
Cadmium D-Cd	0.00012	0.00014	0.00050	0.00005	11	1
Calcium D-Ca	10.1	2.4	14.6	7.5	11	11
Chromium D-Cr	0.0006	0.0004	0.0010	0.0001	11	5
Cobalt D-Co	0.0075	0.0077	0.0200	0.0001	11	0
Copper D-Cu	0.001	0.001	0.002	0.000	11	8
Iron D-Fe	0.04	0.03	0.11	0.01	11	8
Lead D-Pb	0.0007	0.0015	0.0050	0.0001	11	3
Lithium D-Li	0.009	0.007	0.020	0.001	11	0
Magnesium D-Mg	2.46	0.55	3.61	1.90	11	11
Manganese D-Mn	0.01822	0.02167	0.07700	0.00437	11	9
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	10	0
Molybdenum D-Mo	0.01718	0.01477	0.03000	0.00093	11	4
Nickel D-Ni	0.0113	0.0100	0.0200	0.0002	11	3
Phosphorus D-P	0.3	0.1	0.3	0.1	10	0
Potassium D-K	2	0	2	1	10	2
Selenium D-Se	0.0008	0.0003	0.0010	0.0005	10	0
Silicon D-Si	2.87	0.80	4.23	2.22	10	10
Silver D-Ag	0.00012	0.00030	0.00100	0.00001	11	0
Sodium D-Na	2	0	2	1	11	2
Strontium D-Sr	0.0272	0.0067	0.0370	0.0200	10	10
Thallium D-Tl	0.0445	0.0527	0.1000	0.0001	9	0
Tin D-Sn	0.0185	0.0149	0.0300	0.0001	10	0
Titanium D-Ti	0.01	0.00	0.01	0.00	10	0
Uranium D-U	0.0088	0.0226	0.0600	0.0002	7	6
Vanadium D-V	0.020	0.015	0.030	0.001	11	0
Zinc D-Zn	0.008	0.009	0.033	0.002	11	6

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W26

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	165	21	216	127	16	16
Hardness CaCO3	146.0	19.0	175.0	105.0	15	15
pH	7.82	0.24	8.31	7.48	16	16
Total Suspended Solids	36	98	332	1	11	10
Turbidity (NTU)	7.5	17.7	71.4	1.2	15	15
Alkalinity-Total CaCO3	136	18	161	95	16	16
Chloride Cl	0.6	0.1	0.9	0.5	16	4
Fluoride F	0.25	0.21	1.00	0.02	16	14
Sulphate SO4	17	3	24	12	16	16
Ammonia Nitrogen N	0.018	0.018	0.030	0.005	2	2
Nitrate Nitrogen N	0.056	0.062	0.198	0.005	16	12
Nitrite Nitrogen N	0.039	0.124	0.500	0.001	16	13
Nitrite/Nitrate Nitrogen N	0.061	0.070	0.206	0.005	10	9
Total Cyanide CN	0.008	0.001	0.007	0.005	2	1
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.040	0.027	0.094	0.005	15	13
Antimony T-Sb	0.08148	0.10029	0.20000	0.00018	15	8
Arsenic T-As	0.00774	0.00399	0.02000	0.00306	16	15
Barium T-Ba	0.0670	0.0161	0.1140	0.0400	16	16
Beryllium T-Be	0.0027	0.0023	0.0050	0.0002	16	0
Bismuth T-Bi	0.0482	0.0504	0.1000	0.0005	15	0
Boron T-B	0.054	0.051	0.100	0.001	15	6
Cadmium T-Cd	0.00010	0.00012	0.00050	0.00005	16	3
Calcium T-Ca	36.5	5.3	45.2	26.0	16	16
Chromium T-Cr	0.0011	0.0024	0.0100	0.0001	16	10
Cobalt T-Co	0.0058	0.0071	0.0200	0.0001	16	1
Copper T-Cu	0.001	0.001	0.003	0.001	16	13
Iron T-Fe	0.29	0.32	1.45	0.04	16	16
Lead T-Pb	0.0002	0.0003	0.0010	0.0001	15	5
Lithium T-Li	0.007	0.006	0.020	0.001	16	7
Magnesium T-Mg	14.06	2.03	17.30	9.95	16	16
Manganese T-Mn	0.09044	0.04142	0.18200	0.02600	16	16
Mercury T-Hg	0.00005	0.00001	0.00007	0.00005	15	1
Molybdenum T-Mo	0.01449	0.01415	0.03000	0.00142	16	8
Nickel T-Ni	0.0104	0.0088	0.0200	0.0024	16	9
Phosphorus T-P	0.3	0.0	0.3	0.2	15	1
Potassium T-K	2	0	2	1	15	2
Selenium T-Se	0.0009	0.0001	0.0010	0.0005	14	3
Silicon T-Si	2.56	0.77	5.08	1.81	15	15
Silver T-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium T-Na	2	0	2	2	16	2
Strontium T-Sr	0.1468	0.0232	0.1830	0.1060	15	15
Thallium T-Tl	0.0429	0.0513	0.1000	0.0001	14	0
Tin T-Sn	0.0144	0.0152	0.0300	0.0001	15	0
Titanium T-Ti	0.01	0.00	0.01	0.00	15	1
Uranium T-U	0.0077	0.0174	0.0600	0.0019	11	10
Vanadium T-V	0.016	0.015	0.030	0.001	16	1
Zinc T-Zn	0.004	0.001	0.006	0.002	16	8

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.027	0.049	0.200	0.004	16	11
Antimony D-Sb	0.08151	0.10026	0.20000	0.00018	15	8
Arsenic D-As	0.00696	0.00407	0.02000	0.00274	16	15
Barium D-Ba	0.0723	0.0161	0.0964	0.0400	16	16
Beryllium D-Be	0.0027	0.0023	0.0050	0.0002	16	0
Bismuth D-Bi	0.0482	0.0504	0.1000	0.0005	15	0
Boron D-B	0.059	0.046	0.100	0.001	15	6
Cadmium D-Cd	0.00010	0.00012	0.00050	0.00005	16	2
Calcium D-Ca	36.0	4.7	42.7	25.8	16	16
Chromium D-Cr	0.0011	0.0024	0.0100	0.0001	16	11
Cobalt D-Co	0.0058	0.0071	0.0200	0.0001	16	0
Copper D-Cu	0.001	0.001	0.003	0.001	16	13
Iron D-Fe	0.11	0.11	0.39	0.01	16	13
Lead D-Pb	0.0005	0.0012	0.0050	0.0001	16	4
Lithium D-Li	0.007	0.006	0.020	0.001	16	7
Magnesium D-Mg	13.92	1.81	16.60	9.91	16	16
Manganese D-Mn	0.04771	0.05167	0.18900	0.00500	16	15
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	15	0
Molybdenum D-Mo	0.01449	0.01414	0.03000	0.00154	16	8
Nickel D-Ni	0.0102	0.0090	0.0200	0.0020	16	8
Phosphorus D-P	0.3	0.0	0.3	0.2	15	1
Potassium D-K	2	0	2	1	15	2
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	14	2
Silicon D-Si	2.50	0.74	4.96	1.80	15	15
Silver D-Ag	0.00008	0.00025	0.00100	0.00001	16	1
Sodium D-Na	2	0	2	2	16	4
Strontium D-Sr	0.1447	0.0196	0.1750	0.1050	15	15
Thallium D-Tl	0.0429	0.0513	0.1000	0.0001	14	0
Tin D-Sn	0.0144	0.0152	0.0300	0.0001	15	2
Titanium D-Ti	0.01	0.00	0.01	0.00	15	0
Uranium D-U	0.0077	0.0173	0.0600	0.0020	11	10
Vanadium D-V	0.016	0.015	0.030	0.001	16	0
Zinc D-Zn	0.007	0.005	0.018	0.002	16	11

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

WATER QUALITY AT STATION W27

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	89	42	167	56	6	6
Hardness CaCO3	73.1	43.3	160.0	41.7	6	6
pH	7.58	0.44	8.29	6.99	6	6
Total Suspended Solids	5	5	10	1	3	3
Turbidity (NTU)	1.2	0.6	2.1	0.6	6	6
Alkalinity-Total CaCO3	70	38	145	43	6	6
Chloride Cl	0.5	0.0	0.5	0.5	6	0
Fluoride F	0.13	0.03	0.17	0.10	6	6
Sulphate SO4	10	9	28	5	6	6
Ammonia Nitrogen N	0.013	0.011	0.020	0.005	2	0
Nitrate Nitrogen N	0.023	0.038	0.101	0.005	6	3
Nitrite Nitrogen N	0.001	0.000	0.001	0.001	6	3
Nitrite/Nitrate Nitrogen N	0.008	0.004	0.012	0.005	5	2
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	0.01	#DIV/0!	0.01	0.01	1	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.021	0.008	0.034	0.014	5	5
Antimony T-Sb	0.04009	0.08939	0.20000	0.00005	5	1
Arsenic T-As	0.00138	0.00059	0.00188	0.00030	6	6
Barium T-Ba	0.0846	0.0072	0.0915	0.0733	6	6
Beryllium T-Be	0.0028	0.0025	0.0050	0.0005	6	0
Bismuth T-Bi	0.0403	0.0545	0.1000	0.0005	5	0
Boron T-B	0.051	0.054	0.100	0.001	6	1
Cadmium T-Cd	0.00010	0.00008	0.00020	0.00005	6	0
Calcium T-Ca	19.7	10.2	39.9	11.7	6	6
Chromium T-Cr	0.0021	0.0039	0.0100	0.0002	6	3
Cobalt T-Co	0.0052	0.0082	0.0200	0.0001	6	0
Copper T-Cu	0.001	0.000	0.001	0.000	6	4
Iron T-Fe	0.13	0.06	0.18	0.01	6	5
Lead T-Pb	0.0004	0.0005	0.0010	0.0001	6	1
Lithium T-Li	0.007	0.008	0.020	0.001	6	0
Magnesium T-Mg	6.00	4.64	15.40	3.15	6	6
Manganese T-Mn	0.04358	0.02483	0.08280	0.00600	6	6
Mercury T-Hg	0.00005	0.00000	0.00005	0.00005	6	0
Molybdenum T-Mo	0.01101	0.01471	0.03000	0.00115	6	4
Nickel T-Ni	0.0072	0.0099	0.0200	0.0007	6	4
Phosphorus T-P	0.3	0.0	0.3	0.3	5	0
Potassium T-K	2	1	2	0	5	1
Selenium T-Se	0.0009	0.0002	0.0010	0.0005	6	1
Silicon T-Si	3.09	0.85	4.57	2.52	5	5
Silver T-Ag	0.00004	0.00005	0.00010	0.00001	6	0
Sodium T-Na	2	0	2	2	6	1
Strontium T-Sr	0.0673	0.0588	0.1720	0.0315	5	5
Thallium T-Tl	0.0200	0.0447	0.1000	0.0001	5	0
Tin T-Sn	0.0121	0.0164	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.01	5	0
Uranium T-U	0.0004	0.0002	0.0008	0.0002	3	3
Vanadium T-V	0.016	0.016	0.030	0.001	6	0
Zinc T-Zn	0.003	0.002	0.005	0.001	6	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.041	0.078	0.200	0.005	6	4
Antimony D-Sb	0.04007	0.08940	0.20000	0.00005	5	1
Arsenic D-As	0.00120	0.00053	0.00170	0.00020	6	6
Barium D-Ba	0.0815	0.0088	0.0900	0.0700	6	6
Beryllium D-Be	0.0028	0.0025	0.0050	0.0005	6	0
Bismuth D-Bi	0.0403	0.0545	0.1000	0.0005	5	0
Boron D-B	0.051	0.053	0.100	0.001	6	1
Cadmium D-Cd	0.00010	0.00008	0.00020	0.00005	6	0
Calcium D-Ca	19.4	10.0	39.3	11.5	6	6
Chromium D-Cr	0.0021	0.0039	0.0100	0.0001	6	3
Cobalt D-Co	0.0053	0.0082	0.0200	0.0001	6	1
Copper D-Cu	0.001	0.000	0.001	0.000	6	4
Iron D-Fe	0.08	0.04	0.12	0.01	6	5
Lead D-Pb	0.0004	0.0005	0.0010	0.0001	6	0
Lithium D-Li	0.007	0.008	0.020	0.001	6	0
Magnesium D-Mg	5.96	4.47	15.00	3.14	6	6
Manganese D-Mn	0.01990	0.01156	0.03520	0.00500	6	5
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	6	0
Molybdenum D-Mo	0.01101	0.01471	0.03000	0.00116	6	4
Nickel D-Ni	0.0072	0.0099	0.0200	0.0006	6	4
Phosphorus D-P	0.3	0.0	0.3	0.3	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0009	0.0002	0.0010	0.0005	6	1
Silicon D-Si	3.00	0.79	4.41	2.55	5	5
Silver D-Ag	0.00004	0.00005	0.00010	0.00001	6	0
Sodium D-Na	2	0	2	2	6	1
Strontium D-Sr	0.0672	0.0563	0.1670	0.0317	5	5
Thallium D-Tl	0.0200	0.0447	0.1000	0.0001	5	0
Tin D-Sn	0.0121	0.0164	0.0300	0.0001	5	0
Titanium D-Ti	0.01	0.00	0.01	0.01	5	0
Uranium D-U	0.0004	0.0002	0.0008	0.0002	3	3
Vanadium D-V	0.016	0.016	0.030	0.001	6	0
Zinc D-Zn	0.004	0.002	0.005	0.001	6	3

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WATER QUALITY AT STATION W28

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	136	96	435	70	14	14
Hardness CaCO3	115.2	91.9	406.0	51.1	13	13
pH	7.76	0.24	8.12	7.37	14	14
Total Suspended Solids	23	29	100	1	10	10
Turbidity (NTU)	3.7	6.9	26.4	0.4	13	13
Alkalinity-Total CaCO3	99	74	340	41	14	14
Chloride Cl	0.5	0.1	0.9	0.5	14	4
Fluoride F	0.17	0.24	1.00	0.06	14	13
Sulphate SO4	20	20	78	6	14	14
Ammonia Nitrogen N	0.013	0.011	0.020	0.005	2	0
Nitrate Nitrogen N	0.033	0.079	0.300	0.005	14	8
Nitrite Nitrogen N	0.037	0.133	0.500	0.001	14	7
Nitrite/Nitrate Nitrogen N	0.014	0.023	0.080	0.005	10	6
Total Cyanide CN	0.005	0.000	0.005	0.005	2	0
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.111	0.123	0.495	0.007	14	12
Antimony T-Sb	0.09391	0.10237	0.20000	0.00011	13	6
Arsenic T-As	0.00204	0.00520	0.02000	0.00020	14	13
Barium T-Ba	0.0778	0.0454	0.2100	0.0400	14	14
Beryllium T-Be	0.0027	0.0024	0.0050	0.0002	14	0
Bismuth T-Bi	0.0479	0.0505	0.1000	0.0005	13	0
Boron T-B	0.055	0.051	0.100	0.002	13	6
Cadmium T-Cd	0.00016	0.00018	0.00061	0.00005	14	9
Calcium T-Ca	28.6	20.2	92.0	13.1	14	14
Chromium T-Cr	0.0016	0.0025	0.0100	0.0005	14	9
Cobalt T-Co	0.0066	0.0073	0.0200	0.0001	14	6
Copper T-Cu	0.003	0.001	0.006	0.001	14	13
Iron T-Fe	0.24	0.37	1.47	0.02	14	13
Lead T-Pb	0.0010	0.0018	0.0053	0.0001	14	12
Lithium T-Li	0.007	0.007	0.020	0.001	14	0
Magnesium T-Mg	11.02	10.09	43.80	4.46	14	14
Manganese T-Mn	0.03138	0.05117	0.19600	0.00500	14	12
Mercury T-Hg	0.00005	0.00000	0.00005	0.00005	13	0
Molybdenum T-Mo	0.01577	0.01481	0.03000	0.00074	14	6
Nickel T-Ni	0.0116	0.0088	0.0200	0.0020	14	6
Phosphorus T-P	0.3	0.1	0.3	0.1	13	0
Potassium T-K	2	0	2	0	13	1
Selenium T-Se	0.0011	0.0004	0.0024	0.0005	12	2
Silicon T-Si	3.86	1.84	9.23	2.19	13	13
Silver T-Ag	0.00009	0.00026	0.00100	0.00001	14	3
Sodium T-Na	2	1	4	2	14	2
Strontium T-Sr	0.1236	0.0920	0.3920	0.0550	13	13
Thallium T-Tl	0.0334	0.0492	0.1000	0.0001	12	0
Tin T-Sn	0.0143	0.0152	0.0300	0.0001	13	0
Titanium T-Ti	0.01	0.00	0.01	0.00	13	0
Uranium T-U	0.0065	0.0188	0.0600	0.0002	10	9
Vanadium T-V	0.016	0.015	0.030	0.001	14	1
Zinc T-Zn	0.012	0.021	0.084	0.003	14	9

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.046	0.062	0.200	0.005	14	11
Antimony D-Sb	0.09395	0.10233	0.20000	0.00010	13	6
Arsenic D-As	0.00186	0.00524	0.02000	0.00019	14	13
Barium D-Ba	0.0818	0.0400	0.2000	0.0357	14	14
Beryllium D-Be	0.0027	0.0024	0.0050	0.0002	14	0
Bismuth D-Bi	0.0479	0.0505	0.1000	0.0005	13	0
Boron D-B	0.060	0.046	0.100	0.002	13	6
Cadmium D-Cd	0.00013	0.00013	0.00050	0.00005	14	4
Calcium D-Ca	29.2	19.9	92.0	13.1	14	14
Chromium D-Cr	0.0014	0.0025	0.0100	0.0003	14	9
Cobalt D-Co	0.0065	0.0073	0.0200	0.0001	14	1
Copper D-Cu	0.002	0.001	0.005	0.001	14	13
Iron D-Fe	0.08	0.12	0.45	0.01	14	10
Lead D-Pb	0.0006	0.0013	0.0050	0.0001	14	7
Lithium D-Li	0.007	0.007	0.020	0.001	14	0
Magnesium D-Mg	11.29	9.74	42.80	4.46	14	14
Manganese D-Mn	0.01770	0.02452	0.07400	0.00262	14	11
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	13	0
Molybdenum D-Mo	0.01578	0.01479	0.03000	0.00076	14	6
Nickel D-Ni	0.0112	0.0092	0.0200	0.0017	14	6
Phosphorus D-P	0.3	0.1	0.3	0.1	13	0
Potassium D-K	2	0	2	0	13	1
Selenium D-Se	0.0011	0.0004	0.0023	0.0005	12	3
Silicon D-Si	3.83	1.78	9.06	2.55	13	13
Silver D-Ag	0.00009	0.00026	0.00100	0.00001	14	1
Sodium D-Na	2	1	4	2	14	2
Strontium D-Sr	0.1272	0.0883	0.3870	0.0547	13	13
Thallium D-Tl	0.0334	0.0492	0.1000	0.0001	12	0
Tin D-Sn	0.0143	0.0151	0.0300	0.0001	13	1
Titanium D-Ti	0.01	0.00	0.01	0.00	13	0
Uranium D-U	0.0065	0.0188	0.0600	0.0002	10	9
Vanadium D-V	0.016	0.015	0.030	0.001	14	0
Zinc D-Zn	0.012	0.008	0.030	0.003	14	11

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FINLAYSON PROJECT

WATER QUALITY AT STATION W29

	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Total Dissolved Solids	152	47	198	73	5	5
Hardness CaCO3	137.5	49.5	180.0	52.7	5	5
pH	7.70	0.30	8.14	7.33	5	5
Total Suspended Solids	8	7	15	2	4	4
Turbidity (NTU)	2.4	2.0	5.0	0.7	5	5
Alkalinity-Total CaCO3	127	45	167	50	5	5
Chloride Cl	0.5	0.0	0.6	0.5	5	1
Fluoride F	0.17	0.07	0.24	0.10	5	5
Sulphate SO4	19	7	27	9	5	5
Ammonia Nitrogen N	0.020	#DIV/0!	0.020	0.020	1	1
Nitrate Nitrogen N	0.058	0.078	0.179	0.005	5	2
Nitrite Nitrogen N	0.001	0.001	0.003	0.001	5	3
Nitrite/Nitrate Nitrogen N	0.049	0.089	0.182	0.005	4	1
Total Cyanide CN	0.011	#DIV/0!	0.011	0.011	1	1
WAD Cyanide CN	#DIV/0!	#DIV/0!	0.00	0.00	0	0

Total Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum T-Al	0.024	0.026	0.070	0.005	5	4
Antimony T-Sb	0.04019	0.08934	0.20000	0.00013	5	4
Arsenic T-As	0.00447	0.00408	0.00988	0.00030	5	5
Barium T-Ba	0.0677	0.0245	0.1000	0.0338	5	5
Beryllium T-Be	0.0023	0.0025	0.0050	0.0005	5	0
Bismuth T-Bi	0.0403	0.0545	0.1000	0.0005	5	0
Boron T-B	0.041	0.054	0.100	0.001	5	2
Cadmium T-Cd	0.00009	0.00007	0.00020	0.00005	5	1
Calcium T-Ca	34.8	11.5	44.5	15.2	5	5
Chromium T-Cr	0.0006	0.0005	0.0012	0.0002	5	4
Cobalt T-Co	0.0023	0.0043	0.0100	0.0001	5	3
Copper T-Cu	0.001	0.000	0.002	0.001	5	4
Iron T-Fe	0.16	0.22	0.53	0.02	5	5
Lead T-Pb	0.0003	0.0004	0.0010	0.0001	5	3
Lithium T-Li	0.005	0.005	0.010	0.001	5	2
Magnesium T-Mg	12.93	5.18	17.20	4.05	5	5
Manganese T-Mn	0.03277	0.03754	0.09010	0.00386	5	5
Mercury T-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum T-Mo	0.00743	0.01263	0.03000	0.00085	5	4
Nickel T-Ni	0.0056	0.0081	0.0200	0.0010	5	4
Phosphorus T-P	0.3	0.0	0.3	0.3	5	0
Potassium T-K	2	1	2	0	5	1
Selenium T-Se	0.0011	0.0002	0.0014	0.0010	5	2
Silicon T-Si	2.75	1.18	4.70	1.69	5	5
Silver T-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium T-Na	2	0	2	2	5	1
Strontium T-Sr	0.1380	0.0549	0.1800	0.0470	5	5
Thallium T-Tl	0.0400	0.0547	0.1000	0.0001	5	0
Tin T-Sn	0.0121	0.0164	0.0300	0.0001	5	0
Titanium T-Ti	0.01	0.00	0.01	0.01	5	0
Uranium T-U	0.0017	0.0011	0.0024	0.0005	3	3
Vanadium T-V	0.013	0.016	0.030	0.001	5	1
Zinc T-Zn	0.006	0.002	0.009	0.003	5	4

Dissolved Metals	Average	Standard Dev.	Maximum	Minimum	Sample Size	# of Detections
Aluminum D-Al	0.007	0.006	0.018	0.002	5	3
Antimony D-Sb	0.04017	0.08935	0.20000	0.00007	5	4
Arsenic D-As	0.00381	0.00327	0.00762	0.00020	5	5
Barium D-Ba	0.0682	0.0217	0.0900	0.0327	5	5
Beryllium D-Be	0.0023	0.0025	0.0050	0.0005	5	0
Bismuth D-Bi	0.0403	0.0545	0.1000	0.0005	5	0
Boron D-B	0.044	0.051	0.100	0.001	5	3
Cadmium D-Cd	0.00008	0.00007	0.00020	0.00005	5	0
Calcium D-Ca	34.1	11.4	44.0	14.6	5	5
Chromium D-Cr	0.0005	0.0005	0.0011	0.0001	5	4
Cobalt D-Co	0.0023	0.0043	0.0100	0.0001	5	0
Copper D-Cu	0.001	0.001	0.003	0.001	5	4
Iron D-Fe	0.03	0.01	0.04	0.01	5	3
Lead D-Pb	0.0003	0.0004	0.0010	0.0001	5	1
Lithium D-Li	0.005	0.005	0.010	0.001	5	2
Magnesium D-Mg	12.74	5.13	17.10	3.91	5	5
Manganese D-Mn	0.00783	0.00530	0.01590	0.00287	5	3
Mercury D-Hg	0.00005	0.00000	0.00005	0.00005	5	0
Molybdenum D-Mo	0.00742	0.01264	0.03000	0.00082	5	4
Nickel D-Ni	0.0054	0.0082	0.0200	0.0009	5	4
Phosphorus D-P	0.3	0.0	0.3	0.3	5	0
Potassium D-K	2	1	2	0	5	1
Selenium D-Se	0.0011	0.0001	0.0013	0.0010	5	2
Silicon D-Si	2.67	1.13	4.49	1.58	5	5
Silver D-Ag	0.00003	0.00004	0.00010	0.00001	5	0
Sodium D-Na	2	0	2	2	5	1
Strontium D-Sr	0.1355	0.0531	0.1790	0.0455	5	5
Thallium D-Tl	0.0400	0.0547	0.1000	0.0001	5	0
Tin D-Sn	0.0121	0.0164	0.0300	0.0001	5	1
Titanium D-Ti	0.01	0.00	0.01	0.01	5	0
Uranium D-U	0.0018	0.0012	0.0025	0.0005	3	3
Vanadium D-V	0.013	0.016	0.030	0.001	5	1
Zinc D-Zn	0.008	0.006	0.019	0.005	5	4

APPENDIX 3C

WOLVERINE AREA – SEDIMENT QUALITY DATA

EXPATRIATE RESOURCES LTD.
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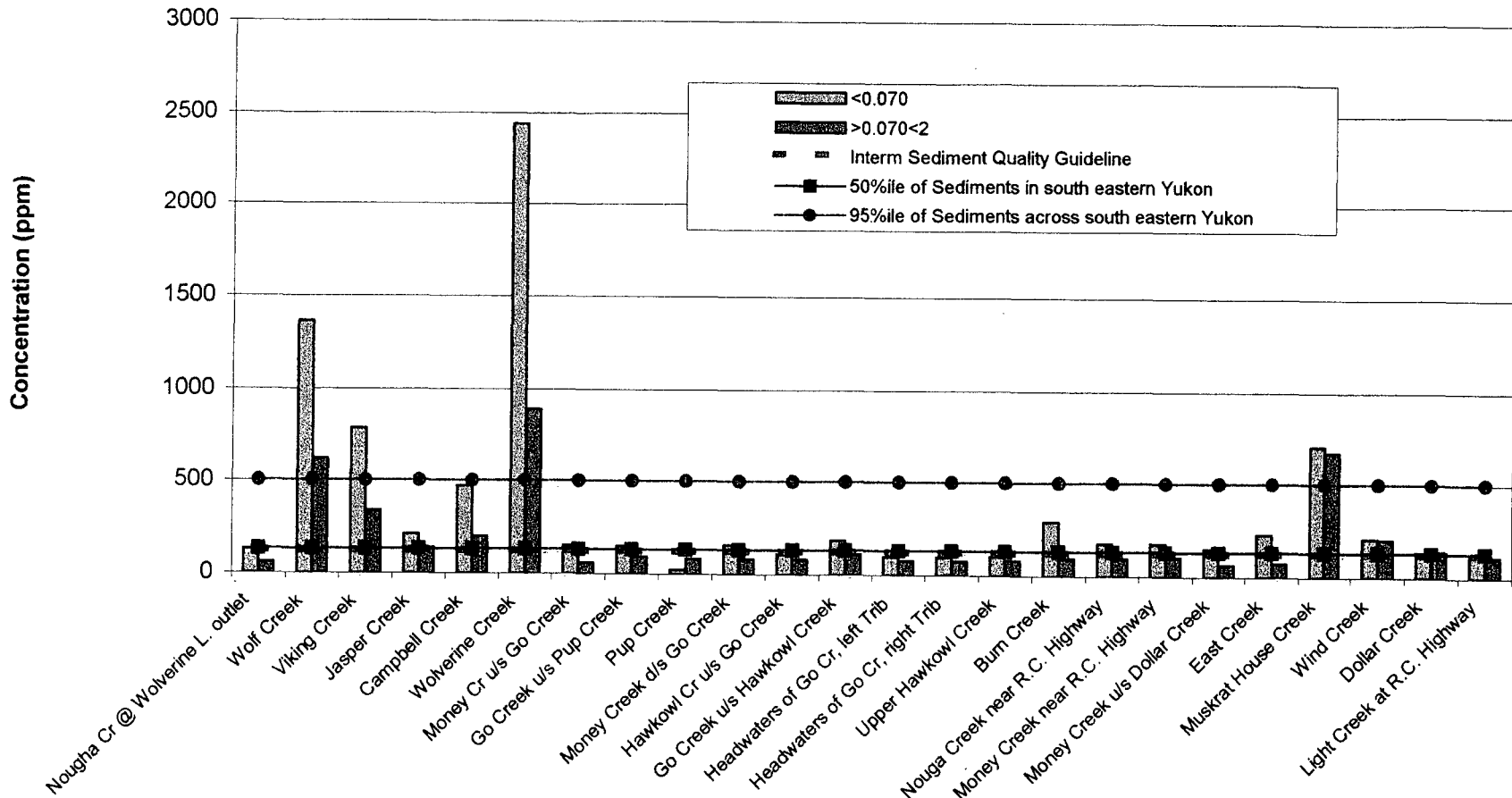
Stream Sediment Quality in the Wolverine Area

SITE #	SAMPLE DESCRIPTION	D.O.C. ppm		Cd ppm		Co ppm		Cr ppm		Cu ppm		Fe %	
		<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2
W-1	Nougha Cr @ Wolverine L. outlet	275	95	<.5	<.5	9	5	147	99	17	7	2.77	1.59
W-2	Wolf Creek	3250	700	9	4	26	14	96	70	40	12	5.67	2.97
W-4	Viking Creek	300	100	7.5	3	15	10	110	112	152	96	3.69	2.46
W-6	Jasper Creek	170	42	1.5	1	17	16	109	88	44	28	3.83	3.33
W-8	Campbell Creek	410	120	2.5	0.5	15	11	108	65	63	22	3.67	2.59
W-9	Wolverine Creek	262	60	11.5	4.5	14	11	98	61	50	20	4.01	2.84
W-11	Money Cr u/s Go Creek	340	95	<.5	<.5	13	7	108	55	17	7	4.33	1.91
W-12	Go Creek u/s Pup Creek	1000	240	1	<.5	18	11	112	132	42	22	4.08	3.44
W-13	Pup Creek	550	90	<.5	<.5	4	15	29	145	8	24	0.84	4
W-14	Money Creek d/s Go Creek	380	130	1.5	<.5	18	9	114	66	36	16	4.11	2.61
W-15	Hawkowl Cr u/s Go Creek	310	87	<.5	<.5	19	15	135	163	70	48	4.23	3.67
W-16	Go Creek u/s Hawkowl Creek	500	160	3.5	0.5	28	23	172	167	53	36	5.81	5.34
W-17	Headwaters of Go Cr, left Trib	400	120	<.5	<.5	39	33	238	327	82	65	6.71	6.82
W-18	Headwaters of Go Cr, right Trib	187	127	<.5	<.5	39	35	220	193	86	64	7.31	7.02
W-19	Upper Hawkowl Creek	220	75	<.5	<.5	36	32	150	130	80	53	6.81	6.7
W-20	Burn Creek	600	70	2	0.5	10	7	79	72	27	9	2.72	1.73
W-21	Nougha Creek near R.C. Highway	650	215	0.5	<.5	13	10	150	142	26	11	2.62	2.15
W-22	Money Creek near R.C. Highway	233	92	0.5	<.5	16	12	139	137	47	31	3.66	2.79
W-23	Money Creek u/s Dollar Creek	937	182	0.5	<.5	21	11	101	56	24	7	5.27	2.35
W-24	East Creek	510	87	1.5	<.5	29	13	116	76	27	11	5.96	2.61
W-25	Muskrat House Creek	2200	487	7	7.5	9	10	28	25	17	16	2.49	2.73
W-26	Wind Creek	1450	1100	3	3	8	9	62	63	40	35	2.09	1.98
W-27	Dollar Creek	5250	4750	2.5	3	5	4	42	42	17	19	2.77	3.17
W-28	Light Creek at R.C. Highway	262	215	0.5	0.5	11	11	60	76	28	19	2.07	1.96

SITE #	SAMPLE DESCRIPTION	Mn ppm		Mo ppm		Ni ppm		Pb ppm		Zn ppm	
		<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2
W-1	Nougha Cr @ Wolverine L. outlet	300	190	3	1	51	42	21	16	128	58
W-2	Wolf Creek	6230	2480	5	1	212	106	32	21	1365	620
W-4	Viking Creek	1265	725	6	3	117	70	29	20	786	336
W-6	Jasper Creek	1225	1560	4	2	57	46	17	14	208	138
W-8	Campbell Creek	815	600	3	1	71	35	34	19	472	198
W-9	Wolverine Creek	935	740	4	3	79	37	35	20	2440	892
W-11	Money Cr u/s Go Creek	1695	600	3	1	58	25	30	28	148	60
W-12	Go Creek u/s Pup Creek	1740	1040	2	1	42	31	17	16	148	92
W-13	Pup Creek	280	985	<1	2	13	42	45	15	24	82
W-14	Money Creek d/s Go Creek	2010	880	3	1	51	28	23	20	156	82
W-15	Hawkowl Cr u/s Go Creek	1100	875	1	<1	60	77	18	15	108	82
W-16	Go Creek u/s Hawkowl Creek	1860	1185	1	1	64	48	8	6	182	110
W-17	Headwaters of Go Cr, left Trib	1205	1145	5	2	89	118	9	8	98	76
W-18	Headwaters of Go Cr, right Trib	1280	1175	2	<1	98	79	11	10	98	78
W-19	Upper Hawkowl Creek	1320	1265	1	2	65	51	11	8	104	82
W-20	Burn Creek	600	495	3	1	46	24	30	18	290	94
W-21	Nougha Creek near R.C. Highway	1405	625	2	2	88	85	15	14	174	94
W-22	Money Creek near R.C. Highway	1015	640	6	3	83	70	23	17	174	102
W-23	Money Creek u/s Dollar Creek	3070	1100	4	1	71	39	36	34	150	64
W-24	East Creek	8550	2230	7	2	123	49	15	9	226	74
W-25	Muskrat House Creek	5310	6060	6	7	29	28	17	13	706	672
W-26	Wind Creek	915	880	3	4	55	63	15	13	206	200
W-27	Dollar Creek	1410	1760	4	4	44	50	13	9	136	140
W-28	Light Creek at R.C. Highway	620	560	4	1	45	55	23	17	124	114

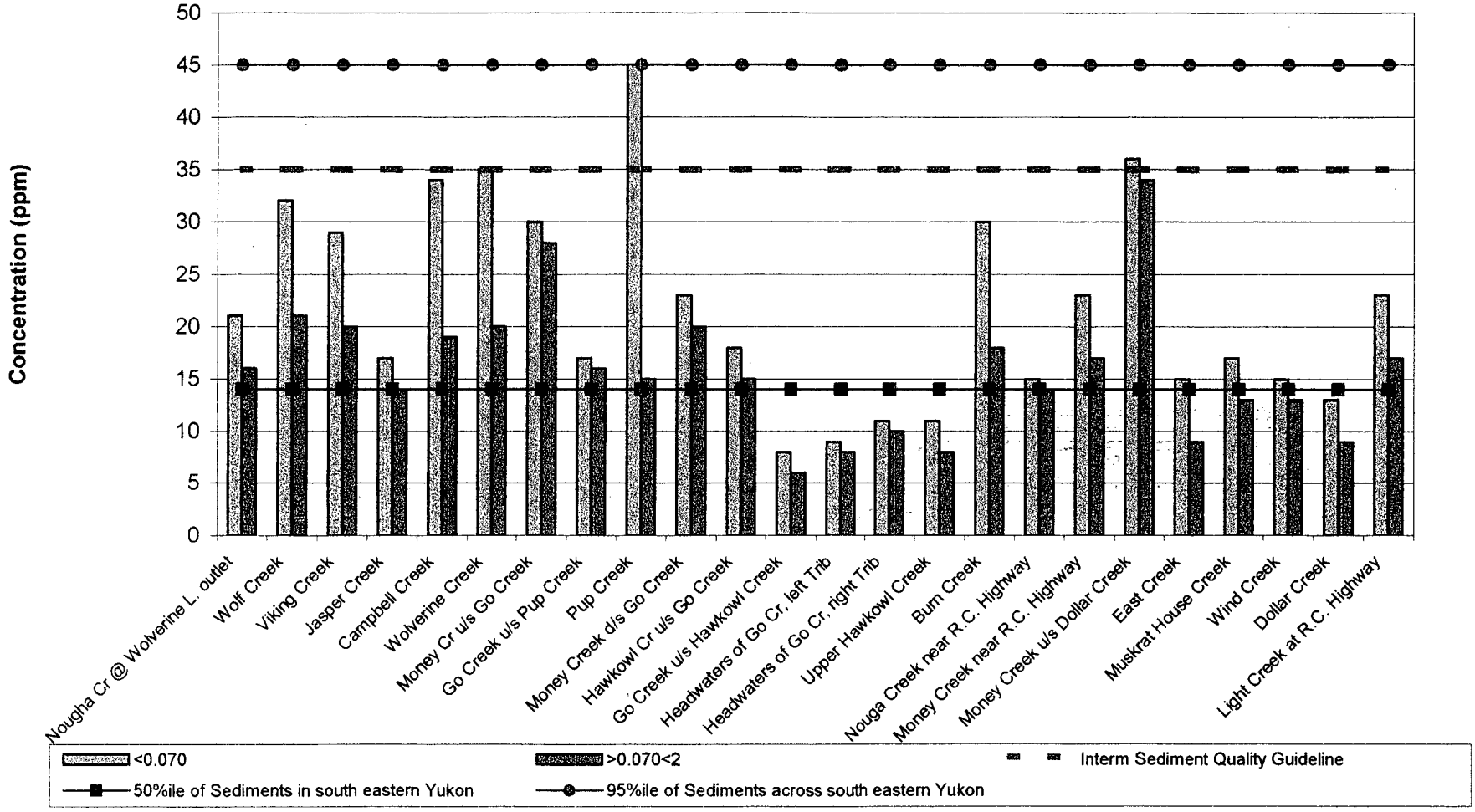
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Concentrations of Zinc in Stream Sediments in the Wolverine Area



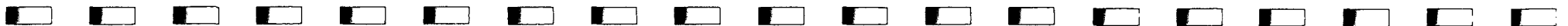
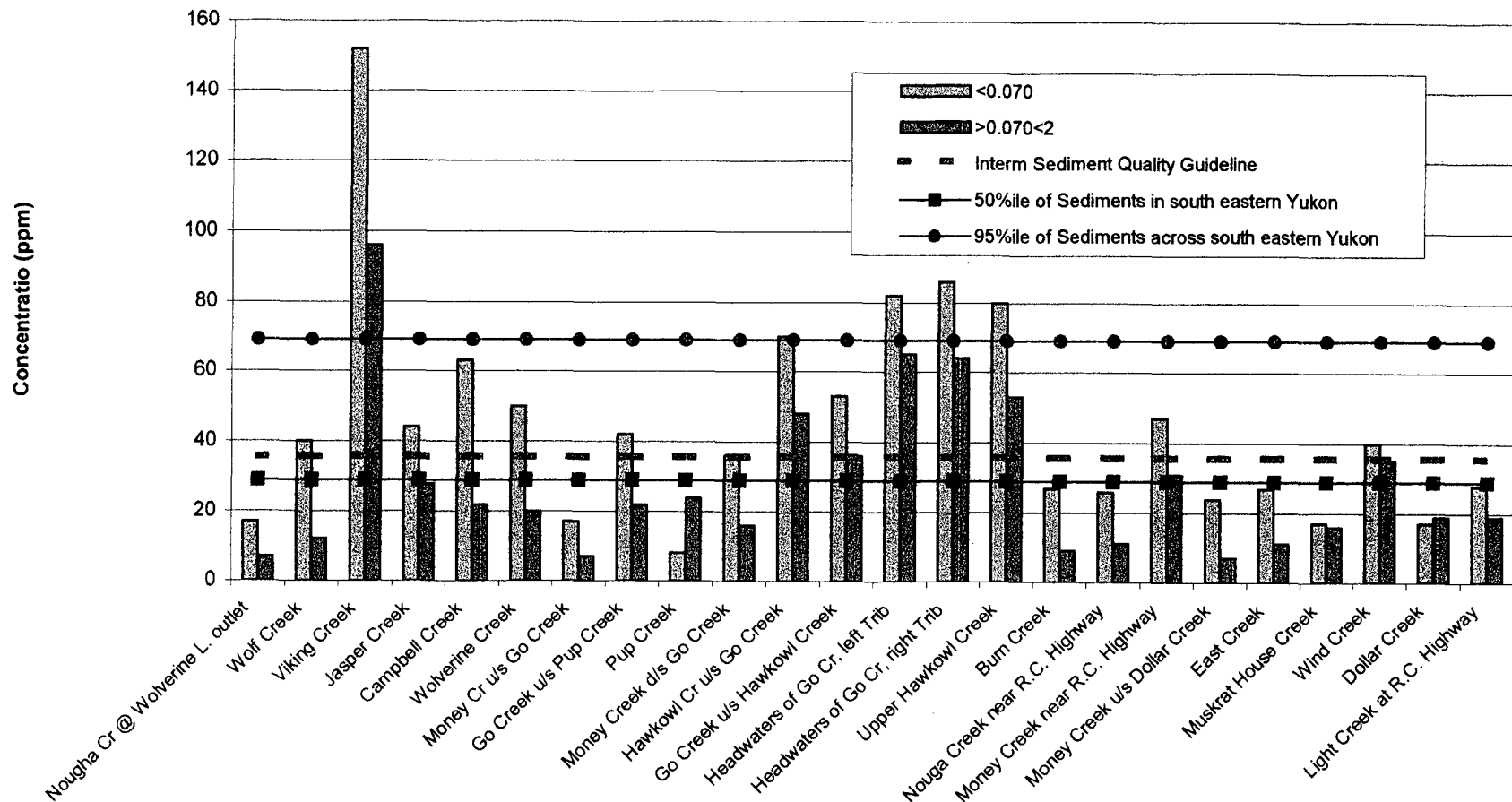
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FINLAYSON PROJECT

Concentrations of Lead in Stream Sediments in the Wolverine Area



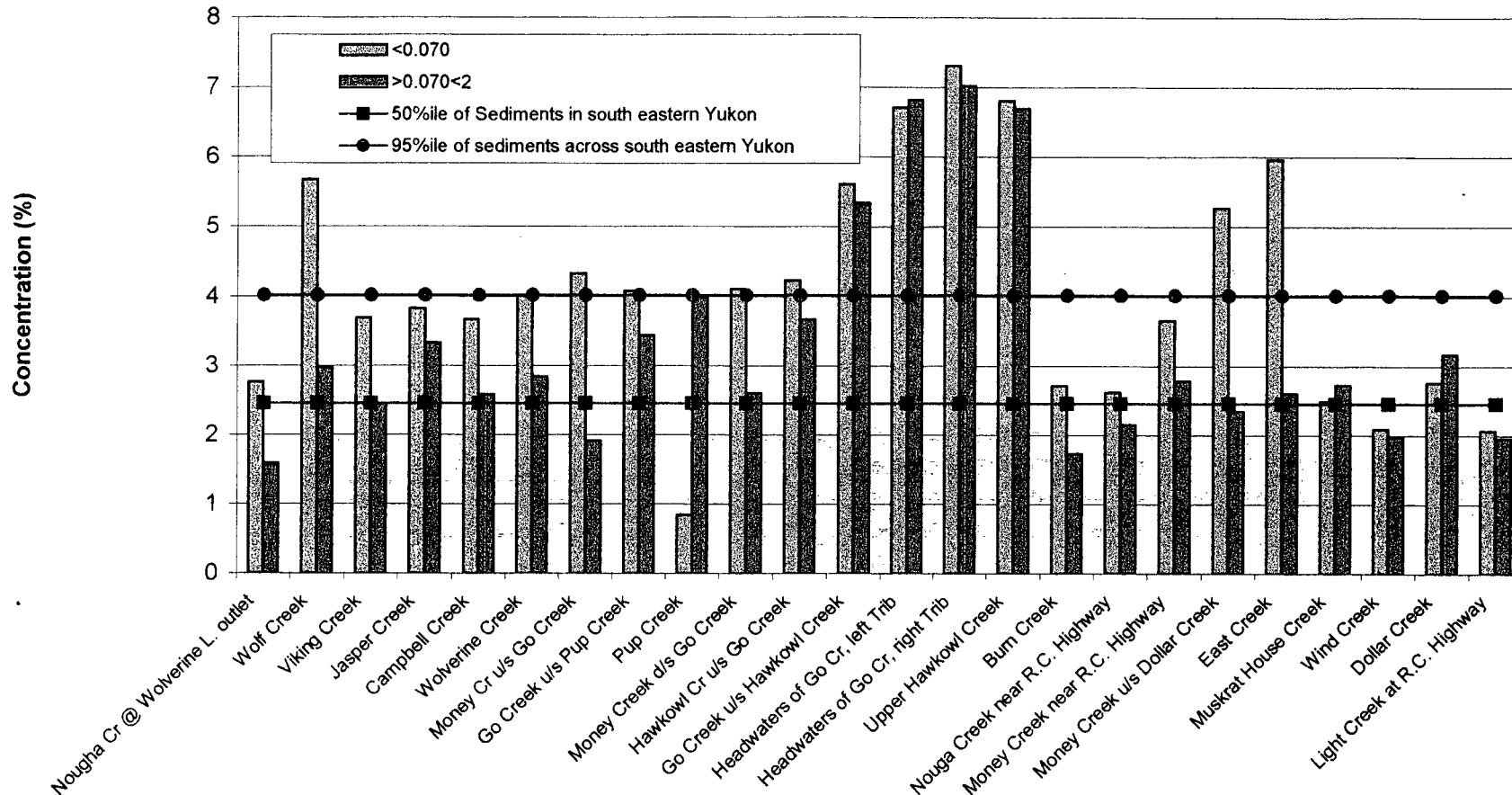
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Copper in Stream Sediments in the Wolverine Area



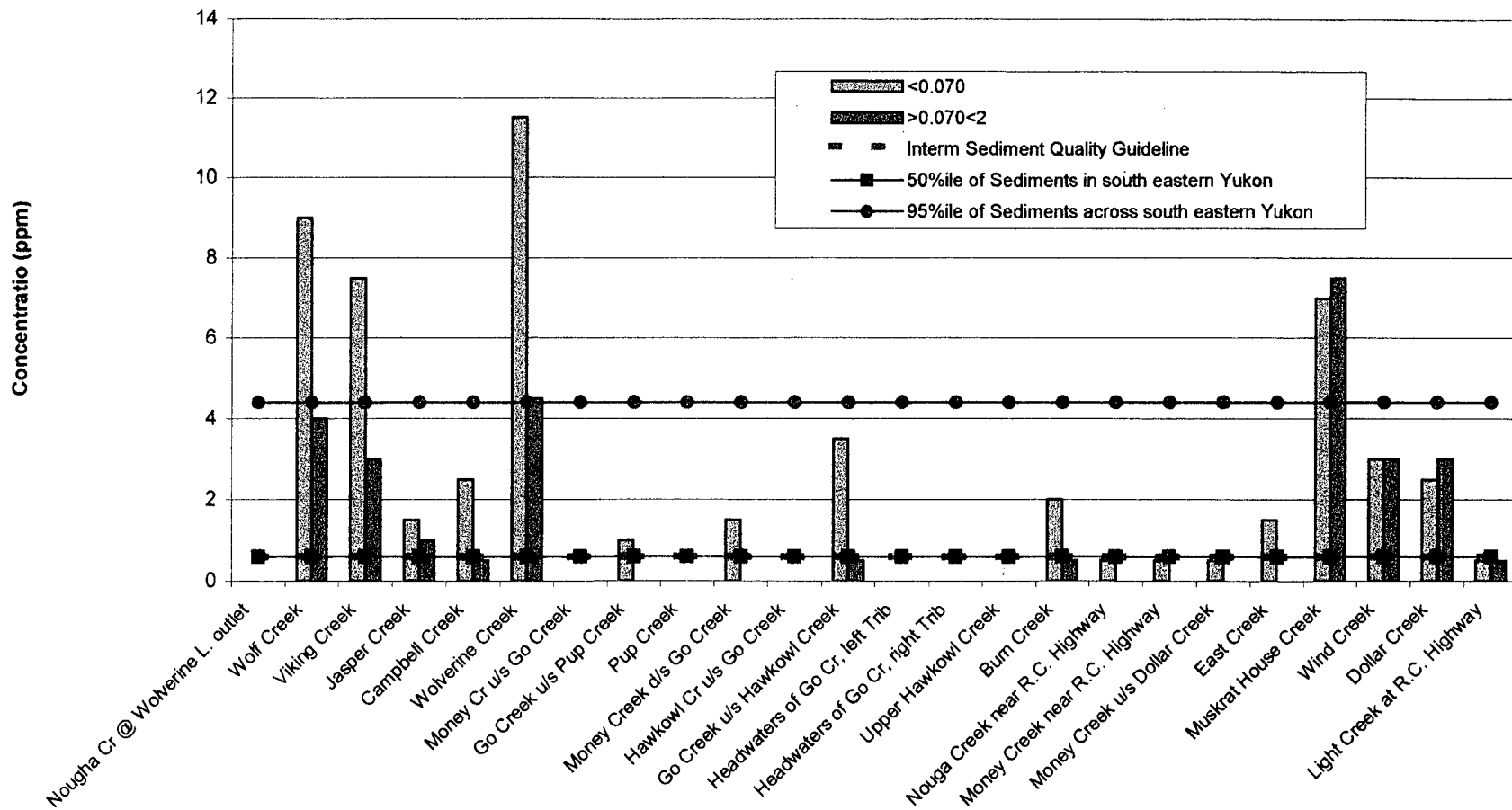
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Iron in Stream Sediments in the Wolverine Area



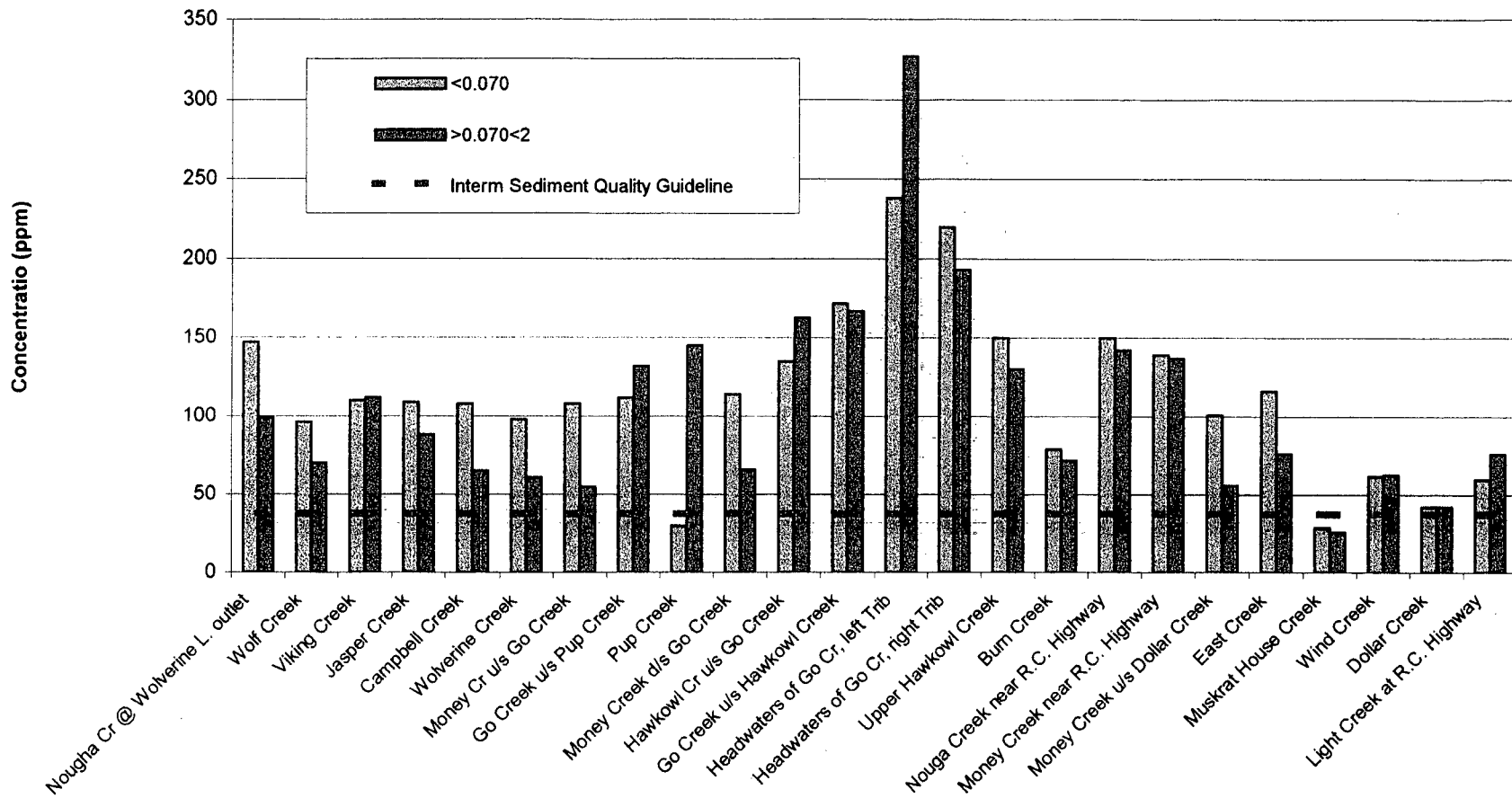
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Cadmium in Stream Sediments in the Wolverine Area



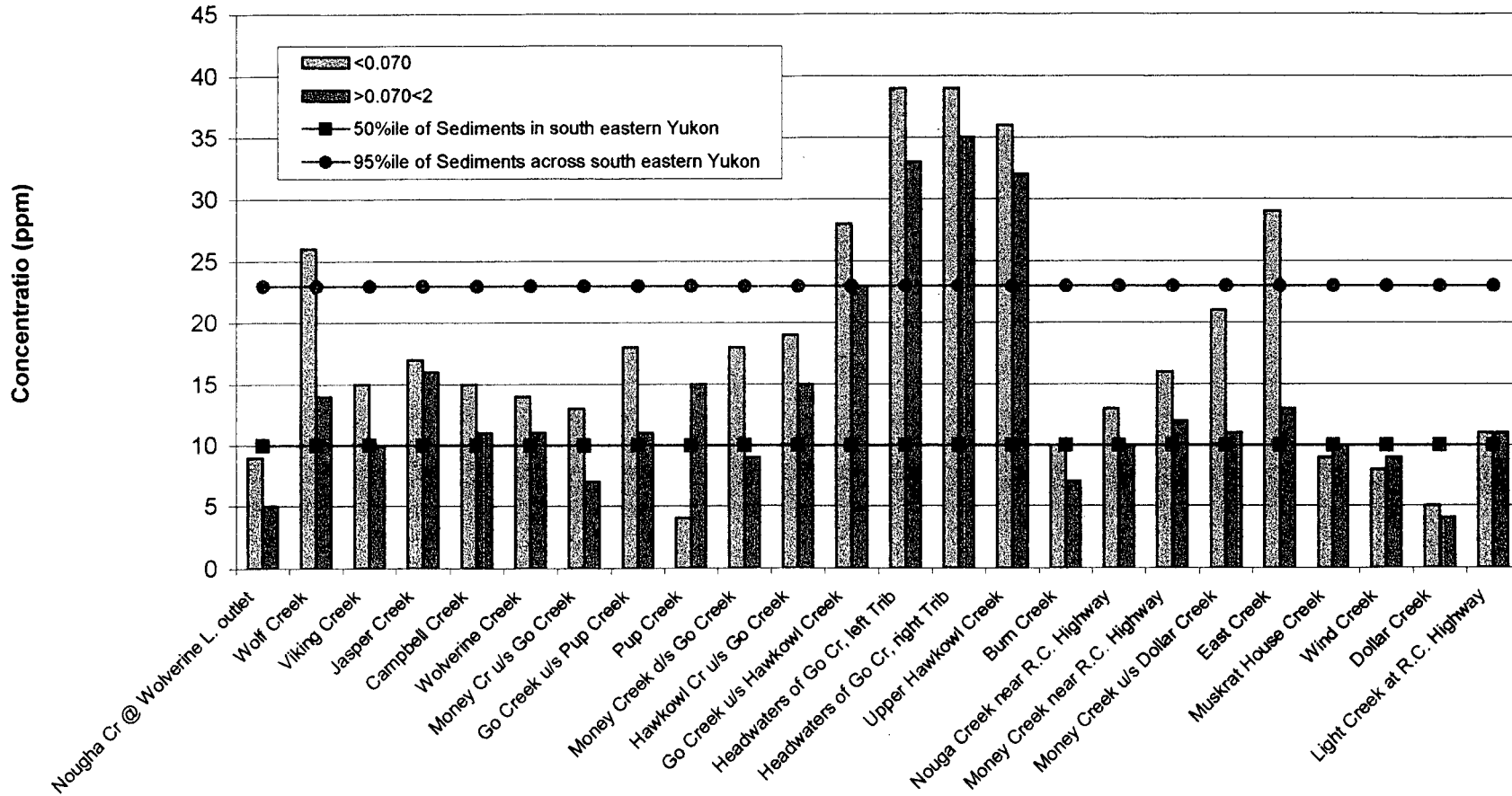
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Chromium in Stream Sediments in the Wolverine Area



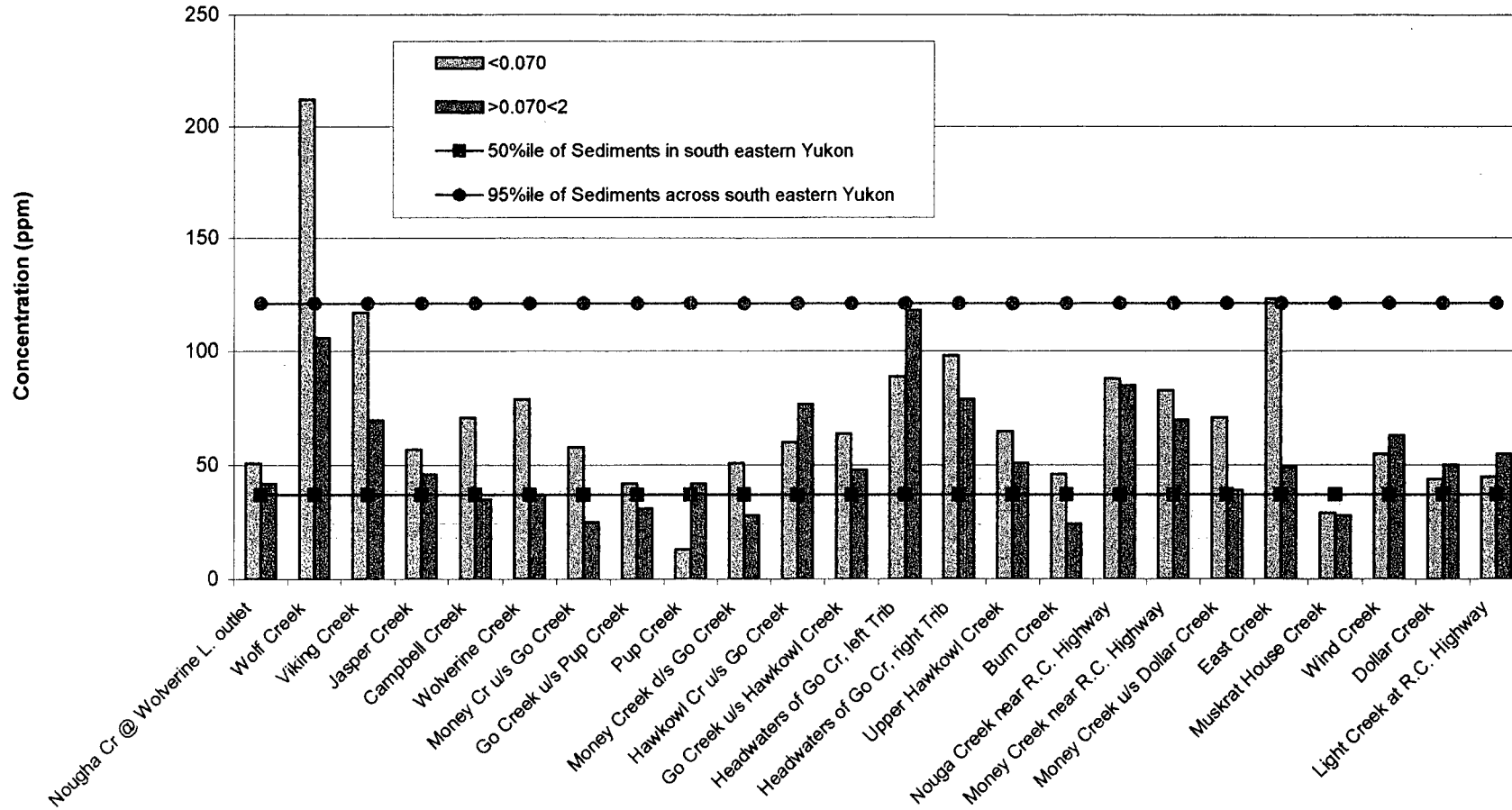
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Cobalt in Stream Sediments in the Wolverine Area



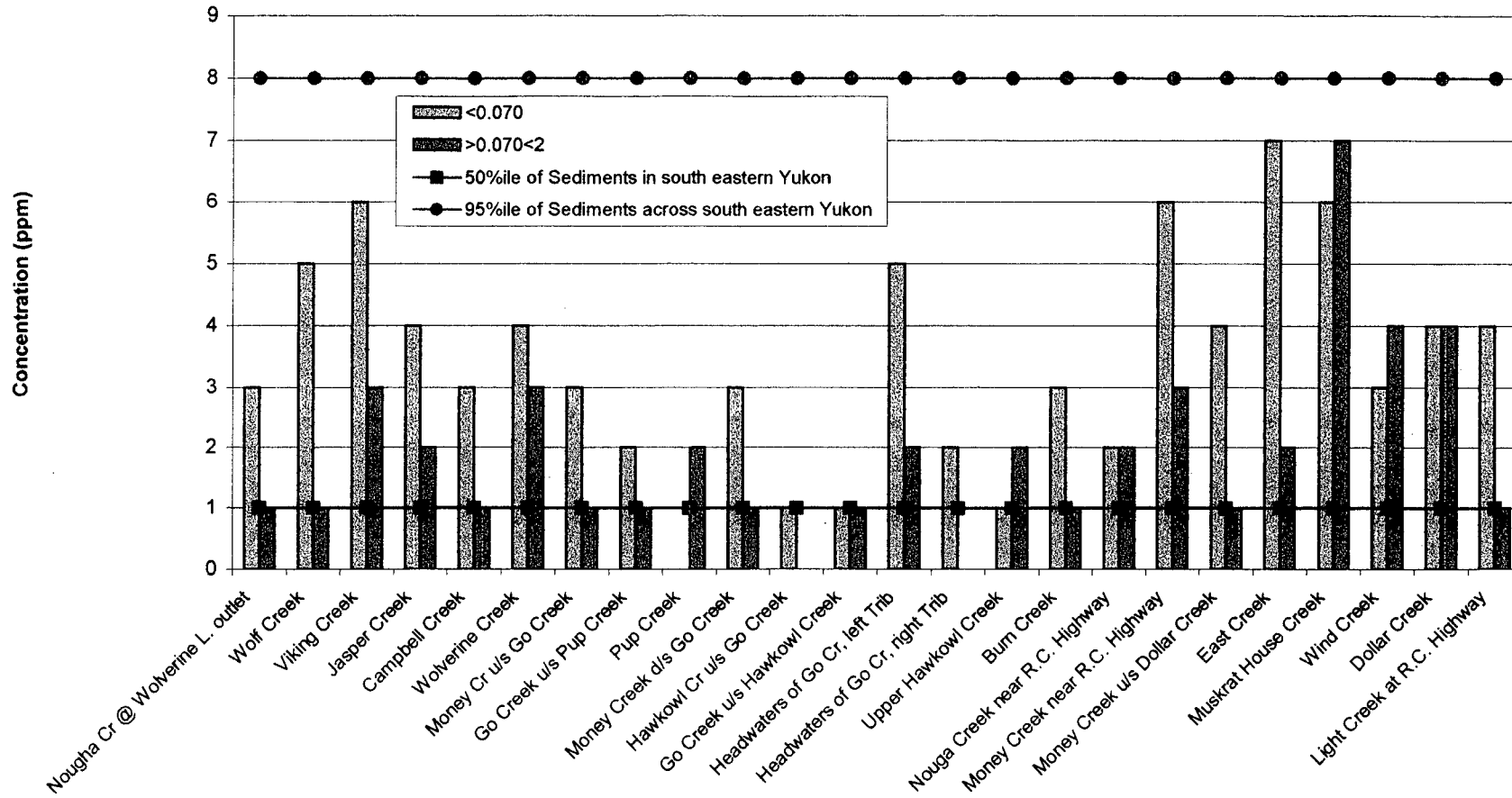
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Nickel in Stream Sediments in the Wolverine Area



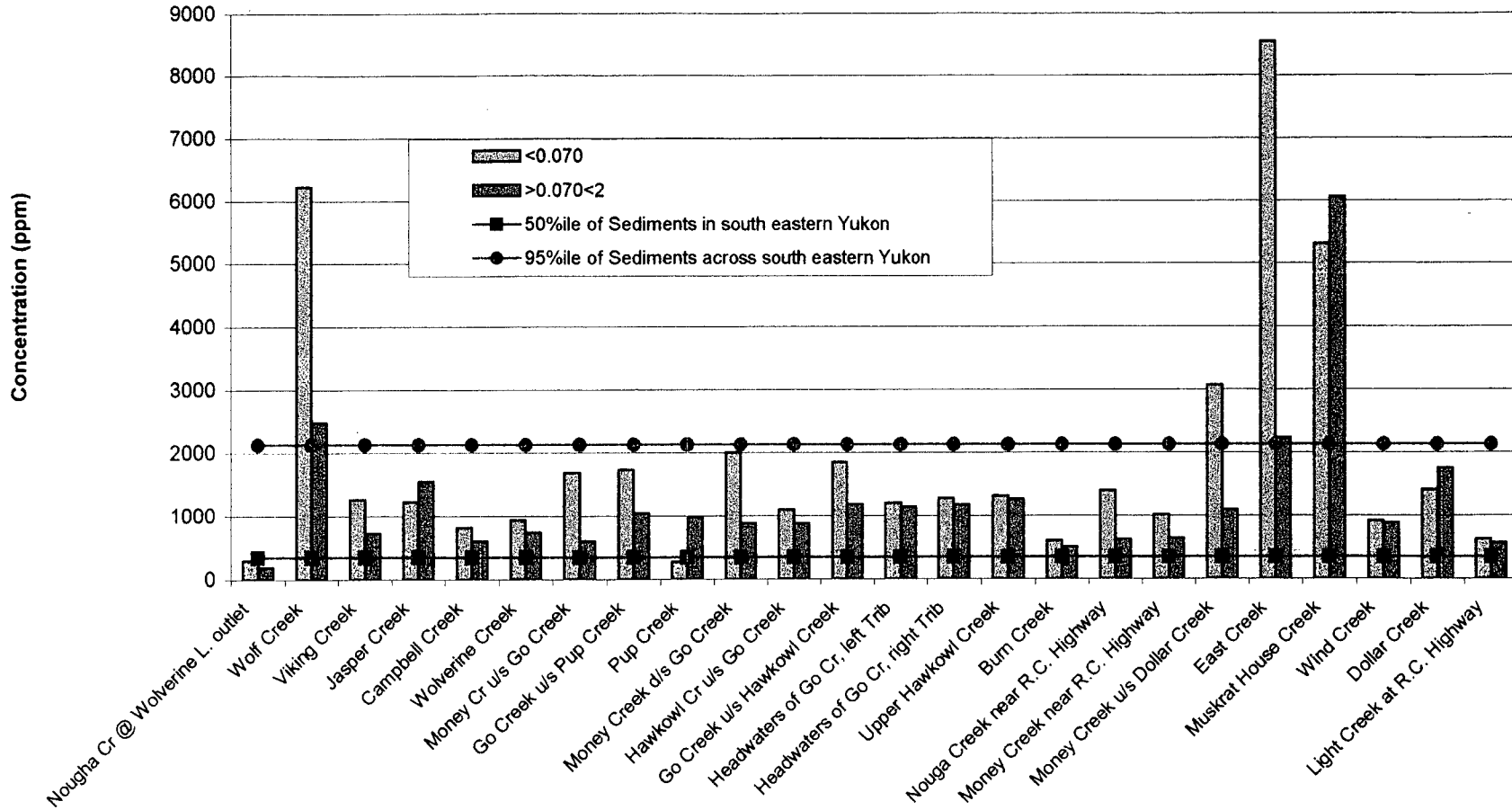
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Molybdenum in Stream Sediments in the Wolverine Area



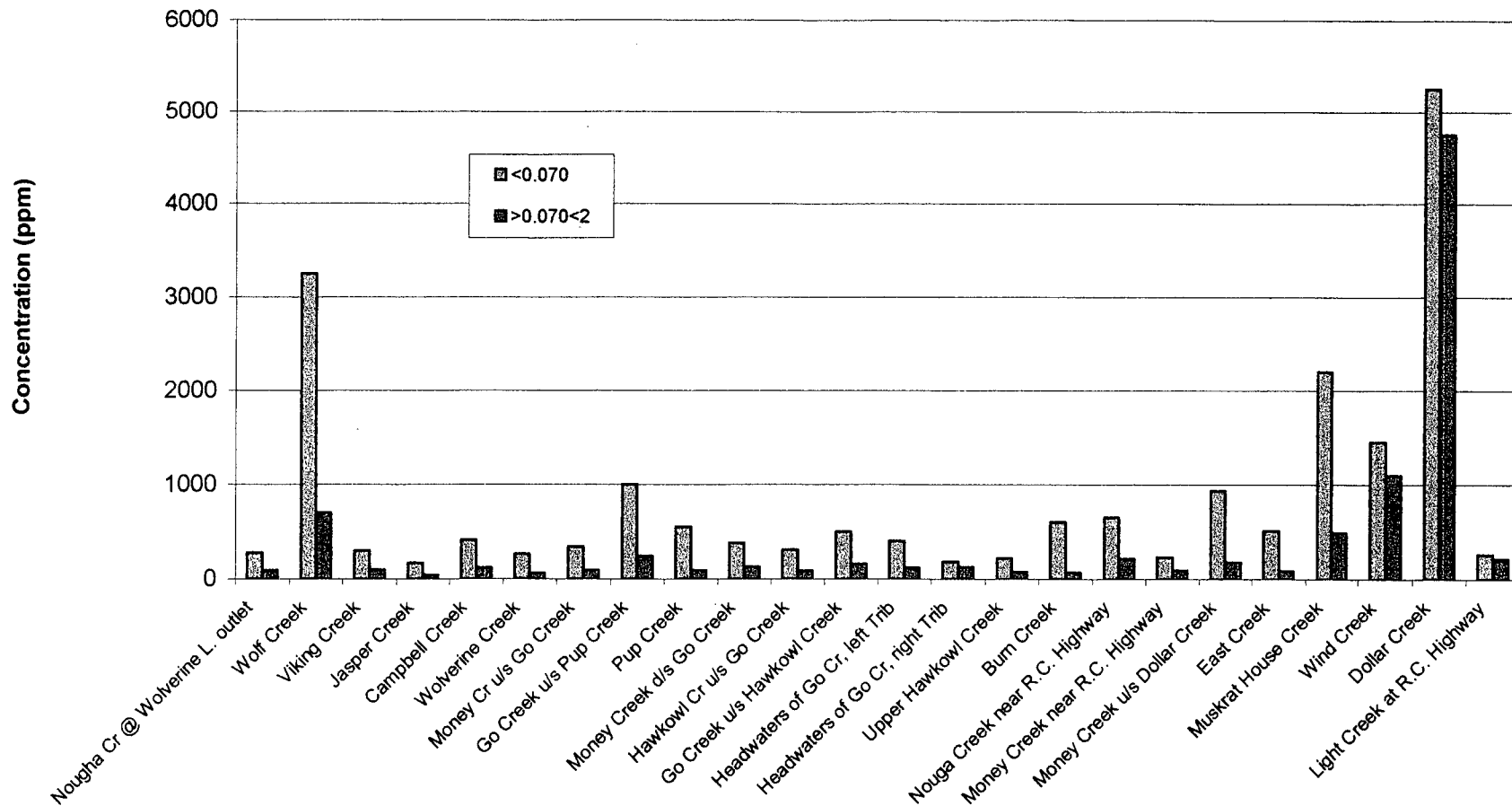
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Manganese in Stream Sediments in the Wolverine Area



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Concentrations of Dissolved Organic Carbon in Stream Sediments in the Wolverine Area



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

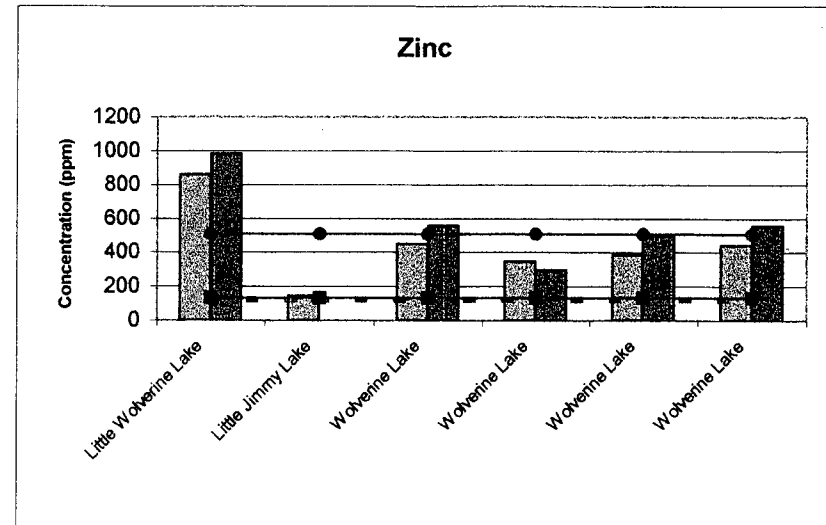
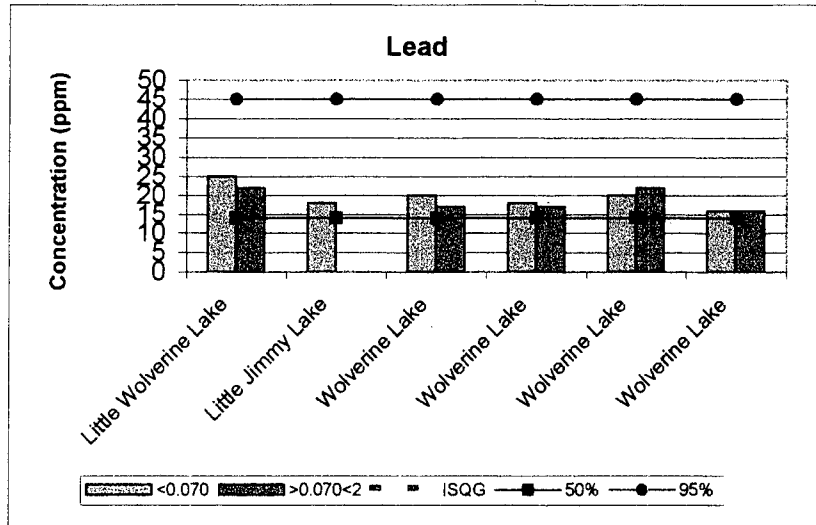
Lake Sediment Quality in the Wolverine Area

SITE #	SAMPLE DESCRIPTION	D.O.C. ppm		Cd ppm		Co ppm		Cr ppm		Cu ppm		Fe %	
		<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2
L-1 @16m	Little Wolverine Lake	2350	2850	9	10	15	14	81	77	68	71	5.86	5.51
M-1 @13m	Little Jimmy Lake	1150	not/ss	2.5	not/ss	5	not/ss	48	not/ss	23	not/ss	1.45	not/ss
P-1 @21m	Wolverine Lake	1800	1080	4.5	5	11	14	71	77	47	52	4.58	6.07
P-2@35.2m	Wolverine Lake	387	300	3	3	12	10	58	58	37	31	6.38	6.59
P-3 @68m	Wolverine Lake	1250	1050	4	6	13	16	43	49	39	48	3.67	4.25
P-4 @73m	Wolverine Lake	750	625	4	6	14	17	58	58	55	54	3.64	4.38

		Mn ppm		Mo ppm		Ni ppm		Pb ppm		Zn ppm	
		<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2	<0.070	>0.070<2
L-1 @16m	Little Wolverine Lake	2050	1850	4	5	52	54	25	22	860	982
M-1 @13m	Little Jimmy Lake	580	not/ss	9	not/ss	28	not/ss	18	not/ss	142	not/ss
P-1 @21m	Wolverine Lake	2180	2680	5	8	78	97	20	17	446	554
P-2@35.2m	Wolverine Lake	5330	6690	8	9	47	45	18	17	342	292
P-3 @68m	Wolverine Lake	6370	6780	4	4	52	68	20	22	382	496
P-4 @73m	Wolverine Lake	4980	5070	6	5	66	78	16	16	438	556

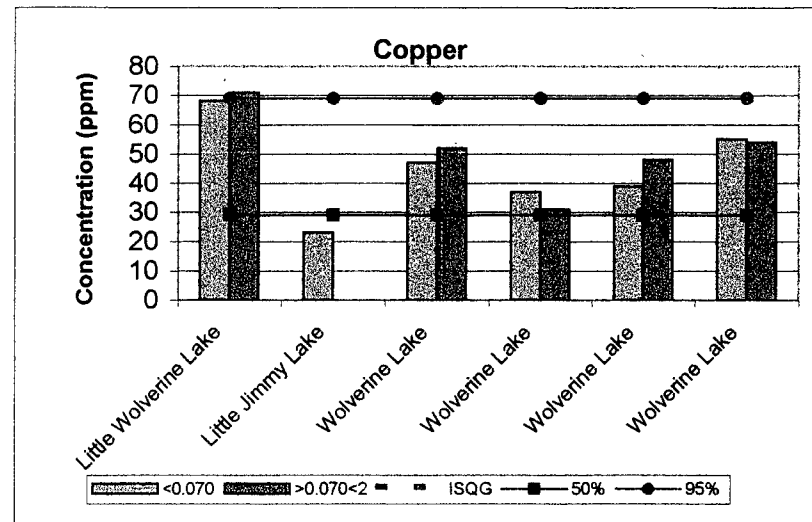
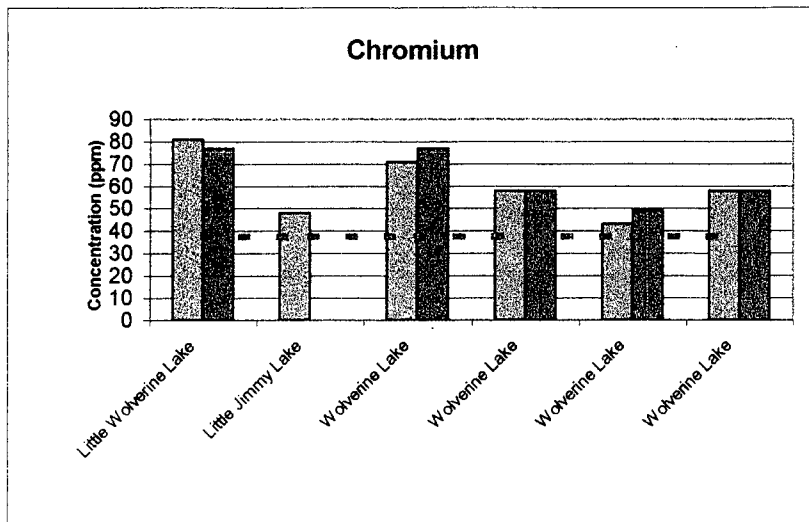
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Sediment Quality in Lakes in the Wolverine Area



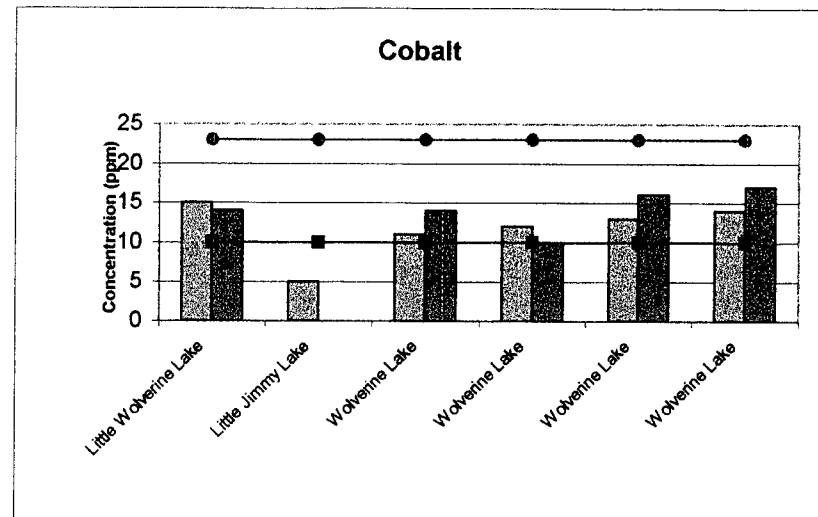
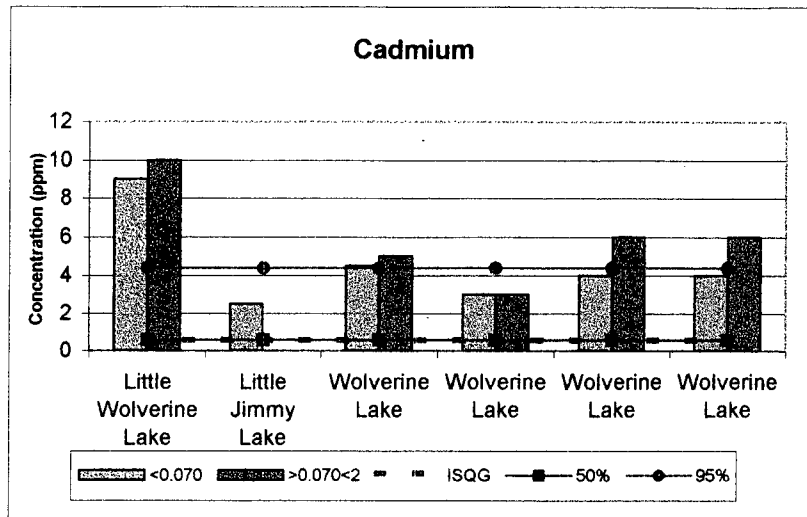
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Sediment Quality in Lakes in the Wolverine Area



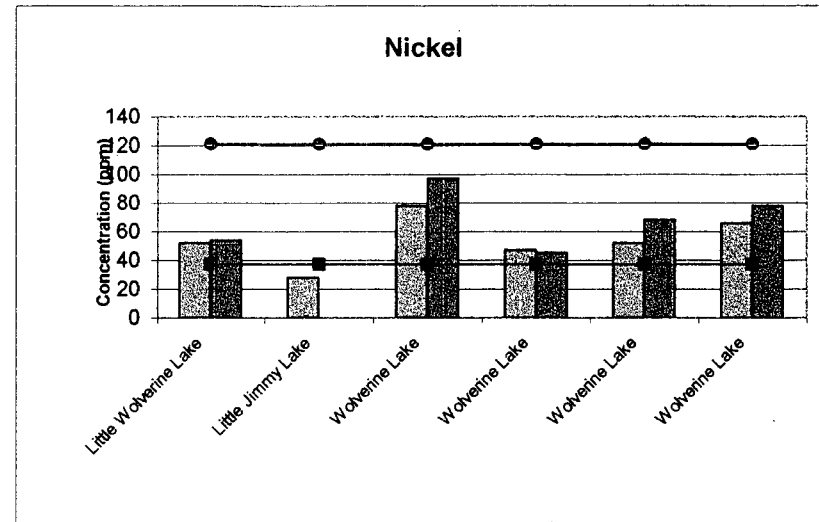
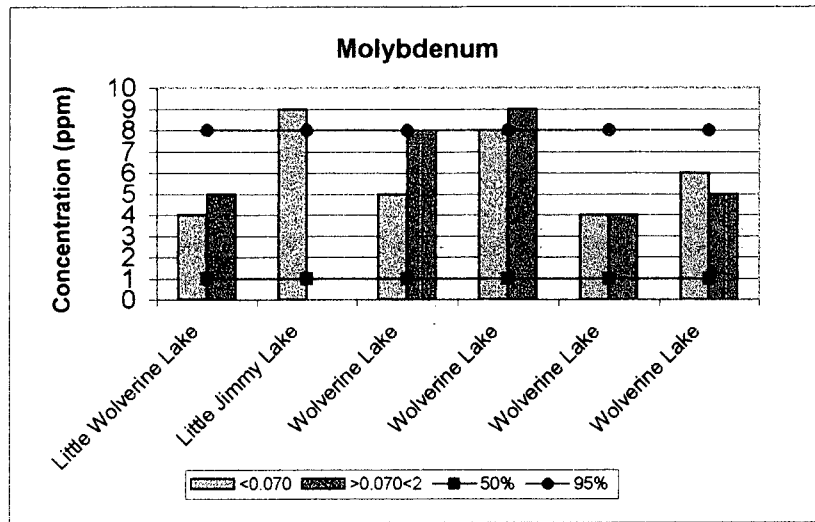
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Sediment Quality in Lakes in the Wolverine Area



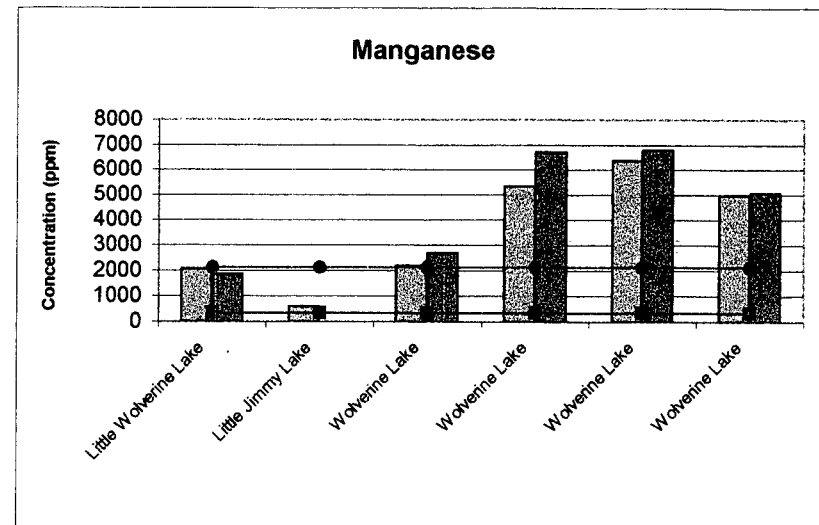
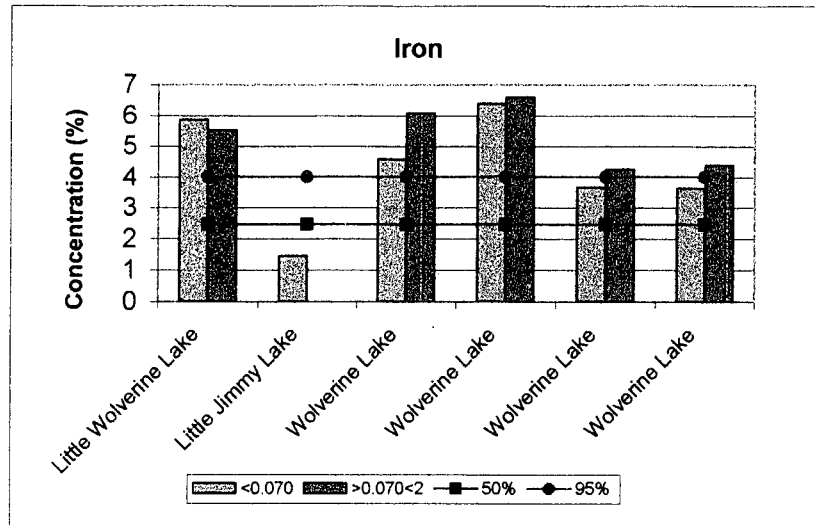
EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Sediment Quality in Lakes in the Wolverine Area



EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Sediment Quality in Lakes in the Wolverine Area



APPENDIX 3D

**WOLVERINE AREA
BENTHIC INVERTEBRATE AND ZOOPLANKTON DATA**

EXPATRIATE RESOURCES
FINLAYSON PROJECT

Benthic Invertebrate Data for Streams in the Wolverine Area

Site Location Site Number	Nougha Cr @ outlet			Go Creek			Money Cr d/s Go Cr			Nougha Cr @ Hwy			Money Cr u/s Dollar			Wind Cr		
	W1a	W1b	W1c	W12a	W12b	W12c	W14a	W14b	W14c	W21a	W21b	W21c	W23a	W23b	W23c	W26a	W26b	W26c
Ameletus sp																		
Baetis sp	146	240	60	76	52	169	1082	548	2019	257	219	425	209	1060	63	196	10	179
Cinygmula sp				2	3	2	42	22	5			6						32
Ephemerella coloradensis				5		5			3									
Ephemerella doddsi							20	8	23	3	7	7						
Ephemerella inermis	1	4					12	7	23	4	4			2				
Ephemerella grandis							19	7	14	3	6	5	1	32	2			
Epeorus (Iron) albertae										6	1	7						
Epeorus (Iron) longimanus				4	9	14		1	5	14	4	8		32				
Ephemerella sp							31	5	3	5	22	33	4	1	6	1		
Rhithrogena sp				7	3	17	10	20	39	11	36	15	8	33	19			
Siphonurus sp																1		
Trichoptera, Unid J				31	14	32							80	160	14	24		64
Trichoptera pupae			1													1	1	
Agraylea sp			1										1					
Agrypnia sp																		
Arctopsyche sp	5			13	12	32		3	8	41	154	105	16	32			33	2
Brachycentrus sp				14	5	6	38	38	78	24	58	65	48	79	6	1	2	
Ceraclea sp			1													4	4	1
Clostoeca sp													1		1			
Dicosmoecus sp				1														
Glossosoma sp		1					8											
Grammotaulius sp																10	15	4
Hydropsychidae unid J							12	49	17									
Hydropsyche sp	452	576	395				11	8										
Hydroptilidae J		81	64															
Hydroptila sp												1	8	32	1	8		
Micrasema sp				13	20	17	3	11		3	7	9	1			1		
Mystacides sp																		
Psychoglypha sp																1		2
Rhyacophila sp juv			8								4							
Rhyacophila acropedes/vao		4	2	2			3	2	3	2	2	11		1	1	2		
Rhyacophila (hyalinata?)										2	2	3						
Diptera, Unid adult											1	2		1				1
Diptera Unid P													1					
Tipulidae																		
Antocha sp											4							
Dicranota sp	1				4								1			1	4	2
Dolichopeza sp																		
Tipula sp																		
Simuliidae																		
Prosimulium sp				1	1													
Simulium sp L	1773	942	434	4	12	16	3	2	9	692	160	211				2701	2282	5399
Simulium sp P	984	1320	100		1				1	153	29	230					2	3
Chironomidae adult																		
Chironomidae pupae	195	584	104	5	20	17	17	20	48	64	40	112	16	33	10	185	369	408
Chironomidae unid J/D	1978	1584	242	432	203	1238	357	347	1715	443	111	76	2808	1452	264	2740	4999	10543
Tanytopodinae																		
Procladius sp					3													
Thienemannimyia sp	781	882	156							2	3	1	26	21	21	78	43	300
Chironomini																		
Chironomus sp																		
Constempelina sp																		
Cryptochironomus sp							1											
Dicrotendipes sp																10	33	257
Endochironomus sp																		
Microsectra sp							1	4								25		290
Microtendipes sp																		
Pagastiella sp																		
Paraccladius sp																		
Paralauterborniella sp																		
Phaenopsectra sp																		
Polypedilum (Polypedilum) sp																		
Rheotanytarsus sp	16									13	10	8	40	16	4	272	449	5344
Stempelina sp																8		
Stichtochironomus sp																		
Tanytarsus sp																		
Orthocladinae																		
Brillia sp										4	6					1		32
Cardiocladius sp	4	36	9	52	52	59	79	65	199	39	9	133	335	51				
Corynoneura sp				1	4		1			4	6		32		6	48	32	128
Cricotopus sp	192	316	84	110	146	268	230	195	581	117	127	132	420	338	217	760	1171	2996
Eukiefferiella sp	516	968	143	132	61	155	263	128	384	191	122	181	676	329	109	704	1876	
Euryhapsis sp										4	6					1		32

EXPATRIATE RESOURCES
FINLAYSON PROJECT

Benthic Invertebrate Data for Streams in the Wolverine Area

Site Location Site Number	Nougha Cr @ outlet			Go Creek			Money Cr d/s Go Cr			Nougha Cr @ Hwy			Money Cr u/s Dollar			Wind Cr		
	W1a	W1b	W1c	W12a	W12b	W12c	W14a	W14b	W14c	W21a	W21b	W21c	W23a	W23b	W23c	W26a	W26b	W26c
Heterotrissocladius sp																		
Synorthocladius sp	28	96	282		15	42	1	8	16	2	10	9			4	81	64	449
Thienemanniella sp				30	4	16	16	20	66	8	42	20	64	112	20	16		64
Diamesinae																		
Monodiamesa sp																		1
Blephariceridae																		
Bibiocephala sp										1								
Ceratopogonidae																		
Palpomyia sp																		1
Deuterophlebiidae																		
Deuterophlebia sp										1								
Empididae pupae									1							1		
Chelifera sp				4	7	1	1		4									
Clinocera sp						1			2			4						1
Weidemanna sp												4						
Psychodidae																		
Pericoma sp				4	2	1				4						2		66
Coleoptera																		
Elmidae, unid J											1							
Optioservus sp												2						
Homoptera																		
Cicadellidae																		1
Hymenoptera Unid A	1												1					2
Lepidoptera L													1					2
Turbellaria unid	7	32	16													48		512

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Benthic Invertebrate Data for Lakes in the Wolverine Area

Site Location	Little Jimmy L.			Wolverine Lake			Wolverine Lake			Wolverine Lake			Little Wolverine L.		
	M1a	M1b	M1c	W3a	W3b	W3c	W5a	W5b	W5c	W7a	W7b	W7c	W10a	W10b	W10c
Cnidaria															
Hydra sp						2		9							
Bryozoa Unid															
Cristatella mucedo													P	P	P
Porifera															
Spongilla lacustris													P	P	P
Tardigrada															
Bivalvia															
Pisidium sp	70	3	44	12	18	17	25	80	27	64	52	95	107	16	94
Sphaerium sp	6		7			15			1	8	3	5	421	195	93
Gastropoda															
Gyraulus parvus						1							5		1
Stagnicola arctica				2	1										4
Valvata sincera			1	3	22	48	3	8	26		1	18	4	4	13
Nematoda	870	65	429	67	61	58	689	865	460	104	311	746	303	62	411
Hirudinea															
Dina sp (D parva?)													10	4	1
Erpobdella sp															
Helobdella stagnicola													2		1
Oligochaeta															
Chaetogaster sp	8	4	14		3	9	48	192	36		112	32	72	28	32
Nais sp								1			1		4		8
Slavinia appendiculata						1								2	8
Enchytraeidae	8			1	1	4			4			8	72	7	1
Lumbriculus variegatus	3	2	1			3						2	13	9	4
Tubificidae unid J	116	155	194	14	23	151	85	37	65	28	73	46	406	45	178
Cladocera															
Alona sp	3	10	171	2	6	113	249	56	24	32	169	192	352	110	8
Allonella sp															
Camptocercus rectirostris					2	1				4	8	8			
Ceriodaphnia reticulata		3	1	2			2						4	6	1
Chydorus sphaericus				10	2	15	3280	144	36				8		8
Daphnia sp															
Eurycerus (Bullatifrons) sp													14		17
Ilyocryptus sordidus										4					
Copepoda															
Calanoida	8	6	6	3	2	2		8	8		32				2
Cyclopoida		2	30	3	3	34	16	72	16	4	32	8		8	17
Harpacticoida	97	38	490	25	49	48	192	240	140	128	456	560	32	22	24
Amphipoda															
Gammarus lacustris					1										2
Hyalella azteca	26	23	74		1	9			4	6	11	6	108	187	22
Ostracoda Unid		1		20	6	8		184	64	4	56	32	44		2
Candona sp	14	7	89	14	13	111	33	112	9		16	64	44	22	54
Cypria sp	23	15	177	102	133	263	60	360	56	36	76	32	36	12	16
Hydracarina, unid J/D				2	3	2	1	40	13			8			
Arrenurus sp									1						
Frontipodia sp			4	1				8							
Lebertia sp	1				2	1		1							

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Benthic Invertebrate Data for Lakes in the Wolverine Area

Site Location	Little Jimmy L.			Wolverine Lake			Wolverine Lake			Wolverine Lake			Little Wolverine L.		
	M1a	M1b	M1c	W3a	W3b	W3c	W5a	W5b	W5c	W7a	W7b	W7c	W10a	W10b	W10c
Sperchon sp															
Torrenticola sp															
Oribatei															
Plecoptera, Unid J/D															
Capnia sp												1			
Isoperla sp															
Podmosta sp															
Malenka sp															
Megarcys sp															
Skwala curvata															
Skwala parallela															
Sweitsa sp gp															
Taenionema sp															
Zapada sp															
Ephemeroptera															
Ameletus sp															
Baetis sp						1									
Cinygmula sp															
Ephemerella coloradensis															
Ephemerella doddsi															
Ephemerella inermis															
Ephemerella grandis															
Epeorus (Iron) albertae															
Epeorus (Iron) longimanus															
Ephemerella sp															
Rhithrogena sp															
Siphonurus sp															
Trichoptera, Unid J					1	1	3							5	
Trichoptera pupae		1													
Agryllea sp														4	
Agrypnia sp															1
Arctopsyche sp					1										
Brachycentrus sp															
Ceraclaea sp						1			1					1	1
Clostoecca sp		3								1				3	
Dicosmoecus sp															
Glossosoma sp															
Grammotaulius sp															
Hydropsychidae unid J															
Hydropsyche sp															
Hydroptilidae J					24										
Hydroptila sp															
Micrasema sp															
Mystacides sp		2				1				1					4
Psychoglypha sp															
Rhyacophila sp juv															
Rhyacophila acropedes/vao															
Rhyacophila (hyalinata?)															
Diptera, Unid adult															
Diptera Unid P															
Tipulidae															
Antocha sp															
Dicranota sp															
Dolichopeza sp															1
Tipula sp														1	
Simuliidae															
Prosimulium sp															
Simulium sp L						1								4	

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Benthic Invertebrate Data for Lakes in the Wolverine Area

Site Location	Little Jimmy L.			Wolverine Lake			Wolverine Lake			Wolverine Lake			Little Wolverine L.		
	M1a	M1b	M1c	W3a	W3b	W3c	W5a	W5b	W5c	W7a	W7b	W7c	W10a	W10b	W10c
Simulium sp P															
Chironomidae adult				1											
Chironomidae pupae			1				37	5	2		16	8	8	4	
Chironomidae unid J/D	150	20	239	34	48	34	354	289	412	252	920	1161	450	142	874
Tanypodinae															
Procladius sp	23	10	22	10	13	12	13	10	49	40	7	41	23	14	53
Thienemannimyia sp	1		6	1	4	1			9	12	50	66	6	8	11
Chironomini															
Chironomus sp			1												
Constempelina sp			1												
Cryptochironomus sp													9	1	11
Dicrotendipes sp			6			1					2		89	107	190
Endochironomus sp													1	1	
Micropsectra sp		35	69												
Microtendipes sp	349	17	6	5	16	4			117	4	1		79	16	30
Pagastella sp															16
Paracladius sp				1			1	8	1						
Paralauterborniella sp				1						4	8	1			
Phaenopsectra sp	10	6	21	4	8	4	2	3	33	2	12	1	2	4	
Polypedilum (Polypedilum) sp				1	11	2		8	11	10	10		6		3
Rheotanytarsus sp	8	2	58	14	43	70	336	133	207	49	24	26	10	4	8
Stempelina sp								8							
Stichtochironomus sp										2	10	2	4		
Tanytarsus sp	4			1	2	4	4	8	7	47	106	84	16	8	8
Orthoclaadiinae															
Brillia sp															
Cardiocladius sp															
Corynoneura sp														12	
Cricotopus sp				1	5	5	2	16					1	3	
Eukiefferiella sp				1	2	1	1	8							1
Euryhapsis sp															
Heterotrissocladius sp							1								
Synorthocladius sp													54	17	
Thienemanniella sp															
Diamesinae															
Monodiamesa sp															
Blephariceridae															
Bibiocephala sp															
Ceratopogonidae															
Palpomyia sp							1						10	2	7
Deuterophlebiidae															
Deuterophlebia sp															
Empididae pupae															
Chelifera sp							1	9	1	1					
Clinocera sp															
Weidemannia sp															
Psychodidae															
Pericoma sp															
Coleoptera															
Elmidae, unid J															
Optioservus sp															
Homoptera															
Cicadellidae															
Hymenoptera Unid A															
Lepidoptera L															
Turbellaria unid	2	3	12	2	1	3	5	79	1	4	97	37	64	66	

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

MEASUREMENTS OF ADULT COPEPODA

LITTLE JIMMY LAKE

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns
JIMMY #1 VERT HAUL		female	male	female	male
	1	2,693.9	2,734.7	1,326.5	1,183.3
	2	2,551.3	2,489.8	1,367.3	1,183.7
	3	2,734.9	2,428.6	1,295.3	1,285.7
	4	2,816.6	2,816.3	1,308.1	1,142.8
	5	2,857.4	2,653.0	1,326.5	1,183.7
	6	2,837.0	2,581.8	1,265.3	1,183.7
	7	2,837.0	2,734.7	1,326.5	1,122.4
	8	2,571.7	2,755.1	1,285.7	1,163.3
	9	2,877.8	2,836.7	1,367.3	1,183.7
10	2,796.2	2,775.5	1,408.2	1,244.9	
AVE		2767.36	2681.61	1324.48	1185.70

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns
JIMMY #2 VERT HAUL		female	male	female	male
	1	2,734.7	3,020.4	1,308.1	1,224.5
	2	2,816.6	2,653.0	1,224.5	1,183.7
	3	2,775.8	2,959.2	1,285.7	1,224.5
	4	2,734.9	2,897.9	1,285.7	1,285.7
	5	2,755.4	2,755.1	1,308.1	1,204.1
	6	2,653.3	2,714.3	1,285.7	1,183.3
	7	2,755.4	2,714.3	1,308.1	1,183.7
	8	3,122.7	2,653.0	1,265.3	1,244.9
	9	2,816.6	3,081.2	1,367.3	1,183.3
10	2,775.8	2,795.9	1,326.5	1,204.1	
AVE		2794.10	2822.43	1295.91	1208.15

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns
JIMMY #3 VERT HAUL		female	male	female	male
	1	2,581.8	2,816.3	1,326.5	1,265.3
	2	2,796.2	2,755.1	1,346.9	1,326.5
	3	2,877.8	2,755.1	1,265.3	1,265.3
	4	2,918.6	2,693.9	1,387.7	1,183.7
	5	2,571.7	3,081.2	1,326.5	1,142.8
	6	2,755.4	2,836.7	1,346.9	1,142.8
	7	2,775.8	2,795.9	1,285.7	1,183.3
	8	3,122.7	2,897.9	1,367.3	1,122.4
	9	2,959.5	3,000.0	1,346.9	1,183.7
10	2,775.8	2,897.9	1,265.7	1,142.8	
AVE		2814.51	2861.00	1328.66	1193.87

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns
JIMMY #4 VERT HAUL		female	male	female	male
	1	2,816.3	2,653.0	1,367.3	1,224.5
	2	2,959.5	2,816.3	1,346.9	1,224.5
	3	2,755.4	2,734.7	1,326.5	1,183.3
	4	2,959.5	2,755.1	1,265.3	1,142.8
	5	2,796.2	2,755.1	1,265.3	1,183.7
	6	2,714.5	2,714.3	1,367.3	1,244.9
	7	2,734.9	2,795.9	1,387.7	1,224.5
	8	2,694.1	2,795.9	1,346.9	1,183.7
	9	2,979.9	2,857.1	1,265.3	1,224.5
10	2,755.4	2,755.1	1,265.3	1,224.5	
AVE		2826.76	2763.24	1320.40	1204.07

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns
JIMMY #5 VERT HAUL		female	male	female	male
	1	2,653.0	2,571.4	1,387.7	1,308.1
	2	2,714.5	2,755.1	1,408.2	1,244.9
	3	2,775.8	2,693.9	1,326.5	1,183.7
	4	2,837.0	2,653.0	1,428.6	1,142.8
	5	2,694.1	2,673.4	1,387.7	1,265.3
	6	2,898.2	2,755.1	1,449.0	1,224.5
	7	2,877.8	2,857.1	1,346.9	1,285.7
	8	2,694.1	2,714.3	1,387.7	1,224.5
	9	2,551.3	2,857.1	1,408.2	1,183.7
10	2,857.4	2,795.9	1,367.3	1,204.1	
AVE		2756.32	2732.63	1389.78	1226.62

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

ZOOPLANKTON ANALYSIS

Site: LITTLE JIMMY LAKE
Date: 22-Aug-92

Phylum * Subclass ** Order	Suborder	Species	stage	JIMMY	JIMMY	JIMMY	JIMMY	JIMMY
				08-22-92	08-22-92	08-22-92	08-22-92	08-22-92
				HAUL	HAUL	HAUL	HAUL	HAUL
				#1	#2	#3	#4	#5
				NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE
COPEPODA**	CYCLOPOIDA	CYCLOPS scutifer	fem & eggs					
			fem no eggs	112	64	448	576	
			male					
			cop	26,720	22,848	35,328	56,576	22,856
		Total	26,832	22,912	35,776	57,152	22,856	
	CALANOIDA	HETEROCOPE septentrionalis	female	64	260	236	176	260
			male	68	288	252	156	288
			Total	132	548	488	332	548
		DIAPTOMUS pribilofensis	fem & eggs	120	128	128	768	384
			fem no eggs	6,080	11,904	18,752	20,736	12,288
			male	3,392	9,536	8,704	12,288	12,928
		DIAPTOMUS ashlandi	fem & eggs					
			fem no eggs					
			male					
		TOTAL DIAPTOMUS copepodites	cop	4,032	2,048	3,584	3,328	2,944
		Total	13,624	23,816	31,168	37,120	29,544	
Total nauplii	nauplii	25,408	23,616	50,240	62,848	20,800		
TOTAL COPEPODA (excluding nauplii)				40,888	47,976	67,432	84,604	51,748
ROTIFERA * PLOIMA		KELICOTTIA		960	1,600	3,712	4,416	896
		POLYARTHRA						
FLOSCULARIACEAE		CONOCHILUS unicornis (colonies)		140	496	128	432	
TOTAL ROTIFERA (excluding Conochilus colonies)				800	1,600	3,712	4,416	896
loose DIAPTOMUS eggs				4,608	9,728	12,460	19,392	11,840

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

MEASUREMENTS AND REPRODUCTIVE CONDITION

LITTLE WOLVERINE LAKE

Date: 19-Aug-92		BOSMINA longispina			
LAKE	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	
LITTLE WOLVERINE #1 VERT HAUL	32.0	653.1	1	1	
	34.0	693.9	1	1	
	32.0	653.1	1	1	
	36.0	734.7	3	3	
	33.0	673.5	1	1	
	29.0	591.8	1	1	
	33.0	673.5	1	1	
	32.5	663.3	1	1	
	31.0	632.6	1	1	
	32.0	653.1	1	1	
					667.63

Date: 19-Aug-92		BOSMINA longispina			
LAKE	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	
LITTLE WOLVERINE #4 VERT HAUL	35.0	714.3	1	1	
	32.0	653.1	1	1	
	33.0	673.5	1	1	
	33.0	673.5	1	1	
	31.0	632.6	1	1	
	32.0	653.1	1	1	
	32.0	653.1	1	1	
	33.0	673.5	1	1	
	29.0	591.8	1	1	
	30.0	612.2	1	1	
					664.72

Date: 19-Aug-92		BOSMINA longispina			
LAKE	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	
LITTLE WOLVERINE #2 VERT HAUL	35.0	714.3	1	1	
	35.0	714.3	1	1	
	34.0	693.9	1	1	
	32.0	653.1	1	1	
	32.0	653.1	1	1	
	32.0	653.1	1	1	
	31.0	632.6	1	1	
	33.0	673.5	1	1	
	34.0	693.9	1	1	
	34.0	693.9	1	1	
					673.46

Date: 19-Aug-92		BOSMINA longispina			
LAKE	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	
LITTLE WOLVERINE #5 VERT HAUL	32.0	653.1	1	1	
	32.0	653.1	1	1	
	31.0	632.6	1	1	
	30.0	612.2	1	1	
	30.0	612.2	1	1	
	28.0	571.4	1	1	
	31.0	632.6	1	1	
	32.0	653.1	1	1	
	32.0	653.1	1	1	
	31.0	632.6	1	1	
					623.90

Date: 19-Aug-92		BOSMINA longispina			
LAKE	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	
LITTLE WOLVERINE #3 VERT HAUL	32.5	663.3	1	1	
	33.0	673.5	1	1	
	30.0	612.2	1	1	
	29.5	602.0	1	1	
	32.0	653.1	1	1	
	30.0	612.2	1	1	
	32.0	653.1	1	1	
	35.0	714.3	1	1	
	33.5	683.7	1	1	
	26.0	571.4	1	1	
					638.48

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

ZOOPLANKTON ANALYSIS

Site: LITTLE WOLVERINE
Date: 19-Aug-92

Phylum * Subclass ** Order	Suborder	Species	stage	L.WOLVERINE	L.WOLVERINE	L.WOLVERINE	L.WOLVERINE	L.WOLVERINE	
				08-19-92	08-19-92	08-19-92	08-19-92	08-19-92	
				HAUL	HAUL	HAUL	HAUL	HAUL	
				#1	#2	#3	#4	#5	
				NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	
CLADOCERA		EUBOSMINA longispina	fem & eggs	656	348	56	8	12	
			fem no eggs	480	124	52	8	8	
			small	208	196	28	24		
			male	912	376	80	28	44	
			Total	2,256	1,044	216	68	64	
			ACROPERUS harpae		8				
			ALONA sp.		4				
			CERIODAPHNIA pulchella		12	12	24	20	88
			CHYDORUS sphaericus		20		12	20	72
			EURYCERCUS lamellatus						12
			SIMOCEPHALUS vetulus				1		36
			DAPHNIA pulex	fem & eggs		4	2		
				fem no eggs	16			8	
		small					1		
		male							
		Total	16	4	2	8	1		
COPEPODA**	CYCLOPOID	CYCLOPS scutifer	fem & eggs	32	8		11	4	
			fem no eggs	704	188	240	464	88	
			male	576	96	56	320	36	
			cop	14,496	4,336	2,220	7,056	680	
			Total	15,808	4,628	2,516	7,851	808	
	CALANOIDA	HETEROCOPE septentrionalis	female	34	13	6	3		
			male	35	37	54	1	1	
			Total	69	60	60	4	1	
		DIAPTOMUS pribilofensis	fem & eggs	80		4	4		
			fem no eggs	624	84	112	34	28	
			male	2,336	380	732	11	16	
		TOTAL DIAPTOMUS copepod	cop	8,480	2,596	936	480	684	
			Total	11,820	3,060	1,784	529	728	
Total nauplii	nauplii	4,432	6,688	6,892	2,896	1,320			
TOTAL CLADOCERA and COPEPODA (excluding nauplii)				29,781	8,250	4,612	8,500	1,810	
ROTIFERA * PLOIMA		KERATELLA cochlearis		64	48	16			
		KERATELLA quadrata		64	16				
		KELICOTTIA	8,672	13,616	12,880	24,224	57,600		
		POLYARTHRA	64	144	224	16			
FLOSCULARIACEAE	CONOCHILUS unicornis (colonies)				12				
TOTAL ROTIFERA (excluding CONOCHILUS colonies)				8,736	13,888	13,104	24,240	57,600	
BENTHIC ORGANISMS:									
(and loose eggs)									
loose DIAPTOMUS eggs				486	28	16	26		
CLADOCERA sphaericus eggs								5	
CHIRONOMIDAE larvae								262	
HYDRA								14	
MITE								8	
OSTRACODA								8	

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

MEASUREMENTS OF ADULT COPEPODA

LITTLE WOLVERINE LAKE

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns female	SIZE microns male	SIZE microns female	SIZE microns male
L. WOLVERINE	1	3,142.8	3,000.0	1,510.2	1,387.7
#1 VERT HAUL	2	2,959.5	3,020.4	1,612.2	1,408.2
	3	3,204.4	3,224.5	1,510.2	1,387.7
	4	3,102.3	2,938.8	1,530.6	1,489.8
	5	3,183.6	3,142.8	1,510.2	1,387.7
	6	3,143.1	3,163.2	1,591.8	1,387.7
	7	3,306.4	2,897.9	1,510.2	1,387.7
	8	3,081.9	2,857.1	1,530.6	1,449.0
	9	2,879.9	3,061.2	1,591.8	1,489.4
	10	3,061.5	3,102.0	1,612.2	1,428.6
	AVE		3114.54	3040.79	1551.01

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns female	SIZE microns male	SIZE microns female	SIZE microns male
L. WOLVERINE	1	2,857.1	3,142.8	1,510.2	1,489.8
#2 VERT HAUL	2	3,224.8	2,795.9	1,510.2	1,387.3
	3	2,918.6	2,857.1	1,428.6	1,408.2
	4	3,143.1	2,714.3	1,489.8	1,449.0
	5	3,081.9	2,857.1	1,530.6	1,326.5
	6	2,796.2	2,857.1	1,530.6	1,326.5
	7	3,041.1	2,775.5	1,428.6	1,326.5
	8	2,857.4	2,897.9	1,510.2	1,306.1
	9	3,143.1	2,979.6	1,449.0	1,326.5
	10	3,020.7	2,683.9	1,428.6	1,408.2
	AVE		3008.41	2857.12	1481.62

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns female	SIZE microns male	SIZE microns female	SIZE microns male
L. WOLVERINE	1	3,224.5	3,020.4	1,571.4	1,387.3
#3 VERT HAUL	2	3,102.3	3,040.8	1,489.8	1,428.6
	3	2,879.9	3,000.0	1,551.0	1,428.6
	4	2,859.5	2,918.3	1,489.8	1,449.0
	5	3,081.5	3,040.8	1,530.6	1,387.7
	6	3,102.3	2,755.1	1,489.8	1,387.3
	7		2,836.7	1,591.8	1,428.6
	8		2,959.2	1,632.6	1,428.6
	9		3,020.4	1,693.9	1,387.7
	10		3,224.5	1,489.8	1,387.3
	AVE		3071.65	2981.61	1553.05

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns female	SIZE microns male	SIZE microns female	SIZE microns male
L. WOLVERINE	1	3,061.2	2,816.3	1,632.6	1,489.8
#4 VERT HAUL	2	3,041.1		1,591.8	1,428.6
	3	2,857.4		1,612.2	1,489.4
	4			1,632.6	1,489.4
	5			1,489.8	1,489.8
	6			1,632.6	1,489.8
	7			1,571.4	1,387.3
	8			1,530.6	1,387.7
	9			1,489.8	1,489.8
	10			1,623.9	1,489.4
	AVE		2986.56	2816.30	1587.74

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis	
LAKE	NO.	SIZE microns female	SIZE microns male	SIZE microns female	SIZE microns male
L. WOLVERINE	1			1,551.0	1,428.6
#5 VERT HAUL	2			1,551.0	1,326.5
	3			1,530.6	1,387.7
	4			1,591.8	1,387.3
	5			1,571.4	1,489.8
	6			1,489.8	1,489.8
	7			1,632.6	1,489.4
	8			1,530.6	1,387.7
	9			1,571.4	1,387.3
	10			1,612.2	1,408.2
	AVE				1563.25

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

MEASUREMENTS OF ADULT COPEPODA

WOLVERINE LAKE

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis		DIAPTOMUS ashlandi	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns
		female	male	female	male	female	male
WOLVERINE #1 VERT HAUL	1	3,326.5	3,020.4	1,387.7	1,326.5	714.3	836.7
	2	3,122.7	2,795.9	1,489.4	1,265.3	775.5	857.1
	3	3,102.3	3,061.2	1,489.4	1,163.3	816.3	816.3
	4	2,755.4	3,102.0	1,449.0	1,265.3	816.3	816.3
	5	3,306.4	3,020.4	1,489.4	1,244.9	755.1	734.7
	6	3,061.5	3,122.4	1,510.2	1,367.3	775.5	795.9
	7	3,163.6	3,061.2	1,510.2	1,244.9	775.5	816.3
	8	3,306.4	2,816.3	1,348.9	1,265.3	857.1	836.7
	9	3,163.6	3,061.2	1,428.6	1,102.0	836.7	734.7
	10	3,306.4	3,163.2	1,428.6	1,265.3	816.3	816.3
AVE		3161.48	3024.47	1446.93	1261.01	793.87	806.12

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis		DIAPTOMUS ashlandi	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns
		female	male	female	male	female	male
WOLVERINE #2 VERT HAUL	1	2,775.5	3,000.0	1,591.8	1,265.3	795.9	857.1
	2	3,000.3	2,734.7	1,408.2	1,265.3	836.7	755.1
	3	3,061.5	2,795.9	1,489.8	1,367.3	775.5	816.3
	4	3,102.3	2,816.3	1,367.3	1,367.3	877.5	734.7
	5	3,000.3	2,897.9	1,449.0	1,326.5	816.3	795.9
	6	2,796.2	3,204.1	1,530.6	1,326.5	795.9	795.9
	7	3,020.7	2,857.1	1,530.6	1,367.3	816.3	816.3
	8	3,163.6	3,000.0	1,489.4	1,285.7	816.3	734.7
	9	2,796.2	3,061.2	1,489.8	1,428.6	836.7	857.1
	10	3,143.1	3,102.0	1,408.2	1,428.6	898.0	755.1
AVE		2966.96	2946.92	1473.46	1342.85	826.52	791.83

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis		DIAPTOMUS ashlandi	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns
		female	male	female	male	female	male
WOLVERINE #3 VERT HAUL	1	2,877.5	3,224.5	1,328.5	1,326.5	816.3	775.5
	2	3,102.3	2,857.1	1,428.6	1,348.9	836.7	816.3
	3	3,204.4	2,836.7	1,387.7	1,285.7	775.5	795.9
	4	2,857.4	3,020.4	1,387.7	1,348.9	816.3	734.7
	5		2,877.5	1,387.7	1,326.5	755.1	734.7
	6		2,795.9	1,428.6	1,367.3	755.1	755.1
	7		2,755.1	1,387.7	1,224.5	816.3	816.3
	8		2,857.1	1,428.6	1,183.7	816.3	775.5
	9			1,489.4	1,204.1	755.1	755.1
	10			1,367.3	1,285.7	795.9	755.1
AVE		3010.40	2903.04	1399.99	1289.79	793.87	771.42

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis		DIAPTOMUS ashlandi	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns
		female	male	female	male	female	male
WOLVERINE #4 VERT HAUL	1	2,857.1	3,346.9	1,428.6	1,367.3	816.3	816.3
	2	3,265.6	3,163.2	1,510.2	1,387.7	775.5	734.7
	3	2,859.5	2,938.8	1,449.0	1,265.3	836.7	734.7
	4	2,959.5	3,102.0	1,489.4	1,183.7	734.7	775.5
	5	2,939.0	3,163.2	1,489.8	1,183.3	775.5	795.9
	6	3,081.9	3,183.6	1,551.0	1,183.7	775.5	734.7
	7	3,020.7	3,040.8	1,510.2	1,326.5	755.1	795.9
	8	3,020.7	2,897.9	1,489.4	1,367.3	816.3	755.1
	9	3,061.5	3,020.4	1,428.6	1,183.7	755.1	734.7
	10	3,061.5	3,061.2	1,428.6	1,387.7	755.1	775.5
AVE		3022.69	3091.81	1473.46	1281.62	779.59	766.30

Date:		HETEROCOPE septentrionalis		DIAPTOMUS pribilofensis		DIAPTOMUS ashlandi	
LAKE	NO.	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns	SIZE microns
		female	male	female	male	female	male
WOLVERINE #5 VERT HAUL	1	3,367.3	3,061.2	1,510.2	1,367.3	898.0	877.5
	2	3,000.3	3,142.9	1,408.2	1,348.9	857.1	755.1
	3	3,449.3	2,938.8	1,387.7	1,285.7	857.1	734.7
	4	3,061.5	2,959.2	1,428.6	1,285.7	755.1	755.1
	5	3,102.3	3,183.2	1,387.7	1,265.3	775.5	775.5
	6	3,143.1	3,142.9	1,428.6	1,387.7	795.9	755.1
	7	3,367.7	3,020.4	1,306.1	1,163.3	775.5	714.3
	8	3,000.3	2,897.9	1,348.9	1,183.7	795.9	755.1
	9	3,204.4	2,959.2	1,367.3	1,204.1	775.5	734.7
	10	3,163.6	2,938.8	1,367.3	1,265.3	816.3	836.7
AVE		3186.97	3022.42	1393.87	1275.50	810.20	769.38

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

ZOOPLANKTON ANALYSIS

Site: WOLVERINE lake
Date: 19-Aug-92

Phylum * Subclass ** Order	Suborder	Species	stage	WOLVERINE	WOLVERINE	WOLVERINE	WOLVERINE	WOLVERINE
				08-19-92 HAUL #1	08-19-92 HAUL #2	08-19-92 HAUL #3	08-19-92 HAUL #4	08-19-92 HAUL #5
				NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE	NR /SAMPLE
CLADOCERA		EUBOSMINA longispina	fem & eggs	72				
			fem no eggs	84	24			16
			small					
			male	24	8			
			Total	180	32			16
		ALONA sp.						
		CERIODAPHNIA pulchella		32				
		CHYDORUS sphaericus		4		8		
		EURYCERCUS lamellatus						
		SIMOCEPHALUS vetulus						
		DAPHNIA pulex	fem & eggs	2	7			
			fem no eggs	28	4	4	16	21
		small	20	16			12	
		male						
		Total	50	27	4	16	33	
COPEPODA**	CYCLOPOIDA	CYCLOPS scutifer	fem & eggs		16		32	
			fem no eggs	112	272	48	272	256
			male			4		
			cop	4,320	6,784	1,392	9,952	4,848
			Total	4,432	7,072	1,444	10,256	5,104
	CALANOIDA	HETEROCOPE septentrionalis	female	57	26	4	42	67
			male	12	15	8	44	76
			Total	69	41	12	86	143
		DIAPTOMUS pribilofensis	fem & eggs	32	8	4	16	16
			fem no eggs	978	488	304	1,648	880
			male	582	376	224	608	800
		DIAPTOMUS ashlandi	fem & eggs		4			
			fem no eggs	48	72	96	128	96
			male	448	80	64	96	64
			TOTAL DIAPTOMUS copepodites	8,192	3,920	3,776	29,904	24,816
	Total nauplii	1,472	1,840	368	2,656	1,280		
TOTAL CLADOCERA and COPEPODA (excluding nauplii)				16,896	12,120	5,836	42,758	31,988
ROTIFERA * PLOIMA		KERATELLA cochlearis		80	64	32	240	32
		KELLICOTTIA		18,736	4,112	3,728	15,424	4,464
FLOSCULARIACEAE		POLYARTHRA		16				
		CONOCHILUS unicornis (colonies)		32				48
TOTAL ROTIFERA (excluding CONOCHILUS colonies)				18,832	4,176	3,760	15,664	4,496
BENTHIC ORGANISMS:								
loose DIAPTOMUS eggs				252	96	60	256	432
CLADOCERA ephippium eggs							28	
Chironimidae							144	
Hydra							299	
Oligochaeta							90	

EXPATRIATE RESOURCES LTD.
FINLAYSON PROJECT

Zooplankton Data for Lakes in the Wolverine Area

MEASUREMENTS AND REPRODUCTIVE CONDITION

WOLVERINE LAKE

Date: 19-Aug-92		spp. <u>DAPHNIA pulex</u>				spp. <u>BOSMINA longispina</u>			
LAKE	NO.	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS
WOLVERINE #1 VERT HAUL	1	95.0	1,938.8	1	2	29.0	591.8	1	1
	2	110.0	2,245.1	1	3	30.0	612.2	1	1
	3					31.0	632.6	1	1
	4					32.0	653.1	1	1
	5					28.0	571.4	1	1
	6					31.0	632.6	1	1
	7					30.0	612.2	1	1
	8					29.0	591.8	1	1
	9					28.0	571.4	1	1
	10					30.0	612.2	1	1
AVER.			2091.93				615.16		

Date: 19-Aug-92		spp. <u>DAPHNIA pulex</u>				spp. <u>BOSMINA longispina</u>			
LAKE	NO.	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS	SIZE UNITS	SIZE microns	STAGE (1-5)	NR EGGS
WOLVERINE #2 VERT HAUL	1	106.0	2,163.2	1	3				
	2	105.0	2,143.1	2	3				
	3	98.0	2,000.2	3	2				
	4	125.0	2,551.3	3	3				
	5	107.0	2,183.9	1	3				
	6	101.0	2,061.4	3	4				
	7	100.0	2,041.0	1	2				
	8								
	9								
	10								
AVER.			2163.43						

THERE ARE NO MORE CLADOCERANS WITH EGGS IN THE SAMPLES

APPENDIX 3E

WOLVERINE AREA – FISHERIES INVESTIGATIONS



Fisheries Resource Investigations

Wolverine Lake Property

Westmin Resources Limited

(Spring, Summer and Fall Surveys)

December, 1996

List of Tables and Figures

- Table A Sampling Period, Number of Gillnet Sets, and Surface Water Temperatures at Sampling Locations During Gillnetting Surveys, Wolverine Lake, 1996
- Table B Mean Fork Lengths and Weights of Lake Trout and Arctic Grayling Captured During Index Gillnetting, Spring, 1996
- Table C Catch/Effort Statistics (CPUE) Generated from Index Gillnetting Results, Spring, 1996
- Table 1 Index Gillnetting Survey, Catch Record, Wolverine Lake Area, 1996
- Table 2 Electro-Fishing Results, Wolverine Lake Area, 1996
- Table 3 Angling Results, Wolverine Lake Area, 1996
- Table 4 Seine Netting Results, Wolverine Lake Area, 1996
- Table 5 Master Sample Record, Wolverine Lake Area, 1996
- Table 6 Number of Visual Observations of Fish in the Wolverine Lake Area, 1996
-
- Figure 1 Locations of Non-Destructive Gillnet Sets
- Figure 2 Locations and Titles of lake Tributaries, Inlets and Outlets Sampled During the Fisheries Investigation
- Figure 3 Locations and Titles of Creek Sample Sites During the Fisheries Investigation
- Figure 4 Spawning Sites for Lake Trout and Arctic Grayling

Note: A summary of the results from these investigations is contained within the Baseline Biophysical Surveys Report produced by Westmin Resources.

ADDENDUM #1

Preliminary Fish Habitat and Utilization Assessments Wolverine Lake Area Spring, 1996

White Mountain Environmental Consulting (WMEC) conducted preliminary fisheries investigations in the Wolverine lake area between June 11 and June 16, 1996. During the course of these investigations WMEC undertook the following:

- Conducted small mesh (non-destructive) gillnet surveys on Wolverine Lake, Little Wolverine Lake and Little Jimmy Lake.
- Investigated the inlet and outlet of Wolverine Lake for spawning activity.
- Investigated the lower reaches of Money and Nougua (Wolverine) creeks for spawning activity and conducted general habitat evaluations.
- Initiated a creel census program at the exploration camp on Wolverine lake.
- Collected fish flesh samples for heavy metal analysis.

METHODS

Gillnetting on Wolverine, Little Wolverine and Little Jimmy Lakes was conducted between June 12 and 15, 1996. A total of 35, 1 hour sets using a net gang consisting of 3, 25 meter panels (3.8mm, 6.4mm and 8.9 mm stretch measure) were completed. Surface water temperature, maximum depth of set and catch by mesh size and species was recorded for each net set (refer to Figure 1 for the locations of gillnet sets)

All fish captured were live sampled for fork length, round weight and any external observations were recorded before the fish were released, unharmed back to the waters of origin.

Incidental mortalities that occurred during gillnetting were sampled for round weight, fork length, stomach contents, sex and maturity, and an otolith was taken and stored for age analysis (aging was not completed as a part of this study, although the otoliths have been appropriately stored and age analysis can be conducted as necessary). Six of the lake trout mortalities were also used to provide fish for metal sample analysis. Flesh of these fish suitable for human consumption was given to local residents working at the exploration camp. Refer to Tables 1 to 6 for data on the fish collected or observed during the study.

RESULTS

Gillnetting survey:

Three species of fish were encountered during the index gillnetting, these were; lake trout (*Salvelinus namaycush*, Walbaum), Arctic grayling (*Thymallus arcticus*), and longnose sucker (*Catostomus catostomus*). A total of 85 lake trout, 199 Arctic grayling and 5 longnose sucker were captured (refer to Tables A to C).

The capture of grayling releasing eggs implies that at least one area of Wolverine Lake shore is used by spawning grayling (on the mainland directly north-east of the island).

Long nose sucker exuding eggs were captured near the outlet of Little Jimmy Lake indicating that the site may be a spawning area for suckers.

Inlet and Outlet of Wolverine Lake:

Based on the ground and aerial surveys conducted on June 11, 13 and 15 the inlet and outlet of Wolverine Lake is a popular spawning area for Arctic grayling. Large numbers of grayling were observed congregating in the inlet and outlet areas. Subsequent capture of fish in these vicinities showed them to be in spawning condition with some females exuding eggs and some males exuding milt. Grayling eggs were found during seining of the inlet to Wolverine lake as were lake trout fry (refer to Figure 2 for the locations of Lake Tributaries and Lake sample sites).

Lower reaches of Money and Wolverine Creeks:

Cursory assessments were conducted at the mouth of Money creek, where it empties into Francis Lake, on June 11 and 16. Seine netting, electrofishing and angling caught only a small number of slimy sculpin (*Cottus cognatus*). No Arctic grayling were caught or observed at this site during these investigations, although suitable habitat was prevalent.

Cursory assessments of the lower reaches of Nougha creek were undertaken on June 16. Angling, electro-fishing and visual surveys indicated Arctic grayling congregating in the mouth area. Longnose sucker fry and slimy sculpin were also captured in very small numbers at the creek mouth (refer to Figure 3 for the locations of Creek sample sites).

Creel Census

A voluntary creel census was initiated for anglers at the Wolverine lake exploration camp on June 15. An environmental person stationed at the camp will oversee the implementation of this census. A catch and release policy is in effect for personnel associated with the exploration camp.

Metal samples

A total of 6 lake trout were taken for heavy metal contaminant analysis, these fish were incidental mortalities from the index gillnetting. A set of three samples from each fish was obtained, a back flesh sample, a stomach flesh sample, and the liver. The metal samples will be sent to Quanta trace laboratories for analysis at the completion of the field studies program.

ADDENDUM #2

Preliminary Fish Habitat and Utilization Assessments Wolverine Lake Area Summer 1996

White Mountain Environmental Consulting (WMEC) conducted preliminary summer fisheries investigations in the Wolverine lake area between July 12 and 17, 1996. These summer investigations consisted of the following:

- preliminary fish habitat and utilization assessments of both Money and Nougha creeks.
- habitat assessments and cursory fish utilization assessments of 36 creek sites within the study area.
- investigating the extent of Dolly Varden trout utilization of Money and Nougha creeks.
- monitoring the creel census program in place at Wolverine lake exploration camp.
- collection of fish flesh samples for heavy metal analysis.

METHODS

Habitat and Fish Utilization Assessments.

A total of 36 creek sites were investigated during the summer assessment. The inlet and outlet of Wolverine Lake were sampled as were any tributaries flowing into the lake. All tributaries flowing into Little Wolverine and Little Jimmy lakes were also sampled.

Aerial surveys of Nougha, Money and Go Creeks were conducted by helicopter to map fish habitats and to note any barriers to fish passage.

Sites where a possible access road may cross small tributary creeks were sampled for fish utilization.

RESULTS

Lake Inlet Creeks

Slimy sculpin were found in most watercourses sampled. Burbot, lake trout fry, Arctic grayling, longnose sucker and/or slimy sculpin were found to utilize the mouths of some tributaries flowing into Wolverine and Little Wolverine Lakes. Lake trout fry and Arctic grayling were found to utilize the inlet and outlet areas of Wolverine Lake (refer to Table 4).

Nougha Creek

An aerial survey of Nougha creek was conducted from its mouth at the Finlayson River to Wolverine lake. At this time, fish habitat was mapped and any barriers to fish passage were noted. Nougha creek was sampled at 4 locations to determine fish utilization.

Arctic grayling was the most abundant species found, followed by slimy sculpin, northern pike and burbot. No Dolly varden were found in Nougha Creek.

Money Creek

An aerial survey of Money Creek was conducted from its mouth at Frances Lake to a point several kilometers above its junction with Go Creek. Fish habitat was mapped and any barriers to fish passage noted. It was also sampled at 7 sites during to determine fish utilization as were 2 tributaries to Money Creek.

Dolly varden trout were present in the upper reaches of Money Creek both above and below its junction with Go Creek. Suitable spawning habitat was observed at various locations throughout Money creek, including above the junction of Money and Go Creeks. Arctic grayling, slimy sculpin and northern pike were the only other species encountered in Money Creek.

Go Creek

An aerial survey of Go Creek was conducted from its mouth at Money creek to just above the site of the airstrip. Fish habitat was mapped and four sites were sampled for fish utilization.

Dolly varden were found in the lower reaches of this creek along with slimy sculpin and adult and sub adult Arctic grayling.

Access Road Creeks

Three creeks that drain into Wind Lake and two creeks draining into Nougha Creek were found to be very poor fish habitat and no fish were found in any of these creeks.

Creel Census

The catch and release policy in place at the exploration camp was generally adhered to. The extent of compliance to the creel census was difficult to assess. It appears that angling pressure from personnel at the exploration camp has been minimal at this time. Angling pressure consisted mostly of angling from shore at camp by camp personnel. An average of 40 minutes angling time per day was observed.

Metal samples

A total of 10 slimy sculpin samples (consisting of 3 to 7 individual fish each) and 4 Arctic grayling samples were taken for heavy metal analysis. The slimy sculpin samples were taken from two tributaries to Little Wolverine Lake, three tributaries to Wolverine Lake, the outlet of Wolverine Lake, and three sites on Money Creek. The Arctic grayling samples were taken from the inlet and outlet of Wolverine Lake (two fish from each site). Arctic grayling samples consisted of both flesh and liver samples.

ADDENDUM #3

Preliminary Fish Habitat and Utilization Assessments Wolverine Lake Area FALL 1996

White Mountain Environmental Consulting (WMEC) conducted fall fisheries investigations in the Wolverine lake area between September 22 and 25, 1996. These investigations constituted the third and final field investigation of the 1996 season. The investigations consisted of the following:

- An Aerial survey of Money Creek to detect any congregations of spawning dolly varden or any signs of dolly spawning such as redds. Ground surveys were conducted at the outlet of Go Creek.
- Investigating the lake trout spawning locations on Wolverine, Little Wolverine, Little Jimmy and Francis lakes.
- Monitoring the creel census program in place at Wolverine Lake exploration camp.
- Conducting preliminary fisheries investigations of Wind Lake including using non-destructive small mesh gillnetting.
- Conducting ground investigations of Nougha Creek at the confluence with the Finlayson River, including angling in the Finlayson River downstream of Nougha Creek to detect presence or absence of dolly varden.
- Investigations into fish utilization of Francis Lake near the outlet of Money Creek, including determination of key fish habitats such as lake trout spawning.
- Obtaining fish samples from Wolverine Lake to determine sexual maturity and timing of spawn and for stomach analysis.
- Obtaining fish samples for heavy metal analysis from Little Jimmy Lake.

Refer to Figures 1, 2 and 3 for the locations of sample sites in the study area. Refer to Tables 1 to 6 for information on the fish captured during the study.

RESULTS

Money creek

The aerial survey of Money Creek found no evidence of dolly varden spawning. No aggregations of fish were detected and no obvious signs of redd building were observed.

Ground surveys near the outlet of Go Creek into Money Creek found only slimy sculpin. Dolly varden spawning strategies vary throughout the species range. Little information on spawning strategies for this type (small river) of population in the Liard River drainage has been compiled. It was suspected that that dolly varden spawning occurred prior to our investigation. Thus, the investigations do not provide sufficient information on dolly varden spawning strategies in Money Creek.

Lake Trout Spawning Surveys

The locations of lake trout and Arctic grayling spawning sites is shown on Figure 4. Note: The spawning sites locations are confidential and should not become published information.

Surveys for lake trout spawning areas were conducted in two stages. The first stage was aerial surveys of the lakes, with flights conducted during the evening and early morning. Fish observations were plotted on topographic maps. The second stage of the survey was conducted by boat using sonar and angling to locate and capture fish.

During the aerial survey, fish were observed in the outlet areas of Little Jimmy, Wolverine and Little Wolverine lakes. Fish were also detected at four other locations on Wolverine Lake.

Boat /sonar surveys showed fish were not widely dispersed in the lakes with most of the fish located occurring in a few large aggregations. Angling was used to determine species and spawning condition.

Little Jimmy Lake

Examination of lake trout captured in Little Jimmy Lake showed these fish had spawned several days prior to September 24. Stomach analysis revealed that the trout in this area were cannibalizing their own eggs and indicated that the outlet area is likely a spawning location for lake trout on this lake.

Little Wolverine Lake

Few fish were observed in Little Wolverine Lake. Arctic grayling were observed in the channel between Little Wolverine and Wolverine lakes and the occasional lake trout was observed near the outlet of Little Wolverine Lake. Two lake trout were captured from this area and sacrificed for metals analysis. Both of these trout were resting fish, one a male and the other a female. This survey indicates that Little Wolverine Lake is not likely a spawning location for lake trout, and trout utilizing this lake are of the same population as those in Wolverine Lake.

Wolverine Lake

Ground surveys in Wolverine Lake indicated that most of the Arctic grayling had moved into shallow areas near creeks, particularly in the outlet area at Nougha Creek. Large numbers of "stacked" lake trout were encountered at two locations in the south east end of the lake, both adjacent to shore in areas with steep drop-offs and water depths in excess of 40 meters within 30 meters of shore. The first of these locations is approximately 1 km north of the exploration camp on the northwest shore. The second location is directly across the lake on the southeast shore. The site on the southeast shore was considerably larger than the site on the northwest shore and fish were stacked in an area approximately 300m long (following the shoreline) and extending 30 meters from shore. Trout were in water depths of 3 to 35 meters.

Trout were easily angled at the site on the southeast shore and several fish were taken for dead samples. Sampling revealed that the fish were close to spawning, skeins in the females had burst, but the eggs had not become loose in the body cavity, indicating that spawning would likely occur during the first few days of October.

Francis Lake

Boat sonar surveys in Francis Lake found significant numbers of fish near the mouth of Money Creek. Based on the number of fish observed, this area appears to be important fish habitat. No fish were captured in the area and the species composition of fish utilizing this area is unknown. Some stacking of fish was found in an area approximately two kilometers north of the mouth of Money Creek. Angling at this site proved unsuccessful and the fish species could not be positively determined, sonar readings did resemble those found at the spawning sites on Wolverine Lake. Because of Francis Lakes lower elevation in comparison to Wolverine Lake it is expected that lake trout spawning would occur at a later date than on Wolverine Lake.

Wind lake

Wind Lake was surveyed on September 23, 1996. A gang of small mesh gillnets consisting of 20 m x 1", 20m x 2" and 25 m x 2.5" was set for 1 hour periods at three different locations on the lake. One large lake trout (5.5kg) was the only trout captured, arctic grayling were numerous as were long nose sucker. The lake has an even bottom with steep drop offs from shore. The maximum depth found was 10 meters (32').

Creel Census

The catch and release policy previously in place at the exploration camp is no longer adhered to, although the high quality waters limit of 1 fish per day has been maintained. The informal creel census was not a camp priority and results were therefore not complete. It appears that angling pressure from personnel at the exploration camp has been minimal and has consisted mostly of angling from shore at the camp.

Metal samples

Samples collected from Muskrat House Lake were used to complete the collection of fish for heavy metal analysis. A composite of livers from 6 trout was taken as was a single flesh sample from one of the trout. Flesh not required for metal analysis was given to local residents working at the exploration camp.

Table 1 Index Gillnetting Survey, Catch Record, Wolverine Lake area - 1996

Set #	Date (M/D/YR)	Time set	Time lifted	H2O Temp.(C)	Mesh size (cm)	Max. Depth (ft)	LT	CATCH			Comments
								AG	LNS		
WLV1	12/06/96	8:05	9:05	4.5	3.8	74	0	0	0		
					6.4		1	0	0		
					8.9		1	0	0		
WLV2	12/06/96	8:45	9:45	4.4	3.8	96	0	0	0		
					6.4		0	0	0		
					8.9		0	0	0		
WLV3	12/06/96	9:30	10:30	4.5	3.8	101	0	0	0		
					6.4		1	2	0		
					8.9		1	0	0		
WLV4	12/06/96	10:05	11:15	4.4	3.8	130	2	0	0		
					6.4		0	0	0		
					8.9		0	0	0		
WLV5	12/06/96	11:00	12:00	4.8	3.8	75	0	0	0		
					6.4		0	0	0		
					8.9		1	1	0		
WLV7	12/06/96	12:50	13:50	4.3	3.8	34	1	0	0		
					6.4		4	0	0		
					8.9		0	0	0		
WLV8	12/06/96	14:25	15:30	5.1	3.8	34	0	0	0	spawning area ?	
					6.4		2	4	0		
					8.9		0	0	0		
WLV9	12/06/96	14:50	15:59	5.1	3.8	40	0	0	0		
					6.4		2	0	0		
					8.9		1	2	0		
WLV10	12/06/96	15:55	16:55	5.3	3.8	30	0	2	0		
					6.4		2	9	0		
					8.9		3	0	0		
WLV11	12/06/96	16:25	17:25	6.8	3.8	7	0	0	0		
					6.4		2	0	0		
					8.9		3	2	0		
WLV12	13/06/96	8:55	9:55	6.8	3.8	6	0	0	0		
					6.4		0	5	0		
					8.9		1	2	0		
WLV13	13/06/96	9:35	10:35	6.4	3.8	6	0	0	0		
					6.4		3	2	0		
					8.9		3	6	0		
WLV14	13/06/96	10:15	11:15	5.8	3.8	8	0	1	0		
					6.4		2	2	0		
					8.9		3	12	0		

Table 1 Index Gillnetting Survey, Catch Record, Wolverine Lake area - 1996

Set #	Date (M/D/YR)	Time set	Time lifted	H2O Temp.(C)	Mesh size (cm)	Max. Depth (ft)	LT	CATCH		Comments
								AG	LNS	
WLV15	13/06/96	12:00	13:00	5.1	3.8	76	0	0	0	
					6.4		0	0		
					8.9		1	0		
WLV16	13/06/96	12:45	13:45	4.9	3.8	38	0	0	0	
					6.4		0	0		
					8.9		0	7		
WLV17	13/06/96	13:35	14:35	4.5	3.8	43	0	0	0	
					6.4		0	2		
					8.9		0	0		
WLV18	13/06/96	14:15	14:50	4.1	3.8	36	0	0	0	
					6.4		0	0		
					8.9		1	1		
WLV19	13/06/96	16:27	17:27	4.5	3.8	29	0	0	0	net pulled early - zodiac problems
					6.4		0	1		
					8.9		0	0		
WLV20	13/06/96	17:00	18:00	4.2	3.8	48	0	0	0	
					6.4		0	0		
					8.9		2	1		
WLV21	13/06/96	17:43	18:43	3.6	3.8	57	0	0	0	
					6.4		1	0		
					8.9		0	0		
WLV22	13/06/96	7:20	8:20	3.1	3.8	51	0	0	0	
					6.4		1	0		
					8.9		0	0		
WLV23	23/09/96	14:10	15:10	4.8	3.8	96	1	0	0	
					6.4		2	0		
					8.9		0	0		
WLV24	15/06/96	14:40	15:45	4.4	3.8	125	1	0	0	
					6.4		0	0		
					8.9		0	0		
WLV25	15/06/96	15:27	16:27	4.8	8.9	26	3	0	0	
					3.8		1	0		
					6.4		2	1		
LWV 1	15/06/96	8:00	9:00	8.9	3.8	4	5	4	0	
					6.4		2	6		
					8.9		6	8		
LWV 2	15/06/96	8:35	9:50	7.5	3.8	36	0	0	0	
					6.4		5	5		
					8.9		0	0		
LWV 3	15/06/96	9:46	10:46	7.5	3.8	22	0	1	0	
					6.4		3	9		

Table 1 Index Gillnetting Survey, Catch Record, Wolverine Lake area - 1996

Set #	Date (M/D/YR)	Time set	Time lifted	H2O Temp.(C)	Mesh size (cm)	Max. Depth (ft)	CATCH			Comments
							LT	AG	LNS	
					8.9		2	12	0	
LWV 4	15/06/96	10:28	11:28	7.8	3.8	39	0	0	0	
					6.4		2	12	0	
					8.9		0	0	0	
LJ1	14/06/96	10:05	11:05	5.9	3.8	21	0	1	0	
					6.4		0	12	1	
					8.9		0	0	0	
LJ2	14/06/96	10:38	11:45	5.4	3.8	32	0	1	0	
					6.4		0	7	0	
					8.9		0	4	0	
LJ3	14/06/96	11:40	12:40	5.6	3.8	21	0	0	0	
					6.4		0	5	0	
					8.9		0	0	0	
LJ4	14/06/96	12:15	13:16	6	3.8	26	0	0	0	
					6.4		0	0	0	
					8.9		1	9	0	
LJ5	14/06/96	13:04	14:05	6.2	3.8	31	0	4	0	
					6.4		1	20	0	
					8.9		0	0	0	
LF6	14/06/96	13:35	14:35	5.9	3.8	103	0	1	0	
					6.4		0	1	0	
					8.9		1	15	0	
WND1	23/09/96	12:45	13:45		6.4	24	1	4	3	
					5.1		0	9	0	
					2.5		1	1	0	
WND2	23/09/96	14:15	15:15		6.4	17	0	4	3	
					5.1		0	2	0	
					2.5		0	2	0	
WND3	23/09/96	15:30	16:40		6.4	28	0	0	1	
					5.1		0	4	0	
					2.5		0	0	0	

Table A Sampling period, number of gillnet sets, and surface water temperatures at sampling locations during gillnetting surveys wolverine lake, 1996.

<u>Lake</u>	<u>Sampling Period</u>	<u>Number of net sets</u>	<u>Surface Temperature © at Sample Locations</u>		
			<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
Wolverine	June 12 - 15, 1996	24.5	4.8	6.8	3.1
Little Wolverine	15-Jun-96	4	7.9	8.9	7.5
Little Jimmy	14-Jun-96	6	5.8	6.2	5.4

Table B Mean fork lengths and weights of lake trout and Arctic grayling captured during index gillnetting, spring 1996.

<u>Lake</u>	<u>Sample size</u>		<u>Mean Fork Length (mm)</u>		<u>Mean Weight (gm)</u>	
	<u>Lake Trout</u>	<u>Arctic Grayling</u>	<u>Lake Trout</u>	<u>Arctic Grayling</u>	<u>Lake Trout</u>	<u>Arctic Grayling</u>
Wolverine	57	63	431.6	370.8	1263.1	603.4
Little Wolverine	25	57	453	333.2	1344	395.9
Little Jimmy	3	79	609.7	325.4	3000	381.2

Table C Catch/Effort statistics (CPUE) generated from index gillnetting results, spring 1996.

<u>Lake</u>	<u>Number captured per Gillnet Hour</u>		<u>Kilograms Captured per Gillnet Hour</u>	
	<u>Lake Trout</u>	<u>Arctic Grayling</u>	<u>Lake Trout</u>	<u>Arctic Grayling</u>
Wolverine	2.3	2.57	2.94	1.55
Little Wolverine	6.25	14.25	8.4	5.6
Little Jimmy	0.5	13.2	1.5	5

Table 2. Electro-fishing Results, Wolverine Lake area - 1996

DATE	SITE	EFFORT (sec)	TEMP (c)	CATCH						comments
				AG	LT	SS	BB	LNS	DV	
11/06/96	M1	156		0	0	0	0	0	0	
11/06/96	M1	460		0	0	9	0	0	0	
14/06/96	WC	184	6.9	0	0	2	0	0	0	
14/06/96	WC	57	6.9	1	0	0	0	0	0	
14/06/96	WT1	64		0	0	0	0	0	0	
16/06/96	N1	258	7.7	1	0	12	0	16	0	
12/07/96	TLW1	445	0.9	0	0	13	1	0	0	5 ss taken for metal samples
12/07/96	TLW2	101	4.6	0	0	5	0	0	0	
12/07/96	TLW2	81	4.6	0	0	0	0	0	0	
12/07/96	TLW3	177	1.9	0	0	0	0	0	0	
12/07/96	TLW4	197	2.4	40	1	11	1	0	0	
12/07/96	TLW4	205	2.4	30	5	21	0	0	0	
12/07/96	TLW4	205	2.4	50	0	5	0	0	0	
13/07/96	TWV3	335	2.1	1	0	5	4	0	0	2 ss taken for metal samples
13/07/96	TWV3	279	2.1	0	0	3	0	0	0	3 ss taken for metal samples
13/07/96	TWV4	160	11.8	31	0	0	0	85	0	20 u.i. fry (LNS?)
13/07/96	TWV5	173	10.7	0	8	0	2	0	0	
13/07/96	TWV5	356	10.7	0	1	6	1	0	0	3 ss taken for metal samples
13/07/96	TWV5	340	10.7	0	1	16	0	0	0	5 ss taken for metal samples
13/07/96	TWV6	179	9.2	0	2	33	4	0	0	
13/07/96	TWV6	109	9.2	0	4	21	2	0	0	3 ss taken for metal samples
13/07/96	TWV6	181	5	0	8	10	0	0	0	2 ss taken for metal samples
13/07/96	TWV6	136	4.7	0	0	5	0	0	0	2 ss taken for metal samples
13/07/96	TWV6	46	4.7	0	0	0	0	0	0	
13/07/96	WO	338	12.5	2	19	32	3	0	0	7 ss taken for metal samples
13/07/96	WO	89	12.5	0	2	2	1	0	0	
13/07/96	WO	148	12.5	12	11	25	0	0	0	
13/07/96	WO	158	12.5	30	3	6	1	0	0	
14/07/96	M3	964	7.8	40	0	17	1	0	0	3 ss taken for metal samples
14/07/96	M4	249	7.6	0	0	9	0	0	5	
14/07/96	M4	195	7.6	1	0	20	0	0	5	
14/07/96	M4 (trib)	129	4.6	0	0	7	0	0	0	upper fork

Table 2. Electro-fishing Results, Wolverine Lake area - 1996

DATE	SITE	EFFORT (sec)	TEMP (c)	CATCH						comments
				AG	LT	SS	BB	LNS	DV	
14/07/96	M4 (trib)	122		0	0	0	0	0	2	
14/07/96	M4 (trib)	128	7.6	0	0	0	0	0	1	lower fork
14/07/96	M5	632		4	0	135	0	0	2	4 ss taken for metal samples
14/07/96	M5	117		143	0	26	0	0	0	
14/07/96	TLJ1	102	2.6	0	0	3	1	0	0	
14/07/96	TLJ1	177	2.6	0	1	3	0	0	0	
15/07/96	AR1	147	2.2	0	0	0	0	0	0	
15/07/96	AR1	80	2.2	0	0	0	0	0	0	
15/07/96	G1	80	4.9	0	0	1	0	0	1	
15/07/96	G1	152	4.9	0	0	4	0	0	1	1 ss taken for metal samples
15/07/96	G1	512	4.9	1	0	6	0	0	2	1 ss taken for metal samples
15/07/96	G1	175	4.9	0	0	10	0	0	1	1 ss taken for metal samples
15/07/96	M6	573	6.5	11	0	118	0	0	5	
15/07/96	M6	120	6.5	0	0	18	0	0	1	
15/07/96	M6	149	6.5	0	0	12	0	0	0	
15/07/96	M6	55	6.5	0	0	5	0	0	0	
15/07/96	M6	74	6.5	0	0	3	0	0	0	
15/07/96	M7G	88	5.1	0	0	4	0	0	0	
15/07/96	M7G	154	5.1	0	0	14	0	0	1	
15/07/96	M7G	443	7.2	6	0	59	0	0	2	4 ss taken for metal samples
15/07/96	M8	148		1	0	12	0	0	0	
15/07/96	M8	139		0	0	18	0	0	0	
15/07/96	M9	302	9.3	19	0	21	0	0	0	
15/07/96	M9	164	9.3	0	0	8	0	0	0	
15/07/96	P1	175	2.8	0	0	6	0	0	0	
16/07/96	AR3	83	3.3	0	0	0	0	0	0	
16/07/96	N4	159	8.5	0	0	11	0	0	0	1 u.i. salmonid
16/07/96	N4	214	8.5	10	0	6	0	0	0	
16/07/96	N4	432	8.5	75	0	32	0	0	0	
16/07/96	N5	52	11.9	100	0	0	1	0	0	
16/07/96	N5	213	11.9	88	0	0	1	0	0	
16/07/96	N5	122	11.9	225	0	0	1	0	0	

Table 2. Electro-fishing Results, Wolverine Lake area - 1996

DATE	SITE	EFFORT (sec)	TEMP (c)	CATCH						comments
				AG	LT	SS	BB	LNS	DV	
16/07/96	N5	196	11.9	150	0	0	1	0	0	
16/07/96	N5	297	11.9	83	0	0	2	0	0	
16/07/96	N5	120	11.9	0	0	7	1	0	0	
16/07/96	N5	20	11.9	60	0	0	0	0	0	
16/07/96	N5	112	11.9	6	0	14	3	0	0	
16/07/96	TN1	148	2	0	0	0	0	0	0	
16/07/96	TWV	109	3.4	0	0	0	0	0	0	
16/07/96	WND	163	16.1	91	0	19	0	0	0	
16/07/96	WND	75	16.1	2000	0	0	0	0	0	
17/07/96	G2	447	5.3	3	0	0	0	0	0	
17/07/96	G3	232	4.1	0	0	0	0	0	0	
17/07/96	G4	90	4.7	0	0	0	0	0	0	
17/07/96	G5	209	2.7	0	0	0	0	0	0	
17/07/96	HO1	244	3.6	0	0	0	0	0	0	
25/09/96	G1	89	1.2	0	0	0	0	0	0	
25/09/96	M7G	159	1.1	0	0	25	0	0	0	
25/09/96	M7G	183	1.1	0	0	5	0	0	1	
25/09/96	N2	165	2.5	15	0	0	0	0	0	
25/09/96	N2	371	2.5	19	0	17	0	0	0	
25/09/96	N2	154	2.5	4	0	2	0	0	0	

Table 3. Angling Results, Wolverine Lake area, 1996.

Date (d/m/yr)	Site	Temp (C)	Effort (min)	Catch		Comments
				Arctic grayling	Lake trout	
13/07/96	WO	12.5	7	2	2	grayling in riffles, trout above riffles
13/07/96	TWV5	10.7	15	4	0	
13/07/96	TWV6	9.2	40	2	4	
13/07/96	TWV3		15	0	3	lake at outlet area
14/07/96	M3	7.8	20	3	0	
14/07/96	LJ		15	1	1	
16/07/96	N4	8.5	15	7	0	
16/07/96	WO		22	3		taken for metal samples
16/07/96	WND	16.1	5	0	0	
16/07/96	WI		60	3	8	2 grayling taken for metal samples
17/07/96	M6		25	4	0	
23/09/96	WO	5	7	2	2	
24/09/96	WO	5	15	10	0	
24/09/96	WI		20	0	0	
24/09/96	LJ	6.4	40	0	16	
24/09/96	LWV		25	0	2	
14/06/96	WC	8.9	52	0	10	
16/06/96	M1	14	50	0	0	
14/06/96	LJ	5.9	3	0	1	
14/06/96	LJ	5.9	1	0	1	
16/06/96	N1	7.7	2	5	0	
23/09/96	WLV		20	0	0	near island
24/09/96	WLV		20	0	0	near island
24/09/96	WLV		20	0	0	spawning site east
24/09/96	WLV		40	0	7	spawning site west
25/09/96	N2		5	2	0	below culverts
25/09/96	Frances Lake		70	0	0	

Table 4. SEINE NETTING RESULTS, WOLVERINE LAKE AREA, 1996.

DATE (d/m/yr)	SITE	TEMP (c)	EFFORT (m2)	DEPTH (avg.)	CATCH				
					AG	LT	SS	BB	DV
11/06/96	M1	6.6	25		0	0	1	0	0
11/06/96	M1	6.4	40		0	0	1	0	0
11/06/96	M1		35		0	0	1	0	0
11/06/96	M1		35		0	0	0	0	0
11/06/96	M1		25		0	0	0	0	0
15/06/96	WO	10.2	20		0	1	1	0	0
15/06/96	WO	10.2	25		0	4	2	0	0
15/06/96	WO	10.2	12		2	0	2	0	0
12/07/96	WI	13.6	50	0.4	114	3	4	0	0
12/07/96	TLW1	3.7	25	0.1	0	0	0	0	0
13/07/96	TWV6	5	42	0.4	0	0	0	0	0
13/07/96	TWV6	5	27	0.4	0	2	1	0	0
13/07/96	TWV6	9.2	84	0.7	4	1	3	0	0
14/07/96	M4 (trib)	7.6	15	0.35	0	0	0	0	0
14/07/96	M4	7.6	30	0.2	0	0	0	0	0
14/07/96	M5		36	0.9	2	0	1	0	0
15/07/96	WI	10.2	20		0	1	0	0	0
15/07/96	WI	10.2	25		0	4	0	0	0
15/07/96	WI	10.2	10		2	0	2	0	0
16/06/96	N1	8.9	20		0	0	2	0	0
16/06/96	N1	8.9	15		0	0	11	0	0
16/06/96	N2	9.8	32		0	0	0	0	0
16/06/96	N2	9.8	18		0	0	0	0	0
16/06/96	N2	9.8	40		0	0	6	0	0

Table 5. Master Sample Records, Wolverine Lake Area, 1996.

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
WOLVERINE LAKE (includes inlet and outlet)	Arctic grayling	AG	16/07/96	ANG	WI	344	300		mature male	
		AG	16/07/96	ANG	WI	321	250		mature male	ants=6
		AG	13/06/96	ANG	WO	394	650			
		AG	13/06/96	ANG	WO	417	800			
		AG	13/06/96	ANG	WO	408	750			
		AG	16/07/96	ANG	WO	384	500		mature male	
		AG	16/07/96	ANG	WO	388	525		mature male	
		AG	16/07/96	ANG	WO	470				
		AG	23/09/96	ANG	WO	350				
		AG	23/09/96	ANG	WO	395				
		AG	14/06/96	ELS	WC	82				
		AG	13/07/96	ELS	WO	23				
		AG	13/07/96	ELS	WO	41				
		AG	13/07/96	ELS	WO	35				
		AG	13/07/96	ELS	WO	34				
		AG	13/07/96	ELS	WO	31				
		AG	13/07/96	ELS	WO	30				
		AG	13/07/96	ELS	WO	125				
		AG	13/07/96	ELS	WO	280				
		AG	12/06/96	GL	WLV10	296	300			
		AG	12/06/96	GL	WLV10	360	650			
		AG	12/06/96	GL	WLV10	399	750			
		AG	12/06/96	GL	WLV10	357	475			
		AG	12/06/96	GL	WLV10	317	325			
		AG	12/06/96	GL	WLV10	272	200			
		AG	12/06/96	GL	WLV10	387	675			
		AG	12/06/96	GL	WLV10	279	275			
		AG	12/06/96	GL	WLV10	342	500			
		AG	12/06/96	GL	WLV10	263	275			
		AG	12/06/96	GL	WLV10	479	650			
		AG	12/06/96	GL	WLV11	378	600			
		AG	12/06/96	GL	WLV11	386	675			
		AG	13/06/96	GL	WLV12	380	675			
		AG	13/06/96	GL	WLV12	405	700			
		AG	13/06/96	GL	WLV12	317	350			
		AG	13/06/96	GL	WLV12	300	250			
		AG	13/06/96	GL	WLV12	290	300			
		AG	13/06/96	GL	WLV12	309	375			
		AG	13/06/96	GL	WLV12	271	200			
		AG	13/06/96	GL	WLV13	366	575			
AG	13/06/96	GL	WLV13	292	250					
AG	13/06/96	GL	WLV13	389	650					
AG	13/06/96	GL	WLV13	334	500					
AG	13/06/96	GL	WLV13	416	800					
AG	13/06/96	GL	WLV13	380	600					
AG	13/06/96	GL	WLV13	382	625					
AG	13/06/96	GL	WLV13	370	600					
AG	13/06/96	GL	WLV14	410	700					
AG	13/06/96	GL	WLV14	410	775					
AG	13/06/96	GL	WLV14	410	775					
AG	13/06/96	GL	WLV14	380	700					
AG	13/06/96	GL	WLV14	389	650					
AG	13/06/96	GL	WLV14	422	850	growth on side of body taken as sample				
AG	13/06/96	GL	WLV14	423	800					
AG	13/06/96	GL	WLV14	391	675	voluntering milt	male			
AG	13/06/96	GL	WLV14	400	750					
AG	13/06/96	GL	WLV14	387	700					
AG	13/06/96	GL	WLV14	401	725					

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		AG	13/06/96	GL	WLV14	407	700			
		AG	13/06/96	GL	WLV14	398	750			
		AG	13/06/96	GL	WLV14	402	750			
		AG	13/06/96	GL	WLV14	372	800			
		AG	13/06/96	GL	WLV16	394	700			
		AG	13/06/96	GL	WLV16	415	850			
		AG	13/06/96	GL	WLV16	355	600			
		AG	13/06/96	GL	WLV16	412	800			
		AG	13/06/96	GL	WLV16	384	700			
		AG	13/06/96	GL	WLV16	368	575			
		AG	13/06/96	GL	WLV16	399	565			
		AG	13/06/96	GL	WLV17	387	750			
		AG	13/06/96	GL	WLV17	366	600			
		AG	13/06/96	GL	WLV18	392	700			
		AG	13/06/96	GL	WLV19	403	825			
		AG	13/06/96	GL	WLV20	380	600			
		AG	15/06/96	GL	WLV25	360	525			
		AG	12/06/96	GL	WLV3	404	700			
		AG	12/06/96	GL	WLV3	389	675			
		AG	12/06/96	GL	WLV5	375	600			
		AG	12/06/96	GL	WLV8	348	575			
		AG	12/06/96	GL	WLV8	368	525	voluntering eggs	female	
		AG	12/06/96	GL	WLV8	367	675			
		AG	12/06/96	GL	WLV8	380	650			
		AG	12/06/96	GL	WLV9	412	825			
		AG	12/06/96	GL	WLV9	351	575	voluntering eggs	female	
		AG	15/06/96	SN	WI	407	700			
		AG	12/07/96	SN	WI	148				
		AG	12/07/96	SN	WI	114				
		AG	12/07/96	SN	WI	93				
		AG	12/07/96	SN	WI	131				
		AG	12/07/96	SN	WI	142				
		AG	12/07/96	SN	WI	114				
		AG	12/07/96	SN	WI	118				
		AG	12/07/96	SN	WI	109				
		AG	12/07/96	SN	WI	141				
		AG	12/07/96	SN	WI	135				
		AG	12/07/96	SN	WI	98				
		AG	12/07/96	SN	WI	138				
		AG	12/07/96	SN	WI	124				
		AG	12/07/96	SN	WI	111				
		AG	12/07/96	SN	WI	118				
		AG	12/07/96	SN	WI	108				
		AG	12/07/96	SN	WI	115				
		AG	12/07/96	SN	WI	125				
		AG	12/07/96	SN	WI	140				
		AG	12/07/96	SN	WI	118				
		AG	12/07/96	SN	WI	121				
		AG	12/07/96	SN	WI	116				
		AG	12/07/96	SN	WI	109				
		AG	12/07/96	SN	WI	94				
		AG	12/07/96	SN	WI	78				
		AG	12/07/96	SN	WI	107				
		AG	12/07/96	SN	WI	118				
		AG	12/07/96	SN	WI	127				
		AG	12/07/96	SN	WI	124				
		AG	12/07/96	SN	WI	114				
		AG	12/07/96	SN	WI	114				
		AG	12/07/96	SN	WI	111				
		AG	12/07/96	SN	WI	109				

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		AG	12/07/96	SN	WI	114				
		AG	12/07/96	SN	WI	97				
		AG	12/07/96	SN	WI	107				
		AG	12/07/96	SN	WI	38				
		AG	12/07/96	SN	WI	132				
		AG	12/07/96	SN	WI	29				
		AG	12/07/96	SN	WI	41				
		AG	12/07/96	SN	WI	26				
		AG	12/07/96	SN	WI	22				
		AG	12/07/96	SN	WI	27				
		AG	12/07/96	SN	WI	23				
		AG	12/07/96	SN	WI	24				
		AG	12/07/96	SN	WI	41				
		AG	12/07/96	SN	WI	23				
		AG	12/07/96	SN	WI	24				
		AG	12/07/96	SN	WI	41				
		AG	12/07/96	SN	WI	23				
		AG	12/07/96	SN	WI	25				
		AG	12/07/96	SN	WI	24				
		AG	12/07/96	SN	WI	22				
		AG	12/07/96	SN	WI	27				
		AG	12/07/96	SN	WI	26				
		AG	12/07/96	SN	WI	26				
		AG	12/07/96	SN	WI	29				
		AG	12/07/96	SN	WI	30				
		AG	12/07/96	SN	WI	31				
		AG	12/07/96	SN	WI	18				
		AG	12/07/96	SN	WI	29				
		AG	12/07/96	SN	WI	39				
WOLVERINE LAKE	Burbot	BB	13/07/96	ANG	WO	138				
		BB	13/07/96	ANG	WO	142				
		BB	13/07/96	ELS	WO	245				
		BB	13/07/96	ELS	WO	93				
WOLVERINE LAKE	Lake trout	LT	14/06/96	ANG	WC	374	700			
		LT	14/06/96	ANG	WC	405	1000			
		LT	14/06/96	ANG	WC	387	650			
		LT	14/06/96	ANG	WC	400	725			
		LT	23/09/96	ANG	WO	400				
		LT	24/09/96	ANG	WO	428	625	on spawning site	F2	
		LT	24/09/96	ANG	WLV	400	750	on spawning site	M10	shrimp=5
		LT	24/09/96	ANG	WLV	410	925	on spawning site	M9	empty
		LT	24/09/96	ANG	WLV	415	925	on spawning site	F4	shrimp=8,snails=2
		LT	13/07/96	ELS	WO	27				
		LT	13/07/96	ELS	WO	32				
		LT	13/07/96	ELS	WO	34				
		LT	13/07/96	ELS	WO	32				
		LT	13/07/96	ELS	WO	36				
		LT	13/07/96	ELS	WO	39				
		LT	13/07/96	ELS	WO	42				
		LT	13/07/96	ELS	WO	34				
		LT	12/06/96	GL	WLV1	760	5500			
		LT	12/06/96	GL	WLV1	364	675			
		LT	12/06/96	GL	WLV10	770	6450			
		LT	12/06/96	GL	WLV10	846	7500			
		LT	12/06/96	GL	WLV10	802	6400			
		LT	12/06/96	GL	WLV10	424	900			
		LT	12/06/96	GL	WLV10	391	675			
		LT	12/06/96	GL	WLV11	423	800	metal sample #3		
		LT	12/06/96	GL	WLV11	406	825			
		LT	12/06/96	GL	WLV11	407	990			

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		LT	12/06/96	GL	WLV11	382	625	metal sample #4		
		LT	12/06/96	GL	WLV11	450	950	metal sample #5		
		LT	13/06/96	GL	WLV12	471	1200			
		LT	13/06/96	GL	WLV13	405	775			
		LT	13/06/96	GL	WLV13	445	975			
		LT	13/06/96	GL	WLV13	405	800			
		LT	13/06/96	GL	WLV13	440	800			
		LT	13/06/96	GL	WLV13	420	975			
		LT	13/06/96	GL	WLV13	415	800			
		LT	13/06/96	GL	WLV14	389	700			
		LT	13/06/96	GL	WLV14	404	800			
		LT	13/06/96	GL	WLV14	394	800			
		LT	13/06/96	GL	WLV14	436	980			
		LT	13/06/96	GL	WLV14	394	750			
		LT	13/06/96	GL	WLV15	680	4200			
		LT	13/06/96	GL	WLV18	425	950			
		LT	13/06/96	GL	WLV20	388	700			
		LT	13/06/96	GL	WLV20	439	875	Sample #6		
		LT	13/06/96	GL	WLV21	414	775	Sample #7		
		LT	14/06/96	GL	WLV22	424	900			
		LT	15/06/96	GL	WLV23	87				
		LT	15/06/96	GL	WLV23	409	650			
		LT	15/06/96	GL	WLV23	431	1000			
		LT	15/06/96	GL	WLV24	437	750			
		LT	15/06/96	GL	WLV25	421	820			
		LT	15/06/96	GL	WLV25	440	1100			
		LT	15/06/96	GL	WLV25	403	750			
		LT	15/06/96	GL	WLV25	406	750			
		LT	15/06/96	GL	WLV25	417	950			
		LT	15/06/96	GL	WLV25	422	925			
		LT	12/06/96	GL	WLV3	578	2600			
		LT	12/06/96	GL	WLV3	393	800			
		LT	12/06/96	GL	WLV4	273	225	Leeches on tail		
		LT	12/06/96	GL	WLV4	172	50			
		LT	12/06/96	GL	WLV5	386	850			
		LT	12/06/96	GL	WLV7	293	250			
		LT	12/06/96	GL	WLV7	444	1050			
		LT	12/06/96	GL	WLV7	404	800			
		LT	12/06/96	GL	WLV7	411	750			
		LT	12/06/96	GL	WLV7	378	675			
		LT	12/06/96	GL	WLV8	395	675	metal sample #1		
		LT	12/06/96	GL	WLV8	458	1100			
		LT	12/06/96	GL	WLV9	345	480	metal sample #2		
		LT	12/06/96	GL	WLV9	401	725			
		LT	12/06/96	GL	WLV9	408	900			
		LT	15/06/96	SN	WI	30				
		LT	15/06/96	SN	WI	30				
		LT	15/06/96	SN	WI	30				
		LT	15/06/96	SN	WI	30				
		LT	15/06/96	SN	WI	30				
		LT	12/07/96	SN	WI	132				
		LT	12/07/96	SN	WI	41				
		LT	12/07/96	SN	WI	41				
WOLVERINE LAKE	Slimy sculpin	SS	13/07/96	ELS	WO	71				
		SS	13/07/96	ELS	WO	68				
		SS	13/07/96	ELS	WO	59				
		SS	13/07/96	ELS	WO	89				
		SS	13/07/96	ELS	WO	55				
		SS	13/07/96	ELS	WO	78				
		SS	13/07/96	ELS	WO	99				

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		SS	15/06/96	SN	WI	31				
		SS	12/07/96	SN	WI	32				
		SS	12/07/96	SN	WI	37				
		SS	12/07/96	SN	WI	36				
LITTLE WOLVERINE LAKE	Arctic grayling	AG	15/06/96	GL	LWV 1	372	500			
		AG	15/06/96	GL	LWV 1	313	350			
		AG	15/06/96	GL	LWV 1	368	475			
		AG	15/06/96	GL	LWV 1	271	175			
		AG	15/06/96	GL	LWV 1	318	350			
		AG	15/06/96	GL	LWV 1	290	200			
		AG	15/06/96	GL	LWV 1	265	190			
		AG	15/06/96	GL	LWV 1	354	500			
		AG	15/06/96	GL	LWV 1	380	550			
		AG	15/06/96	GL	LWV 1	294	300			
		AG	15/06/96	GL	LWV 1	351	500			
		AG	15/06/96	GL	LWV 1	305	350			
		AG	15/06/96	GL	LWV 1	398	675			
		AG	15/06/96	GL	LWV 1	360	500			
		AG	15/06/96	GL	LWV 1	380	600			
		AG	15/06/96	GL	LWV 1	348	500			
		AG	15/06/96	GL	LWV 1	310	300			
		AG	15/06/96	GL	LWV 1	300	275			
		AG	15/06/96	GL	LWV 2	344	525			
		AG	15/06/96	GL	LWV 2	352	450			
		AG	15/06/96	GL	LWV 2	300	250			
		AG	15/06/96	GL	LWV 2	372	550			
		AG	15/06/96	GL	LWV 2	370	550			
		AG	15/06/96	GL	LWV 3	336	400	voluntering milt	male	
		AG	15/06/96	GL	LWV 3	368	500			
		AG	15/06/96	GL	LWV 3	308	300			
		AG	15/06/96	GL	LWV 3	318	325			
		AG	15/06/96	GL	LWV 3	354	400			
		AG	15/06/96	GL	LWV 3	262	200			
		AG	15/06/96	GL	LWV 3	340	400			
		AG	15/06/96	GL	LWV 3	322	300			
		AG	15/06/96	GL	LWV 3	314	300			
		AG	15/06/96	GL	LWV 3	335	375			
		AG	15/06/96	GL	LWV 3	348	400			
		AG	15/06/96	GL	LWV 3	372	650			
		AG	15/06/96	GL	LWV 3	308	350			
		AG	15/06/96	GL	LWV 3	310	300			
		AG	15/06/96	GL	LWV 3	322	325			
		AG	15/06/96	GL	LWV 3	344	400			
		AG	15/06/96	GL	LWV 3	350	450			
		AG	15/06/96	GL	LWV 3	324	325			
		AG	15/06/96	GL	LWV 3	342	375			
		AG	15/06/96	GL	LWV 3	358	450			
		AG	15/06/96	GL	LWV 3	342	425			
		AG	15/06/96	GL	LWV 3	330	400			
		AG	15/06/96	GL	LWV 4	364	450			
		AG	15/06/96	GL	LWV 4	333	400			
		AG	15/06/96	GL	LWV 4	343	475			
		AG	15/06/96	GL	LWV 4	297	300			
		AG	15/06/96	GL	LWV 4	337	400			
		AG	15/06/96	GL	LWV 4	343	400			
		AG	15/06/96	GL	LWV 4	357	475			
		AG	15/06/96	GL	LWV 4	322	350			
		AG	15/06/96	GL	LWV 4	314	300			

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		AG	15/06/96	GL	LWV 4	339	375	voluntering eggs	female	
		AG	15/06/96	GL	LWV 4	326	425			
		AG	15/06/96	GL	LWV 4	295	250			
LITTLE WOLVERINE LAKE	Longnose sucker	LNS	15/06/96	GL	LWV 1	430	1000			
		LNS	15/06/96	GL	LWV 1	460	1350			
		LNS	15/06/96	GL	LWV 1	480	1400			
		LNS	15/06/96	GL	LWV 1	400	875	voluntering eggs	female	
LITTLE WOLVERINE LAKE	Lake trout	LT	24/09/96	ANG	LWV	650				
		LT	24/09/96	ANG	LWV	623	2650	on spawning site	M7	hairbal?=5
		LT	24/09/96	ANG	LWV	418	750	on spawning site	F2	shrimp=10,clams=0
		LT	24/09/96	ANG	LWV	2700				
		LT	15/06/96	GL	LWV 1	437	975			
		LT	15/06/96	GL	LWV 1	395	750			
		LT	15/06/96	GL	LWV 1	428	1000			
		LT	15/06/96	GL	LWV 1	400	925			
		LT	15/06/96	GL	LWV 1	410	900			
		LT	15/06/96	GL	LWV 1	476	1250			
		LT	15/06/96	GL	LWV 1	488	1200			
		LT	15/06/96	GL	LWV 1	429	1100			
		LT	15/06/96	GL	LWV 1	368	550			
		LT	15/06/96	GL	LWV 1	425	900			
		LT	15/06/96	GL	LWV 1	402	750	Sample # 9		
		LT	15/06/96	GL	LWV 1	462	1300			
		LT	15/06/96	GL	LWV 1	444	1100			
		LT	15/06/96	GL	LWV 2	440	800			
		LT	15/06/96	GL	LWV 2	786	6050	Sample # 8		
		LT	15/06/96	GL	LWV 2	392	775			
		LT	15/06/96	GL	LWV 2	338	425	Sample # 10		
		LT	15/06/96	GL	LWV 2	364	500			
		LT	15/06/96	GL	LWV 3	770	6500			
		LT	15/06/96	GL	LWV 3	466	900			
		LT	15/06/96	GL	LWV 3	500	1400			
		LT	15/06/96	GL	LWV 3	382	650	Sample #11		
		LT	15/06/96	GL	LWV 3	415	650			
		LT	15/06/96	GL	LWV 4	528	1450			
		LT	15/06/96	GL	LWV 4	400	800			
LITTLE JIMMY LAKE	Arctic grayling	AG	14/06/96	GL	MHL 1	249	175			
		AG	14/06/96	GL	MHL 1	334	400			
		AG	14/06/96	GL	MHL 1	322	425			
		AG	14/06/96	GL	MHL 1	299	300			
		AG	14/06/96	GL	MHL 1	285	275			
		AG	14/06/96	GL	MHL 1	274	200			
		AG	14/06/96	GL	MHL 1	262	200			
		AG	14/06/96	GL	MHL 1	289	300			
		AG	14/06/96	GL	MHL 1	341	500			
		AG	14/06/96	GL	MHL 1	306	375			
		AG	14/06/96	GL	MHL 1	362	525			
		AG	14/06/96	GL	MHL 1	272	200			
		AG	14/06/96	GL	MHL 2	330	375			
		AG	14/06/96	GL	MHL 2	n/a	350			
		AG	14/06/96	GL	MHL 2	274	200			
		AG	14/06/96	GL	MHL 2	305	450			
		AG	14/06/96	GL	MHL 2	318	450			
		AG	14/06/96	GL	MHL 2	342	450			
		AG	14/06/96	GL	MHL 2	327	400			
		AG	14/06/96	GL	MHL 2	348	525			
		AG	14/06/96	GL	MHL 2	285	300			
		AG	14/06/96	GL	MHL 2	318	350			

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		AG	14/06/96	GL	MHL 2	358	450			
		AG	14/06/96	GL	MHL 2	343	450			
		AG	14/06/96	GL	MHL 3	330	500			
		AG	14/06/96	GL	MHL 3	318	450			
		AG	14/06/96	GL	MHL 3	342	525			
		AG	14/06/96	GL	MHL 3	289	250			
		AG	14/06/96	GL	MHL 3	346	500			
		AG	14/06/96	GL	MHL 4	322	325			
		AG	14/06/96	GL	MHL 4	342	400			
		AG	14/06/96	GL	MHL 4	348	375			
		AG	14/06/96	GL	MHL 4	322	350			
		AG	14/06/96	GL	MHL 4	350	400			
		AG	14/06/96	GL	MHL 4	350	450			
		AG	14/06/96	GL	MHL 4	327	475			
		AG	14/06/96	GL	MHL 4	322	450			
		AG	14/06/96	GL	MHL 4	360	450			
		AG	14/06/96	GL	MHL 5	324	350			
		AG	14/06/96	GL	MHL 5	332	425			
		AG	14/06/96	GL	MHL 5	223	100			
		AG	14/06/96	GL	MHL 5	274	200			
		AG	14/06/96	GL	MHL 5	320	300			
		AG	14/06/96	GL	MHL 5	288	200			
		AG	14/06/96	GL	MHL 5	324	400			
		AG	14/06/96	GL	MHL 5	320	325			
		AG	14/06/96	GL	MHL 5	337	375			
		AG	14/06/96	GL	MHL 5	344	375			
		AG	14/06/96	GL	MHL 5	323	325			
		AG	14/06/96	GL	MHL 5	358	450			
		AG	14/06/96	GL	MHL 5	319	325			
		AG	14/06/96	GL	MHL 5	277	250			
		AG	14/06/96	GL	MHL 5	362	450			
		AG	14/06/96	GL	MHL 5	342	450			
		AG	14/06/96	GL	MHL 5	321	350			
		AG	14/06/96	GL	MHL 5	334	320			
		AG	14/06/96	GL	MHL 5	355	550			
		AG	14/06/96	GL	MHL 5	350	400			
		AG	14/06/96	GL	MHL 5	339	400			
		AG	14/06/96	GL	MHL 5	335	350			
		AG	14/06/96	GL	MHL 5	362	450			
		AG	14/06/96	GL	MHL 5	347	450			
		AG	14/06/96	GL	MHL 6	317	300			
		AG	14/06/96	GL	MHL 6	312	300			
		AG	14/06/96	GL	MHL 6	351	450			
		AG	14/06/96	GL	MHL 6	350	400			
		AG	14/06/96	GL	MHL 6	345	500			
		AG	14/06/96	GL	MHL 6	329	450			
		AG	14/06/96	GL	MHL 6	368	500			
		AG	14/06/96	GL	MHL 6	340	425			
		AG	14/06/96	GL	MHL 6	320	325			
		AG	14/06/96	GL	MHL 6	352	400			
		AG	14/06/96	GL	MHL 6	320	400			
		AG	14/06/96	GL	MHL 6	340	420			
		AG	14/06/96	GL	MHL 6	339	400			
		AG	14/06/96	GL	MHL 6	340	425			
		AG	14/06/96	GL	MHL 6	338	475			
		AG	14/06/96	GL	MHL 6	355	450			
		AG	14/06/96	GL	MHL 6	344	400			
LITTLE JIMMY LAKE	Lake trout	LT	24/09/96	ANG	LJ	418	850	on spawning site	M10	empty
		LT	24/09/96	ANG	LJ	395	650	on spawning site	F5	clam=0,eggs=0,sculpin=15
		LT	24/09/96	ANG	LJ	395	700	on spawning site	F5	bettle=0,eggs=5,shrimp=15

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		LT	24/09/96	ANG	LJ	400	750	on spawning site	M10	eggs=0,rocks=0
		LT	24/09/96	ANG	LJ	385	600	on spawning site	M10	eggs=5
		LT	24/09/96	ANG	LJ	410	700	on spawning site	F2	eggs=4,rocks=1
		LT	24/09/96	ANG	LJ	435	900	on spawning site	F5	plecoptera=2,rocks=4,eggs=4,snail=0
		LT	14/06/96	GL	LJ 4	472	650			
		LT	14/06/96	GL	LJ 5	652	3550			
		LT	14/06/96	GL	LJ 6	705	4800			
MONEY CREEK	Arctic grayling	AG	14/07/96	ANG	M3	365				
		AG	14/07/96	ANG	M3	240				
		AG	14/07/96	ANG	M3	290				
		AG	17/07/96	ANG	M6	430				
		AG	17/07/96	ANG	M6	405				
		AG	17/07/96	ANG	M6	370				
		AG	17/07/96	ANG	M6	365				
		AG	14/07/96	ELS	M3	26				
		AG	14/07/96	ELS	M3	26				
		AG	14/07/96	ELS	M3	24				
		AG	14/07/96	ELS	M3	18				
		AG	14/07/96	ELS	M3	27				
		AG	14/07/96	ELS	M3	26				
		AG	14/07/96	ELS	M3	30				
		AG	14/07/96	ELS	M4	98				
		AG	14/07/96	ELS	M5	23				
		AG	14/07/96	ELS	M5	19				
		AG	14/07/96	ELS	M5	18				
		AG	14/07/96	ELS	M5	19				
		AG	14/07/96	ELS	M5	22				
		AG	14/07/96	ELS	M5	21				
		AG	14/07/96	ELS	M5	24				
		AG	14/07/96	ELS	M5	24				
		AG	15/07/96	ELS	M6	18				
		AG	15/07/96	ELS	M6	102				
		AG	15/07/96	ELS	M7G	102				
		AG	15/07/96	ELS	M7G	84				
		AG	15/07/96	ELS	M7G	21				
		AG	15/07/96	ELS	M8	80				
		AG	15/07/96	ELS	M9	18				
		AG	14/07/96	SN	M5	19				
		AG	14/07/96	SN	M5	21				
		AG	14/07/96	SN	M5	22				
MONEY CREEK	Dolly varden	DV	14/07/96	ELS	M4	84				
		DV	14/07/96	ELS	M4	75				
		DV	14/07/96	ELS	M4	102				
		DV	14/07/96	ELS	M4	36				
		DV	14/07/96	ELS	M4	38				
		DV	14/07/96	ELS	M4	34				
		DV	14/07/96	ELS	M4	95				
		DV	14/07/96	ELS	M4	39				
		DV	14/07/96	ELS	M4	142				
		DV	14/07/96	ELS	M5	216				
		DV	15/07/96	ELS	M6	135				
		DV	15/07/96	ELS	M6	90				
		DV	15/07/96	ELS	M6	78				
		DV	15/07/96	ELS	M7G	75				
		DV	15/07/96	ELS	M7G	84				
		DV	15/07/96	ELS	M7G	90				
		DV	24/09/96	ELS	M7G	90				
MONEY CREEK	Slimy sculpin	SS	14/07/96	ELS	M4	20				

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		SS	14/07/96	ELS	M4	20				
		SS	14/07/96	ELS	M4	20				
		SS	14/07/96	ELS	M4	20				
		SS	14/07/96	ELS	M4	40				
		SS	14/07/96	ELS	M4	80				
		SS	14/07/96	ELS	M4	80				
		SS	15/07/96	ELS	M7G	88				
		SS	15/07/96	ELS	M7G	76				
		SS	15/07/96	ELS	M7G	91				
		SS	15/07/96	ELS	M7G	71				
		SS	11/06/96	SN	M1	45				
		SS	11/06/96	SN	M1	55				
		SS	11/06/96	SN	M1	45				
		SS	11/06/96	SN	M1	47				
		SS	14/07/96	SN	M5	59				
		SS	14/07/96	SN	M5	101				
		SS	14/07/96	SN	M5	62				
		SS	14/07/96	SN	M5	80				
		SS	14/07/96	SN	M5	89				
<hr/>										
GO CREEK	Dolly varden	DV	15/07/96	ELS	G1	64				
		DV	15/07/96	ELS	G1	168				
GO CREEK	Silmy sculpin	SS	15/07/96	ELS	G1	76				
		SS	15/07/96	ELS	G1	78				
<hr/>										
NOUGHA CREEK	Arctic grayling	AG	16/07/96	ANG	N4	280				
		AG	16/07/96	ANG	N4	290				
		AG	16/07/96	ANG	N4	170				
		AG	16/07/96	ANG	N4	200				
		AG	16/07/96	ANG	N4	380				
		AG	16/07/96	ANG	N4	280				
		AG	16/07/96	ANG	N4	270				
		AG	25/09/96	ELS	N2	64				
		AG	25/09/96	ELS	N2	60				
		AG	25/09/96	ELS	N2	66				
		AG	25/09/96	ELS	N2	66				
		AG	25/09/96	ELS	N2	70				
		AG	25/09/96	ELS	N2	70				
		AG	25/09/96	ELS	N2	80				
		AG	25/09/96	ELS	N2	58				
		AG	25/09/96	ELS	N2	56				
		AG	25/09/96	ELS	N2	54				
		AG	25/09/96	ELS	N2	59				
		AG	25/09/96	ELS	N2	64				
		AG	25/09/96	ELS	N2	68				
		AG	25/09/96	ELS	N2	69				
		AG	25/09/96	ELS	N2	66				
		AG	25/09/96	ELS	N2	62				
		AG	25/09/96	ELS	N2	66				
		AG	25/09/96	ELS	N2	70				
		AG	25/09/96	ELS	N2	70				
		AG	16/07/96	ELS	N4	34				
		AG	16/07/96	ELS	N4	29				
		AG	16/07/96	ELS	N4	27				
		AG	16/07/96	ELS	N4	36				
		AG	16/07/96	ELS	N4	28				
		AG	16/07/96	ELS	N4	29				
		AG	16/07/96	ELS	N4	31				

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		AG	16/07/96	ELS	N5	18				
		AG	16/07/96	ELS	N5	22				
		AG	16/07/96	ELS	N5	30				
		AG	16/07/96	ELS	N5	33				
		AG	16/07/96	ELS	N5	21				
		AG	16/07/96	ELS	N5	20				
		AG	16/07/96	ELS	N5	41				
		AG	16/07/96	ELS	N5	42				
		AG	16/07/96	ELS	N5	45				
		AG	16/07/96	ELS	N5	41				
		AG	16/07/96	ELS	N5	38				
		AG	16/07/96	ELS	N5	43				
		AG	16/07/96	ELS	N5	44				
		AG	16/07/96	ELS	N5	21				
		AG	16/07/96	ELS	N5	27				
		AG	16/07/96	ELS	N5	18				
		AG	16/07/96	ELS	N5	47				
		AG	16/07/96	ELS	N5	48				
		AG	16/07/96	ELS	N5	49				
		AG	16/07/96	ELS	N5	49				
		AG	16/07/96	ELS	N5	44				
		AG	16/07/96	ELS	N5	41				
		AG	16/07/96	ELS	N5	42				
		AG	16/07/96	ELS	N5	45				
		AG	16/07/96	ELS	N5	47				
		AG	16/07/96	ELS	N5	38				
		AG	16/07/96	ELS	N5	43				
		AG	16/07/96	ELS	N5	49				
		AG	16/07/96	ELS	N5	39				
		AG	16/07/96	ELS	N5	25				
		AG	16/07/96	ELS	N5	32				
		AG	16/07/96	ELS	N5	26				
		AG	16/07/96	ELS	N5	38				
		AG	16/07/96	ELS	N5	108				
		AG	16/07/96	ELS	N5	132				
		AG	25/09/96	VIS	N2	120				
		AG	25/09/96	VIS	N2	190				
NOUGHA CREEK	Burbot	BB	16/07/96	ELS	N5	115				
		BB	16/07/96	ELS	N5	132				
		BB	16/07/96	ELS	N5	108				
NOUGHA CREEK	Longnose sucker	LNS	16/06/96	ELS	N1	35				
NOUGHA CREEK	Slimy sculpin	SS	16/06/96	SN	N1	43				
		SS	16/06/96	SN	N1	22				
		SS	16/06/96	SN	N1	26				
		SS	16/06/96	SN	N1	25				
		SS	16/06/96	SN	N1	28				
		SS	16/06/96	SN	N1	23				
		SS	16/06/96	SN	N1	25				
		SS	16/06/96	SN	N1	25				
		SS	16/06/96	SN	N1	25				
		SS	16/06/96	SN	N1	25				
		SS	16/06/96	SN	N1	22				
		SS	16/06/96	SN	N1	26				
		SS	16/06/96	SN	N1	21				
		SS	16/06/96	SN	N1	26				
		SS	16/06/96	SN	N2	50				
		SS	16/06/96	SN	N2	43				
		SS	16/06/96	SN	N2	24				
		SS	16/06/96	SN	N2	26				
		SS	16/06/96	SN	N2	26				
		SS	16/06/96	SN	N2	22				

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach		
WIND CREEK	Arctic grayling	AG	16/07/96	ELS	WND	121						
		AG	16/07/96	ELS	WND	26						
		AG	16/07/96	ELS	WND	28						
		AG	16/07/96	ELS	WND	32						
		AG	16/07/96	ELS	WND	32						
		AG	16/07/96	ELS	WND	43						
		AG	16/07/96	ELS	WND	45						
WIND LAKE	Arctic grayling	AG	23/09/96	GL	WNDL1	300						
		AG	23/09/96	GL	WNDL1	310						
		AG	23/09/96	GL	WNDL1	290						
		AG	23/09/96	GL	WNDL1	305						
		AG	23/09/96	GL	WNDL2	260						
		AG	23/09/96	GL	WNDL2	265						
		AG	23/09/96	GL	WNDL2	275						
		AG	23/09/96	GL	WNDL2	240						
		AG	23/09/96	GL	WNDL2	300						
		AG	23/09/96	GL	WNDL2	300						
		AG	23/09/96	GL	WNDL2	345						
		AG	23/09/96	GL	WNDL3	250						
		AG	23/09/96	GL	WNDL3	210						
		AG	23/09/96	GL	WNDL3	290						
WIND LAKE	Longnose sucker	LNS	23/09/96	GL	WNDL1	310	400					
		LNS	23/09/96	GL	WNDL2	380	600					
		LNS	23/09/96	GL	WNDL3	320						
WIND LAKE	Lake trout	LT	23/09/96	GL	WNDL1	700	5600					
TRIBUTARIES TO WOLVERINE LAKE	Arctic grayling	AG	13/07/96	ANG	TWV6	410						
		AG	13/07/96	ANG	TWV6	432						
		AG	13/07/96	ELS	TWV3	85						
		AG	13/07/96	ELS	TWV4	32						
		AG	13/07/96	ELS	TWV5	408						
		AG	13/07/96	ELS	TWV5	385						
		AG	13/07/96	ELS	TWV5	398						
		AG	13/07/96	ELS	TWV5	425						
		AG	13/07/96	SN	TWV6	25						
		AG	13/07/96	SN	TWV6	27						
		AG	13/07/96	SN	TWV6	29						
		AG	13/07/96	SN	TWV6	28						
		TRIBUTARIES TO WOLVERINE LAKE	Burbot	BB	13/07/96	ELS	TWV3	92				
				BB	13/07/96	ELS	TWV3	108				
BB	13/07/96			ELS	TWV3	86						
BB	13/07/96			ELS	TWV5	106						
BB	13/07/96			ELS	TWV5	86						
BB	13/07/96			ELS	TWV5	92						
BB	13/07/96			ELS	TWV6	96						
BB	13/07/96			ELS	TWV6	115						
BB	13/07/96			ELS	TWV6	88						
BB	13/07/96			ELS	TWV6	84						
BB	13/07/96			ELS	TWV6	87						
TRIBUTARIES TO WOLVERINE LAKE	Longnose sucker	LNS	13/07/96	ELS	TWV4	73						
		LNS	13/07/96	ELS	TWV4	83						
		LNS	13/07/96	ELS	TWV4	68						
		LNS	13/07/96	ELS	TWV4	71						
		LNS	13/07/96	ELS	TWV4	65						

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach	
TRIBUTARIES TO WOLVERINE LAKE	Lake trout	LNS	13/07/96	ELS	TWV4	72					
		LNS	13/07/96	ELS	TWV4	74					
		LNS	13/07/96	ELS	TWV4	79					
		LNS	13/07/96	ELS	TWV4	81					
		LNS	13/07/96	ELS	TWV4	75					
	Lake trout	LT	13/07/96	ANG	TWV6	400					
		LT	13/07/96	ANG	TWV6	440					
		LT	13/07/96	ANG	TWV6	515					
		LT	13/07/96	ANG	TWV6	410					
		LT	13/07/96	ELS	TWV5	42					
		LT	13/07/96	ELS	TWV5	41					
		LT	13/07/96	ELS	TWV5	41					
		LT	13/07/96	ELS	TWV5	42					
		LT	13/07/96	ELS	TWV5	45					
		LT	13/07/96	ELS	TWV6	39					
		LT	13/07/96	ELS	TWV6	36					
		LT	13/07/96	ELS	TWV6	34					
		LT	13/07/96	ELS	TWV6	33					
		LT	13/07/96	ELS	TWV6	64					
		LT	13/07/96	ELS	TWV6	40					
LT	13/07/96	ELS	TWV6	37							
LT	13/07/96	ELS	TWV6	35							
LT	13/07/96	SN	TWV6	32							
LT	13/07/96	SN	TWV6	34							
LT	13/07/96	SN	TWV6	41							
TRIBUTARIES TO WOLVERINE LAKE	Slimy sculpin	SS	13/07/96	ELS	TWV3	51					
		SS	13/07/96	ELS	TWV3	60					
		SS	13/07/96	ELS	TWV3	83					
		SS	13/07/96	ELS	TWV3	62					
		SS	13/07/96	ELS	TWV5	66					
		SS	13/07/96	ELS	TWV5	64					
		SS	13/07/96	ELS	TWV5	56					
		SS	13/07/96	ELS	TWV5	71					
		SS	13/07/96	ELS	TWV5	63					
		SS	13/07/96	ELS	TWV5	71					
		SS	13/07/96	ELS	TWV5	61					
		SS	13/07/96	ELS	TWV5	68					
		SS	13/07/96	ELS	TWV6	51					
		SS	13/07/96	ELS	TWV6	58					
		SS	13/07/96	ELS	TWV6	60					
		SS	13/07/96	ELS	TWV6	58					
		SS	13/07/96	ELS	TWV6	75					
		SS	13/07/96	ELS	TWV6	63					
		SS	13/07/96	ELS	TWV6	68					
		SS	13/07/96	ELS	TWV6	61					
SS	13/07/96	ELS	TWV6	61							
SS	13/07/96	SN	TWV6	57							
SS	13/07/96	SN	TWV6	37							
SS	13/07/96	SN	TWV6	41							
SS	13/07/96	SN	TWV6	42							
TRIBUTARIES TO LITTLE WOLVERINE LAKE	Burbot	BB	12/07/96	ELS	TLW1	105					
		BB	12/07/96	ELS	TLW4	88					
TRIBUTARIES TO LITTLE WOLVERINE LAKE	Lake trout	LT	12/07/96	ELS	TLW4	42					
		LT	12/07/96	ELS	TLW4	36					
TRIBUTARIES TO LITTLE WOLVERINE LAKE	Slimy sculpin	SS	12/07/96	ELS	TLW1	80					
		SS	12/07/96	ELS	TLW1	84					
		SS	12/07/96	ELS	TLW1	91					
		SS	12/07/96	ELS	TLW1	63					

Location	Species	Species code	Date (m/d/yr)	Method	Site	Fork Length (mm)	Round Weight (g)	Comments	sex/mat	stomach
		SS	12/07/96	ELS	TLW1	56				
		SS	12/07/96	ELS	TLW2	73				
		SS	12/07/96	ELS	TLW2	81				
		SS	12/07/96	ELS	TLW2	75				
TRIBUTARIES TO LITTLE JIMMY LAKE	Burbot	BB	14/07/96	ELS	TLJ1	82				
	Lake trout	LT	14/07/96	ELS	TLJ1	91				

Table 6 . Number of Visual Observations of Fish in the Wolverine Lake Area, 1996.

Date (d/m/yr)	Site	Species				
		lake trout	Arctic grayling	longnose sucker	dolly varden	Unidentified
13/06/96	WC		20			
13/06/96	WO	1	37			
14/06/96	WC					100
15/06/96	WI		200+			
13/07/96	TWV4		30	95		
13/07/96	TWV5		5			
16/07/96	WND		2000+	2000		
17/07/96	M6				1	
24/09/96	WI		1			
25/09/96	N2		2			



WHITE MOUNTAIN ENVIRONMENTAL CONSULTING

Proposed Access Road Creek Crossings

Fish Habitat Evaluation and Utilization Assessment, 1997

INTRODUCTION

At present two possible access roads to the Wolverine Lake property are being considered to access the property for future development. All creeks crossed by the two proposed routes were investigated by White Mountain Environmental Consulting (WMEC) during the 1997 open water season. Creeks were evaluated at the proposed crossing locations and at their outlets for the presence of both fish and fish habitat. Site investigations were conducted during June, July and September in order to provide an evaluation of spring, summer and fall utilization and account for seasonal movements of fish. The following report documents habitat availability and utilization during all seasons of investigation.

METHODS

A total of fifteen creeks were studied during the proposed access road crossing investigation. The creeks investigated consisted of the following:

- A tributary to East Lake;
- Two tributaries to Wind Lake;
- Seven tributaries of Nougha Creek;
- Nougha Creek;
- Three tributaries to Wolverine Lake, and
- A small headwater feeder creek of Van Bibber Creek.

The titles and descriptions of each of the 1996 and 1997 sample sites are provided on Table 1.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

Table 1 Sample Sites

Site	Description
TE	Tributary to East Lake
TW-1	Access Road Crossing Site, a Tributary that Drains into Wind Lake
TW-2	Access Road Crossing Site, a Tributary that Drains into Wind Lake
WO	Outlet of Wolverine Lake
TN-1	Access Road Crossing Site, a Tributary that Drains into Nougha Creek 300 m Downstream of Wolverine Lake Outlet
TN-2	Access Road Crossing Site, a Tributary that Drains into Nougha Creek 350 m Downstream of Wolverine Lake Outlet
TN-3	Tributary of Nougha Creek, 800 m Downstream of Wolverine Lake Outlet
TN3F	Feeder Tributary to TN3
NTN3	Nougha at Mouth of TN3
TN-7	Tributary to Nougha Creek Approximately 8.9 km Downstream of Wolverine Lake
TN-8	Tributary to Nougha Creek Approximately 8.6 km Downstream of Wolverine Lake
TN-9	Tributary to Nougha Creek Approximately 7.6 km Downstream of Wolverine Lake
TN-10	Tributary to Nougha Creek Approximately 6.9 km Downstream of Wolverine Lake
TWV-1	Tributary to Wolverine Lake
TWV-2	Tributary to Wolverine Lake
TWV-3	Tributary to Wolverine Lake
TVB	Tributary to Van Bibber Creek
TVB-1	Tributary to TVB

The location of each of sample sites are presented in Figure 1. Figure 2 shows the two potential access routes to the Wolverine Lake property. A general description of the physical fish habitat for each site investigated is provided in Appendix 1. Results from all fish utilization assessments, including catch and sample records are contained in Appendix 2, Tables 1 to 3. Photos were also taken at each site and are provided in Appendix 3.

Habitat characteristics evaluated at each site included; creek depths and widths, water velocities, pool to riffle ratios, substrates, overhanging and adjacent vegetation and potential fish cover. Methods used to determine fish presence were electro-fishing, seining (where

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

possible), angling and visual observations. Polarized glasses were used at all times to enhance visibility.

With the exception of Nougha Creek, all crossing sites occur in areas where the creek flows in a small draw with dense willow cover over and adjacent to the creeks. These creeks flow through dense tangles of willow in incised channels which are typically deeper than they are wide. These creeks rarely exceed a width of greater than 0.3 m, and have velocities averaging >1 m/sec. This type of creek, generally, does not provide good fish habitat. Auries noted during spring investigations implies the creeks bottom freeze, a factor that severely limits ability to support over-wintering by fish. Rare and occasional ground water feeds may provide habitats suitable for slimy sculpin over wintering, and Arctic grayling may move into the creeks during summer months. During our investigations no fish were found in any of the creeks above the point where streamflow flowed through dense willows.

TE: The tributary to East Lake, as marked on the map sheet, does not at this time represent an above ground flow. This creek has been denoted as non-fish bearing and as such requires no further fisheries investigations.

TW-1: Tributary to Wind Lake #1 has two distinct reaches, the first being from the outlet to Wind Lake upstream for 400 m through a large wetland area, the second reach is above the first and extends up its valley, as a willow tangled draw, to the headwater area. The lower reach provides critical spawning, rearing and feeding habitat for Arctic grayling, particularly where it is closer to the lake. Long nose sucker and slimy sculpin also utilize this reach. Arctic grayling fry were the only species utilizing this reach during fall investigations. The upper reach is of little value as fish habitat; the proposed access road crosses the upper reach near the headwater area in an area not considered as fish habitat.

TW-2: Tributary to Wind Lake #2 consists of a small creek flowing through a willow draw. This creek does not provide fish habitat in its upper reaches. The only reach of this creek to provide fish habitat is the lowest 35 m, which forms a small bay of the lake. This area has significant influence from the lakes warmer water. The location of the proposed crossing site is approximately 2 km upstream of the lake in non-fish habitats.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

WO and N: Nougha Creek near the outlet from Wolverine Lake represents important fish habitat. Utilization of the reach adjacent to the lake was documented as supporting Arctic grayling spawning and rearing, lake trout rearing and adult feeding and long nose sucker, slimy sculpin, and burbot were also present. Large numbers of adult Arctic grayling observed during fall surveys may indicate this is an over-wintering site for grayling. Fish habitats vary seasonally with water levels and velocities.

TN-1: Tributary to Nougha Creek #1 is a small creek (0.35 m wide x 0.05 m depth). The lowest 10 m of the creek consists of a gravel boulder bottomed riffle with velocities >1m/sec. Above this reach, the creek flows through tangled willows alternating between being a narrow incised channel with velocities >1m/sec to areas with little or no defined channel with flows flooding out through the adjacent willows and sedges. Limited fish habitats exist in the creek in the form of eddies and pools below boulders. Two trails cross this creek 35 and 50 m upstream of Nougha Creek. Small pools with gravel substrates have been created by the trails crossing the creek. No fish were found in this creek.

TN-2: Tributary to Nougha Creek #2 does not have a defined channel outlet into Nougha Creek, rather it spills over the bank along a 10 m reach. Above this the creek flows through a tangle of willow and the channel is not well defined in most places. The most defined channel area occurs where the creek has been crossed by two winter trails, 30 and 40 m upstream of Nougha Creek. This creek does not represent fish habitat.

TN-3: Tributary to Nougha Creek #3 has flow and size sufficient to support fish. The outlet into Nougha Creek creates two important eddy pools in Nougha, one upstream and one downstream of the outlet. The first 10 m of the creek upstream of Nougha consist of a shallow glide at the mouth then a fast riffle before narrowing and entering into heavy willow tangles. Substrates in the creek are consistently heavily silted with clay and sand in the lower reach, gravel and cobbles occur occasionally at distances greater than 20 m upstream of Nougha Creek.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

This creek is crossed by two winter trails 40 and 50 m upstream of Nougha Creek. Significant ice buildups were observed at the crossing sites during our spring investigations. The creek flows in a gully at the site of crossing with banks rising as much as 2.5 m above the actual flow. Arctic grayling juveniles were recorded in the first 20 m of the creek upstream of Nougha Creek during fall investigations and in the zone of influence during both summer and fall investigations.

TN-7: Tributary to Nougha Creek #7 does not have a discernible flow above ground at the outlet to Nougha Creek. The creek does have a large ponded area adjacent to Nougha Creek but flows from the creek enter this pond as seepage from the surrounding area. The distinct above ground channel that flows into a small alluvial area 50 m up from Nougha quickly dissipates into the wetland area leaving no above ground flow. Flows within the ponded area occur as seepage. The creek proper drains a willow tangled and spruce filled draw. Vegetation adjacent to the channel is alpine shrub.

The creek does not provide fish habitat, nor access to Nougha Creek, however the outlet bay formed by the creeks historic flows does offer a zero velocity area adjacent to Nougha Creek and as such provides some fish habitat.

TN-8: Tributary to Nougha Creek #8 is a small creek (depth was 0.2 m and width was 0.8 m), narrowing to < 0.25 m) which flows as stepped 0.3 m waterfalls interspersed by riffle/rapids (velocity > 2 m/sec) through a dense tangle of willow. The tributary flows directly into Nougha Creek in a narrow, confined and incised channel. There is very little in terms of a zone of influence where the tributary enters Nougha Creek, since it enters on a deep side into velocities >2m/sec. The tributary provides very limited fish habitat, primarily due to steep gradient and high velocities. This creek does not merit further fisheries investigations.

TN-9: Tributary to Nougha Creek #9 enters Nougha Creek as a waterfall approximately 3 m high. A second waterfall occurs within 20 m. The waterfalls cascade over bedrock with boulders. Above the waterfall area the creek channel is narrow and confined with velocities >2 m/sec over predominantly boulder/cobble substrates. The creek is heavily covered with willow and spruce.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

The potential for fish utilization of this tributary is extremely limited due to high water velocities. The first 20 m of the creek forms a permanent barrier to fish passage. The creek enters Nougha directly with very little zone of influence. Nougha Creeks flows are fast (>2 m/sec) in this reach with a narrow and confined channel that provides very little low velocity habitats. This tributary creek does not provide fish habitat.

TN-10: Tributary to Nougha Creek #10. The upper reach starts 15 m u/s of Nougha Creek and is narrow and confined in an incised channel. The upper reach is 0.3 m wide and 0.5 m deep, on average, with surface velocities >1 m/sec.

The lower 15 m reach consists of mostly boulder substrates with a wetted width of 2 m, or greater. The lower reach of the creek has potential to support fish. The boulder substrates are clear of any silts or fines, a situation that may indicate ground welling.

This creek enters Nougha Creek where the flows are mostly <1 m/sec and some channel braiding occurs. The zone of influence to Nougha consists of an upstream pool of 2 m by 3 m and a downstream mix trail of approximately 2 m by 8 m, both of these areas have depths >0.5 m. Fish were captured in Nougha Creek adjacent to the tributary, however no fish were captured in the tributary itself. Sculpins and Arctic grayling juveniles were recorded in the zone of influence during summer and fall investigations.

TWV-1 Tributary to Wolverine Lake #1, also known as Jasper Creek, provides very little fish habitat and shows very low utilization. The creek is small with a depth of 0.3 m and a width of 0.6 m and has a high flow (<2 m/sec) through a heavy tangle of willow. The creek does provide an important mix zone as it enters Wolverine Lake. Several slimy sculpin and a single Arctic grayling juvenile were recorded in the creek. Large numbers of lake trout fry and grayling fry were recorded in the mix area of Wolverine Lake. Seines pulled in adjacent areas of Wolverine Lake had very low catches relative to those pulled in area influenced by TWV-1.

TWV-2 Tributary to Wolverine Lake #2 is a very small creek with depths of <0.01 m and width that does not exceed 0.3 m. The Creek does not provide any fish habitat.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

TWV-3 Tributary to Wolverine Lake #3 drains a wetland area adjacent to Wolverine Lake. The creek is has a low gradient in its lower reaches and in several locations throughout its length. Numerous species of fish, in limited numbers, were recorded in the creek near the outlet during all seasonal investigations. Available fish habitat occurs predominantly within 150 m of the lake, however small pockets of good habitat occur 500 m upstream of the lake near the confluence of two feeder creeks.

TVB & TVB-1 Tributary to van Bibber Creek, and tributary to this tributary. The site of investigation consisted of the headwater reaches at the confluence of two feeder creeks. The northern most of the feeder creek intersects the proposed access route just upstream of its confluence with the second feeder creek. The creeks both consist of wide, flat, stepped riffles with available structural habitats with very low conductivity (i.e. very pure water) and cold water temperatures. The reaches investigated are above a long reach consisting of high velocity water and a narrow channel with limited fish migration potential. Fish were not recorded in any of the channels of this creek.

Investigations into the outlet areas of these creeks revealed several to have significant fish values. The tributary to Wind Lake, TW-1, has an extended outlet area flowing through small bluffs of willow mixed with dwarf birch. The area is extensively worked by beavers and extends over 300 m from the lake. This area provides spawning and rearing habitat for Arctic grayling. Juvenile long nose sucker and juvenile Arctic grayling utilize the ponds associated with the creek near the lakeshore.

Tributary TWV3, at its outlet to Wolverine Lake, provides rearing habitats for juvenile Arctic grayling, juvenile lake trout, juvenile long nose sucker and juvenile burbot, resident slimy sculpin also utilize this creek. Suitable habitats are located upstream of the lake for a distance of 150 m, aerial assessments showed potential for fish habitat in scattered pockets up to the point of the confluence of two feeder creeks 500 m from the lake.

Most of the tributaries entering Nougha Creek are colder than Nougha throughout the year. Tributaries TN1 and TN3 provide limited fish habitats near the outlets, however utilization was restricted to within 20 m of Nougha Creek. Several of the tributaries create eddying in Nougha

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Proposed Access Road Creek Crossings
Fish Habitat Evaluation and Utilization Assessment, 1997

Creek at their point of entry creating important habitats in an otherwise fast flowing Nougha Creek.

Although most of the creeks investigated did not provide fish habitat, the outlet areas often enhanced fish habitats by introducing oxygen and nutrient rich waters to the lake and receiver creek. This was especially evident in the lakes where utilization of the waters at the creek outlet was significantly higher than in similar adjacent areas.

APPENDIX 1

**Complete General Descriptions of Creeks Crossed
by the
Two Possible Access Roads to the Wolverine Property**

**(Based on data collected on June 23- 26, July 29-31, and September
14-17,1997)**

Site: TeastL (TE)
Location: S.E. end East Lake
Aspect: South
Date Sampled: 25/06/97
Cover: 100% Willow filled draw
Photos: Plate 1
Comments: Creek has no apparent above ground flow. Possible ground flow enters TWND1 before entering the wetland area associated with East Lake.
Fish: Zero fish habitat.

Site: TW1
Lat/Long: 61°30.52 N / 130°25.48 W
Location: outlet of Creek to Wind Lake
Aspect: South East
Date Sampled: 23/06/97
Average Depth: 0.5 m
Average Width: 3 m
Average Velocity: >0 m/s
Temperature: 10.2 °C
Substrate: sand and sorted gravels in main flow, silt in adjacent slow water
Banks: abrupt up to 3 m high, mud banks
Cover: 60% willow
Vegetation: Willow, Dwarf birch and sedges
Channel: glides with slow pools
Photos: Plates 2, 3, 4, 5
Comments: Outlet has several ponds associated along the lake shore. beaver present
Fish: Numerous adult Arctic grayling in creek and occasional slimy sculpin and long nose sucker.

Site: TW1
Location: 30m u/s of Wind Lake to 300 m u/s of Wind Lake
Date Sampled: 30/07/97
Average Depth: 0.4 m
Average Width: 1.2 m
Average Velocity: >0.25 m/s
Temperature: 7.9 °C
Substrate: mostly silt, some gravel
Channel: even, slow glide
Comments: three old beaver dams have created a series of ponds, sporadic patches of pea gravel may provide spawning sites for grayling
Fish: many (65+) grayling juvenile/ sub adults and fry.

Site: TW1
Location: 30m u/s of Wind Lake to 300 m u/s of Wind Lake.
Date: 14/09/97
Substrates: a new layer of organic silts covers all substrates, including in flow areas.
Fish: abundant Arctic grayling fry

Site: TW2
Lat/Long: 61°30.51 N / 130°24.06 W
Location: Outlet to Wind Lake
Aspect: South
Date: 25/06/97
Average Depth: 0.5 m
Average Width: 0.3 m
Average Velocity: < 0.3 m/s
Temperature: 0.8°C
Substrate: silted sand and gravel
Banks: incised silt and sand 0.2 m high
Cover: 100% willow choked within 30 m of Wind Lake
Channel: above 35 m from lake narrow and incised, below 1-3 m wide flooded pools
Photos: Plates 6, 7, 8, 9
Comments: Zero fish habitat above 30 m from lake
Fish: Sub adult Arctic grayling adjacent to lake

Site: TW2
Location: outlet area at Wind Lake
Date: 30/07/97
Average Depth: 0.4 m
Average Width: 0.75 m
Average Velocity: >0 m/s
Temperature: 1.2°C
Vegetation: willow/sedge
Cover: 15% willow/sedge to 100% willow by 35 m u/s
Channel: first 35 m is glide in lake influence area, then to riffle in narrow confined channel (velocity is >1 m/sec above 35 m)
Comments: creek narrows 35 m from lake to 0.3 m wide into sedge / willow draw
Fish: very limited fish habitat u/s of 35 m

Site: WO
Location: Mouth of Nougha Creek at Wolverine Lake
Date: 25/06/97
Average Depth: 0.5 m

Average Width: 12 m
Average Velocity: > 1 m/s
Temperature: 11.2°C
Substrate: cobble / gravel with occasional boulders
Banks: abrupt rising 0.6 m above water level
Cover: 15% willow alder along shorelines only
Channel: Mostly Glide / reach ends with first riffles
Comments: see previous surveys
Fish: numerous grayling adult/ sub-adult, lake trout fry and juvenile., slimy sculpin, burbot

Site: WO
Date: 29/07/97
Fish: Arctic grayling adults, juvenile and post fry, lake trout adults, juveniles and fry, longnose sucker juveniles, slimy sculpin.

Site: WO
Date: 17/09/97
Fish: Arctic grayling adults (numerous), juvenile and fry, lake trout adults, burbot juveniles, long nose sucker juveniles and slimy sculpin

Site: TN1
Lat/Long: 61°30.11 N / 130°19.01 W
Location: Outlet to Nougha Creek
Aspect: South East
Date: 25/06/97
Average Depth: 0.15 m
Average Width: 0.5 m
Average Velocity: 1 m/s
Temperature: 5.6 °C
Substrate: 90 % gravel / 10 % boulders
Banks: tight and confined in places, undefined in others with flow through grass and trees
Cover: willow
Channel: mostly fast riffles with the occasional boulder pool
Photos: Plates 10, 11
Comments: 2 trails cross the creek 30 and 40 m from Nougha Creek, some gravel has become exposed on the trails and has developed into shallow riffles.
Fish: Zero observed / poor and limited fish habitats

Site: TN1-1
Location: outlet at Nougha Creek u/s for 20 m
Date: 29/07/97

Average Depth: 0.05 m
Average Width: 0.35 m
Average velocity: >1 m/s
Temperature: 4.5 °C
Substrate: gravel/boulder, occasional cobble
Fish: none captured or observed

Site: TN1-2
Location: trail crossing 30to 40 meters u/s from Nougha
Date: 29/07/97
Average Depth: 0.05 m
Average Width: 0.35 m
Average Velocity >1 m/s
Temperature: 4.5 °C
Substrate: 40 % cobble/ 60% gravel
Banks: open roadway with shallow sandy edges
Vegetation: sedge, with willows adjacent to roadway
Fish: none captured or observed

Site: TN1
Location: outlet to Nougha Creek u/s for 20 m
Date: 17/09/97
Temperature: 0.9°C
Fish: none recorded

Site: TN2
Location: Outlet to Nougha Creek
Aspect: South
Date: 25/06/97
Substrate: organics
Banks: undefined
Cover: 100%willow/alder
Channel: overland seepage
Photos: Plates 12, 13, 14, 15
Comments: Channel not defined, flow apparent only were it parallels Nougha Creek for 20 m, spills over banks over 5 m reach with no distinct outlet.
Fish: Zero fish habitat

Site: TN2
Location: uppermost winter road crossing
Date: 17/09/97
Comments: Creek channel crossing roadway is fed by ground welling approximately 1 m upstream of the roadway.

Site: TN3
Lat/Long: 61°30.42 N / 13°18.78 W
Location: Outlet to Nougha Creek
Aspect: East
Date: 25/06/97
Average Depth: 0.3 m
Average Width: 0.75 m
Average Velocity: 1 m/s
Temperature: 3.0 °C
Substrate: heavily silted with clayey sands
Banks: mossy 0.5 m high, well defined
Cover: 100% willow above 10 m outlet are
Channel: outlet is smooth glide/ above creek flows as fast riffle
Photos: Plates 16, 17
Comments: crossed by 2 roadways 40m from Nougha, large ice builds at upper roadway, entry to Nougha creates good eddy pools up and d/s of outlet
Fish: None observed, has potential especially near outlet

Site: TN3
Location: outlet area at Nougha Creek
Date: 29/07/97
Average Depth: 0.35 m
Average Width: 0.8 m
Average Velocity: <1 m/s
Temperature: 3.8 °C
Fish: 2 Arctic grayling post fry in d/s influence area

Site: TN3
Date: 17/09/97
Temperature: 1.1 °C
Fish: Arctic grayling juveniles/ post fry within 20 m of Nougha Creek

Site: TN7
Lat/Long: 61°33.55 N / 130°14.15 W
Location: Outlet to Nougha Creek
Aspect: North
Date: 24/06/97
Average Depth: 0.35 m
Average Width: 4 m

Average Velocity: 0 m/s
Temperature: 12.7 °C
Substrate: Silt, organic debris and occasional boulder
Banks: flooded
Cover: 30% willow
Channel: Back filled with water from Nougha Creek., small discernible above ground flow
Photos: Plates 18, 19, 20
Comments: Above ground flow appears as seepage from adjacent areas
Fish: Does not provide fish habitat other than flood bay adjacent to Nougha Creek, 1 grayling juvenile.

Site: TN8
Lat/Long: 61°33.44 N / 130°14.24 W
Location: Outlet to Nougha Creek
Aspect: North
Date: 24/06/97
Average Depth: 0.2 m
Average Width: 0.8 m
Average Velocity: > 2 m/s
Temperature: 2.2 °C
Substrate: cobble boulder with occasional log
Banks: pinched and confined, incised
Cover: 100% willow
Channel: Riffle/rapid
Photos: Plates 21, 22, 23
Comments: Channel remains narrow until entering Nougha Creek, Zone of influence greatly reduced by swift current in Nougha Creek.
Fish: Zero fish observed, very limited habitat, limited access due to velocities

Site: TN9-1
Lat/Long: 61°32.57 N / 130°14.96 W
Location: Outlet to Nougha Creek
Aspect: North
Date: 24/06/97
Average Depth: 0.4 m
Average Width: 1 m
Average Velocity: 0.1 m/s
Temperature: 3.2 °C
Substrate: bedrock and boulders
Banks: moss covered
Cover: 20% willow
Channel: Waterfall within 1 m of Nougha, slope greater than 30 % for 20 m

Photos: Plates 24, 25, 26, 27
Comments: Waterfall poses major and permanent barrier to fish passage, no outlet area habitat
Fish: None observed, extremely limited habitat

Site: TN9-2
Location: 80m u/s of outlet to Nougha Creek
Aspect: north
Date: 30/07/97
Average Depth: 0.1 m
Average Width: 0.5 m
Average Velocity: >2 m/s
Temperature: 4.1 °C
Substrate: 95% cobble/ 5% boulder
Banks: steep, mossy, incised banks
Vegetation: willow/moss
Cover: 100% willow
Channel: high velocity riffle
Comments: minimal fish habitat
Fish: no fish captured or observed

Site: TN10-1
Lat/Long: 61°32.56 N / 130°15.15 W
Location: Outlet to Nougha Creek u/s for 15m
Aspect: North
Date: 24/06/97
Average Depth: 0.5 m
Average Width: 0.5 m
Average Velocity: 1 m/s
Temperature: 2.0 °C
Substrate: Boulders
Banks: constricting and confining above 15 m from Nougha
Cover: 100% willow above 15 m from Nougha
Channel: Fast flowing riffle
Photos: Plate 28
Comments: potential fish habitat in first 15 m from Nougha. Very limited above constriction.
Fish: Zero observed

Site: TN10-2
Lat/Long: 61°32.54 N / 130°15.03 W
Location: 15 to 40 m u/s of Nougha

Aspect: north
Date: 30/07/97
Average Depth: 0.5 m
Average Width: 0.3 m
Average Velocity: >1 m/s
Temperature: 2.4 °C
Substrate: silt with occasional boulders
Banks: incised
Vegetation: willow
Cover: 100% willow
Channel: fast, narrow and deep, some undercut banks, riffle : rapid ratio = 10:1
Photos: Plate 29
Fish: Zero observed

Site: TN10
Location: Nougha Creek at outlet of TN10

Aspect: north
Date: 30/07/97
Average Depth: 0.35 m
Average Width: 14 m
Average Velocity: 1 m/s
Temperature: 14.1 °C
Substrate: 40% cobble/ 40% boulder/ 20% gravel
Banks: stable, 50% slope with rise of 0.5m
Vegetation: sedge/willow
Cover: 5% willow
Channel: mainly riffle, two islands present
Fish: juvenile grayling

Site: TN10-1
Date: 14/09/97
Temperature: 3.0 °C
Fish: Arctic grayling juveniles in TN10 zone of influence of Nougha Creek.

Site: VB1
Lat/Long: 61°30.31 N / 130°09.80 W
Location: 500 m reach below 2 headwater tributaries that form Van Bibber Creek
Aspect: East
Date: 25/06/97
Average Depth: 0.2 m
Average Width: 5 m
Average Velocity: 0.75 m/s
Temperature: 2.7 °C

Substrate: 80 % boulder / 20 % cobble / trace gravel
Banks: shallow but well defined, moss covered
Cover: None
Channel: riffle with occasional pool forming behind boulders
Photos: Plates 30, 31, 32, 33
Comments: Very low conductivity ELS at 600 v, large aulies build up at confluence area

Fish: None observed

Site: **TVB1**

Lat/Long: 61°30.28 N / 130°09.85 W

Location: immediately above confluence with other feeder to Van Bibber Creek

Aspect: North East

Date: 25/06/97

Average Depth: 0.3 m

Average Width: 0.8 m

Average Velocity: > 1 m/s

Temperature: 2.4 °C

Substrate: 60 % boulder/ 35 % cobble / 5 % gravel

Banks: incised well defined

Cover: 100% willow

Channel: mostly stepped riffles

Fish: No fish observed

Site: **TVB1**

Location: 500 m reach below confluence

Date: 31/07/97

Average Depth: 0.15 m

Average Velocity: 1 m/s

Temperature: 4.4 °C

Substrate: cobble/boulder

Vegetation: willow/moss

Channel: stepped riffle

Fish: none observed or captured

Sites: **VB, TVB1, and TVB2**

Date: 14/09/97

Temperature: 2.2 °C

Fish: None recorded

Site: **TWV1**

Lat/Long: 61°26.69 N / 130°10.88 W

Location: Outlet to Wolverine Lake

Aspect: South West

Date: 26/06/97
Average Depth: 0.2 m
Average Width: 1.2 m
Average Velocity: < 1 m/s
Temperature: 3.1 °C
Substrate: 80 % gravel / 10 % cobble / 10 % sand
Banks: well defined
Cover: 70- 100 % willow
Channel: 90 % riffle 10% pooling
Photos: Plates 34, 35
Comments: 10 m from lake channel narrows to 0.5 m width
Fish: Slimy sculpin near outlet

Site: TWV1
Location: outlet to Wolverine Lake u/s for 30 m
Date: 30/07/97
Average Depth: 0.15 m
Average Width: 0.6 m
Average Velocity: <2 m/s
Temperature: 4.7 °C
Substrate: 40% cobble / 50% gravel / 10% boulder
Vegetation: willow/moss
Cover: 50% willow for first 10 m then to 100% willow
Fish: Many grayling and lake trout fry in zone of influence of lake

Site: TWV1
Location: outlet to Wolverine Lake u/s for 30 m
Date: 16/09/97
Temperature: 1.2 °C
Fish: Slimy sculpin and one post fry Arctic grayling in creek, numerous Arctic grayling and occasional lake trout fry in creek influence zone of lake.

Site: TWV2
Lat/Long: 61°27.54 N / 130° 13.90 W
Location: Outlet to Wolverine Lake
Aspect: South West
Date: 26/06/97
Average Depth: 0.2 m
Average Width: 0.4 m
Average Velocity: 1 m/s
Temperature: 1.0 °C
Substrate: 50 % sand / 50 % gravel
Banks: mossy 50% slope rise 1 m

Cover: 100 % willow
Channel: incised and very small
Photos: Plate 36
Comments: Limited habitat with poor cover
Fish: None observed

Site: TWV3

Lat/Long: 61° 28.34 N / 130° 16.70 W
Location: Outlet into Wolverine Lake
Aspect: South West
Date: 26/06/97
Average Depth: 0.35 m
Average Width: 1 m
Average Velocity: < 0.5 m/s
Temperature: 1.1 °C
Substrate: silted sand/ gravel with much submerged willow
Banks: abrupt and defined rise 0.5 to 1 m
Cover: 0 for first 20 m from lake
Channel: 4:1 pool : riffle
Photos: Plates 37, 38
Comments: shelf ice along creek edge, good cover and habitats in lowest 20 m before lake
Fish: Lake trout fry, slimy sculpin, and burbot

Site: TWV3

Location: outlet to Wolverine Lake u/s for 40m
Date: 29/07/97
Average Depth: 0.4 m
Average Width: 1 m
Average Velocity: < 0.25 m/s
Temperature: 4.7 °C
Substrate: silt/sand
Channel: 100% glide below 40 m, pool / riffle 1:1 above 40m
Fish: lake trout fry and slimy sculpin captured

Site: TWV3

Location: outlet to Wolverine Lake u/s for 40 m
Date: 17/09/97
Temperature: 1.0 °C, Wolverine Lake temp. 8.5 °C
Fish: 14 Arctic grayling juveniles, 1 burbot juvenile, and 6 slimy sculpin.



Appendix 2

**Summary of Fish Sampling and Catch Records
Obtained During Investigations Conducted in the
Wolverine Lake Area During 1997**

Table 1 Seine Netting Results from the Wolverine Lake Area, 1997

DATE (d/m/yr)	SITE	TEMP (°C)	EFFORT (m ²)	CATCH						COMMENTS / COORDINATES
				AG	LT	SS	BB	DV	LNS	
23/06/97	TW1	10.2	42	6	0	0	0	0	0	
23/06/97	TW1	10.2	56	23	0	1	0	0	0	
25/06/97	WO	13.2	100	300+	1	0	0	0	0	
26/06/97	TWV3	1.1	49	0	3	4	1	0	0	
30/07/97	TW1		21	3	0	5	0	0	0	
30/07/97	TW1		6	0	0	1	0	0	1	
30/07/97	TN10 (@ Nougha)		28	0	0	0	0	0	0	
30/07/97	TN10 (@ Nougha)		28	1	0	0	0	0	0	
30/07/97	TWV1 (in lake)		84	4	0	0	0	0	0	
30/07/97	TWV1 (in lake)		70	68	16	0	0	0	0	
29/07/97	WO		77	144	0	0	0	0	0	
29/07/97	WO		40	13	0	0	0	0	0	
29/07/97	TWV3		49	3	0	0	0	0	0	
30/07/97	TWV1 (in lake)		70	3	2	0	0	0	0	
14/09/97	N-TN10		45	11	0	0	0	0	0	
14/09/97	WLVLK		105	19	0	2	0	0	0	
14/09/97	WLVLK		84	9	1	0	0	0	0	
16/09/97	M		90	0	0	6	0	0	0	
16/09/97	M		84	0	0	0	0	0	0	
16/09/97	M		42	0	0	0	0	0	0	
16/09/97	M		56	0	0	0	0	0	0	
16/09/97	M		60	0	0	2	0	0	0	
16/09/97	M		40	0	0	1	0	0	0	
16/09/97	M5		224	0	0	1	0	0	0	
16/09/97	M		70	0	0	0	0	0	0	61.18.42; 130.01.18
16/09/97	M		105	0	0	0	0	0	0	61.18.42; 130.01.18
16/09/97	M		63	0	0	0	0	0	0	61.18.42; 130.01.18
16/09/97	M		98	0	0	0	0	0	0	61.18.42; 130.01.18
16/09/97	M		60	0	0	0	0	0	0	61.23.13; 129.54.31
16/09/97	M		40	0	0	0	0	0	0	61.23.13; 129.54.31
16/09/97	M		50	0	0	0	0	0	0	61.23.13; 129.54.31
16/09/97	M6		21	0	0	0	0	0	0	
16/09/97	M5		30	0	0	0	0	0	0	
16/09/97	M5		66	0	0	0	0	0	0	
16/09/97	M		98	0	0	0	0	0	0	
16/09/97	M		60	0	0	0	0	0	0	
16/09/97	M		40	0	0	0	0	0	0	

* Species code: AG= Arctic grayling, LT= lake trout, SS= slimy sculpin, BB= burbot, DV= dolly varden/bull trout
LNS= longnose sucker.

Table 2 Summary of Results from Minnow Trapping in the Wolverine Lake Area, 1997

DATE SET (d/m/yr)	SITE	TIME SET	TIME PULLED	EFFORT (hrs)	CATCH *	
					DV	SS
14/09/97	TWLV1	16:25	18:30	50	0	0
15/09/97	G-1	10:16	9:20	23	0	0
15/09/97	G-2	10:20	9:20	23	0	0
15/09/97	G-3	10:25	9:25	23	0	0
15/09/97	G-4	10:30	9:25	23	0	0
15/09/97	G-5	10:37	9:25	23.2	0	0
15/09/97	M1	10:45	9:10	22.5	0	0
15/09/97	M2	10:45	9:10	22.5	0	0
15/09/97	M3	11:15	9:35	22.3	0	0
15/09/97	M4	11:20	9:35	22.25	0	0
15/09/97	M5	11:30	9:40	22.2	0	0
15/09/97	M6	11:45	10:00	22.25	0	0
15/09/97	M7	11:55	10:05	22.2	1	0
15/09/97	M	12:00	10:15	22.25	0	0
15/09/97	M	12:15	10:20	22	0	0
15/09/97	M	12:20	10:20	22	0	0
15/09/97	M	12:25	10:20	22	1	0
15/09/97	M	12:30	10:30	22	0	0
15/09/97	M	12:35	10:35	22	0	0
15/09/97	M	12:40	10:15	21.5	0	0
16/09/97	CkM4	15:40	9:40	42	0	0
16/09/97	CkM4	15:50	9:45	42	0	0
16/09/97	CkM4	15:50	9:45	42	0	0
16/09/97	CkM4	15:55	9:50	42	0	0
16/09/97	M4	16:00	9:50	41.8	0	0
16/09/97	M4	16:05	9:55	41.8	0	0
16/09/97	M4	16:10	9:55	41.75	0	0
16/09/97	M4	16:15	10:00	41.75	0	1
16/09/97	M4	16:20	10:00	41.6	0	0
16/09/97	M4	16:25	10:00	41.6	0	0
16/09/97	M4	16:25	10:05	41.6	0	0
16/09/97	M4	16:30	10:05	41.6	0	0
16/09/97	M4	16:35	10:10	41.5	0	0
16/09/97	M4	16:40	10:10	41.5	0	0
16/09/97	M4	16:45	9:35	40.8	0	0
16/09/97	M4	16:45	9:35	40.8	0	0

* Species code: SS= slimy sculpin, DV= dolly varden/bull trout

Table 3. Summary of Electro-fishing Results, Wolverine Lake Area - 1997

DATE	SITE	EFFORT (sec)	CATCH *						COMMENTS
			AG	LT	SS	BB	LNS	DV	
25/06/97	VB1	868	0	0	0	0	0	0	
25/06/97	TVB1	81	0	0	0	0	0	0	
25/06/97	TW2	174	5	0	0	0	0	0	AG = subadult
25/06/97	TN1	63	0	0	0	0	0	0	
25/06/97	TW2	87	5	0	0	0	0	0	
25/06/97	TN3	99	0	0	0	0	0	0	
25/06/97	TN3	59	1	0	1	0	0	0	downstream of trib
25/06/97	TN3	85	100+	0	0	1	0	0	upstream of trib
25/06/97	TN2	148	100+	0	0	0	1	0	upstream of trib
25/06/97	TN2	319	0	0	1	0	2	0	upstream of trib
26/06/97	TWV3	458	0	0	11	0	1	0	
26/06/97	TWV1	99	0	0	2	0	0	0	
23/06/97	TW1	260	7	0	0	0	0	0	
23/06/97	TW1	250	125+	0	0	0	0	0	
24/06/97	TN7	285	1	0	0	0	0	0	
24/06/97	TN8	106	0	0	0	0	0	0	
24/06/97	TN9	35	0	0	0	0	0	0	waterfall @ mouth = barrier
24/06/97	TN10	202	0	0	0	0	0	0	
30/07/97	TWV1	50	0	0	1	0	0	0	
30/07/97	TLW1	20	3	0	0	0	0	0	below beaver dam
30/07/97	TLW1	60	0	0	0	0	0	0	above beaver dam
30/07/97	TLW2	170	0	1	5	1	0	0	Campbell creek
30/07/97	TLW3 (IN LAKE)	74	0	0	3	0	0	0	at margin of creek apron into lake
30/07/97	TW1	481	75	0	0	0	0	0	
30/07/97	TW1	111	18	0	0	0	0	0	
30/07/97	TN9 (mouth Nougha)	106	4	0	1	0	0	0	Nougha creek at mouth of TN9
30/07/97	TN10	102	0	0	0	0	0	0	mouth u/s 15m
30/07/97	TN10 (mouth Nougha)	108	1	0	1	0	0	0	Nougha creek at mouth of TN10
29/07/97	TWV3	283	0	2	7	0	0	0	
29/07/97	TN3	60	0	0	0	0	0	0	1 unidentified fish
29/07/97	TN3	58	0	0	0	0	0	0	
29/07/97	TN3 (in Nougha)	61	(75-90)	0	0	0	0	0	
29/07/97	TN1	31	0	0	0	0	0	0	
29/07/97	TN1	18	0	0	0	0	0	0	
31/07/97	TW2	275	5	0	3	0	0	0	
31/07/97	TW2	20	0	0	0	0	0	0	
31/07/97	TVB1	511	0	0	0	0	0	0	
31/07/97	TVB1	122	0	0	0	0	0	0	
14/09/97	TVB	515	0	0	0	0	0	0	
14/09/97	TVB1	109	0	0	0	0	0	0	
14/09/97	TN10	135	0	0	0	0	0	0	
15/09/97	M	1044	0	0	69	0	0	4	
15/09/97	M4	170	0	0	0	0	0	0	
15/09/97	M4	127	0	0	2	0	0	2	
15/09/97	MONEY	171	0	0	1	0	0	0	upstream of site M4
17/09/97	WO	256	32	0	9	4	0	0	
17/09/97	WO	64	30	0	1	0	0	0	
17/09/97	TN1	30	0	0	0	0	0	0	
17/09/97	WO	358	10	0	0	0	0	0	
17/09/97	TWL3	148	14	0	6	1	0	0	
17/09/97	TN3	75	0	0	0	0	0	0	
17/09/97	TN3	73	2	0	1	0	0	0	
17/09/97	TN3	119	8	0	0	0	0	0	
17/09/97	WO	64	10	0	1	0	0	0	
17/09/97	WO	135	5	0	7	5	0	0	

* Species Code: AG= Arctic grayling, LT= lake trout, SS= slimy sculpin, BB= burbot, LNS= longnose sucker, DV= dolly varden/bull trout

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING

Habitat Evaluation of Money Creek

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Money Creek

Summary

Aerial assessments of Money Creek were conducted on July 14, 1997 in order to provide an evaluation of the creek and its potential to support fish. The July survey was a continuation of the 1996 investigation which focussed on species utilization along specific sections of Money Creek.

Money Creek flows as a high velocity creek with predominantly cobble substrates interspersed with boulders and sorted gravel. Fish habitats are limited and typically small. Concentrated pockets of key habitats exist along the creek, the most notable being the potential overwintering sites near Reach #7. The creek flows clear and shallow with high velocities that provide poor cover and few resting areas for fish.

The descriptions start at the creeks outlet at Francis Lake and continue upstream in ascending order to a point above Go Creek in the alpine headwaters of Money Creek. Money and Go Creek are shown on Figure 1 of the "Proposed Access Road Creek Crossings – Habitat Evaluation and Utilization Assessment, 1997" report.

Reach #1

Outlet area to Frances Lake 61°24.80 N/ 129°38.30 W.

Some silting of gravel and sand substrates, open area with many exposed gravel bars. Mostly shallow flat glide. Reach extends 150 m from Francis Lake.

Reach #2

Starts 150 m from lake, extends 350 m upstream of the Robert Campbell Highway bridge. Gravel/cobble substrate with some braiding the creek is primarily riffle runs and glides with few pools. This reach is 1.4 km long.

Reach #3

Increasing boulders and riffles begin above the Robert Campbell highway. Rapids begin at the point where the creek becomes confined by a canyon. Rapids interspersed by occasional pools and gravel bars. This reach is 3 km long.

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Habitat Evaluation of Money Creek

Reach #4

Start at 61°24.00 N/ 129°40.75 W.

Canyon becomes deeper and more abrupt, many cliff areas, rapids at bends of the creek, typically against cliffs. Mostly high velocity riffles over boulder cobble substrates. This reach includes sample site M3. This reach is 1 km long.

Reach #5

Starts at 61°23.85 N/ 129°41.00 W.

Longer glides with fewer pools and riffles, cobble/boulder substrates with very few side pools. The creek velocity has slowed with rare rapid "shoots" occurring in confined areas. Reach is 4 km long.

Reach #6

Starts at 61°23.85 N/ 129°44.00 W.

The creek develops more rapids and deep pools with large boulders becoming more common in boulder cobble substrates. Creek remains confined by canyon Riffle / pool sequences common. The reach is 2.3 km long and flows out across the edge of the Pelly Mountains.

Reach #7

Starts at 61°24.20 N/ 129°46.20 W.

A short reach that consists of a series of deep pools below stepped rapid / small pool sequences. This reach represents the most likely over wintering habitats (deepest and most frequent pools) observed on Money Creek. Reach is 0.8 km long.

Reach #8

Approximately three foot high falls at 61°24.17 N/ 129°46.45 W.

May be an impediment to fish passage at certain flows (high or low). Does not likely form a constant barrier to fish passage but is the most restrictive area in terms of fish passage on Money Creek. Substrates are predominantly bedrock with boulders and areas of sorted gravels. This reach is approximately 150 m long.

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Habitat Evaluation of Money Creek

Reach #9

Starts at waterfall in Reach #8.

Long flat glide/riffle with high velocities, substrates predominantly boulder with some cobble/gravel areas. This reach is 2.5 km long.

Reach #10

Starts at 61°24.33 N/ 129°48.50 W.

Large boulders occur commonly in fast flowing riffles, with some corner pools and glide areas. Substrates consist of an even mix of boulder, cobble, gravel substrate. A narrow flood plain exists within the continuing steep sided canyon. Occasional islands occur in braided areas where substrates are composed mainly of gravel and cobble mix (this includes site 10a). This reach is 3.5 km long.

Reach 10a

At 61°24.20 N/ 129°50.00 W.

Island with shallow, low volume channel on north side.

Reach #11

Starts at 61°24.33 N/ 129°52.00 W.

Wide shallow glides, creek channel up to 20 m wide, confined by steep sided valley. Gravel / cobble substrate.

Reach #11a

At 61°24.10 N/ 129°53.20 W.

Boulder strewn riffle area of higher velocity at tight meander scroll, steep sided cliff on north bank.

Reach #12

Starts at Outlet of tributary creek TM4 at sample site M4, located at 61°23.85 N/ 129°53.60 W

Wide flat glides with few smaller boulders dispersed throughout. Several gravel point bars and side channels, occasional small cliff banks with small pools associated at outside corners. Valley broadens to 800m wide flood plain, creek channel confined by banks averaging 2 m in

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Habitat Evaluation of Money Creek

height above water line. Creek becomes more meandering with abandoned channels visible. This reach is 4 km long.

Reach #12a

Large point bar with sorted gravels. Two old channels apparent on downstream side.

Reach #12b

At 61°24.33 N/ 129°48.50 W

Marks the downstream edge of recent burn. This burn extends up the Money Creek valley into the headwater area. Channel is braided in the wide flood plain, with substrates predominantly gravel. Large island (5m x 200m) formed by braided channel, excellent combination of habitat with pools and back eddies.

Reach #13

Starts at 61°22.10 N/ 129°53.70 W.

Finer gravel substrates with few boulders. Mainly glides with few riffles. Moderate velocities. Reach is 1.5 km long.

Reach #14

Starts at 61°21.50 N/ 129°53.90 W.

Creek increases in velocity and becomes more sinuous with increasing numbers of boulders. Few log sweepers with stick and log jams along corner banks, several boulder riffle runs interspersed by gravel bottom glides. The reach is 5.8 km long.

Reach #14a

At 61°21.00 N/ 129°54.80 W.

A potential obstruction created by a log jam backs water levels up to between 0.75 and 1.2 m high along the log jam area. Beaver activity has added to the obstruction. The channel has split as a result of the log jam. The original channel no longer flows through and exists as a pond, the new channel, also obstructed has backed up water so that the creek flows through adjacent vegetated areas to pass the obstruction.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Money Creek

Reach #15

Starts at 61°19.25 N/ 129°57.00 W.

Channel is wide and flat (up to 20 m wide) and boulder filled. Wide flood plain ends and vegetation becomes more dispersed typical of higher altitudes. Creek has predominantly cobble substrates with boulders consistently dispersed throughout; glide areas are short and rare. The reach is 3 km long.

Reach #15a

Ends at 61°18.65 N/ 129°59.00 W.

Large braided channel has shifted main flow into what map shows as side channel, which now has main flow. Old channel has maintained some flow now has limited flow linked by gentle shallow riffles. New channel is 650 m long. The downstream end (junction) of both channels is sample site M5.

Reach #16

Starts at 61°18.45 N/ 129°59.50 W.

Creek becomes noticeably smaller, substrates are boulder strewn cobbles and gravel, with occasional patches (up to 200 m in length) of sorted fine gravel. Creek consists mostly of long riffle areas, few glides or pools, open flood plain, glides with point bars, occasional strip of fine gravel (up to 200 m in length). This reach is 9.4 km long.

Reach #17

Starts at 61°24.33 N/ 129°48.50 W.

Channel narrows with the average width in this reach is 7 m and is as narrow as 3 m. Creek consists of mainly boulder riffles interspersed with gravel bottom glides with some wetland areas nearby. Wide flood plain with willow vegetation (no spruce near channel). Evidence of channel shifting throughout the reach with many abandoned channels visible. This reach includes sample sites M6 and M7 (outlet of Go Creek area) and is approximately 9 km long.

Reach #18

Starts at 61°21.15 N/ 130°04.50 W.

Area above Go Creek confluence. Flood plain narrows, adjacent vegetation remains similar with little streamside vegetation as elevation increases and vegetation becomes alpine with few

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Habitat Evaluation of Money Creek

shrubs and no trees. Approximately 10 km up this reach the creek flows shallow and braided over a glacial feature with angular and fractured cobbles for almost 1 km. This same type of creek structure occurs in several other areas further up the creek. The braided area 10 km up this reach marks the furthest point studied during our investigation.

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Habitat Evaluation of Nougha Creek

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Nougha Creek

Summary

The lower reaches may provide habitats for bull trout, although none were recorded during 1996 or 1997 surveys. Nougha Creek provides many good fish habitat areas but fish passage is blocked to upstream movements by waterfalls in Reach # 4. The creek provides many habitats for Arctic grayling.

Aerial assessments of Nougha Creek were conducted on July 16, 1997 in order to provide general comments about the creek and its potential to support fish.

The reaches of Nougha Creek are described below in ascending order, starting at the outlet to Finlayson River and moving upstream to the mouth of the creek at Wolverine Lake. Nougha Creek is shown on Figure 1 of the "Proposed Access Road Creek Crossings – Habitat Evaluation and Utilization Assessment, 1997" report.

Reach #1

Outlet to Finlayson River at 61°36.05 N/ 130°08.04W.

Flat slow glides with deep silts near the outlet and fine gravels becoming more prevalent nearer the Robert Campbell highway. This reach is 1.2 km long.

Reach #2

Starts at bridged crossing of the Robert Campbell highway at 61°35.65 N/ 130°08.04W.

Above the Robert Campbell highway cobble/gravel bottom glides with occasional boulders and deep pools occurring near undercut banks at creek bends. This reach is 2.8 km long.

Reach #2a

At 61°35.10 N/ 130°11.80 W.

A new channel has been cut due to beaver activity, beavers continue to dam in this location on the new channel. This beaver dam (>1 meter height) represents a partial obstruction to fish passage.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Nougha Creek

Reach #3

This reach starts at 61°35.30 N/ 130°10.75 W.

Boulders become more common, velocity increases causing more riffles with fewer pools, creek flows through a steep sided valley with the channel constricted by bedrock rock in places. This reach is 2.5 km long.

Reach #3a

At 61°35.10 N/ 130°11.80 W.

A small waterfall followed by 100 meter section of deep rapids with pools and many boulders. May limit fish passage during high or low flow periods.

Reach #4

Starts at 61°34.80 N/ 130°11.75 W.

Valley constricts, channel narrows and water velocity increases. Many large boulders with intermittent deep pools. First downstream rapid may present a barrier to fish during low water periods. This reach is 1 km long.

Reach #4a

At 61°34.50 N/ 130°12.85 W.

Area marked "rapids" on 1:50,000 topographic maps. Channel confined by a narrow gorge, mainly boulder rapids interspersed with deep pools. These rapids likely present a barrier to fish passage.

Reach #5

Starts at 61°33.44 N/ 130°13.75 W.

Valley broadens and channel flattens with gravel/cobble/boulder substrates. Long riffles/runs with some pools at stream bends. Riffles have high velocities. Good fish habitats are dispersed throughout the reach. This reach includes the outlets of tributaries TN7 and TN8. This reach is 2 km long.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Nougha Creek

Reach #6

Starts at 61°33.40 N/ 130°13.75 W.

Stepped rapids 100 meters in length likely present a barrier to fish passage. This reach flows at the point where Nougha Creek exits the Campbell Range of the Pelly Mountains. This reach is 0.8 km long.

Reach #7

Starts at 61°33.20 N/ 130°14.45 W.

Gradient decreases and stepped rapids become more dispersed with good pools between, several long glides exist and side channels are common, large pools have formed at creek bends. Substrates mostly cobble, some gravel patches and a few areas of fine gravel. This reach includes the outlets of tributary creeks TN9 and TN10 and is 2.3 km long.

Reach #8

Starts at 61°32.35 N/ 130°14.45 W.

Channel widens and velocity is significantly reduced. Gentle riffles followed by slow pools. Glide pools and back eddies are common. Aquatic vegetation and siltation occurs in mid channel areas. Above #8A substrates are composed of fine gravels in an area with sharp meander curves and varying velocities, flows still occur as glides with the occasional short riffle. Heavy willow vegetation encloses the creek and several ponds associated with the creek occur near the top of this reach. This reach is 3 km long.

Reach #8a

At 61°31.75'N/ 130°16.15W.

Wide meanders with sluggish flow and silted bottom. Old ox bow lakes connected and likely recharged during high water events. An extensive patch of fine well sorted pea gravels occurs at this site just above the ox bow lakes. Recent beaver activity is in evidence.

Reach #9

Starts at 61°31.08 N/ 130°17.25 W.

Extensive beaver dam area, a series of beaver dams creates wetland over 100 meters wide and presents an obstruction to fish passage. A wide willow flood plain occurs in this area and shows signs of recent and old beaver activities. Substrates are cobble and gravel in flow areas,

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Habitat Evaluation of Nougha Creek

silt in areas behind beaver dams and other low flow areas. This reach is 1 km long and includes the outlet area of a significant tributary from the South and South East (this tributary was not part of WMEC's investigation).

Reach #10

Starts at 61°30.80 N/ 130°17.90 W.

The creek channel is flat with a mix of substrates, gravel/cobble/boulder riffles occur with few pools interspersed. Good shoreline habitats in the form of side pools and cut banks exist. This reach extends to the mouth of Nougha Creek at the outlet of Wolverine Lake and is 1.6 km long.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING

Money Creek – Bull Trout Utilization Assessment, 1997

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Money Creek – Bull Trout Utilization Assessment, 1997

Assessments of Money Creek and two of its tributaries, Go Creek and an unnamed tributary that enters Money Creek from the north approximately 19 km upstream of Francis Lake, were investigated to determine potential spawning and over-wintering areas for bull trout. The assessments were conducted between September 15 and 18, 1997 and consisted of:

- aerial assessments conducted by helicopter to observe any aggregations of fish and map deep pools suitable for over-wintering;
- ground surveys using minnow traps, electro-fisher, seine net, angling and visual observations; and
- Float surveys conducted with dry suits, mask and snorkel to investigate micro-habitats and determine presence of adult fish.

Table 1 provides a description of the sample sites on Money and Go Creek, including tributaries to Go Creek, during 1996 and 1997 investigations.

Table 1 Station Descriptions and Locations

Site	Description
M1	Mouth of Money Creek at Francis Lake
M2	Money Creek - Mouth at Robert Campbell Highway
M3	Money Creek Approximately 3.5 km Upstream of the Outlet to Francis Lake
M4	Money Creek - Mouth Area of Major Tributary to Money Creek Approximately 18 km upstream of the Outlet to Francis Lake
M5	Money Creek Approximately 36 km Upstream of the Outlet to Francis Lake
M6	Money Creek 1 km Downstream of its Junction with Go Creek
M7G	Money Creek at its Junction with Go Creek
M8	Money Creek Downstream of Little Jimmy Valley Tributary
M9	Money Creek at Downstream End of Wide Gravel Area
G1	Go Creek at Junction Area with Money Creek
G2	Go Creek Approximately 2.5 km Upstream of the Mouth of Go Creek
G3	Go Creek Approximately 5.6 km Upstream of the Mouth of Go Creek
G4	Go Creek Approximately 5.9 km Upstream of the Mouth of Go Creek
G5	Go Creek Approximately 7.5 km Upstream of the Mouth of Go Creek
P1	Pup Creek, a Tributary of Go Creek
HO	Hawk Owl Creek, a Tributary of Go Creek

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Money Creek – Bull Trout Utilization Assessment, 1997

The species of fish in the study belongs to the dolly varden/ bull trout (*Salvelinus malma-confluentus*) complex. To determine the exact species involved, specific genetic tests were undertaken. Three specimens were taken during the field assessment, frozen and later delivered to Yukon Territorial Government Fisheries Department representatives. Genetic testing was done at the University of British Columbia by Eric Taylor, Assistant Professor, Department of Zoology. Growth hormone diagnostic testing was conducted and resulted in a positive identification of the specimens as bull trout *Salvelinus confluentus*. Further testing confirmed the initial result.

Bull trout are a sub-species of the genus *Salvelinus*, which includes Arctic char, lake trout and dolly varden. The species is wide spread throughout western North America and eastern Asia. Within the dolly varden / bull trout complex numerous forms exist, including northern and southern, anadromous and non-anadromous, stream resident and lake resident populations (Armstrong and Morrow, 1980). The different forms have developed varying life history strategies that make it difficult to confidently describe the Money Creek population based on existing models from other areas.

Although a great deal of information has been compiled on the species understanding, references in this specific type of habitat are limited. The similarities between land locked and anadromous individuals are subtle but distinct enough that the species complex has often been subjected to sub-species classifications, (e.g. bull trout/ dolly varden). The life history and habits of the various forms varies greatly depend on the surrounding environment. The fish in Money Creek correspond most closely with the stream resident form of dolly varden/ bulltrout, typically confined to clear water tributaries of major rivers. However, there are similarities with a form described as a stream-lake resident (Morrow and Armstrong, 1980). Genetic analysis, conducted by the Yukon Territorial Government Fisheries Department, in conjunction with the University of British Columbia, on specimens taken from the Liard River drainage in the Yukon has shown all specimens analyzed to be bull trout.

Timing of field investigations was coordinated after assessing several reference sources. The closest (proximity) bull trout population to have existing information is at Shiltsky Lake, Yukon, where spawning occurred between September 16 and 21, consistently over a five year period.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Money Creek – Bull Trout Utilization Assessment, 1997

Water temperatures at spawning vary with the reference; the 1995 spawn at Shiltsky Lake was recorded at 12°C, in contradiction to other recorded references which suggests spawning occurs between 5 and 7°C (Blackett, 1968) or near 8°C (Scott and Crossman, 1974).

Water temperatures in Money Creek were monitored with a data logger located 500 m downstream of the outlet of Go Creek (site W-14). Temperature data was recorded 20 times per day from August 20 to September 12. During this time period daily temperatures rose to highs of between 9 and 12°C, while night time lows fell as low as 5.7°C. Daily temperatures typically fluctuated between 3 to 5°C.

Thermographic records taken at site W-14 on Money Creek indicate that temperatures were approaching a high of 5 to 7°C on September 12 when the recorder was removed. Temperatures remained at that level until our investigations were conducted. Blackett (1960) reported that anadromous dolly varden in Alaska spawned at temperatures between 5 and 6°C but spawning ceased abruptly after a further 2°C drop in temperature. Temperatures at the time of our field investigations were near 6°C. In light of this, the lack of spawning individuals observed during the surveys may indicate that spawning occurred prior to the investigations.

Spawning did not appear to occur in large aggregations, as few suitable locations were recorded and those investigated showed no signs of a recent spawn. One potential area that large numbers may have spawned in is the gravel shoals located immediately upstream of the outlet of Money Creek to Francis Lake. Alternatively, small pockets of sorted, clean washed gravels were observed under undercut banks during the float surveys. These potential micro-spawning sites were small, usually oblong in shape and less than 0.5 x 0.3 m. Fish of this species complex have been recorded utilizing similar habitats (Armstrong and Morrow, 1980, and Blackett 1968).

Money Creek may be used as a spawning and rearing creek for bull trout, with adults utilizing Francis Lake and only entering the creek for spawning. Unpublished data from YTG (Thompson Per. Com, 1997) shows that eleven adult dolly varden / bull trout were captured during index gillnetting surveys of Francis Lake conducted in 1990. Of the eleven fish captured, one was taken in the East arm, one was taken in the small lake at the north end of the West arm, and nine were captured just to the south of the Money Creek outlet. This data suggested

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Money Creek – Bull Trout Utilization Assessment, 1997

that the creek is used for spawning and rearing while the lake is used by adults. This model would explain why extensive effort to capture bull trout produced only randomly scattered immature specimens. Considering this model it seems likely that the spawning locations would be located in the lower reaches of the creek. The steep canyon areas and rapids would present a barrier to adult fish migration during spawning in September when water levels are low. These same rapids become more passable to the fry during high water in the spring, allowing the upstream movement of fry that would rear in the creek for as much as several years, or until they reach sexual maturity.

Given the extended effort into locating bull trout in Money Creek and the low numbers of fish captured or observed, it seems likely that the population density and extent of utilization is quite low. Results of fish sampling from this investigation are provided in Appendix 2 of the Proposed Access Road Creek Crossings – Fish Habitat Evaluation and Utilization Assessment, 1997 report. The locations of the sample sites are shown on Figure 1 within the above noted report.

Potential over wintering sites exist in an area only accessible by helicopter. A very tight canyon starting approximately 8 km upstream of Francis Lake extends for a distance of approximately 2.5 km. The canyon has abrupt valley walls, is 100% confined and flows in a narrow channel interspersed with deep pools below abrupt rapids and steep riffles. This canyon area represents a unique habitat on Money Creek. Pools of the same depth occur rarely elsewhere on the creek and definitely do not occur in such a concentrated cluster. The series of pools starts at a small waterfall at coordinates 61°09'17"N / 129°46'45"W. Float surveys were conducted in the uppermost pool of the reach and Arctic grayling, in an aggregation of 24 adults and sub adults, were observed. One juvenile bull trout was observed below the pool.

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING
Money Creek – Bull Trout Utilization Assessment, 1997

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APPENDIX 3F
WOLVERINE AREA – VEGETATION STUDIES

Vegetation Study
of the
Wolverine Lake Area
Westmin Resources Limited

December, 1996

Overview

The Wolverine Lake study area falls within the Pelly Mountains Ecoregion as defined by Oswald and Senyk (1977) and the Ecoregions Working Group (1995). The terrain within the study area is generally over 1200 meters with widespread discontinuous permafrost. Much of the area is treeless with treeline occurring at 1350 to 1500 meters. The southern part of the study area was burned by a forest fire in 1994 and is now in the early stage of regenerative growth (refer to Figure 3.4 in the Baseline Biophysical Studies report for the regional vegetation communities).

In 1994, vegetation communities and soil types were classified for the Liard Basin and Logan Mountains by the Yukon Department of Renewable Resources (Zoldeski and Cowell, 1996). The proposed Wolverine Lake mine site lies immediately to the west of this area.

Methodology

Aerial photographs (1:40,000 scale taken in August, 1992) were used to delineate the major vegetation communities in the study area on NTS topographic maps. A ground-truthing of the air photos was carried out during a vegetation/habitat survey in mid-July, 1996. The vegetation sampling method was adapted from the format developed during the Southeast Yukon Ecosystem Classification (Zoldeski and Cowell, 1996).

Sampling plots were selected to represent the vegetation communities identified from the air photos. Plots were accessed by boat, helicopter and on foot. All sampling plots were 10 m x 10 m (100 m²). The plant species and their cover-abundance were described for each vegetative layer. Tree species 5 m or more in height constituted the overstorey, while the understorey consisted of three shrub layers (<0.5 m, 0.5-2 m and 2-5 m). The relative abundance of herbaceous plant species, bryophytes and lichens were recorded. Notes on elevation, aspect, slope and moisture regime were also taken. Additional observations of plant communities were taken during the walking transects between sampling plots and during other biophysical surveys in the study area. Locations of sampling plots and transects are shown in Figure 3.5 in the Baseline Biophysical Surveys report).

Vegetation communities were compared to the vegetation types identified by Geomatics International in the southeast Yukon (Zoldeski and Cowell, 1996). The vegetation type classification key provided in the Field Guide to Ecosystem Classification for the Southeast Yukon (Zoldeski and Cowell, 1996) was also used in the identification and naming of plant communities.

Plant specimens were identified in the field where possible. Some specimens were preserved for later identification. Floras used in the identification of vascular plants included Hulthen (1968) and Porsild and Cody (1980). Vitt *et al.* (1988) and MacKinnon *et al.* (1992) were used in the identification of bryophytes and lichens. Herbariums located at Forest Resources (DIAND), Fish and Wildlife Branch (Govt. of Yukon) and Agriculture Branch (Govt. of Yukon) were also used in specimen identification.

Vegetation Communities and Habitat Potential

Vegetation in the Wolverine Lake study area includes bog forests and upland forests, as well as alluvial plain shrub, subalpine transition and alpine tundra zones. A map showing vegetation types is presented in Figure 3.4. Polygons representing vegetation zones have been delineated. Several vegetation types may be shown within each polygon. It should be noted that the boundaries between polygons are not always distinct in some vegetation transition zones.

A complete list of plant species observed is given in Appendix 1. This is not intended to be an exhaustive list of plant species in the study area. A description of individual vegetation types and their extent within the study area is summarized within this section. A description of the strata composition in each vegetation type is presented in Appendix 2.

Closed Trembling Aspen Forest

A closed canopy of trembling aspen (*Populus tremuloides*) with minor occurrences of willow (*Salix* sp.) make up the tree layer. The low shrub layer consists mainly of soapberry (*Shepherdia canadensis*). Kinnikinick (*Arctostaphylos uva-ursi*), twinflower (*Linnaea borealis*) and common juniper (*Juniperus communis*) form the ground cover. The herb layer, not well developed, is dominated by fireweed (*Epilobium angustifolium*). Bryophytes and lichens are uncommon.

The Closed Trembling Aspen Forest vegetation type (V2) of the 1996 Southeast Yukon Ecosystem Classification best describes these aspen stands.

Closed aspen forests are found on well drained sandy sites on south or west facing slopes. This vegetation type is uncommon in the Wolverine Lake area. A few scattered stands occur in the upland vegetation zone, particularly on the southwest facing slopes above Wolverine and Little Wolverine Lakes.

Closed Balsam Poplar Forest

The closed tree canopy and tall shrub layer consist primarily of balsam poplar (*Populus balsamifera*), with occurrences of willow (*Salix* spp.). Soapberry (*Shepherdia canadensis*) and shrubby cinquefoil (*Potentilla fruticosa*) dominate the low shrub layer. Dwarf shrubs include kinnikinick (*Arctostaphylos uva-ursi*), prickly rose (*Rosa acicularis*) and twinflower (*Linnaea borealis*). The herb cover is not extensive, but includes a variety of species. The moss and lichen layer is not well developed.

This vegetation type resembles the Closed Balsam Poplar Forest (V3) of the 1996 Southeast Yukon Ecosystem Classification.

Closed balsam poplar forests, normally found on active alluvial sites, are uncommon in the Wolverine Lake area. A few scattered upland stands occur on the lower slopes northeast of Wolverine Lake.

Open Alpine Fir Forest

The open canopy overstorey in this vegetation type is dominated by alpine fir (*Abies lasiocarpa*). The dwarf shrub layer is particularly well developed and consists mainly of crowberry (*Empetrum nigrum*) and white mountain heather (*Cassiope tetragona*). Herbs are uncommon in this vegetation type. The non-vascular plant layer is comprised primarily of *Cladina* spp.

This vegetation type is similar to the Open Alpine Fir Forest (V16) of the 1996 Southeast Yukon Ecosystem Classification.

Open alpine fir forests are common throughout the subalpine transition zone in the Wolverine Lake area. Alpine fir forests on the upper slopes may transform into krummholtz. The lower extent of these alpine fir stands typically border on white or black spruce forests. On the slopes southwest of Wolverine Lake, alpine fir forests extend almost to the lakeshore.

Open White Spruce Forest

White spruce (*Picea glauca*) dominates the open canopy overstorey. The low and dwarf shrub layer is well developed and consists primarily of shrub birch (*Betula glandulosa*), willow (*Salix* sp.), Labrador tea (*Ledum groenlandicum*) and crowberry (*Empetrum nigrum*). Herbs are poorly represented in this vegetation type. The non-vascular plant layer is dominated by *Pleurozium shreberi* and *Cladina* sp.

This vegetation type resembles the Open White Spruce Forest (V17) of the 1996 Southeast Yukon Ecosystem Classification.

Open white spruce forests are fairly common in the upland vegetation zone, particularly on the slopes northeast of Wolverine and Little Wolverine Lakes. They are typically bordered by black spruce stands in the lower bog forests and extend upslope to open alpine fir forests in the subalpine transition zone.

Open Black Spruce Forest - Lowland

An open canopy of black spruce (*Picea mariana*) makes up the overstorey and tall shrub layers. Low shrubs include black spruce and willows (*Salix* spp.). The dwarf shrub consists of a variety of mainly ericaceous shrubs, predominately Labrador tea (*Ledum groenlandicum*). Herbs, not abundant, include graminoids (*Arctagrostis latifolia*). Sphagnum moss (*Sphagnum* spp.) and lichen (*Cladina* spp.) complete the ground cover.

This vegetation type is best described by the Open Black Spruce Forest (Organic Soil) (V19) of the 1996 Southeast Yukon Ecosystem Classification.

A narrow zone of open black spruce forests on organic soils is found on the lowland bog areas around much of Wolverine and Little Wolverine Lakes. It typically borders on the white spruce forest, alpine fir forest or black spruce forest (mineral soil) of the upland forest zone.

Shrub Birch Low Shrub

Shrub birch (*Betula glandulosa*) thickets, less than 2 m in height, form the dominant vegetative cover. A sparsely developed dwarf shrub layer is formed primarily of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). Herbs are uncommon in this vegetative type. The ground cover consists mostly of lichens (principally *Cladina* spp.).

This vegetation type resembles the Shrub Birch Medium/Tall Shrub (V101) of the 1996 Southeast Yukon Ecosystem Classification.

Low shrub birch thickets are common in the upper subalpine transition zone on the mountains around Wolverine Lake. It is also common in the alluvial plain shrub zone. Shrub birch is a major regeneration species following the 1994 forest fire in the southern portion of the study area.

Willow Low Shrub

A low shrub layer of willows (*Salix* spp.) dominates this vegetation type. The tree layer, mostly white spruce (*Picea glauca*), and tall willow (*Salix* spp.) shrub layer are sparsely developed. Dwarf shrubs consist mainly of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). The herb layer is poorly developed. Non-vascular plants are represented by feather moss (*Hylocomium splendens*), sphagnum moss (*Sphagnum girgensohnii*), and foliose lichens (*Peltigera scabrosa*).

The Willow Medium/Tall Shrub (V104) of the 1996 Southeast Yukon Ecosystem Classification is most similar to this vegetation type.

Stands of low willows are found along the upper tributaries to several of the drainages in the Wolverine Lake area. It also occurs as regeneration following the 1994 forest fire in the southern part of the study area.

Shrub Birch - Labrador Tea Low / Dwarf Shrub

The low and dwarf shrub layers are dominated by shrub birch (*Betula glandulosa*) and Labrador tea (*Ledum groenlandicum*). The sparse tall shrub layer consists of willow (*Salix* sp.) and paper birch (*Betula papyrifera*). Herbs, not abundant, are mostly graminoids, particularly *Festuca altaica*. Non-vascular plants are represented primarily by *Cladina mitis* and *Hyloconium splendens*.

The Shrub Birch-Labrador Tea Medium/Tall Shrub type (V102) of the 1996 Southeast Yukon Ecosystem Classification best resembles these vegetation stands.

This shrub vegetation is found in scattered stands throughout lower slopes of the upland forests around Wolverine Lake. It does not constitute a large portion of the vegetative cover in the area.

Labrador Tea Dwarf Shrub

A dwarf shrub layer of Labrador tea (*Ledum groenlandicum*) and a ground cover of lichen (predominately *Cladina stellaris* and *Cladina rangiferina*) characterize this vegetation type. Herbs are uncommon.

This vegetation type does not correspond to any of those described in the 1996 Southeast Yukon Ecosystem Classification.

This dwarf shrub type covers much of the mid elevation hillside southwest of Wolverine Lake. On slopes with north/northeast aspect, this vegetation extends down to the alpine fir krummholtz of the subalpine transition zone.

Mountain Avens Dwarf Shrub

A dwarf shrub layer of mountain avens (*Dryas integrifolia*) characterizes this alpine vegetation type. Other dwarf shrubs, including net-veined willow (*Salix reticulata*) and cranberry (*Vaccinium vitis-idaea*), also occur as ground cover. A sparse herb layer includes alтай fescue (*Festuca altaica*). Lichens include *Dactylina arctica* and *Cetraria* spp.

The Mountain Aven Dwarf Shrub (V107) of the 1996 Southeast Yukon Ecosystem Classification resembles this vegetation type.

Mountain avens are one of a complex of very low shrub types in the alpine tundra zone. They occur in scattered patches on the well drained upper alpine ridges in the Campbell Range north and east of Wolverine Lake.

Willow Dwarf Shrub

Dwarf shrubs, primarily net-veined willow (*Salix reticulata*) and other dwarf willow species (*Salix* spp.) form the most extensive layer in this vegetation type. The herb layer, although not well developed, includes a variety of species and is dominated by alтай fescue (*Festuca altaica*) in the mesic zones and water sedge (*Carex aquatilis*) in the wetter sites. Bryophytes and lichens are sparse in the mesic areas, while feather moss (*Tomenthypnum nitens*) forms extensive mats in the wet areas.

This vegetation type resembles the Willow Dwarf Shrub (V108) of the 1996 Southeast Yukon Ecosystem Classification.

Dwarf willow is a common shrub in the alpine tundra zone. In the Wolverine Lake study area, it occurs on the upper slopes of the Campbell Range.

Alpine Bearberry Dwarf Shrub

This dwarf shrub vegetation type is dominated by alpine bearberry (*Arctostaphylos alpina*). Crowberry (*Empetrum nigrum*) and shrub birch (*Betula glandulosa*) are also common. Herbs and mosses are uncommon. Lichens, primarily *Cladina stellaris* and *Alectoria ochroleuca*, form much of the ground cover.

This vegetation type resembles the Alpine Bearberry Dwarf Shrub (V118) of the 1996 Southeast Yukon Ecosystem Classification.

A dwarf shrub type that is relatively uncommon in the Wolverine Lake area, it occurs on alpine ridges such as the one west of Little Wolverine Lake.

Low-Bush Cranberry Dwarf Shrub

Low-bush cranberry (*Vaccinium vitis-idaea*) and net-veined willow (*Salix reticulata*) form the dwarf shrub layer. Other significant ground cover includes fruticose lichens (primarily *Alectoria ochroleuca* and *Cladonia* spp.). The herb layer, not extensive, consists mostly of graminoids, usually alтай fescue (*Festuca altaica*).

This vegetation type is similar to the Mountain Cranberry Dwarf Shrub (V121) described in the 1996 Southeast Yukon Ecosystem Classification.

Low-bush cranberry is another component of the dwarf shrub vegetation in the alpine tundra zone. It is found on exposed alpine ridges in the Campbell Range.

Grass Herb

Dense stands of alтай fescue (*Festuca altaica*) are the characterizing feature of this vegetation type. A variety of other herb species occur in low abundance. Shrubs are uncommon. The ground cover also includes lichens (predominately *Cladina rangiferina*).

The Mesic Grass Herb (V202) of the 1996 Southeast Yukon Ecosystem Classification is the vegetation type that best corresponds to these graminoid meadows.

Mesic grass meadows make up only a small component of the vegetation in the Wolverine Lake study area. They occur in moderately well drained depressions in the low alluvial shrub zone.

Sedge Herb

These wet sedge meadows are dominated by the water sedge, *Carex aquatilis*. Shrubs and forb species are uncommon. Extensive layers of brown moss, *Tomenthypnum nitens*, are formed in some areas.

This vegetation type resembles the Wet Sedge Herb type (V206) described in the 1996 Southeast Yukon Ecosystem Classification.

Sedge meadows, although not extensive in the Wolverine Lake area, occur in poorly drained areas in the alluvial shrub zone.

Wet Mixed Herb

Sedges (*Carex aquatilis*) form the dominant cover in this vegetation type. Other herb species, particularly tall Jacob's ladder (*Polemonium acutiflorum*) and swamp cinquefoil (*Potentilla palustris*) are also prevalent. Bryophytes and lichens are uncommon.

The Wet Mixed Herb (V214) of the 1996 Southeast Yukon Ecosystem Classification best describes this vegetation type.

Accounting for a very small component of the vegetative cover in the Wolverine Lake area, mixed herb meadows are found on the better drained lowland sites in the alluvial shrub zone. The open meadows near the creek draining Muskrat House Lake is one such example.

Cetraria - Alectoria Fruticose Lichen

This vegetation type is characterized by a ground cover dominated by fruticose lichens (primarily *Alectoria ochroleuca* and *Cetraria nivalis*). Dwarf shrubs include net-veined willow (*Salix reticulata*), arctic willow (*Salix arctica*) and other willow species (*Salix* spp.). The most prominent herb is alpine holy grass (*Heirochloe alpina*).

This vegetation type is similar to the *Cetraria-Alectoria ochroleuca* Fruticose Lichen (V300) of the 1996 Southeast Yukon Ecosystem Classification.

This high alpine vegetation type occurs on the high windswept ridges of the Campbell Range. It does not comprise a large part of the Wolverine Lake study area's vegetation.

Crustose - Fruticose Lichen

Boulder fields covered with fruticose (*Cetraria* spp.) and crustose (unidentified) lichens characterize this vegetation type. Shrubs are absent and herbs, including mainly altai fescue (*Festuca altaica*), are scarce.

The *Rhizocarpon-Umbilicaria* Crustose Lichen vegetation type (V301) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine boulder fields.

Relatively uncommon in the Wolverine Lake area, these boulder fields are found on the steeper alpine slopes of the Campbell Range.

Cladina Fruticose Lichen

Extensive mats of the lichen *Cladina stellaris* characterize this vegetation type. The herb layer is thin and dominated by arctic blue grass (*Poa arctica*). Shrubs and mosses are uncommon.

The *Cladina* Fruticose Lichen vegetation type (V302) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine lichen dominated zones.

Although normally an alpine vegetation type, a few isolated *Cladina* dominated communities occur within the alluvial shrub zone, such as in the Go Creek valley.

Other vegetation types observed but not sampled include:

Open Black Spruce Forest - Upland (V18 of the 1996 Southeast Yukon Ecosystem Classification) occurring on mineral soil on the fringes of the lowland bog forest and occasionally at higher elevations in the upland forest.

Willow -Shrub Birch Low/Tall Shrub (V105 of the 1996 Southeast Yukon Ecosystem Classification) occurring intermittently in the subalpine transition zone.

White Heather Dwarf Shrub (V115 of the 1996 Southeast Yukon Ecosystem Classification) occurring on exposed ridges in the alpine tundra zone.

Mesic Mixed Herb (V213 of the 1996 Southeast Yukon Ecosystem Classification) occurring infrequently in the subalpine transition zone.

It should be noted that **Open Tamarack-Spruce Forests** (V23 of the 1996 Southeast Yukon Ecosystem Classification) occur just north of the Wolverine Lake study area in the Noug Creek valley, but was not observed in the study area.

Metal Concentrations in Vegetation

Vegetation samples were collected from five sites in the study area in order to determine background levels of metal enrichment. The locations of these sampling stations are shown in Figure 3.5. Elevations and UTM coordinates are given in Table 1.

TABLE 1 VEGETATION SAMPLING STATIONS

Station	Elevation (m)	Location (UTM)
---------	---------------	----------------

1	1150	436850 E	6813350 N
2	1320	441400 E	6808800 N
3	1140	431000 E	6816500 N
4	1770	440550 E	6812100 N
5	1710	435050 E	6816500 N

Samples of lichens (*Cladina* spp.) and the leaves and twigs from willow shrubs (*Salix* spp.) were collected in mid-July, 1996. These species are common within the study area. The entire above ground portion of lichens and the leaves and twigs from the current year's growth of willows were collected. Samples were shipped to a laboratory for ashing and ICP analysis for metals.

The results of the vegetation metals concentration survey is presented in Table 2. The Labs Ltd.'s certificate of analysis is shown in Appendix 3.

Sensitivity of Vegetation to Disturbance

The sensitivity of vegetation in the Wolverine Lake area to human disturbance depends on factors such as elevation, site moisture, slope and soil texture. Lower elevation vegetation communities generally revegetate more easily, particularly aspen forests and willow and alder thickets which reproduce vegetatively (suckering). Alpine areas revegetate much more slowly because of the slower rate of succession due to climatic conditions and because the thin soil horizons are easily destroyed. The soil erosion hazard increases with the slope and with the silt content in the upper soil horizons. In areas with saturated soils and deep layers of organic materials, the removal of surface vegetation can lead to the melting of permafrost.

The vegetation types most vulnerable to disturbance by human activity in the Wolverine Lake study area include all those in the alpine tundra zone (alpine dwarf shrub and alpine lichen dominated vegetation types). Although soil erosion hazards and terrain constraints in the alpine tundra zone may be minimized by avoiding steep slopes and areas of cryoturbation, reclamation/revegetation of disturbed sites in this zone is difficult.

Removal of the surface vegetation and organic layers (primarily sphagnum peat) from lowland black spruce forests, such as those adjacent to the Wolverine and Little Wolverine Lakes may result in the melting of permafrost.

High water tables and deep organic layers typical of the wet sedge and wet mixed herb meadows that occur in lowlands, such as those along the creek draining Little Jimmy Lake, and in poorly drained areas in the alluvial shrub zone, such as along Go Creek near the airstrip may make these communities sensitive to development as well.

Revegetation / Reclamation

Revegetation with seed mixtures of native species (or agronomic varieties developed from northern native species) are most effective in reclaiming disturbed sites. The following species of native seed selections are recommended for the Pelly Mountains region (Kennedy, 1993):

Plant Community	Native Seed Selection	
White spruce/Black spruce	Ticklegrass	(<i>Agrostis scabra</i>)
	Tufted hairgrass	(<i>Deschampsia caespitosa</i>)
	Altai fescue	(<i>Festuca altaica</i>)
	Violet wheatgrass	(<i>Agropyron violaceum</i>)
	Fowl bluegrass	(<i>Poa palustris</i>)
	Bear root	(<i>Hedysarum alpinum</i>)
Mixed deciduous/Coniferous	Yukon wheatgrass	(<i>Agropyron yukonense</i>)
	Northern fescue	(<i>Festuca saximontana</i>)
	Glaucous bluegrass	(<i>Poa glauca</i>)
	Violet wheatgrass	(<i>Agropyron violaceum</i>)
	Big bluegrass	(<i>Poa glauca</i>)
	Arctic lupine	(<i>Lupinus arcticus</i>)
	Yellow locoweed	(<i>Oxytropis campestris</i>)
Black spruce	Ticklegrass	(<i>Agrostis scabra</i>)
	Tufted hairgrass	(<i>Deschampsia caespitosa</i>)
	Polargrass	(<i>Arctagrostis latifolia</i>)
	Violet wheatgrass	(<i>Agropyron violaceum</i>)
	Fowl bluegrass	(<i>Poa palustris</i>)
	Bear root	(<i>Hedysarum alpinum</i>)
Alpine fir	Tufted hairgrass	(<i>Deschampsia caespitosa</i>)
	Sheep fescue	(<i>Festuca ovina</i>)
	Alpine bluegrass	(<i>Poa alpina</i>)
	Violet wheatgrass	(<i>Agropyron violaceum</i>)
	Glaucous bluegrass	(<i>Poa glauca</i>)
	Mackenzie's hedysarum	(<i>Hedysarum mackenzii</i>)
	Yellow locoweed	(<i>Oxytropis campestris</i>)
Alpine fir/shrub birch-willow	Meadow foxtail	(<i>Alopecurus pratensis</i>)
	Tufted hairgrass	(<i>Deschampsia caespitosa</i>)
	Sheep fescue	(<i>Festuca ovina</i>)
	Alpine bluegrass	(<i>Poa alpina</i>)
	Glaucous bluegrass	(<i>Poa glauca</i>)
	Violet wheatgrass	(<i>Agropyron violaceum</i>)
	Mackenzie's hedysarum	(<i>Hedysarum mackenzii</i>)
Alpine dwarf shrub/sedge	Polargrass	(<i>Arctagrostis latifolia</i>)

Tufted hairgrass	<i>(Deschampsia caespitosa)</i>
Sheep fescue	<i>(Festuca ovina)</i>
Glaucous bluegrass	<i>(Poa glauca)</i>
Alpine bluegrass	<i>(Poa alpina)</i>

Guidelines for seed mixtures and fertilizer applications have been recommended by Kennedy (1993). Appropriate agronomic substitutions have also been recommended, if native seed selections are not available.

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APPENDIX 1

PLANT SPECIES

PLANT SPECIES

WOLVERINE LAKE STUDY AREA

Vascular Plants

Scientific name	Common name
<i>Abies lasiocarpa</i>	Alpine fir
<i>Achillea nigrescens</i>	Yarrow
<i>Aconitum delphinifolium</i>	Northern monkshood
<i>Anemone narcissiflora</i>	Narcissus-flowered anemone
<i>Anemone parviflora</i>	Northern anemone
<i>Anemone richardsonii</i>	Yellow anemone
<i>Arabis</i> sp.	Rock cress
<i>Arctagrostis latifolia</i>	Grass
<i>Arctostaphylos alpina</i>	Alpine bearberry
<i>Arctostaphylos rubra</i>	Red bearberry
<i>Arctostaphylos uva-ursi</i>	Kinnikinick
<i>Arnica cordifolia</i>	Heart-leaved arnica
<i>Artemesia arctica</i>	Wormwood
<i>Aster sibiricus</i>	Siberian aster
<i>Astragalus alpinus</i>	Alpine milk-vetch
<i>Betula glandulosa</i>	Shrub birch
<i>Betula papyrifera</i>	Paper birch
<i>Betula pumila</i>	Dwarf birch
<i>Campanula</i> sp.	Harebell
<i>Cardamine pratensis</i>	Cuckoo flower
<i>Carex aquatilis</i>	Water sedge
<i>Carex physocarpa</i>	Sedge
<i>Cassiope tetragona</i>	White mountain heather
<i>Cerastium arvense</i>	Mouse-ear chickweed
<i>Claytonia tuberosa</i>	Tuberous spring-beauty
<i>Cornus canadensis</i>	Bunchberry
<i>Corydalis pauciflora</i>	Few-flowered corydalis
<i>Delphinium glaucum</i>	Larkspur
<i>Dryas integrifolia</i>	Mountain aven
<i>Empetrum nigrum</i>	Crowberry
<i>Epilobium anagallidifolium</i>	Willow-herb
<i>Epilobium angustifolium</i>	Fireweed
<i>Epilobium latifolium</i>	Dwarf fireweed
<i>Equisetum arvense</i>	Common horsetail
<i>Equisetum scirpoides</i>	Dwarf scouring-rush
<i>Equisetum sylvaticum</i>	Woodland horsetail
<i>Festuca altaica</i>	Altai fescue
<i>Galium</i> sp.	Bedstraw

<i>Gentiana glauca</i>	Glaucous gentian
<i>Gentiana propinqua</i>	Four-petaled gentian
<i>Geocaulon lividum</i>	Northern comandra
<i>Hierochloa alpina</i>	Alpine holy grass
<i>Hedysarum alpinum</i>	Liquorice root
<i>Juniperus communis</i>	Common juniper
<i>Kalmia polifolia</i>	Bog laurel
<i>Ledum decumbens</i>	Northern Labrador tea
<i>Ledum groenlandicum</i>	Labrador tea
<i>Linnaea borealis</i>	Twinflower
<i>Lupinus arcticus</i>	Arctic lupine
<i>Luzula parviflora</i>	Small-flowered wood rush
<i>Lycopodium complanatum.</i>	Flattened clubmoss
<i>Lycopodium sp.</i>	Clubmoss
<i>Mertensia paniculata</i>	Bluebell
<i>Monenses uniflora</i>	Single delight
<i>Myosotis asiatica</i>	Forget-me-not
<i>Oxyria digyna</i>	Mountain sorrel
<i>Parnaisia sp.</i>	Grass-of-parnassus
<i>Pedicularis labradorica</i>	Labrador lousewort
<i>Pedicularis sudetica</i>	Sudeten lousewort
<i>Petasites sp.</i>	Coltsfoot
<i>Phyllodoce empetriformis</i>	Pink mountain heather
<i>Picea glauca</i>	White spruce
<i>Picea mariana</i>	Black spruce
<i>Pinus contorta</i>	Lodgepole pine
<i>Poa arctica</i>	Arctic blue grass
<i>Polemonium acutiflorum</i>	Tall Jacob's ladder
<i>Polygonum viviparum</i>	Alpine bistort
<i>Populus balsamifera</i>	Balsam poplar
<i>Populus tremuloides</i>	Trembling aspen
<i>Potentilla diversifolia</i>	Mountain meadow cinquefoil
<i>Potentilla fruticosa</i>	Shrubby cinquefoil
<i>Potentilla multifida</i>	Many-cleft cinquefoil
<i>Potentilla palustris</i>	Swamp cinquefoil
<i>Pyrola asarifolia</i>	Pink-flowered wintergreen
<i>Pyrola grandiflora</i>	Arctic wintergreen
<i>Ranunculus nivalis</i>	Snow buttercup
<i>Ribes sp.</i>	Black currant
<i>Rorippa sp.</i>	Yellow cress
<i>Rosa acicularis</i>	Prickly rose
<i>Rubus chamaemorus</i>	Cloudberry
<i>Rubus idaeus</i>	Red raspberry
<i>Rubus pubescens</i>	Dwarf raspberry
<i>Salix arctica</i>	Arctic willow
<i>Salix reticulata</i>	Net-veined willow

Salix spp.
Saxifraga caespitosa
Sedum roseum
Senecio lugens
Senecio triangularis
Senecio yukonensis
Shepherdia canadensis
Silene acaulis
Solidago sp.
Stellaria longipes
Thalictrum sparsifolium
Vaccinium uliginosum
Vaccinium vitis-idaea
Veronica wormskjoldii
Viburnum edule
Viola sp.

Willow
Tufted saxifrage
Roseroot
Black-tipped groundsel
Arrow-leaved senecio
Yukon groundsel
Soapberry
Moss campion
Goldenrod
Chickweed
Few-flowered meadowrue
Blueberry
Low-bush cranberry
Alpine speedwell
High-bush cranberry
Violet

Non-vascular Plants

Bryophytes

Grimmia sp.
Hylocomium splendens
Pleurozium schreberi
Racomitrium sp.
Sphagnum capillaceum
Sphagnum girgensohnii
Tomenthypnum nitens

Lichens

Alectoria ochroleuca
Bryoria sp.
Cetraria nivalis
Cetraria islandica
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladonia coccifera
Cladonia coniocraea
Cladonia spp.
Dactylina arctica
Lecidella euphorea
Masonhalea richardsonii
Nephroma arcticum
Peltigera scabrosa
Peltigera sp.
Stereocaulon paschale
Stereocaulon tomentosum

APPENDIX 2

VEGETATION TYPES AND HABITAT UNITS

OPEN ALPINE FIR FOREST

DESCRIPTION

The open canopy overstorey in this vegetation type is dominated by alpine fir (*Abies lasiocarpa*). The dwarf shrub layer is particularly well developed and consists mainly of crowberry (*Empetrum nigrum*) and white mountain heather (*Cassiope tetragona*). Herbs are uncommon in this vegetation type. The non-vascular plant layer is comprised primarily of *Cladina* spp.

This vegetation type is similar to the Open Alpine Fir Forest (V16) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Abies lasiocarpa*

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Abies lasiocarpa*

Low Shrubs (0.5-2 m): *Abies lasiocarpa*, *Betula glandulosa*

Dwarf Shrubs (<0.5 m): *Cassiope tetragona*, *Phyllodoce empetriformis*, *Kalmia polifolia*, *Vaccinium vitis-idaea*, *Empetrum nigrum*, *Vaccinium uliginosum*

Herbs: *Hierochloe alpina*

Bryophytes: *Plerurozium schreberi*, *Racomitrium* sp.

Lichens: *Cladina stellaris*, *Cladina rangeriferina*, *Cladonia coccifera*, *Nephroma arcticum*, *Cetraria nivalis*, *Bryoria* sp.

OPEN WHITE SPRUCE FOREST

DESCRIPTION

White spruce (*Picea glauca*) dominates the open canopy overstorey. The low and dwarf shrub layer is well developed and consists primarily of shrub birch (*Betula glandulosa*), willow (*Salix* sp.), Labrador tea (*Ledum groenlandicum*) and crowberry (*Empetrum nigrum*). Herbs are poorly represented in this vegetation type. The non-vascular plant layer is dominated by *Pleurozium shreberi* and *Cladina* sp.

This vegetation type resembles the Open White Spruce Forest (V17) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Picea glauca*

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Salix* sp.

Low Shrubs (0.5-2 m): *Betula glandulosa*, *Salix* sp.

Dwarf Shrubs (<0.5 m): *Betula glandulosa*, *Ledum groenlandicum*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Rosa acicularis*, *Empetrum nigrum*

Herbs: *Mertensia paniculata*, *Pedicularis labradorica*, *Cornus canadensis*.

Bryophytes: *Pleurozium schreberi*, *Grimmia* sp.

Lichens: *Cladina stellaris*, *Cladina rangiferina*, *Stereocaulon paschale*, *Cetraria nivalis*, *Nephroma arcticum*, *Cladonia* sp., *Bryoria* sp.

SHRUB BIRCH - LABRADOR TEA LOW / DWARF SHRUB

DESCRIPTION

The low and dwarf shrub layers are dominated by shrub birch (*Betula glandulosa*) and Labrador tea (*Ledum groenlandicum*). The sparse tall shrub layer consists of willow (*Salix* sp.) and paper birch (*Betula papyrifera*). Herbs, not abundant, are mostly graminoids, particularly *Festuca altaica*. Non-vascular plants are represented primarily by *Cladina mitis* and *Hyloconium splendens*.

The Shrub Birch-Labrador Tea Medium/Tall Shrub type (V102) of the 1996 Southeast Yukon Ecosystem Classification best resembles these vegetation stands.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Salix* sp., *Betula papyrifera*

Low Shrubs (0.5-2 m): *Betula glandulosa*, *Salix* sp.

Dwarf Shrubs (<0.5 m): *Ledum groenlandicum*, *Empetrum nigrum*,
Arctostaphylos uva-ursi, *Vaccinium vitis-idaea*, *Juniperus communis*

Herbs: *Festuca altaica*, *Epilobium angustifolium*, *Mertensia paniculata*, *Lupinus arcticus*, *Polemonium acutiflorum*,
Gentiana propinqua

Bryophytes: *Hylocomium splendens*

Lichens: *Cladina mitis*, *Cladonia coccifera*, *Peltigera* sp.

SHRUB BIRCH LOW SHRUB

DESCRIPTION

Shrub birch (*Betula glandulosa*) thickets, less than 2 m in height, form the dominant vegetative cover. A sparsely developed dwarf shrub layer is formed primarily of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). Herbs are uncommon in this vegetative type. The ground cover consists mostly of lichens (principally *Cladina* spp.).

This vegetation type resembles the Shrub Birch Medium/Tall Shrub (V101) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Low Shrubs (0.5-2 m): *Betula glandulosa*, *Salix* sp.

Dwarf Shrubs (<0.5 m): *Empetrum nigrum*, *Ledum groenlandicum*, *Betula glandulosa*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Salix* sp.

Herbs: *Pedicularis labradorica*

Bryophytes: *Hylocomium splendens*, *Grimmia* sp.

Lichens: *Cladina stellaris*, *Cladonia* sp., *Lecidella euphorea*, *Stereocaulon paschale*, *Nephroma arcticum*

LABRADOR TEA DWARF SHRUB

DESCRIPTION

A dwarf shrub layer of Labrador tea (*Ledum groenlandicum*) and a ground cover of lichen (predominately *Cladina stellaris* and *Cladina rangiferina*) characterize this vegetation type. Herbs are uncommon.

This vegetation type does not correspond to any of those described in the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Ledum groenlandicum*, *Betula pumila*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Salix* sp.

Herbs: *Pedicularis labradorica*

Bryophytes: *Racomitrium* sp.

Lichens: *Cladina stellaris*, *Cladina rangiferina*, *Masonhalea richardsonii*, *Cladonia coniocraea*, *Dactylina arctica*, *Cetraria nivalis*, *Stereocaulon paschale*, *Alectoria ochroleuca*

***Cetraria - Alectoria* FRUTICOSE LICHEN**

DESCRIPTION

This vegetation type is characterized by a ground cover dominated by fruticose lichens (primarily *Alectoria ochroleuca* and *Cetraria nivalis*). Dwarf shrubs include net-veined willow (*Salix reticulata*), arctic willow (*Salix arctica*) and other willow species (*Salix* spp.). The most prominent herb is alpine holy grass (*Heirochloe alpina*).

This vegetation type is similar to the *Cetraria-Alectoria ochroleuca* Fruticose Lichen (V300) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Salix reticulata*, *Salix arctica*, *Salix* sp., *Vaccinium vitis-idaea*, *Dryas integrifolia*, *Cassiope tetragona*

Herbs: *Hierchloe alpina*, *silene acaulis*, *Saxifraga caespitosa*, *Stellaria longipes*, *Anemone parviflora*

Bryophytes: *Grimmia* sp.

Lichens: *Alectoria ochroleuca*, *Cetraria nivalis*, *Cladina rangiferina*, *Stereocaulon tomentosum*

CLOSED BALSAM POPLAR FOREST

DESCRIPTION

The closed tree canopy and tall shrub layer consist primarily of balsam poplar (*Populus balsamifera*), with occurrences of willow (*Salix* spp.). Soapberry (*Shepherdia canadensis*) and shrubby cinquefoil (*Potentilla fruticosa*) dominate the low shrub layer. Dwarf shrubs include kinnikinick (*Arctostaphylos uva-ursi*), prickly rose (*Rosa acicularis*) and twinflower (*Linnaea borealis*). The herb cover is not extensive, but includes a variety of species. The moss and lichen layer is not well developed.

This vegetation type resembles the Closed Balsam Poplar Forest (V3) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Populus balsamifera*, *Salix* sp.

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Populus balsamifera*

Low Shrubs (0.5-2 m): *Shepherdia canadensis*, *Populus balsamifera*, *Potentilla fruticosa*, *Salix* sp.

Dwarf Shrubs (< 0.5 m): *Arctostaphylos uva-ursi*, *Rosa acicularis*, *Linnaea borealis*, *Juniperus communis*, *Ledum groenlandicum*

Herbs: *Epilobium angustifolium*, *Delphinium glaucum*, *Mertensia paniculata*, *Festuca altaica*, *Gentiana propinqua*, *Hedysarum alpinum*

Bryophytes: *Grimmia* sp.

Lichens: *Cladonia coccifera*, *Cladina ragiferina*

CRUSTOSE - FRUTICOSE LICHEN

DESCRIPTION

Boulder fields covered with fruticose (*Cetraria* spp.) and crustose (unidentified) lichens characterize this vegetation type. Shrubs are absent and herbs, including mainly alтай fescue (*Festuca altaica*), are scarce.

The *Rhizocarpon-Umbilicaria* Crustose Lichen vegetation type (V301) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine boulder fields.

STRATA COMPOSITION

UNDERSTOREY SPECIES

- Herbs:** *Festuca altaica*, *Senecio yukonensis*, *Anemone parviflora*
- Bryophytes:** *Racomitrium* sp.
- Lichens:** *Cetraria nivalis*, *Cetraria islandica*

LOW-BUSH CRANBERRY DWARF SHRUB

DESCRIPTION

Low-bush cranberry (*Vaccinium vitis-idaea*) and net-veined willow (*Salix reticulata*) form the dwarf shrub layer. Other significant ground cover includes fruticose lichens (primarily *Alectoria ochroleuca* and *Cladonia* spp.). The herb layer, not extensive, consists mostly of graminoids, usually altai fescue (*Festuca altaica*).

This vegetation type is similar to the Mountain Cranberry Dwarf Shrub (V121) described in the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Vaccinium vitis-idaea*, *Salix reticulata*

Herbs: *Festuca altaica*, *Lupinus arcticus*, *Anemone parviflora*

Lichens: *Alectoria ochroleuca*, *Cladonia* spp., *Cladina* spp.

WILLOW DWARF SHRUB

DESCRIPTION

Dwarf shrubs, primarily net-veined willow (*Salix reticulata*) and other dwarf willow species (*Salix* spp.) form the most extensive layer in this vegetation type. The herb layer, although not well developed, includes a variety of species and is dominated by alтай fescue (*Festuca altaica*) in the mesic zones and water sedge (*Carex aquatilis*) in the wetter sites. Bryophytes and lichens are sparse in the mesic areas, while feather moss (*Tomenthypnum nitens*) forms extensive mats in the wet areas.

This vegetation type resembles the Willow Dwarf Shrub (V108) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Salix reticulata*, *Salix* spp., *Vaccinium vitis-idaea*

Herbs: *Festuca altaica*, *Carex aquatilis*, *Carex physocarpa*, *Petasites* sp., *Stellaria longipes*, *Mertensia paniculata*, *Pyrola grandiflora*, *Anemone narcissiflora*, *Aconitum delphinifolium*, *Polemonium acutiflorum*, *Pedicularis sudetica*, *Senecio lugens*, *Equisetum arvense*

Bryophytes: *Tomenthypnum nitens*, *Hylocomium splendens*, *Sphagnum capillaceum*

Lichens: *Cetraria nivalis*, *Masonhalea richardsonii*, *Dactylina arctica*, *Cladina stellaris*

WILLOW LOW SHRUB

DESCRIPTION

A low shrub layer of willows (*Salix* spp.) dominates this vegetation type. The tree layer, mostly white spruce (*Picea glauca*), and tall willow (*Salix* spp.) shrub layer are sparsely developed. Dwarf shrubs consist mainly of crowberry (*Empetrum nigrum*) and Labrador tea (*Ledum groenlandicum*). The herb layer is poorly developed. Non-vascular plants are represented by feather moss (*Hylocomium splendens*), sphagnum moss (*Sphagnum girgensohnii*), and foliose lichens (*Peltigera scabrosa*).

The Willow Medium/Tall Shrub (V104) of the 1996 Southeast Yukon Ecosystem Classification is most similar to this vegetation type.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Picea glauca*

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Salix* spp.

Low Shrubs (0.5-2 m): *Salix* spp., *Betula glandulosa*

Dwarf Shrubs (<2 m): *Ledum groenlandicum*, *Empetrum nigrum*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Arctostaphylos rubra*, *Rubus pubescens*

Herbs: *Arctagrostis latifolia*, *Carex aquatilis*, *Parnaisia* sp., *Petasites* sp., *Epilobium angustifolium*, *Anemone richardsonii*, *Equisetum scirpoides*

Bryophytes: *Hylocomium splendens*

Lichens: *Peligeria scabrosa*.

ALPINE BEARBERRY DWARF SHRUB

DESCRIPTION

This dwarf shrub vegetation type is dominated by alpine bearberry (*Arctostaphylos alpina*). Crowberry (*Empetrum nigrum*) and shrub birch (*Betula glandulosa*) are also common. Herbs and mosses are uncommon. Lichens, primarily *Cladina stellaris* and *Alectoria ochroleuca*, form much of the ground cover.

This vegetation type resembles the Alpine Bearberry Dwarf Shrub (V118) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Arctostaphylos alpina*, *Empetrum nigrum*, *Betula glandulosa*,
Vaccinium uliginosum, *Vaccinium vitis-idaea*

Herbs: *Lupinus arcticus*, *Pedicularis labradorica*

Lichens: *Cladina stellaris*, *Alectoria ochroleuca*, *Cetraria nivalis*,
Stereocaulon tomentosum

GRASS HERB

DESCRIPTION

Dense stands of alтай fescue (*Festuca altaica*) are the characterizing feature of this vegetation type. A variety of other herb species occur in low abundance. Shrubs are uncommon. The ground cover also includes lichens (predominately *Cladina rangiferina*).

The Mesic Grass Herb (V202) of the 1996 Southeast Yukon Ecosystem Classification is the vegetation type that best corresponds to the these graminoid meadows.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Herbs: *Festuca altaica*, *Artemesia arctica*, *Aconitum delphinifolium*,
Mertensia paniculata, *Solidago* sp., *Senecio lugens*, *Achillea*
nigrescens, *Artemesia arctica*

Bryophytes: *Hylocomium splendens*

Lichens: *Cladina rangiferina*, *Nephroma arcticum*, *Dactylina arctica*,
Cladonia coccifera, *Cladonia* sp.

MIXED HERB

DESCRIPTION

Sedges (*Carex aquatilis*) form the dominant cover in this vegetation type. Other herb species, particularly tall Jacob's ladder (*Polemonium acutiflorum*) and swamp cinquefoil (*Potentilla palustris*) are also prevalent. Bryophytes and lichens are uncommon.

The Wet Mixed Herb (V214) of the 1996 Southeast Yukon Ecosystem Classification best describes this vegetation type.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Herbs:

Carex aquatilis, *Polemonium acutiflorum*, *Potentilla palustris*, *Parnaisia* sp., *Luzula parviflora*



SEDGE HERB

DESCRIPTION

These wet sedge meadows are dominated by the water sedge, *Carex aquatilis*. Shrubs and forb species are uncommon. Extensive layers of brown moss, *Tomenthypnum nitens*, are formed in some areas.

This vegetation type resembles the Wet Sedge Herb type (V206) described in the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Herbs: *Carex aquatilis*

Bryophytes: *Tomenthypnum nitens*

***Cladina* FRUTICOSE LICHEN**

DESCRIPTION

Extensive mats of the lichen *Cladina stellaris* characterize this vegetation type. The herb layer is thin and dominated by arctic blue grass (*Poa arctica*). Shrubs and mosses are uncommon.

The *Cladina* Fruticose Lichen vegetation type (V302) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine lichen dominated zones.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Herbs: *Poa arctica*, *Artemesia arctica*, *Rubus pubescens*

Lichens: *Cladina stellaris*, *Masonhalea richardsonii*, *Cladonia coniocraea*

CLOSED BALSAM POPLAR FOREST

DESCRIPTION

The closed tree canopy and tall shrub layer consist primarily of balsam poplar (*Populus balsamifera*), with occurrences of willow (*Salix* spp.). Soapberry (*Shepherdia canadensis*) and shrubby cinquefoil (*Potentilla fruticosa*) dominate the low shrub layer. Dwarf shrubs include kinnikinick (*Arctostaphylos uva-ursi*), prickly rose (*Rosa acicularis*) and twinflower (*Linnaea borealis*). The herb cover is not extensive, but includes a variety of species. The moss and lichen layer is not well developed.

This vegetation type resembles the Closed Balsam Poplar Forest (V3) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Populus balsamifera*, *Salix* sp.

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Populus balsamifera*

Low Shrubs (0.5-2 m): *Shepherdia canadensis*, *Populus balsamifera*, *Potentilla fruticosa*, *Salix* sp.

Dwarf Shrubs (< 0.5 m): *Arctostaphylos uva-ursi*, *Rosa acicularis*, *Linnaea borealis*, *Juniperus communis*, *Ledum groenlandicum*

Herbs: *Epilobium angustifolium*, *Delphinium glaucum*, *Mertensia paniculata*, *Festuca altaica*, *Gentiana propinqua*, *Hedysarum alpinum*

Bryophytes: *Grimmia* sp.

Lichens: *Cladonia coccifera*, *Cladina ragiferina*

CLOSED TREMBLING ASPEN FOREST

DESCRIPTION

A closed canopy of trembling aspen (*Populus tremuloides*) with minor occurrences of willow (*Salix* sp.) make up the tree layer. The low shrub layer consists mainly of soapberry (*Shepherdia canadensis*). Kinnikinick (*Arctostaphylos uva-ursi*), twinflower (*Linnaea borealis*) and common juniper (*Juniperus communis*) form the ground cover. The herb layer, not well developed, is dominated by fireweed (*Epilobium angustifolium*). Bryophytes and lichens are uncommon.

The Closed Trembling Aspen Forest vegetation type (V2) of the 1996 Southeast Yukon Ecosystem Classification best describes these aspen stands.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Populus tremuloides*, *Salix* sp.

UNDERSTOREY SPECIES

Low Shrubs (0.5-2 m): *Shepherdia canadensis*, *Populus tremuloides*, *Potentilla fruticosa*

Dwarf Shrubs (< 0.5 m): *Arctostaphylos uva-ursi*, *Linnaea borealis*, *Juniperus communis*, *Arctostaphylos rubra*, *Rosa acicularis*, *Shepherdia canadensis*, *Populus tremuloides*, *Picea glauca*

Herbs: *Epilobium angustifolium*, *Festuca altaica*, *Mertensia paniculata*, *Lupinus arcticus*, *Delphinium glaucum*, *Solidago* sp., *Gentiana propinqua*

Bryophytes: *Racomitrium* sp.

Lichens: *Stereocaulon tomentosum*, *Peltigera scabrosa*

CRUSTOSE - FRUTICOSE LICHEN

DESCRIPTION

Boulder fields covered with fruticose (*Cetraria* spp.) and crustose (unidentified) lichens characterize this vegetation type. Shrubs are absent and herbs, including mainly alтай fescue (*Festuca altaica*), are scarce.

The *Rhizocarpon-Umbilicaria* Crustose Lichen vegetation type (V301) of the 1996 Southeast Yukon Ecosystem Classification best describes these alpine boulder fields.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Herbs: *Festuca altaica*, *Senecio yukonensis*, *Anemone parviflora*

Bryophytes: *Racomitrium* sp.

Lichens: *Cetraria nivalis*, *Cetraria islandica*

MOUNTAIN AVENS DWARF SHRUB

DESCRIPTION

A dwarf shrub layer of mountain avens (*Dryas integrifolia*) characterizes this alpine vegetation type. Other dwarf shrubs, including net-veined willow (*Salix reticulata*) and cranberry (*Vaccinium vitis-idaea*), also occur as ground cover. A sparse herb layer includes altai fescue (*Festuca altaica*). Lichens include *Dactylina arctica* and *Cetraria* spp.

The Mountain Aven Dwarf Shrub (V107) of the 1996 Southeast Yukon Ecosystem Classification resembles this vegetation type.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Dryas integrifolia*, *Salix reticulata*, *Vaccinium vitis-idaea*

Herbs: *Anemone parviflora*, *Festuca altaica*, *Saxifraga caespitosa*

Lichens: *Dactylina arctica*, *Cetraria* spp.

LOW-BUSH CRANBERRY DWARF SHRUB

DESCRIPTION

Low-bush cranberry (*Vaccinium vitis-idaea*) and net-veined willow (*Salix reticulata*) form the dwarf shrub layer. Other significant ground cover includes fruticose lichens (primarily *Alectoria ochroleuca* and *Cladonia* spp.). The herb layer, not extensive, consists mostly of graminoids, usually alтай fescue (*Festuca altaica*).

This vegetation type is similar to the Mountain Cranberry Dwarf Shrub (V121) described in the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

UNDERSTOREY SPECIES

Dwarf Shrubs (<0.5 m): *Vaccinium vitis-idaea*, *Salix reticulata*

Herbs: *Festuca altaica*, *Lupinus arcticus*, *Anemone parviflora*

Lichens: *Alectoria ochroleuca*, *Cladonia* spp., *Cladina* spp.

OPEN BLACK SPRUCE FOREST - LOWLAND

DESCRIPTION

An open canopy of black spruce (*Picea mariana*) makes up the overstorey and tall shrub layers. Low shrubs include black spruce and willows (*Salix* spp.). The dwarf shrub consists of a variety of mainly ericaceous shrubs, predominately Labrador tea (*Ledum groenlandicum*). Herbs, not abundant, include graminoids (*Arctagrostis latifolia*). Sphagnum moss (*Sphagnum* spp.) and lichen (*Cladina* spp.) complete the ground cover.

This vegetation type is best described by the Open Black Spruce Forest (Organic Soil) (V19) of the 1996 Southeast Yukon Ecosystem Classification.

STRATA COMPOSITION

OVERSTOREY SPECIES

Trees (>5 m): *Picea mariana*

UNDERSTOREY SPECIES

Tall Shrubs (2-5 m): *Picea mariana*

Low Shrubs (0.5-2 m): *Salix* sp., *Picea mariana*

Dwarf Shrubs (<0.5 m): *Ledum groenlandicum*, *Empetrum nigrum*, *Picea mariana*,
Vaccinium uliginosum, *Vaccinium vitis-idaea*, *Arctostaphylos*
rubra, *Rubus chamaemorus*

Herbs: *Arctagrostis latifolia*, *Petasites* sp., *Veronica wormskjoldii*,
Equisetum scirpoides

Bryophytes: *Sphagnum* spp.

Lichens: *Cladina* spp., *Bryoria* sp.

APPENDIX 5A

**MEETINGS AND CONSULATIONS HELD FOR
THE WOLVERINE PROJECT
WESTMIN RESOURCES LIMITED, 1996**

June 26, 1996
Land Resources Room 3A Federal Building

Attendees:

D. Mchaina, Westmin, M. Zrum, DIAND Lands, J. Hough, DIAND Lands, M. Fraser, DIAND Lands, D. Cornett, Access Mining Consultants

Issue	Response
<p>Project Land Use/Access</p> <ul style="list-style-type: none"> • Existing land use not documented for area. Want information on existing land use in area. • Planning for project – the earlier the better. • A lot of political based concerns and comments on any project these days. • Possible access routes for project should be considered now. • Access could be a problem/political issue. 	<ul style="list-style-type: none"> • Wildlife being looked at with YTG and RRC • Heritage not being considered for road. • S. Greer met with RRC elders. • Discussed with elders specific comments. • Field survey to identify gravesites, animal licks, cabin sites. • Met with RRC to discuss future work – Aug. 1996. • Also discussed important plants, medicinal, vegetation, trails, and traplines. • Baseline document to be revised based on comments from RRC.
<ul style="list-style-type: none"> • Access corridor needs to be considered. • Surface tenure for infrastructure and facilities needed. • Basic idea of infrastructure – get to lands ASAP. • File application with basic layout of property ASAP. 	<ul style="list-style-type: none"> • RRC asking for global look at area (global view) • Acknowledge this
<ul style="list-style-type: none"> • DIAND being asked by RRC re: land/access. • Part of CEEA – impacts – cumulative impacts – historic use of area needs to be addressed. 	<ul style="list-style-type: none"> • RRC concerns: land use; heritage; wildlife • RRC want global component – good for some area i.e. wildlife, more difficult for heritage. • RRC letter – Agreement in Principle to support global view of project area – especially for wildlife.
<ul style="list-style-type: none"> • RRC – wants global view in other projects. • Level of review different for each project. 	<ul style="list-style-type: none"> • Westmin supports global view for certain areas – wildlife. • Cominco – 13 million tonnes KZK – small • Westmin – good size mine

Issue	Response
<p>CEAA Review</p> <ul style="list-style-type: none"> • Sooner into the review process the better . • Get lands application submitted. • RRC needs to lobby for global approach. 	<ul style="list-style-type: none"> • Acknowledge
<ul style="list-style-type: none"> • Will land tenure and land use be included in study. • Sooner Westmin knows project the better • Be advised that threshold limits for surface tenure – Order in Council needed. 	<ul style="list-style-type: none"> • Westmin working on this.
<ul style="list-style-type: none"> • Keep communication up – in advance of target dates. EA process uncertain. 	<ul style="list-style-type: none"> • Airstrip - June 10 – reclamation underway – camp area being reclaimed where site moved. • Garbage permit for burning. • Did inspection of camp. Would like inspection with Lands – 1 week – 2 week notice for field inspection – 1st week of August – target date/

**June 27, 1996
Fisheries Meeting – DFO Boardroom**

Attendees:

D. Mchaina, Westmin; G. Faulkner, DFO; C. Osborne, DFO; D. Cornett, Access Mining Consultants Ltd.

Issue	Response
<p>Wolverine Lake Fish Management</p> <ul style="list-style-type: none"> • Lake trout productivity high in Wolverine Lake. YTG designated as high quality management lake. • YTG to provide copy of YTG order when done. • Restricts fish size – 69 – 100 mm – slot restrict – spawning size restriction. • If in camp, procession of fish restricted. • More strict limits and requirements to release fish – conservation measure. 	<ul style="list-style-type: none"> • If high quality management water lake – what does it mean to Westmin?
<ul style="list-style-type: none"> • YTG could do more monitoring if needed. Education to ensure conversation of stocks. Idea to inform people of important resources. 	<ul style="list-style-type: none"> • Is monitoring intensified by YTG/DFO?

Issue	Response
<p>Fish Survey</p> <ul style="list-style-type: none"> • Preliminary fish survey – Identify area for fish compensation? 	<ul style="list-style-type: none"> • Approach to try to document any visible area of concern. But this is a preliminary survey. • Review drainage layout – discuss spring, summer, fall survey overview. • Summer program: good coverage; habitat classification – White Mountain Environmental Consulting (WMEC); check out area for dolly varden use; expect survey to ensure extent of dolly usage. Permit for summer – ensure documented. Westmin to review survey with WMEC.

Issue	Response
<p>Benthos Benthic program: Limited number of control stations for project area: Reference to Report: Environment Canada, June 1993. "Control site" needed on Money and Wolverine Creek. Match habitat types within area – a consideration for control sites.</p>	<ul style="list-style-type: none">• Acknowledge.• Revised document in September 1996



June 28, 1996
DIAND Mineral Resources Meeting – Room 4B

Attendees:

D. Mchaina, Westmin; D. Cornett, Access Mining Consultants Ltd., H. Copeland, DIAND Minerals; K. Besso, DIAND Minerals; M. Dejohn, DIAND Minerals; P. MacLeod, Dawson Mining Recorder

Issue	Response
<p>Mining Land Use Regulations</p> <ul style="list-style-type: none"> • DIAND encourages company to comply with Mining Land Use Regulations so that no surprises down the road. 	<ul style="list-style-type: none"> • Agreed

Issue	Response
<p>Project</p> <ul style="list-style-type: none"> • When is project decision to be made? 	<ul style="list-style-type: none"> • Fall 1996 – Project overview expected • Baseline study developed with initial scoping meeting with the RRC/Regulatory agencies. • Document not complete – socio economic/land use/ cumulative effects not considered. • Comments incorporated from agencies, review of study plan undertaken in field program this season; • Will also incorporate RRC TEK. • Also plan non-native consultations for study surveys. • Plan to discuss with Liard First Nation down the road, but RRC wants to be main contact.
<ul style="list-style-type: none"> • Comments from Liard First Nation? • DIAND Minerals problem with Cominco • Project management team (PMT) used for other project which uses First Nations. • PMT is possible approach – DIAND Minerals reviewing 	<ul style="list-style-type: none"> • Westmin concerned with timing and when to involve other First Nation groups

<ul style="list-style-type: none"> • DIAND Minerals has met with RRC on Mineral Acts. • Better to get all involved from beginning. • RRC knowledge is limited. • DIAND Minerals planning more meetings to discuss Mineral Regulations/Acts with RRC. 	
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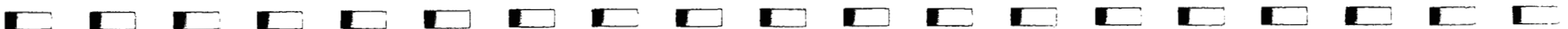
Issue	Response
Wildlife <ul style="list-style-type: none"> • RRC concerns? 	<ul style="list-style-type: none"> • RRC concerned with global wildlife management. • Agreement in Principle with RRC to regional approach to wildlife issues. Don't agree with heritage and land use regional. RRC should spearhead wildlife management. Westmin committed to help/fund; but don't want to see global programs delay project development.
<ul style="list-style-type: none"> • YTG responsible for wildlife: • Expect scoping exercise – especially for cumulative effects and baseline study. • Plan for scoping meeting. 	<ul style="list-style-type: none"> • Westmin acknowledges this.

Issue	Response
Heritage <ul style="list-style-type: none"> • RRC view to study? 	Heritage Update: <ul style="list-style-type: none"> • S. Greer & DM visit with RRC; • Identify field visit sites; • Elder were with company and S.Greer – couldn't locate gravesites as located on claim sheets; • A revised Terms of Reference will be developed and trip planned in Sept. 1996
<ul style="list-style-type: none"> • Document all sites visited (even if no heritage sites found) for IEE 	<ul style="list-style-type: none"> • Not enough time allotted. Need more time on ground.

<ul style="list-style-type: none"> Type of protection for sites? 	<ul style="list-style-type: none"> RRC wants protection of existing sites; Confidentiality a concern with RRC No sites in real conflicts with development sites now for roads or mine.
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Issue	Response
<p>Rock Characterization</p> <ul style="list-style-type: none"> See comments in DIAND Minerals letter (surficial geology) 	<ul style="list-style-type: none"> First cut mapping at 1:30,000 for surficial geology.
<ul style="list-style-type: none"> Detailed map for infrastructure needed (1:10,000 scale better). 	<ul style="list-style-type: none"> Westmin acknowledges
<ul style="list-style-type: none"> Composition of geological units a concern. 	<ul style="list-style-type: none"> 20 drill holes used. h.w. – 30 m/range for sampling f.w. 20 m/range Composite within geological units used EP has concerns with 3 sample/unit For composite geo units – do ABA, check results, direct next stage, esp. kinetic test. On basis of test results, additional tests to be done. ICP for all samples, but number of kinetic and sulphide sulphur tests not same. For further program, when revised, want Environment Canada and DIAND Geology input into study design.

Issue	Response
<p>Mining Land Use Regulations</p> <ul style="list-style-type: none"> • Claim inspections out recently – Finlayson area • Camp set up to do claim inspections, expect education program for MLUR. • Will be at Wolverine Lake (Rob Thompson, Leo Vankeabek) • Take draft of MLUR • Auto mail out for MLUR update • Fuel storage - 4000 L limit – needs secondary containment in MLUR • Under MLUR – yes. • Keeping fuel to <10 drums at camp; 	<ul style="list-style-type: none"> • Westmin operating procedures – on site protocol – based on MLUR – company auditing use of procedures. • Let camp know that mineral inspection this summer – MLUR/claims/water. • If 20 drums – can have in separate area? • Airstrip secondary fuel area in compliance now.



June 28, 1996
DIAND Water Resources Meeting – Room 4B

Attendees:

D. Mchaina, Westmin; R. Janowicz, DIAND Water Resources; S. Herron, DIAND Water Resources; G. Whitley, DIAND Water Resources; D. Cornett, Access Mining Consultants Ltd.

Issue	Response
General <ul style="list-style-type: none"> • Any work on Cominco claims? 	<ul style="list-style-type: none"> • None as of yet.
Climate <ul style="list-style-type: none"> • Manual meteorological station – monitoring temperature, precipitation. • Expect more sophisticated weather data. • Could use KZK data. • Problem with Cominco site, as not same area. 	<ul style="list-style-type: none"> • Cominco and Westmin relationship means that data is not shared. • Costs for automated weather station high; • Recognize data need.
<ul style="list-style-type: none"> • Wind, solar radiation should be collected – automatic station needed. 	<ul style="list-style-type: none"> • Student trained for climate data collection. • Westmin/Access Mining Consultants audited student's work. • Doing other data collection.
Project <ul style="list-style-type: none"> • Mine plan – any ideas? 	<ul style="list-style-type: none"> • September 1996 – project overview with concepts of mine plan. • Water quality program tied into rock characterization program.
Water Quality <ul style="list-style-type: none"> • What are water quality issues? 	<ul style="list-style-type: none"> • Water licence required; therefore, focus on watershed water quality.
<ul style="list-style-type: none"> • Why were locations for water quality stations chosen? 	<ul style="list-style-type: none"> • Global aspects considered for program that covered off two

	drainages.
<ul style="list-style-type: none">• Winter snow survey – should be done for Mar 1997.• Use regional data and tie into program• Need snow data and more low flow data.	<ul style="list-style-type: none">• Comments to be incorporated in revised document



June 28, 1996
DIAND Environment Meeting – Room 2B

Attendees:

D. Mchaina, Westmin; M. Crombie, DIAND Environment; Len Mychasiuw, DIAND Environment; D. Cornett, Access Mining Consultants Ltd.

Issue	Response
<p>General</p> <ul style="list-style-type: none"> • Sheep location on foot claims? 	<ul style="list-style-type: none"> • July 1 post caribou calve survey to look at sheep areas. • March survey – no sheep identified.
<ul style="list-style-type: none"> • Cominco/Westmin Joint Venture Area? 	<ul style="list-style-type: none"> • Yes – not sure of exploration program in this area.
<p>Issue</p>	<p>Response</p>
<p>RRC Concerns</p> <ul style="list-style-type: none"> • Cominco IEE – KZK – Wolverine Lake central area from RRC heritage surveys 	<ul style="list-style-type: none"> • Heritage scoping issue discussed with RRC. • Chief RRC wants global approach. • Chief letter to Westmin – agree with Westmin study as long as Westmin support global approach to wildlife. • Westmin – think that heritage is not global.
<ul style="list-style-type: none"> • What does RRC want done in area? 	<ul style="list-style-type: none"> • RRC wants joint company/government/RRC joint wildlife management in area • Want to have key habitats identified and control measures in place • RRC concern with increased access to area • Westmin committed to participate in wildlife global approach lead by RRC • Westmin could support this with money
<ul style="list-style-type: none"> • Traditional ecological knowledge (TEK) – oral history – use for specific problems questionable. • Should try to work with RRC to define valued ecosystem component to help use oral history. 	<ul style="list-style-type: none"> • Oral history to be owned by RRC; • Westmin wants to protect heritage resources.

<ul style="list-style-type: none"> • Use of TEK for other areas – wildlife, etc? 	<ul style="list-style-type: none"> • Use for mitigation program, etc. • TEK document and use for RRC history • Plan to integrate TEK with baseline study • Wildlife information “confidential” • Westmin to respect RRC wishes for confidentiality.
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Issue	Response
Land Use <ul style="list-style-type: none"> • Documenting trapline, outfitter, and recreation use in area. 	<ul style="list-style-type: none"> • Planning to use KZK model • Dorothy Dick did Cominco land use will address.
<ul style="list-style-type: none"> • Document non traditional use of area? Could also use YTG – hunter survey. 	<ul style="list-style-type: none"> • K. Kiemele passed along existing land use in area – trails/use etc. will be used. • Non-native stakeholder – Westmin still trying to address plan for this.
<ul style="list-style-type: none"> • Guide operating in area. Recreational use of area. 	<ul style="list-style-type: none"> • Discussed with YTG/Lands Resources.

Issue	Response
Liard First Nation <ul style="list-style-type: none"> • Why is Liard First Nation not involved? 	<ul style="list-style-type: none"> • RRC letter saying they speak for Kaska Dena. • Contact Liard Band – 3 Liard bands. Should contact each band group.
<ul style="list-style-type: none"> • Liard First Nation needs to be brought in as Liard First Nation traditional area. • DIAND Environment has map of traditional area. 	
<ul style="list-style-type: none"> • Wolverine Lake outside RRC trapping area – will be private trap line. 	<ul style="list-style-type: none"> • Acknowledge
<ul style="list-style-type: none"> • Make sure covering all RRC interests in area and land. 	<ul style="list-style-type: none"> • Meeting with Chief in June • Westmin to contact Liard First Nation as well. • RRC Contact: N. Sterriah/George Smith
<ul style="list-style-type: none"> • DIAND Environment discussion with RRC that in IEE regional land use can't be considered 	<ul style="list-style-type: none"> • Westmin position – timeline important; Wolverine deposit in area of RRC. Need to focus on deposit area.

Issue	Response
<p>Project</p> <ul style="list-style-type: none"> • Results of drilling in? 	<ul style="list-style-type: none"> • Expect Sept. 1996 – decision on drilling number of tonnes/ resources. • Use results to make decision on project. • Limnological study to be done; • Vegetation studies – add roots to survey for containment testing. • Vegetation RRC wildlife use – ensure contaminates testing for key plants (roots/leaves/twigs)
<ul style="list-style-type: none"> • Report on contaminants in vegetation in Yukon. See M. Gamberg or M. Palmer DIAND for copy of report. 	<ul style="list-style-type: none"> • Acknowledge

Issue	Response
<p>Cumulative Effects</p> <ul style="list-style-type: none"> • Cumulative effects: ensure considered in baseline thinking. • Must consider Cominco in cumulative impacts. • Address Westmin's operation/mitigation for impact, then minimize cumulative impacts. 	<ul style="list-style-type: none"> • Will consider Cominco KZK in cumulative effects. • Consider phased approach – operational, exploration – impacts added to Westmin's cumulative effects. • Cumulative impacts must be looked for CEEA (projects status in area to be looked at)
<ul style="list-style-type: none"> • Ownership could be tied to anyone – monitoring may have to be shared. • If cumulative effects are outside of area, then have to be addressed. • Wildlife key area in cumulative effects - company policy important in this area. 	<ul style="list-style-type: none"> • Acknowledge

**June 28, 1996
YTG Renewable Resources Meeting
Transport Canada Boardroom**

Attendees:

D. Mchaina, Westmin, D. Cornett, Access Mining Consultants Ltd.,
YTG: Rick Ward, Val Lorin, Ken Kiemele, Jean Carey, Rob Florkowicz, Rick Farnel, Manfred Hoefs, Bruce McLean, Kelvin Leary

Issue	Response
Wildlife <ul style="list-style-type: none"> ● Focus of March Survey? 	<ul style="list-style-type: none"> ● General reconnaissance for caribou and moose

Issue	Response
Project <ul style="list-style-type: none"> ● Drills rigs – chopper moved? ● Number of drill holes? 	<ul style="list-style-type: none"> ● Access by trail ● 30 holes 1996 and 1995 ● Problems with drilling this year (slow) ● Water problems/access
<ul style="list-style-type: none"> ● Project decision date? ● How long to get through process? 	<ul style="list-style-type: none"> ● Sept/Oct target date – submit project overview ● Revise baseline biophysical
<ul style="list-style-type: none"> ● Did Westmin discuss with M. Crombie (DIAND Environment)? ● Any permits required? 	<ul style="list-style-type: none"> ● Discussion planned with DIAND ● Land use – expires Oct/95 ● YWA notification ● Bulk sample – planned – this will require permit for bulk sample ● Want to have preliminary understanding for overview.
<ul style="list-style-type: none"> ● Access required for project? 	<ul style="list-style-type: none"> ● Access for bulk sample needed – two routes – East Creek via KZK road and Money Creek ● Access being looked at for baseline studies

<ul style="list-style-type: none"> • Comments are global in nature • When specific details are in regarding project, YTG will provide more comments 	<ul style="list-style-type: none"> • Westmin trying global approach (baseline studies such as wildlife/ fish/hydrology); • Approach global – get more specific when details of project are known. • Baseline document to be revised with more specific information – project related; • Ross River wants a global approach to study of area; • Westmin to participate in global wildlife – but RRC to spearhead.
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Issue	Response
<p>Wildlife Survey</p> <ul style="list-style-type: none"> • Rob Florkiewicz heading up program for YTG. • YTG looking for corporate participation. 	<ul style="list-style-type: none"> • Need well defined Terms of Reference • This needs to be defined before Westmin supports.
<ul style="list-style-type: none"> • YTG Management support different than RERC • YTG welcomes Westmin support. 	<ul style="list-style-type: none"> • Westmin supports, but must still meet CEAA requirements.
<ul style="list-style-type: none"> • Management planning project – Westmin not obligated to participate, but will be a positive thing for company; • Voluntary, specific to wildlife management; • Company involvement in wildlife survey is important. 	<ul style="list-style-type: none"> • Need to keep processes separate; • RRC wants it together; • Need to keep separate
<ul style="list-style-type: none"> • Management process is YTG process; • Voluntary, welcome Westmin support 	<ul style="list-style-type: none"> • Public hearing for water licence still could be stalled.
<ul style="list-style-type: none"> • YTG to make clear to RRC that CEAA process and management processes are separate and voluntary, and not linked to issuance of regulatory permits. 	
<ul style="list-style-type: none"> • Terms of Reference for wildlife program being developed. • Circulate draft for comments. 	<ul style="list-style-type: none"> • December meeting with YTG/RRC/Westmin planned. • Are Terms of Reference developed? • Westmin support and needs to see this going.

<ul style="list-style-type: none"> • Not just wildlife issue with project, Fish and Game, YCS, all stakeholders; • Expect difficulty with review, but find ways to resolve issue. • “do 1990’s mining” • can protect Finlayson herd; • Can help with regulatory process • Early consensus on process and project • Benefit to company 	<ul style="list-style-type: none"> • As long as separate, Westmin comfortable.
<ul style="list-style-type: none"> • Overview of Finlayson Herd provided. • YTG also doing moose survey • YTG comfortable building network of data – Westmin assisting with data collection survey is adequate; • Good to share data and management – leads up to cooperate to plan and address mitigation. 	<ul style="list-style-type: none"> • Westmin to cooperate and share data.
<ul style="list-style-type: none"> • Exploration – has caused some strain on caribou; less calves in area; displaced cows to lower elevations; • Want to plan ahead to address cumulative effects – good mitigation needed. • Some individual surveys may be needed later. • Post calving survey is on. • YTG assessment of information – is available to Westmin for wildlife report write up 	<ul style="list-style-type: none"> • Westmin to obtain YTG data on caribou survey.

Issue	Response
<p>Cumulative Effects</p> <ul style="list-style-type: none"> • YTG does agree that this is a potential problem • Take into consideration Cominco’s project as well 	<ul style="list-style-type: none"> • Cominco could be hypothetical mine (not existing impact if no mine)
<ul style="list-style-type: none"> • Include development that exists as potential cumulative effect. • Cumulative impacts must be addressed; • Cominco could be asked to reevaluate impacts; • Need to address Cumulative Effects for whole area. 	<ul style="list-style-type: none"> • If mine – need monitoring to assess prediction for impact.

<ul style="list-style-type: none"> • Don't expect significant work to address cumulative impacts. What will be required is analysis. 	<ul style="list-style-type: none"> • Westmin to address in EA submissions.
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Issue	Response
Fall Survey <ul style="list-style-type: none"> • Fall survey planned; • Surveys conducted in 1987, 1991 in area west and north of Wolverine Lake. • Information available to Westmin; • YTG could extend study into Westmin project area. 	<ul style="list-style-type: none"> • Westmin agreeable, need to know cost for joint participation.
<ul style="list-style-type: none"> • 3rd party could be a problem for YTG 	

Issue	Response
Moose Survey <ul style="list-style-type: none"> • Extend area for Westmin moose survey planned for November. • Discuss with YTG re: fall program • Possible concern – seasonal movement if moose in the drainage area • Significance of movement? Impacts? • Expect moose to move out of area in response to snow • Technique to address – YTG open to discussion 	Westmin has had land discussion with RRC re: TEK

Issue	Response
Traditional Ecological Knowledge <ul style="list-style-type: none"> • Cominco did extensive Traditional Ecological Knowledge (TEK) study with elders • Elder – TEK survey to address moose movement • Still need to verify scientific 	
<ul style="list-style-type: none"> • Need to be specific about questions for TEK to fill data gaps. 	<ul style="list-style-type: none"> • Protocols for TEK and Methodology

<ul style="list-style-type: none">• James Allen – CAFN – may have TEK methods.• Topo – terrain maps, vegetation maps – help to pinpoint TEK• YTG has some mapping information available	<ul style="list-style-type: none">• Possible use of wildlife management committee for TEK• Protocols for TEK and Methodology
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Northern Affairs Program
Exploration and Geological Services
#345 -300 Main Street
Whitehorse, YT Y1A 2B5
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07 June 1996

David Mchaina, P.Eng.
Westmin Resources Limited
#904-1055 Dunsmuir Street
P.O. Box 49066, The Bentall Centre
Vancouver, BC V7X 1C4

Dear Sir:

RE: Wolverine Lake - Proposed Baseline Biophysical Surveys

I am in receipt of your Preliminary Baseline Biophysical Survey dated June 3, 1996. The package was originally destined for Diane Emond in our office but she will be on leave until the middle of September and I will be handling her duties until then. It is good to have this early consultation with companies in order that information requirements down the line are facilitated. Our department's main environmental assessment responsibilities are surficial geology and terrain hazards including permafrost and seismic, as well as mine geology as it relates to Acid Rock Drainage.

Your proposed surficial geology program looks good. We use this information in order to determine the physical stability of foundation materials for tailings dams, buildings, waste dumps, etc., as well as how the surficial materials relate to the hydrogeological characteristics of the region. Proponents in the past have failed to recognize the importance of spatially and physically characterizing permafrost in their project area. Although a survey at 1:30,000 scale is acceptable for the general area, once some indication of where mine facilities will be located, more detailed surficial studies may be necessary in these areas. An indication of the area in which the 1996 surficial mapping is to be conducted would be useful.

With respect to the ARD program there is some overlap in responsibilities with Environment Canada and DIAND Water Resources. We tend to concentrate on determining if the rock types in the area have been adequately characterized by the ARD studies. The ultimate goal of an ARD program is to ensure that once mining commences that waste can be quickly and accurately characterized and disposed of in the appropriate way. The staged approach and the identification of surrogate parameters you have suggested will go a long way in satisfying this requirement. An early characterization of the ARD potential of the various units in the exploration stage is critical to the success of any program. Suites of samples should be selected on the basis of lithology, alteration, and sulphide mineralization. A complete petrographic study of the samples sent for testing is frequently overlooked in the early stages, but is very important in accurately characterizing the material. The number of samples necessary to give a good statistical representation of the deposit usually comes under close scrutiny. This can not be determined until some idea of the complexity and consistency of the various units can be ascertained. Working closely on this matter should avoid any conflicts or delays down the line.

Some specific points regarding your proposed program: I would be hesitant of compositing over too large an interval in the early stages. General recommendations are for sample intervals of not greater than 1.5 metres unless the variations in the rock over larger intervals can be demonstrated not to be a problem. The criteria for which samples will undergo kinetic testing should be clearly spelled out. It appears from Table 2 that samples with NP:AP ratios >1 will undergo kinetic testing? Environment Canada has in the past preferred that ABA testing be done using modified acid-base accounting procedures with the inclusion of a fizz test. We concur with the more conservative values that these tests usually give. More details can be obtained from Benoit Godin at Environment Canada.

Dan Cornett has tentatively scheduled a meeting with us on June 28. We look forward to meeting with you and discussing your program further at that time.

Sincerely,

Hugh Copland, P. Geo.
Environmental Geologist

Environmental Protection
Mile 917.6 Alaska Highway
Building B,
Whitehorse, Yukon
Y1A 5X7

June 17, 1996

RERC - 71

Mr. David Mchaina
Westmin Resources Ltd.
Suite 904, 1055 Dunsmuir Street,
P.O. Box 49066, The Bentall Centre,
Vancouver, B.C.
V7X 1C4

Dear Mr. Mchaina:

Re: Wolverine Lake Project - Preliminary Baseline Biophysical Survey

Thank you for consulting with our organization for your preliminary baseline study. We have reviewed the document and have the following comments:

The company indicated the current restrictions of the survey are due to the lack of definition of the Wolverine project. The baseline study should, however, assess the biophysical characteristics of all potential mine site components such as roads, tailings ponds, milling sites, waste rock locations, diversions, etc. As indicated, the program will require revisions in light of the 1996 data and a better understanding of the project mining components.

Geochemical Characterization

Section 3.2.1.3.1 Sample collection: The drillholes are usually performed based on a mineral target. Environmental concerns usually originate from waste material. There is an indication of using samples 20 to 30 meters away from the ore outline. Would these samples be within what may be reported in a waste rock pile from either an underground or open pit extracting method? Would these samples be within the fracture zones of the footwall or hanging wall?

Results from the sequential testing program will be used to select samples for the next testing program. Will the establishment of variability of key chemical stability parameters (e.g. metal concentration, ABA) be the driving force for the next set of samples?

Detailed stratigraphic characterization will be established by the project geologist. How will the "geological variation" be defined? What parameter will be used and what variability criteria will be verified?

Kinetic testing will involve the exposure to fixed wet/dry cycles to simulate the process of oxidation in the natural environment. Although the standard procedures account for a weekly 3 day dry followed by a 3 day humid air and on the 7th day with flushing with 500 ml of distilled water, these conditions rarely reflect natural conditions. We are concerned that in Yukon conditions, the waste rock material may be exposed to some moist periods (freshet/ rain fall). The waste to precipitation ratio will be completely different and distributed differently during the year. We suspect that the predictions and management of the leachates may be substantially different using schedules reflecting natural conditions than the arbitrary schedule generally used to accommodate laboratory staff schedules. With the current knowledge of the science it is difficult to predict the effects such test variation may have on the Wolverine material without actually performing a comparative study.

Table 2 indicated the type of tests to be performed on the Wolverine material. The preliminary number of samples are indicated for the footwall and hanging wall. Do these numbers include the variation from a stratigraphic or rock unit component?

Section 3.3 Climate monitoring. Will the preliminary information also include the wind direction and speed as part of the program?

Section 3.4.2 Water Quality . Will the "Wolverine Lake Property Surface Water and Stream Sediment Analysis: 1995, Report No. 9503" be available?

Section 3.4.2.6 Wolverine Limnological Study. There are no indications of water quality profile in addition to the water quality sampling. In fact, we argue that the profile is required prior to the sampling in order to properly allocate the sample through the water column. Epilimion, thermocline and hypolimnion water strata may have different water quality characteristics which should be documented to establish the baseline conditions. The lake water profile should include temperature, oxygen, pH and conductivity. We suggest water quality be collected 1 meter below the water surface, 1 meter above and below the thermocline, and 1 meter above the lake bottom.

Analysis regarding productivity (chlorophyll, PO₄, TOC) should also include measurement of water transparency. Secchi disk measurement is probably the easiest method.

Water quality parameters should include DOC in addition to TOC since it is the proper analysis for metal speciation work. That parameter could be included in key routine water quality site. It may help in the interpretation of metal-ligands interactions.

Section 3.4.3 Stream Sediments

The sediments samples should always be collected from the wetted portion of the stream, rather than from the stream bank. Consideration to prevent the fines from being washed away must be given. We have found that a clear acrylic plastic tube works well enough.

We suggest the analysis of metal content be performed on the fraction <63 um rather than 150 um since it contains the greatest surface area/volume ratio. The establishment of metal content of the fine particle size allows the earlier detection of contamination through surface adsorption. Geological baseline metal concentrations can be established through the analysis of particle size between the interval of 10 mesh and 20 mesh [1-2 mm].

Long term storage of archive sediment material should be done on dried and sieved samples. Short term storage (< 3 months) can be done on fresh sediments in cold temperatures. Freezing of the sediment material is not recommended.

Lake sediment samples should be collected based on the evaluation of the bathymetry map where it can be determined based on the slope and topography of the terrain if the sediments collected are within an accumulation zone.

Section 3.4.5.3 Proposed Fisheries studies. We suggest that conservation of the stomachs of sacrificed fish for analysis of food sources be done..

Should you have any questions, please do not hesitate to contact me at (403) 667-3402.

Yours truly,

Benoit Godin, Head
Environmental Contaminants

cc : Len Mychasiw - DIAND

Environmental Protection
Mile 917.6 Alaska Highway
Building B,
Whitehorse, Yukon
Y1A 5X7

June 17, 1996

RERC - 71

Mr. David Mchaina
Westmin Resources Ltd.
Suite 904, 1055 Dunsmuir Street,
P.O. Box 49066, The Bentall Centre,
Vancouver, B.C.
V7X 1C4

Dear Mr. Mchaina:

Re: Wolverine Lake Project - Preliminary Baseline Biophysical Survey

Thank you for consulting with our organization for your preliminary baseline study. We have reviewed the document and have the following comments:

The company indicated the current restrictions of the survey are due to the lack of definition of the Wolverine project. The baseline study should, however, assess the biophysical characteristics of all potential mine site components such as roads, tailings ponds, milling sites, waste rock locations, diversions, etc. As indicated, the program will require revisions in light of the 1996 data and a better understanding of the project mining components.

Geochemical Characterization

Section 3.2.1.3.1 Sample collection: The drillholes are usually performed based on a mineral target. Environmental concerns usually originate from waste material. There is an indication of using samples 20 to 30 meters away from the ore outline. Would these samples be within what may be reported in a waste rock pile from either an underground or open pit extracting method? Would these samples be within the fracture zones of the footwall or hanging wall?

Results from the sequential testing program will be used to select samples for the next testing program. Will the establishment of variability of key chemical stability parameters (e.g. metal concentration, ABA) be the driving force for the next set of samples?

Detailed stratigraphic characterization will be established by the project geologist. How will the "geological variation" be defined? What parameter will be used and what variability criteria will be verified?

Kinetic testing will involve the exposure to fixed wet/dry cycles to simulate the process of oxidation in the natural environment. Although the standard procedures account for a weekly 3 day dry followed by a 3 day humid air and on the 7 th day with flushing with 500 ml of distilled water, these conditions rarely reflect natural conditions. We are concerned that in Yukon conditions, the waste rock material may be exposed to some moist periods (freshet/ rain fall). The waste to precipitation ratio will be completely different and distributed differently during the year. We suspect that the predictions and management of the leachates may be substantially different using schedules reflecting natural conditions than the arbitrary schedule generally used to accommodate laboratory staff schedules. With the current knowledge of the science it is difficult to predict the effects such test variation may have on the Wolverine material without actually performing a comparative study.

Table 2 indicated the type of tests to be performed on the Wolverine material. The preliminary number of samples are indicated for the footwall and hanging wall. Do these numbers include the variation from a stratigraphic or rock unit component?

Section 3.3 Climate monitoring. Will the preliminary information also include the wind direction and speed as part of the program?

Section 3.4.2 Water Quality . Will the "Wolverine Lake Property Surface Water and Stream Sediment Analysis: 1995, Report No. 9503" be available?

Section 3.4.2.6 Wolverine Limnological Study. There are no indications of water quality profile in addition to the water quality sampling. In fact, we argue that the profile is required prior to the sampling in order to properly allocate the sample through the water column. Epilimion, thermocline and hypolimnion water strata may have different water quality characteristics which should be documented to establish the baseline conditions. The lake water profile should include temperature, oxygen, pH and conductivity. We suggest water quality be collected 1 meter below the water surface, 1 meter above and below the thermocline, and 1 meter above the lake bottom.

Analysis regarding productivity (chlorophyll, PO₄, TOC) should also include measurement of water transparency. Secchi disk measurement is probably the easiest method.

Water quality parameters should include DOC in addition to TOC since it is the proper analysis for metal speciation work. That parameter could be included in key routine water quality site. It may help in the interpretation of metal-ligands interactions.

Section 3.4.3 Stream Sediments

The sediments samples should always be collected from the wetted portion of the stream, rather than from the stream bank. Consideration to prevent the fines from being washed away must be given. We have found that a clear acrylic plastic tube works well enough.

We suggest the analysis of metal content be performed on the fraction <63 um rather than 150 um since it contains the greatest surface area/volume ratio. The establishment of metal content of the fine particle size allows the earlier detection of contamination through surface adsorption. Geological baseline metal concentrations can be established through the analysis of particle size between the interval of 10 mesh and 20 mesh [1-2 mm].

Long term storage of archive sediment material should be done on dried and sieved samples. Short term storage (< 3 months) can be done on fresh sediments in cold temperatures. Freezing of the sediment material is not recommended.

Lake sediment samples should be collected based on the evaluation of the bathymetry map where it can be determined based on the slope and topography of the terrain if the sediments collected are within an accumulation zone.

Section 3.4.5.3 Proposed Fisheries studies. We suggest that conservation of the stomachs of sacrificed fish for analysis of food sources be done..

Should you have any questions, please do not hesitate to contact me at (403) 667-3402.

Yours truly,

Benoit Godin, Head
Environmental Contaminants

cc : Len Mychasiw - DIAND

APPENDIX 5B

**MINUTES OF CONSULTATION MEETINGS
FINLAYSON PROJECT
OCTOBER 2000**

**Meeting with
YTG Renewable Resources**

**Expatriate Resources Ltd.
Finlayson Project
Meeting Minutes**

**Meeting with
YTG Renewable Resources,
#10 Burns Road, Whitehorse**

**October 17, 2000
9:00 – 10:30 a.m.**

Attendees:

Justin Himmelright (Expatriate Resources)	Harlan Meade (Expatriate Resources)
Jon Bowen, YTG, Renewable Resources, Manager, Environmental Assessment	Morris George, Renewable Resources, Environmental Assessment
Jan Adamczewski, Renewable Resources, Regional Biologist – Liard Region	
Steve Morison, Gartner Lee Limited	Don McCallum, Gartner Lee Limited

H. Meade, President of Expatriate Resources, began the meeting with a brief introduction to his company and the Finlayson Project before introducing J. Himmelright, Manager of Environment for Expatriate Resources.

J. Himmelright provided a brief overview of Expatriate Resources and their management team before providing details regarding Expatriate's plans for developing the Finlayson project. He explained that the Finlayson project will incorporate production from both the Kudz Ze Kayah (KZK) and Wolverine deposits. The anticipated Environmental Assessment (EA) and permitting requirements were reviewed. While a screening EA report has previously been completed for developing the KZK deposit (by Cominco Ltd.) it is assumed that the combined KZK/Wolverine project will require a Comprehensive Study Report under CEAA legislation. A schedule outlining Expatriate's plans for bringing this project to production stage was reviewed. Estimates of the anticipated time required to facilitate EA and permitting activities were reviewed in some detail.

Questions and Discussion

1. What are the lengths of the 2 road alternatives being considered for connecting the mine sites?
 - The "north" alternative would be approximately 30 km long while the "south" alternative would be approximately 50 km long.
2. Are there any permafrost issues associated with this project ?
3. Where is the camp location at Wolverine ? Is it away from the lake ?
4. What quantities of water are required for mine production and where will it be obtained?
5. What is the expected mine life of the Wolverine deposit?
6. What are the issues associated with selenium? Where and in what form is it emitted?

**Meeting with
YTG Renewable Resources**

- Selenium tends to occur at relatively high levels in rock mineralization in the Finlayson area. The concerns associated with selenium are both environmental and metallurgical in nature. Selenium in high concentrations can be toxic to aquatic life. It was noted that surface water in this area has relatively high, natural selenium levels, yet appears to support broad and diverse aquatic life. Selenium in ore concentrate can create difficulties within the smelting process. Test runs indicate that the ore concentrate from the combined KZK/Wolverine operations can be accommodated in smelting operations. Sources of selenium in mine operations will include ore concentrate, waste rock, and tailings.
7. If/when funding partners are brought into this project with Expatriate Resources, how will this affect the permitting process and environmental liabilities?
 - It will not be affected.
 8. YTG Comment: It would be preferable, from an environmental impact perspective, to avoid building two separate roads connecting mine sites (1 for exploration and 1 for production) if possible.
 9. Do you have any concerns with using the Robert Campbell Highway for a transportation corridor?
 - It is the preferred route but will require upgrading.
 10. YTG Comment: Access control to the mine roads will be a significant wildlife-related issue.
 11. Is there a need to modify the wildlife agreement in the area?

**Meeting with
DIAND - Whitehorse**

**Expatriate Resources Ltd.
Finlayson Project
Meeting Minutes**

**Meeting with
DIAND - Whitehorse**

**Meeting Location:
Suite B – 206 Lowe Street (Gartner Lee Limited Office)**

**October 17, 2000
1:30 – 3:00 p.m.**

Attendees:

Justin Himmelright (Expatriate Resources)	Harlan Meade (Expatriate Resources)
Ian Church (DIAND, Director, Environment)	Bob Holmes (DIAND, Director, Mineral Resources)
Kevin McDonnell (DIAND, Environment)	Mark Zrum (DIAND, Regional Manager, Land Resources)
Hugh Copland (DIAND, Mining Land Use)	Dave Jennings (DIAND, Regional Manager, Mining Land Use)
Steve Morison, Gartner Lee Limited	Don McCallum, Gartner Lee Limited

H. Meade, President of Expatriate Resources, began the meeting with a brief introduction to his company and the Finlayson Project before introducing J. Himmelright, Manager of Environment for Expatriate Resources.

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Questions and Discussion

1. Does Cominco currently own the KZK water license?
 - They do, however, it will be assigned to Expatriate Resources within a couple of weeks.
2. Are other permits required, ie. use of explosives, Navigable Waters Protection Act, Fisheries Act, and will other federal departments be Responsible Authorities (R.A's)?
 - DIAND will clearly be the *lead* RA on this project while other federal departments such as DFO will participate in the assessment process as RAs. Expatriate will be looking into the need for permitting related to use of explosives.

**Meeting with
DIAND - Whitehorse**

21. What kind of infrastructure requirements are associated with this project?

- Upgrading to the Robert Campbell Highway will be required (YTG is aware of this).

**Meeting with
DFO/DoE/ DIAND (Water Resources) - Whitehorse**

**Expatriate Resources Ltd.
Finlayson Project
Meeting Minutes**

**Meeting with
DFO, DOE, DIAND (Water Resources)**

**Meeting Location:
91782 Alaska Highway**

**October 18, 2000
3:00 – 4:30 p.m.**

Attendees:

Justin Himmelright (Expatriate Resources)	Harlan Meade (Expatriate Resources)
George Mackenzie-Grieve (DoE, Manager, Environmental Protection)	Bill Slater (DIAND, Water Resources)
Eric Soprovich (DoE, Environmental Prot.)	Benoit Godin (DoE, Environmental Prot.)
Vic Enns (DoE, Environmental Protection)	Byron Nutton (DFO)
Steve Morison, Gartner Lee Limited	Don McCallum, Gartner Lee Limited

H. Meade, President of Expatriate Resources, began the meeting with a brief introduction to his company and the Finlayson Project before introducing J. Himmelright, Manager of Environment for Expatriate Resources.

J. Himmelright provided a brief overview of Expatriate Resources and their management team before providing details regarding Expatriate's plans for developing the Finlayson project. He explained that the Finlayson project will incorporate production from both the Kudz Ze Kayah (KZK) and Wolverine deposits. The anticipated Environmental Assessment (EA) and permitting requirements were reviewed. While a screening EA report has previously been completed for developing the KZK deposit (by Cominco Ltd.) it is assumed that the combined KZK/Wolverine project will require a Comprehensive Study Report under CEAA legislation. A schedule outlining Expatriate's plans for bringing this project to production stage was reviewed. Estimates of the anticipated time required to facilitate EA and permitting activities were reviewed in some detail.

Questions and Discussion

1. Expatriate Comment: Expatriate will circulate the proposed timelines (reviewed at this meeting) to meeting participants.
2. Why doesn't Expatriate proceed immediately with development of the KZK site since approvals already in place?
 - The development of both deposits (KZK and Wolverine) are required to secure project financing.
3. How firm is the delivery dates of concentrates ?
4. Has Expatriate provided security for the transfer of the KZK water license?
5. Will proposed underground development at KZK preclude returning waste rock into the pit?

ARCHER, CATHRO & ASSOCIATES (1981) LIMITED

Box 4127, Whitehorse, Yukon Y1A 3S9

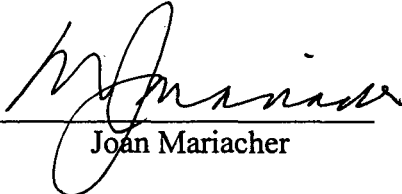
Telephone: (867) 667-4415

Fax: (867) 667-4622

AFFIDAVIT

I, Joan Mariacher, of VANCOUVER, B.C. make oath and say:

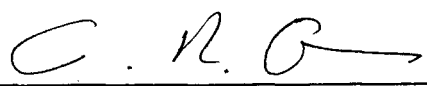
That to the best of my knowledge the attached Statement of Expenditures for exploration work on the 776 CLAIMS AS ATTACHED LIST mineral claims on Claim Sheet 1056/849 is accurate.
10514


Joan Mariacher

Sworn before me at VANCOUVER, B.C.

this 20TH day of

FEBRUARY, 2001


Notary, Yukon Territory

094236

ENVIRONMENTAL STUDY
Statement of Expenditures
February 29, 2001

Labour

J. Himmelright - June 26-February 28, 2001	\$57,538.66
R. Duncan - August to November	2,332.27
B. Jang - May to August	<u>173.03</u>
	\$60,043.96

Consultants

Access Consulting Group	5,793.00
Analytical Service Laboratories	4,213.13
Applied Ecosystem Management	3,745.00
Gartner Lee Limited	43,050.01
A.J. Keen Consultants	1,284.00
Charles J. Low	2,921.10
March Process Consulting	1,974.15
H.D. Meade	391.00
Mehling Environmental Management	3,273.24
Norecol Dames & Moore	321.00
Trans Rocky Consulting	5,296.50
White Mountain Environmental Consulting	<u>505.79</u>
	\$72,767.92

Expenses

Field room and board - 8 days @ \$115/day	984.40
Capital Helicopter - 6.5 hrs @ \$766/hr	4,979.00
Trans North 206B - 12.6 hrs @ \$700/hr plus fuel	9,748.98
- 7.4 hrs @ \$775/hr plus fuel	6,540.27
Jet B - 1473 litres @ \$1.63/litre landed cost	2,569.06
Fixed Wing - Summit Air & Kluane Airway	3,530.09
Travel, accommodation, truck rental and freight	11,982.21
D. Dick - wildlife count - September to February 2001	<u>4,615.50</u>
	\$44,949.51

TOTAL \$177,761.39

EXPATRIATE RESOURCES LTD.
701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
August 25, 2000

To invoice for the following:

Bev Jang - May to July - 3 1/2 hours at \$26.95/hr	\$ 94.33
Justin Himmelright - June 26 to July 31 at \$6771.25/mo	8,310.35
Expenses - Hamish Chrystal \$ 17.12	
Connection Couriers 119.97	
plotter to August 4 <u>1,164.00</u>	<u>1,301.09</u>
	9,705.77
GST (13711 1183)	<u>679.40</u>
	<u>\$10,385.17</u>

8973.01

Please make cheque payable to EXR 475.

*Jul Dec 4, 2000
#109*

*WJV
L2-679.40
B-8404.68
C1-1164.
C2-17.12
D3-119.97
10385.17*

B 4

EXPATRIATE RESOURCES LTD.

701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
August 31, 2000

To invoice for the following:

Bev Jang - August 1-31 - 2 1/2 hours at \$26.95/hr	\$ 67.38
Rob Duncan - August 1-31 - 11 1/4 days at \$281.25/day	3,164.06
Justin Himmelright - August 1-31 at \$6771.25/month	6,771.25
Expenses - Connection Couriers \$ 12.60	
plotter August 5-31 <u>522.00</u>	
	<u>534.60</u>
	10,537.29
GST (13711 1183)	<u>737.61</u>
	<u>\$11,274.90</u>

562.270
7919.41

Please make cheque payable to EXR 475.

On Oct 4, 2000
#260

L2 - 737.61

B - 10000.69

C1 - 500.

D3 - 14.60
11274.90

64

EXPATRIATE RESOURCES LTD.

701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
September 30, 2000

To invoice for the following:

Rob Duncan - September 1-30 - 3 1/2 days at \$281.25/day	\$ 984.38
Justin Himmelright - September 1-30 - 6 days at \$322.44/day	5,159.04
Expenses - Connection Couriers	\$ 16.70
Fedex	87.41
expenses R. Duncan & B. Jang	32.01
plotter September 1-30	<u>27.00</u>
	<u>163.12</u>
	6,306.54
GST (13711 1183)	<u>441.46</u>
	<u>\$6,748.00</u>

5520.17

Please make cheque payable to EXR 475.

441.46
B-6143.42
C1-47.88
C2-11.13
D3-104.11

pre hnd r2, v2000
#081

B ↑

e

EXPATRIATE RESOURCES LTD.
701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
October 31, 2000

To invoice for the following:

Rob Duncan - October 1 - 31 - 5 days at \$281.25/day		\$1,406.25
Justin Himmelright - October		6,771.25
Expenses - Connection Couriers	\$ 25.15	
Fedex	112.46	
plotter October 1-31	<u>46.00</u>	
		<u>183.61</u>
		8,361.11
GST (13711 1183)		<u>585.28</u>
		<u>\$8,946.39</u>

7245.24

Please make cheque payable to EXR 475.

575.18
B - 8177.50
C1 - 46.
D3 - 127.61

John Henry, 1000
#881

B ch *P*

EXPATRIATE RESOURCES LTD.

701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
November 30, 2000

To invoice for the following:

Rob Duncan - November 1-30 - 5 3/4 days at \$281.25/day	\$1,617.19
Justin Himmelright - November 1-30	6,771.25
Bev Jang - November 1-30 - 19 hours at \$26.95/hr	525.53
Expenses - Connection Couriers \$ 45.05	
Mike Davies, drafting <u>450.00</u>	<u>495.05</u>
	9,409.02
GST (13711 1183)	<u>658.63</u>
	<u>\$10,067.65</u>

8974.63

Please make cheque payable to EXR 475.

*Order Jan 20, 2001
#317*

b-h

EXPATRIATE RESOURCES LTD.
701 - 475 Howe Street
Vancouver, B.C. V6C 2B3

Telephone: (604) 682-5474

Fax: (604) 682-5404

In Account With
Wolverine Joint Venture
December 31, 2000

WJV

To invoice for the following:

Justin Himmelright - December 1-31 - 15 days at \$322.44/day	\$4,836.60
Expenses - Connection Couriers	\$5.20
Bev Jang expenses	<u>9.35</u>
	14.55
	<u>4,851.15</u>
GST (13711 1183)	<u>339.58</u>
	<u>\$5,190.73</u>

B
CLV 174.16
LV

Please make cheque payable to EXR 475.

B-V f

Feb. 15, 2001

Plur J. Himmelright

Jan & Feb 2001 @ 6771.25/mo

14490.48

(not yet invoiced to Wellesley)



- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

204D Strickland Street, Whitehorse, Yukon Y1A 2J8
 PHONE (867) 668-6463 FAX (867) 667-6680
 www.accessconsulting.yk.ca

INVOICE

G.S.T # 89899 7689

To: Expatriate Resources Ltd.
 Suite 1016 - 510 West Hastings Street
 Vancouver, British Columbia
 V6B 1L8

Invoice Number:	EXPAT-0607
Date:	08-Aug-00
For Period Ending:	31-Jul-00

Attention: Mr. Justin Himmelright

Description: Kudz Ze Kayah Property - Environmental Audit

Professional Services (see attached breakdown)

DAYS	PERSON	PURPOSE	RATE	AMOUNT	G.S.T.
1.5	R. McIntyre	Environmental Assessment	\$760 /diem	\$1,140.00	\$79.80
Sub-total				\$1,140.00	\$79.80

Total Prof/Services	\$1,219.80	Incl. GST
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Disbursements Charged at Cost

Date	Description	Amount w/o GST	GST
26-Jun-00	Jason Adams, expense report EXJA00-06A, purchase topo maps	\$29.85	\$2.09
28-Jun-00	The Welcome Inn, accommodation for R. McIntyre, Receipt #1627	\$95.00	\$6.65
29-Jun-00	Vehicle Kilometerage for R. McIntyre site visit, Invoice ACG01	\$410.48	\$28.73
29-Jun-00	Travel Claim form for R. McIntyre site visit, Invoice ACG02	\$75.20	\$5.26
30-Jun-00	Access Consulting Group, paper charges for June, 21 pages @ \$0.25/pg	\$5.25	\$0.37
Sub-total		\$615.78	\$43.10

Total Disbursements	\$658.88	Incl. GST
----------------------------	-----------------	------------------

Invoice subtotal	\$1,755.78	\$122.90
	without GST	GST

Advanced	
-----------------	--

Grand total due	\$1,878.68	Incl. GST
------------------------	-------------------	------------------

*THANK YOU
 R. McIntyre*

Please make cheque payable to Access Mining Consultants Ltd. at the above address, Thank You
 Terms: Payable upon receipt of invoice, 1.5% interest per month charged on accounts over 30 days

*pay from Pat - F
 mark -
 PR Oct 4, 2000 #603
 KZK
 22-122.90
 A - 1140.
 C2 - 70.10
 D3 - 580.68
 1878.68*



- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

204D Strickland Street, Whitehorse, Yukon Y1A 2J8
 PHONE (867) 668-6463 FAX (867) 667-6680
 www.accessconsulting.yk.ca

INVOICE

G.S.T # 89899 7689

To: Expatriate Resources Ltd.
 Suite 1016 - 510 West Hastings Street
 Vancouver, British Columbia
 V6B 1L8

Invoice Number:	SWMP-08 Rev
Date:	19-Sep-00
For Period Ending:	31-Aug-00

Attention: Mr. Justin Himmelright

Description: Kudz Ze Kayah Property - Solid Waste Management Plan

RECEIVED
 SEP 27 2000

found to loan out 3/00

Professional Services (see attached breakdown)

HOURS	PERSON	PURPOSE	RATE/HR	AMOUNT	GST
5.00	R. McIntyre	Sr. Technologist	\$95 /hour	\$475.00	\$33.25
3.00	C. MacMillan	Clerical	\$50 /hour	\$150.00	\$10.50
Sub-total				\$625.00	\$43.75

Total Professional Services	\$668.75	Incl. GST
------------------------------------	-----------------	------------------

Disbursements Charged at Cost

Date	Description	Amount w/o GST	GST
31-Jul-00	Access Consulting Group, general office charges for July (see attached Invoice ACG01)	\$24.75	\$1.73
31-Aug-00	Access Consulting Group, general office charges for August (see attached Invoice ACG02)	\$38.50	\$2.70
31-Aug-00	Long distance telephone and fax charges (see attached Invoice ACG03)	\$7.65	\$0.54
Sub-total		\$70.90	\$4.96

Total Disbursements	\$75.86	Incl. GST
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Project Financial Progress to August 31, 2000	
Original Budget (not incl GST):	\$725.00
Less Invoices to Aug. 31:	-\$695.90
Budget Remaining:	\$29.10

Invoice sub-total	\$695.90	GST	\$48.71
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Advances			
-----------------	--	--	--

Grand total due	\$744.61	Incl. GST
------------------------	-----------------	------------------

*Thank you
 [Signature]*

Please make cheque payable to Access Mining Consultants Ltd. at the above address, Thank You
 Terms: Payable upon receipt of invoice, 1.5% interest per month charged on accounts over 30 days

*OK - KZK
 Justin H
 [Signature] pr Oct 4, 2000 #603*



- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

204 D Strickland Street, Whitehorse, Yukon Y1A 2J8
 PHONE (867) 668-6463 FAX (867) 667-6680
 www.accessconsulting.yk.ca

INVOICE

G.S.T # 89899 7689

To: Expatriate Resources Ltd.
 Suite 1016 - 510 West Hastings Street
 Vancouver, British Columbia
 V6B 1L8

Invoice Number:	EXPAT-08
Date:	20-Sep-00
For Period Ending:	31-Aug-00

Attention: Mr. Justin Himmelright

Description: Kudz Ze Kayah Property - Environmental Audit

RECEIVED
 SEP 27 2000
fred h. jones Oct 3/00

Professional Services (see attached breakdown)

HOURS	PERSON	PURPOSE	RATE	AMOUNT	G.S.T
9.00	R. McIntyre	Environmental Assessment	\$95 /hr	\$855.00	\$59.85
3.75	T. Ritchie	Jr. Environmental Scientist	\$60 /hr	\$225.00	\$15.75
Sub-total				\$1,080.00	\$75.60

Total Prof. Services	\$1,155.60	incl. GST
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Disbursements Charged at Cost

Date	Description	Amount w/o GST	G.S.T
Sub-total		\$0.00	\$0.00

Total Disbursements	\$0.00	incl. GST
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Invoice sub-total	without GST	GST
	\$1,080.00	\$75.60

Advances		
----------	--	--

Grand total due	\$1,155.60	incl. GST
-----------------	------------	-----------

Thank You

Please make cheque payable to Access Mining Consultants Ltd. at the above address, Thank You
 Terms: Payable upon receipt of invoice, 1.5% interest per month charged on accounts over 30 days

paid out 4,000 # 603

*OK - KZK
 J. Himmelright
 ADU*



- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

204 D Strickland Street, Whitehorse, Yukon Y1A 2J8
 PHONE (867) 668-6463 FAX (867) 667-6680
 www.accessconsulting.yk.ca

INVOICE

G.S.T # 89899 7689

To: Expatriate Resources Ltd.
 Suite 1016 - 510 West Hastings Street
 Vancouver, British Columbia
 V6B 1L8

Invoice Number	EXP-03-01
Date	08-Nov-00
Reporting Period	31-Oct-00

Attention: Mr. Justin Himmelright

Description: Kudz Ze Kayah Property - Solid Waste Management Plan - Final Report

Account #: AFE-00-001

Professional Services (see attached breakdown)

HOURS	PERSON	TITLE	RATE/HR	AMOUNT	GST
8.00	R. McIntyre	Sr. Technologist	\$95 /hour	\$760.00	\$53.20
3.00	C. MacMillan	Secretarial	\$45 /hour	\$135.00	\$9.45
Sub-total				\$895.00	\$62.65

Total Prof. Services	\$957.65	Incl. GST
-----------------------------	-----------------	------------------

Disbursements Charged at Cost

Date	Description	Amount	GST
31-Oct-00	Canadian Airlines Int'l, courier charges, Inv. S65499690	\$19.90	\$1.39
31-Oct-00	Canada Post, TR124484, postage	\$3.00	\$0.21
31-Oct-00	Long distance telephone and fax charges (see attached breakdown #ACG01)	\$9.45	\$0.66
31-Oct-00	Access Consulting Group, general office charges (see attached breakdown #ACG02)	\$25.00	\$1.75
Sub-total		\$57.35	\$4.01

Total Disbursements	\$61.36	Incl. GST
----------------------------	----------------	------------------

Project Financial Progress to October 31, 2000	
Original Budget (not incl GST):	\$970.00
Less Invoices to Oct. 31:	-\$952.35
Budget Surplus:	\$17.65

Invoice sub-total	without GST	GST
	\$952.35	\$66.66

Grand Total Due	\$1,019.01	Incl. GST
------------------------	-------------------	------------------

Please make cheque payable to Access Mining Consultants Ltd. at the above address, Thank You
 Terms: Payable upon receipt of invoice, 1.5% interest per month charged on accounts over 30 days

*Thank you
 RCM*

*Order #111111
 #682*

BH

*Xlat-F
 K2K*

*A-895
 CR-37.45
 DB-19.90
 LL-66.66

 1019.01*



- Access Mining Consultants Ltd.
- Access Field Services Ltd.
- Access Oil & Gas Services

204D Strickland Street, Whitehorse, Yukon Y1A 2J8
 PHONE (867) 668-6463 FAX (867) 667-6680
 www.accessconsulting.yk.ca

INVOICE

G.S.T # 89899 7689

To: Expatriate Resources Ltd.
 Suite 1016 - 510 West Hastings Street
 Vancouver, British Columbia
 V6B 1L8

Invoice Number:	EXP-03-02
Date:	13-Dec-00
For Period Ending:	30-Nov-00

Attention: Mr. Justin Himmelright

Description: Finlayson Project

Account #: AFE-00-001

Professional Services (see attached breakdown)

HOURS	PERSON	PURPOSE	RATE/HR	AMOUNT	G.S.T.
8.00	D. Cornett	Sr. Environmental Scientist	\$95 /hour	\$760.00	\$53.20
3.00	C. MacMillan	Secretarial	\$45 /hour	\$135.00	\$9.45
Sub-total				\$895.00	\$62.65

Total Prof. Services	\$957.65	Incl. GST
-----------------------------	-----------------	------------------

Disbursements Charged at Cost

Date	Description	amount w/o GST	GST
30-Nov-00	Access Consulting Group, general office charges for November (see attached breakdown)	\$12.50	\$0.88
30-Nov-00	Access Consulting Group, long distance telephone and fax charges	\$22.50	\$1.58
			\$0.00
			\$0.00
Sub-total		\$35.00	\$2.45

Total Disbursements	\$37.45	Incl. GST
----------------------------	----------------	------------------

Project Financial Progress to November 30, 2000	
Original Budget (not incl GST):	\$1,160.00
Less Invoices to Nov. 30:	-\$900.00
Budget Balance:	\$230.00

	without GST	GST
Invoice sub-total	\$930.00	\$65.10

Advances		
-----------------	--	--

Grand total due	\$995.10	Incl. GST
------------------------	-----------------	------------------

X

Please make cheque payable to Access Mining Consultants Ltd. at the above address, Thank You
 Terms: Payable upon receipt of invoice, 1.5% interest per month charged on accounts over 30 days

WJV

THANK YOU
 PLUM

A - 495.
 CV - 35.
 LV - 65.10
 995.10

PAID
 \$ 310

by D.



Analytical Service Laboratories Ltd.

INVOICE

Date: 2000/10/20

Invoice No. 94859

TO: Expatriate Resources
701 - 475 Howe Street
Vancouver, BC
V6C 2B3

Customer No. EXP200

RECEIVED
OCT 24 2000

ATTN: Accounts Payable
per: Mr. Justin Himmelright -

P.O.: KZK
Date Sampled: 2000/09/06

File No.'s M1926

Water Analysis:				
9	General Water Quality	@	\$165.00	\$1485.00*
1	Less 10% Volume Discount	@	-\$148.50	-\$148.50*
9	Total Metals	@	\$170.00	\$1530.00*
8	Dissolved Metals	@	\$170.00	\$1360.00*
1	Less 10% Volume Discount	@	-\$289.00	-\$289.00*

Sub Total	\$3937.50
GST (#R100291913)	\$275.63
Total Invoice	\$4213.13 X

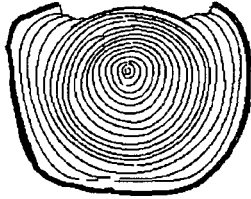
* GST charged on items noted.

Net 30 days - 2% per month may be charged on overdue accounts

*pd Oct 20 / 2000
#622*

*X Pat - F
KZK
E - 3937.50
275.63
4213.13*

dh



Applied Ecosystem Management Ltd.

100 - 211 Hawkins Street
Whitehorse, Yukon Y1A 1X3
ph: (867) 393-3793 fax: (867) 393-2247
email: whitehorse@aemltd.ca
Business Number: 894730639

RECEIVED
DEC - 4 2000

INVOICE

Invoice Number: YT00045-1

Date: November 28, 2000

Services Provided To: Justin Himmelright
Expatriate Resources Ltd.
701 - 475 Howe Street
Vancouver, BC V6B 2B3

Project Title: **Finlayson Project Environmental Review (Wolverine and Kudz Ze Kayah Data)**

Contract/Purchase Order Number: N/A

Description of Costs	Rate	Amount
PROJECT COMPLETION Completion and Delivery of Final Report and Recommend Future Workplans	N/A	\$3,500.00
Total		\$3,500.00
GST		\$245.00
Project Total		\$3,745.00

A
LV

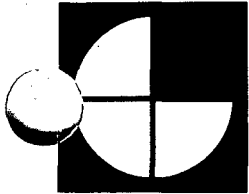
Thank you from Applied Ecosystem Management Ltd.

OK - WSN
J. Himmelright
- WILDLIFE & ECOSYSTEMS
DESCRIPTION FOR THE
REPORT WSN

John 20, 2000
#278

BH

APPLIED ECOSYSTEM
MANAGEMENT LTD.



Gartner Lee Limited

Suite C - 206 Lowe Street
Whitehorse, Yukon
Y1A 1W6

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Fax: (867) 633-6321

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- First Nations Liaison



Expatriate Resources Ltd.
#1016-510 West Hastings Street
Vancouver, British Columbia V6B 1L8

10557-20918-2
April 30, 2000
Invoice #: 106493
GST# 101953248RT

RE: Data Review and Information Synopsis

SERVICES RENDERED up to and including April 30, 2000 with respect to the above project;

TOTAL FOR PROFESSIONAL SERVICES \$ 4,334.00

DISBURSEMENTS:

Parking
Kilometres

TOTAL DISBURSEMENTS

RECEIVED
JUN - 6 2000

\$ 2.83
11.23
\$ 14.06

TOTAL GST

4348.06
304.36

TOTAL INVOICE AMOUNT

\$ 4,652.42

WJV

FEE SUMMARY

Professional	Hours	Rate	Amount
Christy D. Campbell	55.00	\$65.00	\$3,575.00
David S. Osmond	3.50	\$138.00	\$483.00
S.R. Morison	2.00	\$138.00	\$276.00
	60.50		\$4,334.00

pd June 18, 2000
#146

1. Please refer to the above INVOICE NUMBER when remitting payment on this file.

2. Interest at 11% per annum will be charged on all invoices not paid within one month of the date of the invoice.

STATEMENT OF ACCOUNT

Current	30 Days	60 Days	90 Days	120+ Days	Total
4,652.42	0.00	0.00	0.00	0.00	\$ 4,652.42

FVH

ll Approved
WOLVERINE JOINT VENTURE
WOLVERINE "GAP" ANALYSIS
ENVIRONMENT

Expatriate Resources Ltd.
#1016-510 West Hastings Street
Vancouver, British Columbia V6B 1L8

RECEIVED
JUL 10 2000

May 31, 2000
Invoice#C106683
Client# 10557
GST# 101953248RT

SERVICES RENDERED up to and including May 26, 2000
with respect to the projects listed below:
Detailed particulars of each project accompany this summary.

<u>Project</u>	<u>Fees</u>	<u>Disbnts</u>	<u>Subtotal Fees and Disbnts</u>	<u>Tax</u>	<u>Total</u>
20918-2 Expatriate/Data Rev. & In	\$ 1,758.00	\$ 42.34	\$ 1,800.34	\$ 126.02	\$ 1,926.36
20918-5 Expatriate/Development of	2,829.00	345.95	3,174.95	222.25	3,397.20
	\$ 4,587.00	\$ 388.29	\$ 4,975.29	\$ 348.27	\$ 5,323.56

*John July 17, 2000
#185*



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Suite C - 206 Lowe Street
Whitehorse, Yukon
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- Mediation/Negotiation
- Waste Management
- Property Assessments & Audits
- Site Remediation & Cleanup
- First Nations Liaison

Expatriate Resources Ltd.
#1016-510 West Hastings Street
Vancouver, British Columbia V6B 1L8

10557-20918-6
June 30, 2000
Invoice #: 106955
GST# 101953248RT
QST#1023506391 TQ-0001

RE: Phase I - Immediate Environmental Work (Spring Field Program)

SERVICES RENDERED up to and including June 30, 2000 with respect to the above project;

RECEIVED
JUL 31 2000
forwarded to Tom July 31/00

TOTAL FOR PROFESSIONAL SERVICES \$ 2,850.00

DISBURSEMENTS:

Engineering supplies	\$ 839.82
Mail and Delivery	117.79
TOTAL DISBURSEMENTS	\$ 957.61

TOTAL GST

3807.61
266.53

TOTAL INVOICE AMOUNT

\$ 4,074.14

*one time 16, 2000
#226*

FEE SUMMARY

<u>Professional</u>	<u>Hours</u>	<u>Rate</u>	<u>Amount</u>
F. Pearson	37.00	\$75.00	\$2,775.00
Karin Svec	1.50	\$50.00	\$75.00
	38.50		\$2,850.00

1. Please refer to the above INVOICE NUMBER when remitting payment on this file.

2. Interest at 11% per annum will be charged on all invoices not paid within one month of the date of the invoice.

STATEMENT OF ACCOUNT

<u>Current</u>	<u>30 Days</u>	<u>60 Days</u>	<u>90 Days</u>	<u>120+ Days</u>	<u>Total</u>
4,074.14	0.00	0.00	0.00	0.00	\$ 4,074.14

OK - invoice to WTV.

J. Hinchey





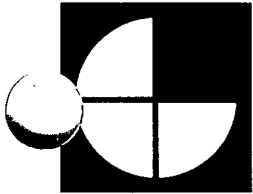
RECEIVED
OCT 12 2000

Expatriate Resources Ltd.
#701-475 Howe Street
Vancouver, British Columbia V6C 2B3

July 31, 2000
Invoice#C107198
Client# 10557
GST# 101953248RT

SERVICES RENDERED up to and including July 31, 2000
with respect to the projects listed below:
Detailed particulars of each project accompany this summary.

<u>Project</u>	<u>Fees</u>	<u>Disbnts</u>	<u>Subtotal Fees and Disbnts</u>	<u>Tax</u>	<u>Total</u>
20918-1 Expatriate/Proj. Man. & C	\$ 1,326.50	\$ 929.95	\$ 2,256.45	\$ 157.95	\$ 2,414.40
20918-6 Expatriate/Spring Field P	1,050.00	10,190.84	11,240.84	786.86	12,027.70
	\$ 2,376.50	\$ 11,120.79	\$ 13,497.29	\$ 944.81	\$ 14,442.10



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- Property Assessments & Audits
- Site Remediation & Cleanup
- First Nations Liaison

Expatriate Resources Ltd.
#701-475 Howe Street
Vancouver, British Columbia V6C 2B3
Attention: Justin Himmelright

RECEIVED
NOV - 1 2000

10557-20918-1
September 30, 2000
Invoice #: 107653
GST# 101953248RT
QST#1023506391 TQ-0001

RE: Project Management and Community Consultation

SERVICES RENDERED up to and including September 30, 2000 with respect to the above project;

TOTAL FOR PROFESSIONAL SERVICES *WJV* *A* \$ 438.50

DISBURSEMENTS:

Telephone and fax *CV* \$ 29.55
TOTAL DISBURSEMENTS \$ 29.55

TOTAL GST *LV* 32.76

TOTAL INVOICE AMOUNT \$ 500.81 ✕

FEE SUMMARY

<u>Professional</u>	<u>Hours</u>	<u>Rate</u>	<u>Amount</u>
Administration	0.50	\$49.00	\$24.50
Steve Morison	3.00	\$138.00	\$414.00
	3.50		\$438.50

1. Please refer to the above INVOICE NUMBER when remitting payment on this file.

2. Interest at 11% per annum will be charged on all invoices not paid within one month of the date of the invoice.

STATEMENT OF ACCOUNT

<u>Current</u>	<u>30 Days</u>	<u>60 Days</u>	<u>90 Days</u>	<u>120+ Days</u>	<u>Total</u>
500.81	0.00	2,414.40	0.00	0.00 \$	2,915.21



and 001 14, 2000
and hw 14, 2000 #276
B 41
OK - WJV
J. Himmelright
ADM
8

RECEIVED
JAN - 2 2001

Expatriate Resources Ltd.
#701-475 Howe Street
Vancouver, British Columbia V6C 2B3

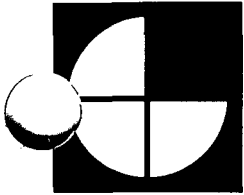
November 30, 2000
Invoice#C108229
Client# 10557
GST# 101953248RT

SERVICES RENDERED up to and including November 30, 2000
with respect to the projects listed below:
Detailed particulars of each project accompany this summary.

<u>Project</u>	<u>Fees</u>	<u>Disbnts</u>	<u>Subtotal Fees and Disbnts</u>	<u>Tax</u>	<u>Total</u>
20918-1 Expatriate/Proj. Man. & C	\$ 212.00	\$ 430.24	\$ 642.24	\$ 44.96	\$ 687.20
20918-6 Expatriate/Spring Field P	150.00	41.91	191.91	13.43	205.34
20918-9 Expatriate/ Report Assist	7,499.50	0.00	7,499.50	524.97	8,024.47
20918-10 Expatriate/Report Collati	1,284.50	0.00	1,284.50	89.92	1,374.42
	<u>\$ 9,146.00</u>	<u>\$ 472.15</u>	<u>\$ 9,618.15</u>	<u>\$ 673.28</u>	<u>\$ 10,291.43</u>

A

*On Jan 2000
10557
1000/1000*



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- Site Remediation & Cleanup
- First Nations Liaison



Expatriate Resources Ltd.
#701-475 Howe Street
Vancouver, British Columbia V6C 2B3
Attention: Justin Himmelright

10557-20918-8
October 31, 2000
Invoice #: 108019
GST# 101953248RT
QST#1023506391 TQ-0001

RECEIVED
JAN - 2 2001

RE: Presentations to Federal and Territorial Government Agencies

SERVICES RENDERED up to and including October 31, 2000 with respect to the above project;

TOTAL FOR PROFESSIONAL SERVICES	\$	2,172.00 A
TOTAL GST		<u>152.04</u>
TOTAL INVOICE AMOUNT	\$	<u><u>2,324.04</u></u> A

FEE SUMMARY

<u>Professional</u>	<u>Hours</u>	<u>Rate</u>	<u>Amount</u>
Donald W. McCallum	2.00	\$120.00	\$240.00
Steve Morison	14.00	\$138.00	\$1,932.00
	16.00		\$2,172.00

1. Please refer to the above INVOICE NUMBER when remitting payment on this file.
2. Interest at 11% per annum will be charged on all invoices not paid within one month of the date of the invoice.

STATEMENT OF ACCOUNT

<u>Current</u>	<u>30 Days</u>	<u>60 Days</u>	<u>90 Days</u>	<u>120+ Days</u>	<u>Total</u>
2,324.04	0.00	0.00	0.00	0.00	\$ 2,324.04

OK- RWV
RE: GL SCOPE CHANGE # July 27
Justin Himmelright

B A P

Expatriate Resources Ltd.
 #701-475 Howe Street
 Vancouver, British Columbia V6C 2B3

RECEIVED
 JAN 30 2001

December 31, 2000
 Invoice#C108485
 Client# 10557
 GST# 101953248RT

paid to Jan Jan 30/01

SERVICES RENDERED up to and including December 31, 2000
 with respect to the projects listed below:
 Detailed particulars of each project accompany this summary.

<u>Project</u>	<u>Fees</u>	<u>Disbnts</u>	<u>Subtotal Fees and Disbnts</u>	<u>Tax</u>	<u>Total</u>
20918-9 Expatriate/ Report Assist	\$ 264.50	\$ 338.41	\$ 602.91	\$ 42.20	\$ 645.11
20918-10 Expatriate/Report Collati	0.00	744.30	744.30	52.10	796.40
	\$ 264.50	\$ 1,082.71	\$ 1,347.21	\$ 94.30	\$ 1,441.51
			A	L2	

OK - evon - ck#320 Jan 31/01
[Signature]

Number 142

March 29, 2000

Brad Marchant
Vice President, Mining and Development
Expatriate Resources Ltd
1016 – 510 West Hastings Street
Vancouver, B.C.
V6B 1L8

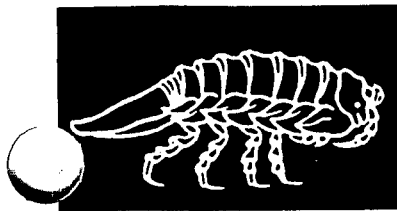
INVOICE

Re: negotiations with Ross River,

A.J. Keen Professional Services 12 hours @ \$100.00	\$1,200.00
GST @ 7%	84.00
Total	<u>\$ 1,284.00</u>

*Jon Gail 14/1/2000
#85*

G.S.T Number 89902 0226



CHARLES J. LOW, PhD.

INVERTEBRATE BIOLOGIST

4580 WILKINSON ROAD
VICTORIA, B.C. V8Z 5B7
PHONE 250-479-6712
FAX 250-744-4108
EMAIL chaslow@pinc.com

RECEIVED
NOV 15 2000

Nov 13, '00

Expatriate Resources Ltd.,
701 - 475 Howe St.,
Vancouver, B.C. V6C 2B3

Attn Accounting:

Dear Sirs:

Invoice re sorting, identification and enumeration of 21 samples of benthic organisms, requested by Justin Himmelright:

21 samples @ \$130.00 ea = \$2730.00 A
GST (126 953 181 RT) = \$191.10 LZ

X Pat-F-ck #670 Dec. 4/00
(KZK)

Total = \$2921.10.

If there are any questions, please feel free to call or email me.

Yours truly,

Chas Low

OK - KZK

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
 Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Expatriate Resources Ltd
 1016-510 West Hastings Street
 Vancouver, B.C. V6B 1L8

Date: 31 March,2000

Terms: payable upon receipt

Attention: Accounts Payable

Invoice No. EXPAT 00 -32 - 1

Project: Wolverine JV

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Mar-00	
	1. Environmental study 5.5 hours @ \$90/h	495.00
	2. Prefeasibility study 22.5 hours @ \$90/h	2,025.00
	3. Marketing study 0 hours @ \$90/h	-
	4. Socio economic 5 hours @ \$90/h	450.00
	5. Metallurgy 5.5 @ \$90/h	495.00
	6. JV Meeting 5.0 @ \$90/h	450.00
	<i>Approved</i> <i>KAM</i>	
	<i>Om</i> <i>Spint 1/2000</i> <i>#101</i>	
	Subtotal	3,915.00
	7% GST (GST # 13077 9903 RT0001)	274.05
	TOTAL	4,189.05
	Less advance payment	
	TOTAL PAYABLE	4,189.05

Outstanding balances over 30 days will be charged 2% interest per month

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Expatriate Resources Ltd
1016-510 West Hastings Street
Vancouver, B.C. V6B 1L8

Date: 30 April, 2000
Terms: payable upon receipt

Attention: Accounts Payable

Invoice No. EXPAT 00 -4 - 1

Project: Wolverine JV

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Apr-00	
	1. Environmental study 0.5 hours @ 90/h	45.00
	2. Prefeasibility study 12 hours @ \$90/h	1,080.00
	3. Marketing study 1 hours @ \$90/h	90.00
	4. Socio economic 0 hours @ \$90/h	-
	5. Metallurgy 5.5 hours @ \$90/h	495.00
	6. Mining 7 hours @ \$90/h	630.00
	7. JV Atna 3 hours @ \$90/h	270.00
	Subtotal	2,610.00
	7% GST (GST # 13077 9903 RT0001)	182.70
	TOTAL	2,792.70
	Less advance payment	
	TOTAL PAYABLE	2,792.70

Paul Murray
#109

Outstanding balances over 30 days will be charged 2% interest per month

Approved
ADW

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
 Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Wolverine Joint Venture
 Expatriate Resources Ltd
 1016-510 West Hastings Street
 Vancouver, B.C. V6B 1L8

Date: 31 May, 2000
 Terms: payable upon receipt

Attention: Accounts Payable

Invoice No. EXPAT 00 -5 - 1

Project: Wolverine JV

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: May-00	
	1. Environmental study 8 hours 90/h	720.00
	2. Prefeasibility study 11.5 hours @ \$90/h	1,035.00
	3. Marketing study 7 hours @ \$90/h	630.00
	4. Socio economic 0 hours @ \$90/h	-
	5. Metallurgy 24.5 hours @ \$90/h	2,205.00
	6. Mining 6.5 hours @ \$90/h	585.00
	7. JV Atna 1.5 hours @ \$90/h	135.00
	Subtotal	5,310.00
	7% GST (GST # 13077 9903 RT0001)	371.70
	TOTAL	5,681.70
	Less advance payment	
	TOTAL PAYABLE	5,681.70

Handwritten signature and note:
 #156

Outstanding balances over 30 days will be charged 2% interest per month

Handwritten initials: ADM

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6

Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Wolverine Joint Venture
Expatriate Resources Ltd
1016-510 West Hastings Street
Vancouver, B.C. V6B 1L8
Attention: Accounts Payable

Date: 30 June, 2000
Terms: payable upon receipt

Invoice No. EXPAT 00 -6 - 1

Project: Wolverine JV

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Jun-00	
	1. Environmental study 0.5 hours @ 90/h	45.00
	2. Prefeasibility study 22.5 hours @ \$90/h	2,025.00
	3. Marketing study 17.5 hours @ \$90/h	1,575.00
	4. Socio economic 2.5 hours @ \$90/h	225.00
	5. Metallurgy 8 hours @ \$90/h	720.00
	6. Mining 4 hours @ \$90/h	360.00
	7. JV Atna 1 hours @ \$90/h	90.00
	<i>ADW</i>	
	<i>one June 17, van #187</i>	
	Subtotal	5,040.00
	7% GST (GST # 13077 9903 RT0001)	352.80
	TOTAL	5,392.80
	Less advance payment	
	TOTAL PAYABLE	5,392.80

Outstanding balances over 30 days will be charged 2% interest per month

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
 Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Wolverine Joint Venture
 Expatriate Resources Ltd
 1016-510 West Hastings Street
 Vancouver, B.C. V6B 1L8
 Attention: Accounts Payable

Date: 31 August, 2000
 Terms: payable upon receipt

Invoice No. EXPAT 00 - 8 - 1

Project: Wolverine JV

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Aug-00	
	1. Environmental study 1 hours @ 90/h	90.00
	2. Prefeasibility study 24.5 hours @ \$90/h	2,205.00
	3. Marketing study 15 hours @ \$90/h	1,350.00
	4. Socio economic 0 hours @ \$90/h	-
	5. Metallurgy 1 hours @ \$90/h	90.00
	6. Mining 4.5 hours @ \$90/h	405.00
	7. JV Atna 0 hours @ \$90/h	-
	RECEIVED SEP - 5 2000	
	<i>Hold 30 days</i>	
	<i>John Atna #247</i>	
	Subtotal	4,140.00
	7% GST (GST # 13077 9903 RT0001)	289.80
	TOTAL	4,429.80
	Less advance payment	
	TOTAL PAYABLE	4,429.80

Outstanding balances over 30 days will be charged 2% interest per month

3/4

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
 Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: **Wolverine Joint Venture**
Expatriate Resources Ltd
 1016-510 West Hastings Street
 Vancouver, B.C. V6B 1L8

Attention: **Accounts Payable**

Date: **31 October, 2000**

Terms: **payable upon receipt**

Invoice No. **EXPAT 00 -10 - 1**

Project: **Wolverine JV**

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Oct-00	
	1. Environmental study 3 hours 90/h	270.00
	2. Prefeasibility study 47.5 hours @ \$90/h	4,275.00
	3. Marketing study 0 hours @ \$90/h	-
	4. Socio economic 1.5 hours @ \$90/h	135.00
	5. Metallurgy 1.5 hours @ \$90/h	135.00
	6. Mining 4.5 hours @ \$90/h	405.00
	7. JV Atna. 0 hours @ \$90/h	-
	<i>WJV</i>	
	Subtotal	5,220.00
	7% GST (GST # 13077 9903 RT0001)	365.40
	TOTAL	5,585.40
	Less advance payment	
	TOTAL PAYABLE	5,585.40

Outstanding balances over 30 days will be charged 2% interest per month

bk

pd Dec 4 2000 #2775

ADM

MARCH PROCESS CONSULTING LIMITED

4360 Canterbury Crescent, North Vancouver, B.C. V7R 3N6
 Tel: (604) 980-9873 Fax: (604) 980-9837 email: pbmarchant@attcanada.net

INVOICE

To: Wolverine Joint Venture
 Expatriate Resources Ltd
 1016-510 West Hastings Street
 Vancouver, B.C. V6B 1L8

Date: 30 November, 2000

Terms: payable upon receipt

Attention: Accounts Payable

Invoice No. EXPAT 00 -11 - 1

Project: **Wolverine JV**

INVOICE FOR PROFESSIONAL SERVICES

ACCOUNT	DESCRIPTION	AMOUNT
	Fees: Nov-00	
	1. Environmental study 2 hours 90/h	180.00
	2. Prefeasibility study 30.5 hours @ \$90/h	2,745.00
	3. Marketing study 4 hours @ \$90/h	360.00
	4. Socio economic 0 hours @ \$90/h	-
	5. Metallurgy 0 hours @ \$90/h	-
	6. Mining 0 hours @ \$90/h	-
	7. Joint venture 14 hours @ \$90/h	1,260.00
	8. Feasibility Study 3 hours @ \$90/h	270.00
	9. Project presentations 4.5 hours @ \$90/h	405.00
	Subtotal	5,220.00
	7% GST (GST # 13077 9903 RT0001)	365.40
	TOTAL	5,585.40
	Less advance payment	
	TOTAL PAYABLE	5,585.40

RECEIVED
 JAN - 9 2001

WJV ch# 326 Jan 31/01

*A
L2*

ADW

Outstanding balances over 30 days will be charged 2% interest per month

HARLAN D. MEADE
7931 Goldstream Place
Richmond, B.C.
V7A1L8

INVOICE 2000-3b - March 31, 2000

Wolverine Joint Venture
C/o Mr. Alan Archer
Chief Financial Officer
Expatriate Resources Ltd.
1016-510 West Hastings Street
Vancouver, B.C
V6B1L8

8 1/2 hrs = 391.00

Dear Al,

MANAGEMENT SERVICES PROVIDED to Wolverine JV: March 1 to March 31, 2000

ALLOCATION:

Wolverine JV 26.5 hrs @46.00 = \$1219

Total \$1219.00

Deliver in person or in my absence mail to my home or to:
Canadian Imperial Bank of Commerce,
400 Burrard Street,
Vancouver, B.C., V6C3A6
for deposit to account of:
Harlan and Linda Meade
Account 19-56930

*pd March 1, 2000
#87*

Thank you.



Harlan D. Meade

Mehling Environmental Management Inc.

3826 Balaclava Street
Vancouver, B.C., V6L 2S8
phone: (604) 731-4150
fax: (604) 733-4255

January 15, 2001

Mr. Justin Himmelright
Expatriate Resources Ltd.
Suite 701 - 475 Howe Street
Vancouver, BC V6C 2B3

MEM Invoice No.2000-55

RECEIVED
JAN 19 2001

Invoice 2000-55
Project Work on the Wolverine / KZK ARD Data
For October / November 2000

Please accept the following invoice for professional services rendered on the Wolverine and KZK geochemistry data review.

Fees: Peri Mehling (see attached timesheet)

33.0 hrs @ \$90/hour = \$ 2,970.00

Disbursements:

Office expenses (3% of fees) \$ 89.10 = \$ 89.10

3059.10 A

GST: (GST Registration No. 890957590)

fees \$ 207.90

disbursements \$ 6.24 = \$ 214.14 L2

Total this invoice: \$ 3,273.24

* Attention to 2000
budget perturbation

OK - wtv - ck # 319 Jan 30/01
[Signature]



NORECOL DAMES & MOORE

A DAMES & MOORE SUBSIDIARY

NORECOL DAMES AND MOORE CANADA
650 WEST GEORGIA STREET, SUITE 1900, VANCOUVER, BC V6B 4N7** (604) 681-1672

** INVOICE **

26 OCTOBER 2000

EXPATRIATE RESOURCES LTD.
701-475 HOWE STREET
VANCOUVER, BC
V6C 2B3

RECEIVED
OCT 26 2000

ATTN: JUSTIN R. HIMMELRIGHT

PLEASE INCLUDE)
ON REMITTANCE) --> INVOICE NUMBER : 04830-310

KUDZ ZE KAYAH DRAWINGS

	CANS
PROFESSIONAL SERVICES RENDERED	A 300.00
(GST Reg: R135618791) GST	LV 21.00
TOTAL INVOICE	321.00

*Justin R. Himmelright
27V* *WJV
as per cost*

PROGRESS BILLING
PLEASE REMIT TO: URS/NORECOL DAMES & MOORE

INTEREST AT THE RATE OF 1.5% PER MONTH WILL BE ADDED AFTER 30 DAYS

THIS INVOICE IS DUE AND PAYABLE UPON PRESENTATION
PLEASE RETURN ONE COPY OF THIS INVOICE WITH YOUR REMITTANCE

BH



TRANS ROCKY CONSULTING INC.

c/ Terry L. Tucker
P.O. Box 789 (188 Porter Avenue)
Millet, Alberta T0C 1Z0
PHONE 780.387.5994

email terrytucker@expatriateresources.com

Invoice No.

32

INVOICE

Customer

Name ~~Expatriate Resources~~ Wolverine Joint Venture c/o Expatriate
Address 701 - 475 Howe Street
City Vancouver Province BC Zip V6C 2B3
Phone 604.682.5474

Date 31/03/00

Quan.	Description	Unit Price	TOTAL
4.00	permitting review, road proposal, environmental data review	\$300.00	\$1,200.00
8.00	wolverine compilation, drill data, claim information,	\$300.00	\$2,400.00
<i>one permit to 1,000 #100</i>			

Payment Details

Cash
 Check
 Credit Card

Name _____
 CC # _____

SubTotal	\$3,600.00
Taxes GST	\$252.00
TOTAL	\$3,852.00

GST NUMBER 86974 6685 RT0001

Please forward cheque directly to EXR's office at 701 - 475 Howe Street

[Handwritten signature]

*Approved
Harlan Meach
April 17 / 2000*



TRANS ROCKY CONSULTING INC.

c/ Terry L. Tucker
P.O. Box 789 (188 Porter Avenue)
Millet, Alberta T0C 1Z0
PHONE 780.387.5994

email terrytucker@expatriateresources.com

Invoice No.

34

INVOICE

Customer

Name Expatriate Resources Wolverine Joint Venture
Address 701 - 475 Howe Street
City Vancouver Province BC Zip V6C 2B3
Phone 604.682.5474

Date 26/04/00
APRIL 2000

Quan.	Description	Unit Price	TOTAL
18.00	exploration project organization, data compilation Strathcona Minerals meeting, Environmental review by Gartner Lee - supervision and meetings, drill bids, analyst meeting, logistics prefield expense	\$300.00	\$5,400.00

1800⁰⁰

*John Gartner, 1000
#104*

Payment Details

- Cash
- Check
- Credit Card

Name _____
CC # _____

SubTotal	\$5,400.00
Taxes	GST
	\$378.00
TOTAL	\$5,778.00

GST NUMBER 86974 6685 RT0001

Please forward cheque directly to EXR's office at 701 - 475 Howe Street

[Signature]
[Signature]
April 26/2000



TRANS ROCKY CONSULTING INC.

c/ Terry L. Tucker
P.O. Box 789 (188 Porter Avenue)
Millet, Alberta T0C 1Z0
PHONE 780.387.5994

email terrytucker@expatriateresources.com

Invoice No.

42

INVOICE

Customer

Name	Expatriate Resources Ltd.		
Address	701 - 475 Howe Street		
City	Vancouver	Province	BC
Zip	V6C 2B3		
Phone	604.682.5474		

Date	04/12/00
	November 2000

Quan.	Description	Unit Price	TOTAL
13.00	KZK - Wol drilling / office claims	\$300.00	\$3,900.00
5.00	FP - Goal Net drilling claims office	\$300.00	\$1,500.00
5.00	WJV environmental work/ drill database presentation material etc.	\$300.00	\$1,500.00

WTU - 1500 - A
105
1605

750.00

and Dec 6, 1999
#10116

Payment Details

Cash
 Check
 Credit Card

Name _____
CC # _____

SubTotal	\$6,900.00
Taxes GST	\$483.00
TOTAL	\$7,383.00

GST NUMBER 86974 8685 RT0001

Please deposit to the following account CIBC, Millwoods Main Street 6150 - 28th Avenue, Edmonton , AB T6L 6N4 Branch 6869 account 1203819

B 49

P



TRANS ROCKY CONSULTING INC.

c/ Terry L. Tucker
P.O. Box 789 (188 Porter Avenue)
Millet, Alberta T0C 1Z0
PHONE 780.387.5994
email terrytucker@expatriateresources.com

Invoice No.

44

INVOICE

Customer

Name Expatriate Resources Ltd.
Address 701 - 475 Howe Street
City Vancouver Province BC Zip V6C 2B3
Phone 604.682.5474

Date 01/02/01
January 2001

Quan.	Description	Unit Price	TOTAL
18.00	KZK Assessment/Budgeting/environmental/etc year end summary reports/etc Roundup - Core shack/preparation/booth etc. <i>Xlat - F ck #713 Feb 2/01</i>	\$300.00	\$5,400.00
	<i>ADW</i> <i>Jan 31/2001</i>		<i>1100.00</i>
		SubTotal	\$5,400.00
		Taxes GST	\$378.00
		TOTAL	\$5,778.00

Payment Details

- Cash
- Check
- Credit Card

Name _____
CC # _____

Taxes GST \$378.00
TOTAL \$5,778.00

GST NUMBER 86974 6685 RT0001

Please deposit to the following account CIBC, Millwoods Main Street 6150 -
28th Avenue, Edmonton , AB T6L 6N4 Branch 6869 account 1203819

f

WHITE MOUNTAIN ENVIRONMENTAL CONSULTING

P.O. Box 10140, Whitehorse, Yukon
Y1A 7A1
Phone: (867) 393-4189 fax: (867) 399-4122

INVOICE STATEMENT

January 12,2001

Invoice # 01-01

Attention: Justin Himmelright
Manager of Environment
Expatriate Resources Ltd.

Re: Consultation and archival research on Wolverine Lake fish resources.

PROFFESIONAL FEES AND EXPENSES

Professional fees for 6 hours archival research and consultations @ \$ 45/hr \$ 270.00
Meetings Jan.10 and 12 = 4.5 hours @ \$45/hr \$ 202.50

SUBTOTAL \$ 472.50
GST @7% on \$472.50 \$ 33.29

TOTAL AMOUNT OF THIS INVOICE \$ 505.79

GST # 89 84825 75

OK - wjv
AFE-01-001
[Signature]

BH

A
LV
A



CAPITAL HELICOPTERS
(1995) INC.
P.O. BOX 4387
WHITEHORSE, YUKON Y1A 3T5

PHONE (403) 668-6200
FAX (403) 668-6201

INVOICE

NO: 1126

DATE 10/20/00

PAGE 1 of 1

SOLD TO

SHIP TO

Expatriate Resources Ltd.
701-475 Howe St
Vancouver, BC
V6C 2B3

Expatriate Resources Ltd.
701-475 Howe St
Vancouver, BC
V6C 2B3

Business No.: 899587984

ITEM NO.	QUANTITY	UNIT	DESCRIPTION	GST PST	UNIT PRICE	AMOUNT
766	6.5	Hour	Bell 206 Jet Ranger Charter 0 - GST exempt Terms: Net 30. Due 11/19/00. <i>Xpat-F K2K 61</i>	0	766.00	4,979.00
<p>COMMENTS</p> <p>Thank You! Your Business Is Appreciated!</p>						<p>TOTAL 4,979.00</p>

OK- K2K RE: WILDLIFE MONITORING AGREEMENT

*one hr to 1000
610-*

[Signature]

BH

P

ACCOUNT NUMBER **ARCHWOL**
 INVOICE NUMBER **24835**
 INVOICE DATE **28 06 00** AREA **B.C. YUKON NWT ALTA**
 A/C TYPE **206** AIRCRAFT REGISTRATION C **GPGH**
 FLIGHT DATE **14 06 00** DAY MONTH YEAR
 PURCHASE ORDER NO.

WJSV
 CHARTERER
P.O. Box 4127
 BILLING ADDRESS
Whitehorse, Y.T. Y1A 3S9
 FUEL & OIL-X TANTA FUEL USED HRS/LITRES FROM
 TANTA CUST.

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
YDM		2.8	WJSV
Wolverine			ENV Contractor
			Ag

SUB	G.L.	AMOUNT			
1603502		1960-	2.8	@ 700⁰⁰	1960 -
			HOLDING TIME:	@ / HR.	
0000323		13720	FUEL	@ / LITRE	
			FUEL	@ / LITRE	
			MEALS & LODGINGS		
			OTHER		
			OTHER		
			SUB TOTAL		1960 -
			GOODS & SERVICES TAX		137 20
			REGISTRATION NO. R121483135		

TOTAL \$ 2097.20

ACCOUNT NUMBER **ARCHWOL**
 INVOICE NUMBER **24836**
 INVOICE DATE **28 06 00** AREA **B.C. YUKON NWT ALTA**
 A/C TYPE **206** AIRCRAFT REGISTRATION C **GPGH**
 FLIGHT DATE **16 06 00** DAY MONTH YEAR
 PURCHASE ORDER NO.

WJSV
 CHARTERER
 BILLING ADDRESS
 FUEL & OIL-X TANTA FUEL USED HRS/LITRES FROM
 TANTA CUST.

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
Wolverine		2.2	WJSV
Wolverine			Water
			ENV
			Ag

SUB	G.L.	AMOUNT			
1603502		1540-	2.2	@ 700	1540 00
			HOLDING TIME:	@ / HR.	
0000323		10780	FUEL	@ / LITRE	
			FUEL	@ / LITRE	
			MEALS & LODGINGS		
			OTHER		
			OTHER		
			SUB TOTAL		1540 -
			GOODS & SERVICES TAX		107 80
			REGISTRATION NO. R121483135		

TOTAL \$ 1647.80



REMIT PAYMENT TO:
TRANS NORTH HELICOPTERS
 TRANS NORTH TURBO AIR LTD.
 20 NORSEMAN ROAD • WHITEHORSE • YUKON • Y1A 6E6
 TELEPHONE (867) 668-2177 FAX (867) 668-3420

ACCOUNT NUMBER	ARCHWOL		
INVOICE NUMBER	24516		
INVOICE DATE	28	06	00
A/C TYPE	206	AIRCRAFT REGISTRATION C	GFKD
FLIGHT DATE	17	MONTH	YEAR
	00		
PURCHASE ORDER NO.			

WJSV
 CHARTERER
 P.O Box 4127
 BILLING ADDRESS
 Whitehorse, Y.T Y1A 3S9

FUEL & OIL-X	TNTA FUEL USED	HRS./LITRES	FROM
TNTA CUST.			
X			

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
Wolverine		3	
TO Wolverine		3	
"		3	WTV
"			ENVIRONMENT
			By

SUB	GL	AMOUNT		
1607	502	630	-09	@ 700 ⁰⁰ 630 00
				@
				HOLDING TIME: @ / HR.
0000	323	44	10	FUEL @ / LITRE
				FUEL @ / LITRE
				MEALS & LODGINGS
				OTHER
				OTHER
				SUB TOTAL 630 00
				GOODS & SERVICES TAX 44 10
				REGISTRATION NO. R121483135
			TOTAL	\$ 674 10

TERMS PAYABLE UPON RECEIPT OF INVOICE.
 2% INTEREST PER MONTH (24% PER ANNUM) WILL BE CHARGED ON ALL OUTSTANDING AMOUNTS OVER 30 DAYS.
 IF INTEREST IS NOT PAID, FUTURE FLIGHTS WILL BE ON A CASH BASIS.

X *[Signature]*
 CHARTERER'S SIGNATURE

[Signature]
 CHARTERER'S NAME (PRINTED)

INITIALS *GMS*
 PILOTS SIGNATURE

BMS
 ENGINEER'S NAME

BGD

CARRIAGE SUBJECT TO TERMS OF PUBLISHED TARIFF.
 TARIFF AVAILABLE TO PUBLIC VIEW AT TRANS NORTH OFFICE.

THIS IS YOUR ONLY INVOICE - PAY UPON RECEIPT

OK!



REMIT PAYMENT TO:
TRANS NORTH HELICOPTERS
 TRANS NORTH TURBO AIR LTD.
 20 NORSEMAN ROAD • WHITEHORSE • YUKON • Y1A 6E6
 TELEPHONE (867) 668-2177 FAX (867) 668-3420

ACCOUNT NUMBER	ARCHEXP		
INVOICE NUMBER	26851		
INVOICE DATE	30	09	00
A/C TYPE	2206	AIRCRAFT REGISTRATION C	FCH4
FLIGHT DATE	07	09	00
PURCHASE ORDER NO.			

CHARTERER Expatriate Resources

BILLING ADDRESS

FUEL & OIL-X	TNTA FUEL USED	HRS/PRES	FROM
<input checked="" type="checkbox"/>	364	6.7	YQH
TNTA CUST.	400cust		

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
YQH Base			
to Res/camp Hwy	0800		
pick Dave - Whitehorse			Environmental Sampling
camp - Gate repairs			(Job for Terry Tucker.)
pick up water			
Samplers. 2 id			
5 sample sites, saw			
out + sling welder			
out, samples out			
rtn YQH Base.	17:54		

SUB	G.L.	AMOUNT			
3427	502	4690.00	6.7	@ 700 ⁰⁰	4690 00
3400	131	291.20		@	
0000	823	348.68	FUEL 364	@ .80 / LITRE	291 20

TERMS: PAYABLE UPON RECEIPT OF INVOICE.
 2% INTEREST PER MONTH (24% PER ANNUM) WILL BE CHARGED ON ALL OUTSTANDING AMOUNTS OVER 30 DAYS. IF INTEREST IS NOT PAID, FUTURE FLIGHTS WILL BE ON A CASH BASIS.

X Terry Tucker
 CHARTERER'S SIGNATURE
 TERRY TUCKER
 CHARTERER'S NAME (PRINTED)
 INITIALS MSR
 PILOTS SIGNATURE
 ENGINEER'S NAME Bill Dean
 BILL DEAN

FUEL RECEIVED
 MEALS & LODGINGS
 OTHER
 OTHER
 SUB TOTAL 4981.20
 GOODS & SERVICES TAX REGISTRATION NO. R121483135 348.68

TOTAL \$ 5329.88

CARRIAGE SUBJECT TO TERMS OF PUBLISHED TARIFF.
 TARIFF AVAILABLE TO PUBLIC VIEW AT TRANS NORTH OFFICE.

THIS IS YOUR ONLY INVOICE - PAY UPON RECEIPT

This invoice entirely w/iv sampling
by w/iv ADM

ACCOUNT NUMBER **ARCH EXP**
 INVOICE NUMBER **26894**
 INVOICE DATE **22 01 01** AREA **B.C. YUKON NWT ALTA**
 A/C TYPE **B206** AIRCRAFT REGISTRATION C **FCHU**
 FLIGHT DATE **14 01 01**
 PURCHASE ORDER NO. **01-001**

Expatriate Res Ltd

CHARTERER
 BILLING ADDRESS

FUEL & OIL-X TMTA FUEL USED **245.4** HRS. AIRTIME **3.9** FROM **YQH**
 TMTA CUST. **200**

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
YQH Base			
TO Valuerine LK	08:48		3 pass + Gear
area, 4 Sample points then to KKK, photo's, Rtn YQH Base.			(Greater Samples)
	4:36		

NEW ADDRESS	3.9	@ 775.00	3022.50
TNTA		@	
P.O. BOX #8			
WHITEHORSE, YUKON			
C Y1A 5X9			
HOLDING TIME:		@ / HR.	
FUEL 245	@ .85 / LITRE		208.25
FUEL	@ / LITRE		
MEALS & LODGINGS			
OTHER			
OTHER			
SUB TOTAL			3230.75
GOODS & SERVICES TAX			226.15
REGISTRATION NO. R121483135			

TERMS: PAYABLE UPON RECEIPT OF INVOICE.
 2% INTEREST PER MONTH (24% PER ANNUM) WILL BE CHARGED ON ALL OUTSTANDING AMOUNTS OVER 30 DAYS. IF INTEREST IS NOT PAID, FUTURE FLIGHTS WILL BE ON A CASH BASIS.

X *[Signature]*
 CHARTERER'S SIGNATURE

CHARTERER'S NAME (PRINTED)
 INITIALS **MSR** PILOTS SIGNATURE **myReed.**
 ENGINEER'S NAME **DE WIT**

TOTAL \$ 3456.90

FEB - 5 2001

CARRIAGE SUBJECT TO TERMS OF PUBLISHED TARIFF. TARIFF AVAILABLE TO PUBLIC VIEW AT TRANS NORTH OFFICE.

THIS IS THE ONLY INVOICE - PAY UPON RECEIPT

ACCOUNT NUMBER **ARCH EXP**
 INVOICE NUMBER **26893**
 INVOICE DATE **22 01 01** AREA **B.C. YUKON NWT ALTA**
 A/C TYPE **B206** AIRCRAFT REGISTRATION C **FCHU**
 FLIGHT DATE **13 01 01**
 PURCHASE ORDER NO. **01-001**

Expatriate Res Ltd

CHARTERER
 BILLING ADDRESS

FUEL & OIL-X TMTA FUEL USED **199.4** HRS. AIRTIME **3.5** FROM **YQH**
 TMTA CUST. **200**

FROM	UP/DOWN TIME	HOURS	REMARKS - NO. OF PASS - FREIGHT Kg
YQH Base			
TO Valuerine LK	0800		3 pass + Gear
area, Drop crew of. Pick up i ply through to KKK			
via prop Road w/ Rtn for crew Rtn			
YQH Base.	1650		

NEW ADDRESS	3.5	@ 775.00	2712.50
TNTA		@	
P.O. BOX #8			
WHITEHORSE, YUKON			
Y1A 5X9			
HOLDING TIME:		@ / HR.	
FUEL 199	@ .85 / LITRE		169.15
FUEL	@ / LITRE		
MEALS & LODGINGS			
OTHER			
OTHER			
SUB TOTAL			2881.65
GOODS & SERVICES TAX			201.72
REGISTRATION NO. R121483135			

TERMS: PAYABLE UPON RECEIPT OF INVOICE.
 2% INTEREST PER MONTH (24% PER ANNUM) WILL BE CHARGED ON ALL OUTSTANDING AMOUNTS OVER 30 DAYS. IF INTEREST IS NOT PAID, FUTURE FLIGHTS WILL BE ON A CASH BASIS.

X *[Signature]*
 CHARTERER'S SIGNATURE

CHARTERER'S NAME (PRINTED)
 INITIALS **MSR** PILOTS SIGNATURE **myReed.**
 ENGINEER'S NAME **DE WIT**

TOTAL \$ 3083.37

FEB - 5 2001

CARRIAGE SUBJECT TO TERMS OF PUBLISHED TARIFF. TARIFF AVAILABLE TO PUBLIC VIEW AT TRANS NORTH OFFICE.

THIS IS THE ONLY INVOICE - PAY UPON RECEIPT



INVOICE
No 12508

Phone: (250) 651-7600 Fax: (250) 651-7537
P.O. Box 134, Atlin, B.C. V0W 1A0

Phone: (867) 667-7327 Fax: (867) 667-4510
Box 5299, Whitehorse, Yukon Y1A 4Z2

Purchase Order No. _____
Aircraft NYD Pilot J.H.L.

Empty Weight _____ Aircraft Op. Wt. _____

ACCOUNT WITH: EX PATRIATE

Rate = WTX / WTR / DRY / FER

FROM:	Time Off	Time On	Hours	Miles	Rate	No. of Pass	Lbs. Cargo
<u>WHITE HORSE</u>							
ROSS RIVER							
<u>WOLVERINE</u>	<u>1810</u>	<u>1940</u>	<u>1.5</u>	<u>180</u>		<u>1</u>	<u>200</u>
<u>ROSS RIVER</u>	<u>1950</u>	<u>2010</u>	<u>.4</u>	<u>155</u>		<u>2</u>	<u>600</u>
<u>WHITE HORSE</u>	<u>2030</u>	<u>2130</u>	<u>1.0</u>	<u>125</u>		<u>1</u>	<u>500</u>
TOTALS				<u>460</u>		<u>4</u>	<u>1300</u>

PASSENGER'S NAMES / CARGO REMARKS
<u>GLENNIS.</u>
<u>FOREST</u>
<u>GREG.</u>
<u>WTV</u>

I certify that the C of G and aircraft weight are within limits.

Signed [Signature]
Pilot or Dispatcher Signature

<u>460</u> Miles @ <u>2.60</u> per mile	<u>1196</u> 00
Hours @ per hour	
Fuel @	

This Contract of Carriage is issued subject to the terms and conditions as stated in the Company Tariffs on file with the Air Transport Board.

Flight Authorized by [Signature] Charge Cash

Date: June 16

NAV Canada Fees	
Other Fuel surcharge	<u>50</u> 60
Subtotal	<u>1246</u> 60
G.S.T. #R120801972	<u>87</u> 26
Total	<u>1333</u> 86 <u>1/4</u>

COPY to be LEFT at Point of Departure.

NOT REQUIRED FOR TRAINING or FERRY FLIGHTS

WILLOW PRINTERS LTD.

FROM:	Time Off	Time On	Hours	Miles	Rate	No. of Pass	Lbs. Cargo
TOTALS				<u>460</u>		<u>4</u>	<u>1300</u>

<u>460</u> Miles @ <u>2.60</u> per mile	<u>1196</u> 00
Hours @ per hour	
Fuel @	

This Contract of Carriage is issued subject to the terms and conditions as stated in the Company Tariffs on file with the Air Transport Board.

Flight Authorized by [Signature] Charge Cash

Date: June 16

NAV Canada Fees	
Other Fuel surcharge	<u>50</u> 60
Subtotal	<u>1246</u> 60
G.S.T. #R120801972	<u>87</u> 26
Total	<u>1333</u> 86 <u>1/4</u>

COPY to be LEFT at Point of Departure.

NOT REQUIRED FOR TRAINING or FERRY FLIGHTS

WILLOW PRINTERS LTD.

Summit Air

CHARTERS LTD.


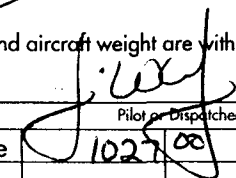
INVOICE
NO 12208

Phone: (250) 651-7600 Fax: (250) 651-7537 | Phone: (867) 667-7327 Fax: (867) 667-4510
P.O. Box 134, Atlin, B.C. V0W 1A0 | Box 5299, Whitehorse, Yukon Y1A 4Z2

Purchase Order No. _____
Aircraft NYP Pilot Wolsky
Empty Weight 2085 Aircraft Op. Wt. 3500
Rate = WTX / WTR / DRY / FER

ACCOUNT WITH: EXPARTIATE

FROM:	Time Off	Time On	Hours	Miles	Rate	No. of Pass	Lbs. Cargo
WHSE							
ROSS RIVER	14:15	15:16	1.0	125		1	80
WOLVERINE	15:32	16:17	.8	90		2	160
WHSE	16:28	17:58	1.5	100		Ø	Ø
TOTALS			3.3	395			

PASSENGER'S NAMES / CARGO REMARKS	
FOREST PEARSON PEARSON CARGO & GREG	
	
I certify that the C of G and aircraft weight are within limits.	
Signed	 Pilot or Dispatcher Signature
395 Miles @ 2.60 per mile	1027.00
Hours @ per hour	
Fuel @	

This Contract of Carriage is issued subject to the terms and conditions as stated in the Company Tariffs on file with the Air Transport Board.

Flight Authorized by  Charge Date: JUNE 13/05
 Cash 1230.66
 COP to be LEFT at Point of Departure. NOT REQUIRED FOR TRAINING or FERRY FLIGHTS

NAV Canada Fees	
Other Fuel surcharge	35.55
Subtotal	1062.55
G.S.T. #R120801972	38
Total	1100.05



SALES AGT: AC/YBAUAC
67972

Especially for:
HIMMELRIGHT/JUSTIN

Sold to:

EXPATRIATE RESOURCES LTD.
701-475 HOWE STREET
VANCOUVER BC
V6C 2B3

INVOICE

DATE: JUN 23 2000

TERMS: PAYMENT DUE UPON PRESENTATION
5893 INVOICE

AIRLINE	FLIGHT	CLASS	DATE	FROM	TO	LEAVE	ARRIVE	ST
---------	--------	-------	------	------	----	-------	--------	----

CANADA THREE THOUSAND	27JUN			VANCOUVER	WHITEHORSE	1255P	0320P	
2T 743	L		TUE	INTL				
	NON SMOKING			TERMINAL M				
				SNACK				
								NON STOP
								2:25 DURATION
				AIRCRAFT: AIRBUS INDUSTRIE A320-100/200				

CANADA THREE THOUSAND	01JUL			WHITEHORSE	VANCOUVER	1015A	1240P	
2T 744	W		SAT	INTL				
	NON SMOKING			TERMINAL M				
				SNACK				
								NON STOP
								2:25 DURATION
				AIRCRAFT: AIRBUS INDUSTRIE A320-100/200				

MISCELLANEOUS 01OCT VANCOUVER
SUN

FARE	359.00	TAX	0.00	GST/HST	25.13	TOTAL CAD	384.13
				PAID BY VISA/THANKS			-384.13
				AIR TOTAL			0.00
				INVOICE TOTAL			0.00

25.13
384.13

PAYMENT: ZCVI4516019070946016/1102/A067657 - *HOM VISA*

RESERVATION NUMBER(S) 2T/R2H5B

TICKET: 570 3374058057

PLEASE CHECK IN AT LEAST 1 HOUR PRIOR TO DEPARTURE
HUME TRAVEL 24 HOURS TOLL FREE EMERGENCY SERVICE
THROUGH GLOBAL PRIVILEGE. QUOTE VIT CODE *E6749*
FROM ANYWHERE IN CANADA CALL 1-800-488-2444 OR CALL
US DIRECT AT 1-800-663-9787 DURING BUSINESS HOURS.
THIS TICKET IS EXEMPT FROM SERVICE FEES
GLAD WE COULD HELP.....ANNE

WTV

INVOICE NUMBER 0000067972

Trans. date M D	Posting date M D	Ref. no.	Description	Amount
			CARD NO: 5191 2300 1142 1014	
			[REDACTED]	
			[REDACTED]	
			[REDACTED]	
06/27	06/28	7	LONDON DRUGS #02 VANCOUVER BC	9.78 ✓
06/27	06/28	8	EXTRA FOODS #8567 WHITEHORSE YT	26.74 ✓
06/27	06/28	9	CANADA 3000 RICHMOND BC	35.00 ✓
06/27	06/28	10	NORCAN LEASING LTD WHITEHORSE YT CAN	200.00 ✓
06/27	06/29	12	SUBWAY WHITEHORSE YT	7.06 ✓
06/27	06/29	13	SUNRISE SERVICE CENTRE LTCARMACKS YT	13.00 ✓
06/28	06/29	14	EILEEN'S PLACE ROSS RIVER CAN	88.28 ✓
06/27	06/30	15	VAN. AIRPORT FEE CANADA BC	5.00 ✓
06/28	06/30	16	YELLOW CAB CO LTD. VANCOUVER BC	25.80 ✓
07/01	07/04	17	TAGS WHITEHORSE WHITEHORSE YT	11.79 ✓
06/29	07/04	18	TATCHUN CENTRE CARMACKS YT	31.03 ✓
07/02	07/04	19	EDGEWATER HOTEL WHITEHORSE YT	261.15 ✓
			[REDACTED]	
07/02	07/05	22	VANCOUVER INTL AIRPORT RICHMOND BC	6.00 ✓
07/01	07/05	23	AIR NORTH WHITEHORSE YT	40.00 ✓
07/01	07/05	24	NORCAN LEASING LTD WHITEHORSE YT CAN	366.06 ✓
			[REDACTED]	
			TOTAL = 1126.69	

Previous balance	1,630.00
Purchases	2,207.78
Cash advances	100.00
Interest	10.71
Fees	1.50
Debit adjustments	
Other	
Payments	1,630.00
Credit adjustments	854.98
Other	
New balance \$	1,465.01
Amount past due	0.00
Minimum payment	43.00
Credit limit	5,000.00
Credit available	3,534.99
Paid \$	

MasterCard AIR MILES Travel miles summary

Travel Miles additions/adjustments 33CR

Interest information Interest charges posted on this statement are for transactions appearing on:

	Current statement	Last month's statement	Previous statements	Total interest charge	Interest rate next period Annual %	Daily
Cash advances	\$ 0.40	\$ 4.39	\$ 1.95	\$ 6.74	18.40000	0.05027
Purchases and other	0.00	0.00	3.97	3.97	18.40000	0.05027

Please address any written enquiries to:

MASTERCARD P.O. BOX 11064 STN CENTRE-VILLE
 MONTREAL PQ H3C5A2

Please report any items shown which do not agree with your records within 30 days.

Tear off here and return bottom portion with your payment.

Toll-free calls Canada & U.S.A. 1-800-361-3361 - stolen cards - (800) 361-336
 1-800-263-2263 - Enquiries - 1-800-263-226
 Telephone Device for the Deaf - (604) 665-711



Card number	New balance	Minimum payment	Payment due by	Payment amount
[REDACTED]	1,465.01	43.00	30JUL2000	\$

- Please:
1. Write your MasterCard card number on the back of your cheque or money order
 2. Direct any questions to the address noted above so that our Customer Service Department can respond promptly.
 3. Payment may be made at any branch in Canada or mailed to one of the addresses on the reverse.
 4. Make cheque payable to:

Bank of Montreal

P.O. BOX 11064 STN CENTRE-VILLE
 MONTREAL PQ H3C 5A2

JUSTIN R HIMMELRIGHT
 23084 126 AVE
 MAPLE RIDGE BC
 V2X 4P3

5191230011421014 000004300 000146501

72.83
 CL-18.47
 DI-9.17
 DL-351.56
 D3-104.68
 04-570.18

1126.69

WTV
mt July 1, 2000
#195

128892

STATEMENT

THE TOWN & MOUNTAIN HOTEL
401 MAIN STREET
WHITEHORSE, YUKON
Y1A 2B6

DATE 19 July 2000

TAX REG. NO. R123927331

Expatriate Resources

P.O. Box 4127

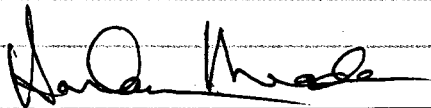
Whitehorse YT

Y1A 359

DATE	DETAILS	DEBIT	CREDIT	BALANCE
	Re: Meade, H.			
	Room chg	89.00		
	GST	6.23		95.23
	Re: Himmelright,			
	Room chg	89.00		
	GST	6.23		95.23
	WTU -178			
	17.46			
	<u>190.46</u>			<u>190.46</u>

BLUELINE DC 101

- CHARGE
- VISA
- MASTERCARD

SIGNATURE 

SIGNATURE

STATEMENT


DATE 19 July 2000

TAX REG. NO. R123927331

Expatriate Resources

Y1A 359

DATE	DETAILS	DEBIT	CREDIT	BALANCE
	Re: Meade, H.			
	Room chg	89.00		
	GST	6.23		95.23
	Re: Himmelright,			
	Room chg	89.00		
	GST	6.23		95.23
	WTU -178			
	17.46			
	<u>190.46</u>			<u>190.46</u>

SIGNATURE 

Handwritten mark resembling a stylized 'y' or 'g'.

Trans. date	Posting date	Ref. no.	Description	Amount	Previous balance
			CARD NO: 5191 2300 1142 1014		1,465.01
06/27	07/10	1	CARA OPERATIONS RICHMOND BC	13.40 - ①	
07/10	07/12	2	GRAND & TOY #5054 VANCOUVER BC	14.81 - ②	
07/18	07/20	3	VAN AIRPORT FEE CANADA BC	5.00 - ②	
07/18	07/20	4	BEL-AIR TAXI COQUITLAM BC	73.00 - ②	
07/22	07/24	5	AOL-CANADA SERVICE 070 888-AOLHELP CAN	43.00 - ③	
07/14	07/25	6	AIR CANADA VANCOUVER CAN	1,416.68 - ②	
07/28	07/28	7	PAYMENT RECEIVED - THANK YOU	1,465.01 CR	
<p>AS A PREFERRED MASTERCARD CARDHOLDER WE HAVE INCREASED YOUR CREDIT LIMIT TO ACCOMMODATE FUTURE PURCHASING NEEDS. YOUR NEW CREDIT LIMIT IS SHOWN ON THIS STATEMENT.</p>					
<p>SUB TOTAL = 1,565.89 (NO RECEIPT) 1594.29 + 9.00 TOTAL = 1603.29</p>					
<p>① = MEALS & ALCOH. ② = TRAVEL ③ = OFFICE SUPPLY/EXPENSE (NOT WJV)</p>					
<p>Interest information: Interest charges posted on this statement are for transactions appearing on:</p>					

Purchases	1,565.89
Cash advances	
Interest	
Fees	
Debit adjustments	
Other	
Payments	1,465.01
Credit adjustments	
Other	
New balance \$	1,565.89
Amount past due	0.00
Minimum payment	46.00
Credit limit	6,000.00
Credit available	4,434.11
Paid \$	

MasterCard AIR MILES
Travel miles summary

Travel Miles additions/adjustments: 39CR

	Interest information					Interest rate next period	
	Current statement	Last month's statement	Previous statements	Total interest charge	Annual %	Daily	
Cash advances	\$ 0.00	\$ 0.00	\$ 0.00	\$ 0.00	18.40000	0.05027	
Purchases and other	0.00	0.00	0.00	0.00	18.40000	0.05027	

Please address any written enquiries to: **MASTERCARD P.O. BOX 11064 STN CENTRE-VILLE MONTREAL PQ H3C5A2**

Toll-free calls Canada & U.S.A.: 1-800-361-3361 (stolen cards), 1-800-263-2263 (Enquiries), Telephone Device for the Deaf - (604) 665-7111

Local calls: (800) 361-3361

Please report any items shown which do not agree with your records within 30 days. Tear off here and return bottom portion with your payment.



Card number	New balance	Minimum payment	Payment due by	Payment amount
[REDACTED]	1,565.89	46.00	30AUG2000	\$

- Please:
- Write your MasterCard card number on the back of your cheque or money order
 - Direct any questions to the address noted above so that our Customer Service Department can respond promptly.
 - Payment may be made at any branch in Canada or mailed to one of the addresses on the reverse.
 - Make cheque payable to:

Bank of Montreal

P.O. BOX 11064 STN CENTRE-VILLE MONTREAL PQ H3C 5A2

JUSTIN R HIMMELRIGHT
23084 126 AVE
MAPLE RIDGE BC
V2X 4P3

Handwritten notes:
 L2 - 8.24
 D2 - 39.26
 D3 - 81.30
 Himmelright - 1416.68 already?
 1545.48

5191230011421014 000004600 000156589

NORCAN LEASING LTD
213 RANGE ROAD
WHITEHORSE YT Y1A3E5

Driver :
JUSTIN HIMMELRIGHT
23084 126 AVE
MAPLE RIDGE, BC V7X-4P3

Bill To :
EXPATRIATE RESOURCES
ATTN: ACCT'S PAYABLE
701-475 HOWE ST.

Client Ref#: 1443
Lic. #: 5208442
Lic Expires: 12/13/2004
P.O.#:

VANCOUVER, BC V6C 2B3

Bill To Code : EX101
Agreement Number: 911001
Statement Date : 11/27/2000

VEHICLE NUMBER	VEHICLE TYPE	VEHICLE PLATE	DATE RENTED	DATE RETURNED
1992310	99 GMC K1500	RBR69	11/23/2000 8:19	11/25/2000 10:16

Rental Period : 2 day(s) - Rate Type : DAILY

S T A T E M E N T O F C H A R G E S :

Rate Charge	:	119.90	Add'l Charges	:	
Kilometers Charge	:	168.50	SSurcharges	:	0.00
Damage Waiver	:	39.90	Credits	:	< 0.00 >
Pers. Accident Ins.	:	11.98	Sub-Total	:	340.28
Additional Driver	:	0.00			
PPD FUEL	:	0.00	Provincial Sales Tax	:	0.00
PEACE/MIND	:	0.00	Goods & Services Tax	:	23.82
CAN/WIN/RK	:	0.00			
DROP OFF	:	0.00	Total Charges	:	
AIR CON	:	0.00			
Fuel Charge	:	0.00			

Company Authorized
Company Payments 0.00

Net Due From Company 364.10

FED ID# R121995476

Please Make Check Payable To and Remit To :

D U E U P O N R E C E I P T

NORCAN LEASING LTD
213 RANGE ROAD
WHITEHORSE, YT Y1A3E5
Phone 867-668-2137 Fax

Please Pay
This Amount 364.10

Loc WAP



JRH

SALES AGT: AA/ZOFLU4
80753

Especially for:
BEV JANG *(WJV)*
EXPATRIATE RESOURCES LTD
701 475 HOWE STREET
VANCOUVER
BC
V6C 2B3

Sold to:
JUSTIN R HIMMELRIGH
701 475 HOWE STREET
VANCOUVER
BC V6C 2B3
CANADA

INVOICE

TERMS: PAYMENT DUE UPON PRESENTATION
INVOICE

DATE: FEB 14 2001

5893

AIRLINE	FLIGHT CLASS	DATE	FROM	TO	LEAVE	ARRIVE	ST
---------	--------------	------	------	----	-------	--------	----

AIR CANADA AC 3580 M	18FEB SUN	VANCOUVER INTL	WHITEHORSE		0755A	1020A	
EQP: BOEING 737 ALL 100-800 SERIES PSGR SEAT 16C CONFIRMED							

AIR CANADA AC 3583 T	21FEB WED	WHITEHORSE INTL	VANCOUVER		1110A	0130P	
EQP: BOEING 737 ALL 100-800 SERIES PSGR SEAT 18D CONFIRMED							

FARE	1238.00	TAX	0.00	GST/HST	86.66	TOTAL CAD	1324.66
PAID BY MASTERCARD/THANKS							-1324.66

INVOICE TOTAL 10.00

PAYMENT: CCCA5191230011421014/0802/CAD1324.66/N121501 -*JRH*

RESERVATION NUMBER(S) AC/TABK2H

HIMMELRIGHT/JUSTIN

TICKET: 014 3184021272

AC FREQUENT FLYER AC718359441
PLEASE CHECK IN AT LEAST 1 HOUR PRIOR TO DEPARTURE
HUME TRAVEL 24 HOURS TOLL FREE EMERGENCY SERVICE
THROUGH GLOBAL PRIVILEGE. QUOTE VIT CODE *E6749*
FROM ANYWHERE IN CANADA CALL 1-800-448-2444 OR CALL
US DIRECT AT 1-800-663-9787 DURING BUSINESS HOURS.
THIS TICKET IS EXEMPT FROM SERVICE FEES
GLAD WE COULD HELP.....ANJU
-FARE ASSURANCE- 13FEB PM

INVOICE NUMBER 0000080753



CAN LEASING LTD
 RANGE ROAD
 WHITEHORSE YT Y1A3E5
 867-668-2137
 FAX# 867-633-3110

1. METHOD OF PAYMENT
 MODE DE PAIEMENT

- AMEX
- CASH/COMPTANT
- DIRECT/FACTURE
- EN ROUTE
- MASTERCARD
- NATIONAL TILDEN (INTCB)
- VISA

JAN 26 2001

**RENTAL AGREEMENT
 CONTRAT DE LOCATION**

RA#: 911385

OK - wju
JHNDM

EXPATRIATE RESOURCES
 701-475 HOWE ST.
 VANCOUVER BC V6C 2B3

OTHER/AUTRE
 This lease and any vehicles leased thereunder will be subject to any rights and interest in and to said vehicles under any respective contract or contracts that GMAC may hold on same.

ACCT# EX101
 VIN: 1GNDT13W3Y2332987 YEAR: 00 MAKE: CHEV

TAX ID#: R121995476

2 UNIT NO./UNITÉ 5002120 WHITE	3 LICENSE NO./N°D'IMM. RCE06	4 MODEL/MODÈLE BLAZER	5 RATE/TARIF CLASS/CAT. 4XSU
6 OWNER STAT/PROPRIÉTAIRE WHITEHORSE		7 TO BE CHECKED I AT/ARRIVERA À WHITEHORSE	
8 CREDIT CARD NO./N° CARTE DE CRÉDIT		EXPIRATION	9 RETURN DATE DE RETOUR JAN 18 01 8:06
10 DRIVER'S LICENSE NO./PERMIS DU CONDUCTEUR 5208442	PROV.	EXP. DEC 04	11 DESTINATION
57 ALTERNATIVE VEHICLE/AUTRE VÉHICULE			
UNIT NO./UNITÉ	DATE & TIME/HEURE	KM IN/RETOUR	
LICENSE/N°D'IMM.		KM OUT/DÉPART	
MODEL/MODÈLE	RATE/TARIF CLASS/CAT.	KM DRIVEN PARCOURUS	
13 REMARKS/REMARQUES OUT: IN: PO#: AIR MILE#			
16 LOSS DAMAGE WAIVER (L.D.W.) BY CUSTOMER'S INITIALS IN CONSIDERATION OF THE PAYMENT OF \$ 19.95 PER DAY		EXONÉRATION EN CAS DE DOMMAGES (ECD) EN APPOSANT LES INITIALES DU CLEINT EN CONSIDÉRATION DU PAIEMENT DE 19.95\$ PAR JOUR	
17 PERSONAL ACCIDENT INSURANCE (PAI) CUSTOMER ACCEPTS OR DECLINES PAI AT RATE SHOWN IN SEPARATE BROCHURE. ACCEPTANCE IS PROOF OF COVERAGE UNDER POLICY ISSUED ON NATIONAL TILDEN AS OUTLINED IN SEPARATE BROCHURE.		ASSURANCE ACCIDEN PERSONNELLE (AAP) LE CLIENT ACCEPTE OU REFUSE L'AAP AU TAUX ÉTABLI DANS UNE BROCHURE SÉPARÉE. LE CONSENTEMENT INDIQUE QUE LE CLIENT EST PROTÉGÉ PAR LA POLICE ÉMISE À NATIONAL TILDEN, COMME L'INDIQUE LA BROCHURE.	
INITIAL ONE		INITALEZ UNE CASE	
18 CUSTOMER AUTHORIZES NATIONAL TILDEN TO PROCESS A CREDIT CARD VOUCHER, IF ANY, IN HIS/HER NAME FOR CHARGES HEREUNDER. I HAVE RECEIVED, AGREED TO AND UNDERSTAND ALL TERMS AND CONDITIONS OF THIS RENTAL AGREEMENT INCLUDING THE SEPERATE FOLDER DELIVERED TO ME WITH THIS RENTAL DOCUMENT.		LE CLIENT AUTORISE NATIONAL TILDEN À ÉMETTRE UN TALON DE CARTE DE CRÉDIT. S'IL Y A LIEU, EN SON NOM POUR LES FRAIS CE-DESSOUS. J'AI RECU, COMPRIS ET ACCEPTE TOUTES LES CONDITIONS ATTENANTES À CE CONTRAT DE LOCATION, Y COMPRIS CELLES QUI SONT DÉCRITES DANS UN DÉPLIANT SÉPARÉ, LEQUEL M'A ÉTÉ REMIS AVEC LE CONTRAT DE LOCATION.	
19 DRIVER'S NAME DU CHAUFFEUR JUSTIN HIMMELRIGHT			
ADDRESS ADRESSE DOMICILE 23084 126 AVE			
21 CITY VILLE MAPLE RIDGE BC		BC V7X 4P3	
22 LOCAL ADDRESS ADRESSE LOCALE 1529		23 TELEPHONE 867-467-7807	
24 # 1 A TA AGENT		25 RES. #	26 RES. CLASS CAT. 4XSU
		27 COMM. CODE	

29 IN RETOUR	DATE & TIME/HEURE	JAN 18 01	8:19
30 OUT DÉPART	DATE & TIME/HEURE	JAN 16 01	8:06
31 25814	KM IN/RETOUR		
32 24968	KM OUT/RETOUR		
33 846	KM DRIVEN/PARCOURUS		
34 200	KM ALLOWED/COMPRIS		
35 646	KM @ 0.25	161	50
36	ADD. HOURS HEURES ADD. 0 @ 15.00	0	00
37 100	DAYS JOURS 2.00 @ 59.95	119	90
38	WEEKS SEMAINES @		
39	MONTHS MOIS @		
39A			
40	TOTAL TIME & KM TEMPS TOTAL & KM	281	40
40A	CUSTOM CHGRS	0	00
40B	ADDL DRVR	0	00
41	INTER-CITY FEE TAUX INTERCITÉ TO: A:		
RATES DO NOT INCLUDE FUEL REPLACEMENT CHARGES	42 L.D.W. E.C.D.	39	90
CUSTOMER RESPONSIBLE FOR ALL PARKING AND TRAFFIC VIOLATIONS	43 SUB-TOTAL SOUS-TOTAL	321	30
INVOICE PAYABLE ON RECEIPT	44 P.A.I. A.A.P.	11	98
RENTAL AGREEMENT IS CLOSED SUBJECT TO AUDIT	45 REFUELING CHARGE REMPLACEMENT DE CARBURANT	\$12.5 PER 1/8	
TARIFS NE COMPRENNENT PAS LES FRAIS REMPLACEMENT DE CARBURANT CLIENT EST TENU RESPONSABLE DE TOUTE INFRACTION DE STATIONNEMENT OU CIRCULATION	46 SUB-TOTAL SOUS-TOTAL	333	28
FACTURE PAYABLE SUR RECEPTION	47 G.S.T./H.S.T. T.P.S./T.V.H.	7.00 %	23 33
AVANT D'ÊTRE FINALISÉ CE CONTRAT DE LOCATION SERA SOUMIS À UNE VÉRIFICATION	48 P.S.T. T.V.P.	0.00 %	0 00
	49 OTHERS/AUTRES		0 00
55 DEPOSITS/DEPOTS	MISC/CREDITS		0 00
	50 TOTAL CHARGES TOTAL DES FRAIS	356	61
56 CASH REFUND REMBOURSEMENT COMPTANT	51 LESS DEPOSITS MOINS DEPOTS		
\$ 0.00	52 BALANCE DUE SOLDE	356	61
I ACKNOWLEDGE RECEIPT OF ABOVE AMOUNT	53 CASH COMPTANT		
J'ACCUSE RECEPTION DU MONTANT CHAUT MENTIONNÉ	54 CHARGE À FACTURER		



SALES AGT: AC/YVBVSV

Especially for:

78133

HIMMELRIGHT, JUSTIN

WJV

Sold to:

EXPATRIATE RESOURCES LTD.
701-475 HOWE STREET
VANCOUVER BC
V6C 2B3

INVOICE

TERMS: PAYMENT DUE UPON PRESENTATION

INVOICE

DATE: JAN 03 2001

5893

AIRLINE	FLIGHT CLASS	DATE	FROM	TO	LEAVE	ARRIVE ST
---------	--------------	------	------	----	-------	-----------

AIR CANADA AC 3580 L		10JAN WED	VANCOUVER INTL TERMINAL M	WHITEHORSE	0755A	1020A
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NON STOP

RESERVATION CONFIRMED 2:25 DURATION

FLIGHT OPERATED BY CP CANADIAN AIRLINES

AIRCRAFT: BOEING 737 ALL 100-800 SERIES PSGR

SEAT 07C NO SMOKING CONFIRMED

AIR CANADA AC 3583 L		19JAN FRI	WHITEHORSE INTL TERMINAL M	VANCOUVER	1110A	0130P
-------------------------	--	--------------	----------------------------------	-----------	-------	-------

NON STOP

RESERVATION CONFIRMED 2:20 DURATION

FLIGHT OPERATED BY CP CANADIAN AIRLINES

AIRCRAFT: BOEING 737 ALL 100-800 SERIES PSGR

SEAT 08C NO SMOKING CONFIRMED

MISCELLANEOUS		19APR THU	VANCOUVER			
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FARE	334.00	TAX	0.00	GST/HST	23.38	TOTAL CAD	357.38
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TICKET FEE 35.00

PAID BY VISA/THANKS -37.45

PAID BY MASTERCARD/THANKS -357.38

7P GST/HST CAD 2.45

AIR TOTAL 0.00

INVOICE TOTAL 0.00

PAYMENT: CCCAS191230011421014/0802/A184006 - JRH

RESERVATION NUMBER(S) AC/T6MR5L

TICKET:

014 3168512655

PLEASE CHECK IN AT LEAST 1 HOUR PRIOR TO DEPARTURE
HUME TRAVEL 24 HOURS TOLL FREE EMERGENCY SERVICE
THROUGH GLOBAL PRIVILEGE. QUOTE VIT CODE *86749*
FROM ANYWHERE IN CANADA CALL 1-800-448-2444 OR CALL
VOICE NUMBER 0000078133

17 2



Jan

Especially for: SALES AGT: AA/X36E36
79492

HIMMELRIGHT/JUSTIN R

WSV

Sold to:

JUSTIN R HIMMELRIGHT
EXPATRIATE RESOURCE
NBR 701 475 HOWE STREET
VANCOUVER BC V6C 2B3

INVOICE

TERMS: PAYMENT DUE UPON PRESENTATION

INVOICE

AIRLINE	FLIGHT CLASS	DATE	FROM	TO	LEAVE	ARRIVE	ST
---------	--------------	------	------	----	-------	--------	----

AIR CANADA AC 3580	T	07FEB WED	VANCOUVER INTL	WHITEHORSE	0755A	1020A	
				TERMINAL M			
				BREAKFAST	NON STOP		
				RESERVATION CONFIRMED	2:25 DURATION		
				AIRCRAFT: BOEING 737 ALL 100-800 SERIES	PSGR		
				SEAT 110 NO SMOKING CONFIRMED			

AIR CANADA AC 3583	T	10FEB SAT	WHITEHORSE INTL	VANCOUVER	1110A	0130P	
				TERMINAL M			
				MEAL	NON STOP		
				RESERVATION CONFIRMED	2:20 DURATION		
				AIRCRAFT: BOEING 737 ALL 100-800 SERIES	PSGR		
				SEAT 05E NO SMOKING CONFIRMED			

MISCELLANEOUS		10MAY THU	VANCOUVER				
---------------	--	--------------	-----------	--	--	--	--

FARE	893.00	TAX	0.00	GST/HST	62.51	TOTAL CAD	955.51
						PAID BY MASTERCARD/THANKS	-955.51
						AIR TOTAL	0.00

INVOICE TOTAL 0.00

PAYMENT: CCCA5191230011421014/0802/A175630 - JRH

RESERVATION NUMBER(S) AC/RATA XU

TICKET: 014 3184020551

AC FREQUENT FLYER AC718359441
 PLEASE CHECK IN AT LEAST 1 HOUR PRIOR TO DEPARTURE
 HUME TRAVEL 24 HOURS TOLL FREE EMERGENCY SERVICE
 THROUGH GLOBAL PRIVILEGE. QUOTE VIT CODE *E6749*
 FROM ANYWHERE IN CANADA CALL 1-800-448-2444 OR CALL
 US DIRECT AT 1-800-663-9787 DURING BUSINESS HOURS.
 THIS TICKET IS EXEMPT FROM SERVICE FEES
 GLAD WE COULD HELP.....ANNE
 -FARE ASSURANCE- 23JAN PM
 INVOICE NUMBER 0000079492

1



CUSTOMER INVOICE SUMMARY/ SOMMAIRE DE LA FACTURE

ACCOUNT NUMBER NO DU COMPTE	MONTH MOIS	DAY JOUR	YEAR ANNEE	AREA REGION	INVOICE NUMBER NUMERO DE LA FACTURE	AMOUNT DUE MONTANT A PAYER
1-5287618	10	06	00	541	3120182 5	34.12

BILL TO/FACTURER A:

EXPATRIOT RESOURCES
701-475 HOWE ST
VANCOUVER
V6C 2B3

RECEIVED
OCT 17 2000

BC

REMIT TO/ENVOYER A:

PUROLATOR COURIER LTD.
P.O. BOX 1100
ETOBICOKE POSTAL STN.
ETOBICOKE, ON
M9C 5K2

TO PAY BY CREDIT CARD PLEASE CALL OUR PAYMENT CENTRE AT 1-800-248-9926.
IN OCTOBER USAM EXPRESSPAK AND FLITEPAK WILL BE REPLACED WITH PUROPAK (F).
PLEASE CHOOSE THE PUROPAK OPTION FOR ALL USAM EXPRESSPAKS AND FLITEPAKS. PUROPAK
IS A 1 PIECE SHIPMENT. MULTI-PIECE SHIPMENTS SHOULD BE SENT IN ALTERNATIVE
PACKAGING.
FOR INFORMATION: 800-363-5420

-5287618 541 3120182 5 0000000

CUSTOMER INVOICE DETAIL/DETAIL DE LA FACTURE

REF/B/L NO. REF/NO DE CONN	SERV. DATE DATE DE SERV.	ORIGINE(E)	DESTINATION	PIECES NOMBRE DE COLIS	WEIGHT POIDS	CHARGES/FRAIS			TOTAL CHARGES FRAIS TOTAUX
						CODE	\$	GST/HST TPS/TVH	
6255487877	08/30/00	EDMONTONT55	AB VANCOUVERV6C	2	5 LB	A T C	26.11 0.78 5.00	2.23	34.12
		TOTAL GST CHARGES/TOTAL TPS: 2.23 GST/HST REG.NO/NO ENR. TPS/TVH: R104116280							
		D3 - 31.89 L2 - 2.23 <u>34.12</u>							
SEE REVERSE FOR CODE DESCRIPTION/VOIR VERSO POUR DESCRIPTION DES CODES						AMOUNT DUE/MONTANT A PAYER: 34.12			

PLEASE DO NOT USE STAPLES. PRIERE DE NE PAS AGRAFER

ACCT. NO. NO. COMPTE	INV. NO. NO. FACTURE	INVOICE DATE DATE DE LA FACTURE	AMOUNT DUE MONTANT A PAYER	AMOUNT PAID MONTANT PAYE
1-5287618	3120182 5	10 06 00	34.12	

PLEASE RETURN THIS COPY WITH PAYMENT
S.V.P. RETOURNER CETTE COPIE AVEC VOTRE REMISE (541)

REMIT TO/ENVOYER A: X 5287618 31201825 00003412
 PUROLATOR COURIER LTD.
 P.O. BOX 1100
 ETOBICOKE POSTAL STN.
 ETOBICOKE, ON
 M9C 5K2

EXPATRIOT RESOURCES
 701-475 HOWE ST
 VANCOUVER
 V6C 2B3 BC

1 B/L'S

*OK - wtv. ck #266
1 Oct 26 100*
[Signature]

AIR CANADA



Cargo

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE PAYABLE TO:
PRIÈRE DE JOINDRE CE COUPON AU VERSEMENT EFFECTUÉ À:

AIR CANADA
P.O. BOX / C.P. 986
WINNIPEG, MANITOBA
CANADA R3C 2V8
GST / TPS R 100092287

INVOICE
FACTURE

IF REMITTANCE IS NOT FOR FULL AMOUNT ALSO
RETURN LOWER PORTION WITH EXPLANATION.
SI LE VERSEMENT EFFECTUÉ NE REPRÉSENTE PAS
LE MONTANT TOTAL VÉUILLEZ NOUS RENVoyer LA
PARTIE INFÉRIEURE DE LA FACTURE ET NOUS
FOURNIR DES PRÉCISIONS.

014-04053350A 50.56
014-04059591B 91.22
014-60427732C 327.40

RECEIVED
NOV 16 2000

EXPATRIATE RESOURCES LTD

701-475 HOWE ST
VANCOUVER BC
V6C 2B3

DATE 03 NOV 00 PAGE 1

ACCOUNT NO. N° DE COMPTE	INVOICE NO. N° DE FACTURE	INVOICE TOTAL TOTAL DE LA FACTURE	CURRENCY MONNAIE
490965	30849096	469.18	CAD

* SEE REVERSE SIDE FOR CODE
IDENTITY
* L'EXPLICATION DES CODES
FIGURE AU VERSO

ACCOUNT NO. 490965 INVOICE NO. 30849096 DATE 03 NOV 00

AIR WAYBILL NUMBER N° DE LETTRE DE TRANSPORT AÉRIEN	DATE	P/C P/RD	ORIGIN ORIGINE	DEST. DEST.	CHARGEABLE WT. POIDS DE TAXATION	CLASS CLASS	RATE TARIF	DESC. DESC.	AMOUNT MONTANT
014-04053350	A 24OCT00	P	YVR	YXY	5.0K	Q	45.00	WGT	45.00
CONS: TUCKER TERRY * EXPRESS 60 NSC 2.25									
SPEEDY EXPEDITING DOCS SCT 60 FLT 3580/2 GTC 3.31									
WHITEHORSE YT TOT 50.56*									
REM HFPUP C/O STEVE SUTHERLAND									
4-04059591	B 25OCT00	P	YVR	YXY	1.0K	N	45.00	WGT	45.00
CONS: APPLIED ECOSYSTEM MANAGE * EXPRESS 60 NSC 2.25									
100-211 HAWKINS ST MAP TUBE & CDS PUC 38.00									
WHITEHORSE YT CA Y1A 1X3 GTC 5.97									
TOT 91.22*									
REM ATTN SHAWN FRANCIS 867-393-3793									
014-60427732	C 24OCT00	P	YXY	YVR	181.0K	Q	291.41	WGT	291.41
SHPR: EXPATRIATE RESOURCES LTD * AIR FREIGHT NSC 14.57									
BOX 4127 ROCK SAMPLES GTC 21.42									
WHITEHORSE YT CA Y1A 3S9 TOT 327.40*									
CONS: ALS CHEMEX									
212 BROOKSBANK AVENUE									
N VANCOUVER BC CA V7J 2C									
REM HFPU									

GST (GTC) INCLUDED IN INVOICE TOTAL: 30.70

DUE TO SIGNIFICANT INCREASES IN FUEL COST OVER THE LAST SEVERAL MONTHS,
AIR CANADA HAS IMPLEMENTED A FUEL SURCHARGE, EFFECTIVE FEBRUARY 15, 2000.
THE CODE FOR FUEL SURCHARGE IS MYC.

A CREDIT CHARGE OF 1.5% PER MONTH (18.0% PER ANNUM)
IS PAYABLE ON OVERDUE ACCOUNTS.
UN INTÉRÊT MENSUEL DE 1.5% (18.0% L'AN)

FACTURÉ SUR LE SOLDE IMPAYÉ

INQUIRIES TO
SER TOUTE CORRESPONDANCE À

TEL (204) 941-2810
FAX (204) 941-2938

AIR CANADA
P.O. BOX / C.P. 986
WINNIPEG, MANITOBA
CANADA R3C 2V6

TO AVOID A
CREDIT CHARGE
PAYMENT OF THE
"INVOICE TOTAL"
MUST BE RECEIVED
BY:

POUR NE AVOIR
À PAYER D'INTÉRÊT
NOUS FAIRE PARVENIR
LA RÉGLEMENT DU
TOTAL DE LA FACTURE
AU PLUS TARD LE:

PAGE TOTAL
TOTAL DE LA PAGE

PAGE
PAGE

469.18

1

INVOICE TOTAL
TOTAL DE LA FACTURE

CURRENCY
MONNAIE

28 NOV 00

469.18

CAD

Handwritten initials



INVOICE
FACTURE

IF REMITTANCE IS NOT FOR FULL AMOUNT ALSO
RETURN LOWER PORTION WITH EXPLANATION.
SI LE VERSEMENT EFFECTUÉ NE REPRÉSENTE PAS
LE MONTANT TOTAL VEUILLEZ NOUS RENVoyer LA
PARTIE INFÉRIEURE DE LA FACTURE ET NOUS
FOURNIR DES PRÉCISIONS.

014-04231220B

220.29

EXPATRIATE RESOURCES LTD

701-475 HOWE ST
VANCOUVER BC
V6C 2B3

DATE
08 DEC 00

PAGE
1

ACCOUNT NO. N° DE COMPTE	INVOICE NO. N° DE FACTURE	INVOICE TOTAL TOTAL DE LA FACTURE	CURRENCY MONNAIE
490965	34349096/5	220.29	CAD

* SEE REVERSE SIDE FOR CODE
IDENTITY
* L'EXPLICATION DES CODES
FIGURE AU VERSO

ACCOUNT NO.
N° DE COMPTE 490965

INVOICE NO.
N° DE FACTURE 34349096/5

DATE 08 DEC 00

AIR WAYBILL NUMBER N° DE LETTRE DE TRANSPORT AÉRIEN	DATE DATE	PC P/D	ORIGIN ORIGINE	DEST. DEST.	CLASS C/V	CHARGEABLE WT. POIDS DE TAXATION	CLASS CLASS	RATE TARIF	DESC. DESC.	AMOUNT MONTANT
014-04231220	B 21NOV00	P	YVR	VXY	*	76.0K	Q	196.08	WGT	196.08
CONS: WESTMARK KLONDIKE INN						* EXPRESS 60			NSC	9.80
2288 2ND AVE						DOCUMENTS			GTC	14.41
WHITEHORSE YT CA Y1A 1C8									TOT	220.29*
REM TEL 668-4747										
GST (GTC) INCLUDED IN INVOICE TOTAL:										14.41

DU TO SIGNIFICANT INCREASES IN FUEL COST OVER THE LAST SEVERAL MONTHS,
AIR CANADA HAS IMPLEMENTED A DOMESTIC FUEL SURCHARGE, EFFECTIVE
JANUARY 1, 2001.

RECEIVED
JAN - 2 2001

OK - WJV ck #310 Jan 11/01
[Handwritten signature]

205.88 - D3
14.41 - L2
220.29

A CREDIT CHARGE OF 1.5% PER MONTH (18.0% PER ANNUM)
IS PAYABLE ON OVERDUE ACCOUNTS.
UN INTÉRÊT MENSUEL DE 1.5% (18.0% L'AN)

TO AVOID A CREDIT CHARGE PAYMENT OF THE "INVOICE TOTAL" MUST BE RECEIVED BY:
POUR NE AVOIR À PAYER D'INTÉRÊT NOUS FAIRE PARVENIR LA RÉGLEMENT DU TOTAL DE LA FACTURE AU PLUS TARD LE:

PAGE TOTAL TOTAL DE LA PAGE	PAGE PAGE
220.29	1
INVOICE TOTAL TOTAL DE LA FACTURE	CURRENCY MONNAIE
220.29	CAD

02 JAN 01

INQUIRIES TO
PAR TOUTE CORRESPONDANCE À
TEL (204) 941-2810
FAX (204) 941-2938
AIR CANADA
P.O. BOX / C.P. 966
WINNIPEG, MANITOBA
CANADA R3C 2V6

Canadian

CANADIAN AIRLINES INT'L
P. O. BOX 210 TOR AMF/VISTA
MISSISSAUGA, ON L5P 1B1

RECEIVED
SEP 20 2000

DATE	DUE DATE	CUSTOMER ACCOUNT NO.	INVOICE NUMBER
14SEP00	14OCT00	F40025286-EG	S69323761
DATE	D'ECHEANCE	NO DE COMPTE DU CLIENT	NUMERO DE FACTURE
AMOUNT DUE		AMOUNT REMITTED	
162.60			
MONTANT DU		MONTANT CI-JOINT	

REMIT TO:

CANADIAN AIRLINES INT'L
PO BOX 8500, STATION TERMINAL
VANCOUVER, BC V6B 6E6

EXPATRIATE RESOURCES LTD
701-475 HOWE ST
VANCOUVER, BC V6C 2B3

FAX 604 682 5404

364002528069323761000001626002

MAKE CHEQUE PAYABLE TO: CANADIAN AIRLINES INT'L
PLEASE RETURN ENTIRE STATEMENT WHEN REMITTING PAYMENT
VEUILLEZ RETOURNER LE RELEVÉ AVEC LE PAIEMENT

0006653

ITEM NUMBER NUMERO DE L'ARTICLE	DATE DATE	GST/HST TPS/TVH	AMOUNT MONTANT
1. 018YVR39433052	31AUG00	6.65 G	101.70
2. 018YVR65800394	30AUG00	3.98 G	60.90

X Pat-F ck#600 Sept 21/00

KZK - 151.97 D3
 10.63 L2

 162.60

OK - [Signature]
INVOICE TO KZK
ADN

GST TOTAL FOR STATEMENT / TOTAL TPS POUR LE RELEVÉ: S69323761 10.63
 GST/HST/QST INCLUDED IN AMOUNT DUE / TPS/TVH/TVQ INCLUSES DANS LE MONTANT DU DE
 GST/HST VENDOR REGISTRATION NUMBER / NUMERO DE FOURNISSEUR POUR LA TPS/TVH: R121511372
 QST VENDOR REGISTRATION NUMBER / NUMERO DE FOURNISSEUR POUR LA TVQ: 1009383421

TOTAL DUE FOR STATEMENT S69323761 / TOTAL DES FRAIS A PAYER 162.60

INSTRUCTIONS: SUPPORT DOCUMENTS ARE ENCLOSED FOR EACH ITEM LISTED ABOVE.
 TERMS: NET CASH WITHIN THIRTY (30) DAYS FROM DATE OF INVOICE. INTEREST CALCULATED AT THE
 RATE OF 1.50% PER MONTH (18.00% PER ANNUM) ON OVERDUE ACCOUNTS.
 CONDITIONS: COMPTANT NET DANS LES TRENTE (30) JOURS SUIVANT LA DATE DE LA FACTURE. DES INTER
 ETES ANNUELS DE 1.50% (18.00% PAR ANNEE) SERONT IMPUTES A TOUT SOLDE IMPAYE DE TRENE (30).
 A PARTIR DU 1ER AVRIL 1998, TOUTES LES TAUX DOMESTIQUES ET INTERNATIONALES SERONT AJUSTES DE 3%.
 SOME EXCEPTIONS MAY APPLY. **

FOR QUESTIONS CONCERNING YOUR ACCOUNT (F40025286-EG) CONTACT: TODD HEY 800-333-8220
 CONSULTEZ-NOUS POUR DE PLUS AMPLES DETAILS: (F40025286-EG) TODD HEY 800-333-8220

Canadian

January 11, 2001



RECEIVED
JAN 15 2001

forward to Jan-Jan 17/01

David R Parker
Manager, Regulatory and
Public Affairs

Mr. Harlan Meade
President & CEO
Expatriate Resources
#701 - 475 Howe Street
Vancouver, BC
V6C 2B3

Dear Harlan:

**Re: Sale of Kudz Ze Kayah assets –
repayment of expenses**

This letter is further to our recent discussions regarding repayment of expenses associated with payments made to Dorothy Dick. As you will recall, it was agreed that Expatriate would reimburse Cominco for payments made subsequent to that point in time when Cominco became able to complete the sale of the Kudz Ze Kayah assets.

The Yukon Territory Water Board authorised the assignment of the Water Licence on August 11, 2000. From that date forward, Cominco has been in a position to complete the transaction. Accordingly, we request that Expatriate reimburse Cominco for expenses associated with Dorothy Dick for the months of September, October, November and December as follows:

September	\$ 5,100
October	\$ 5,270
November	\$ 5,100
December	<u>\$ 5,270</u>
Total	\$20,740 ^{DI}

*X-Ref-F ck# 703 Jan. 18/01
(KZK)*

ADM.
*Service contract
not an employee*

Pursuant to the Ross River Socio-Economic Agreement, Cominco will continue to be obligated to cover the costs of the Liaison position held by Dorothy Dick. We propose to continue making these payments and will provide information to Expatriate to reimburse Cominco on a month-to-month basis. If Cominco is compelled to incur additional expenses associated with holding the assets prior to completion of the sale, we will provide you with

*Jan 0001 5270
Feb 0001 4760
30770
N-D = 4615.50*