



ALEXCO

**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER
USE & QUARTZ MINING LICENCE APPLICATIONS
VOLUME 1 – MAIN REPORT**

*Bellekeno Mine Development
Keno Hill Silver District
Yukon*

February 2009

Prepared by:





Type A Water Use & Quartz Mining Licence Applications
Bellekeno Mine Development
Keno Hill Silver District, Yukon Territory

Submitted by:

Alexco Keno Hill Mining Corp.
Suite 1150 – 200 Granville Street
Vancouver, British Columbia V6C 1S4

DISTRIBUTION LIST

1 Copy + 1 PDF*	Yukon Environmental and Socio-economic Assessment Board, Mayo Designated Office
1 Copy Unbound + 1 PDF	Yukon Water Board
5 Copies + 1 PDF	Yukon Government, Energy, Mines & Resources, Mineral Resources Branch, Mining Lands
1 Copy + 1 PDF	Yukon Government, Environment (Randy Lamb)
2 Copies + 1 PDF	First Nation of Na cho N'yak Dun
1 Copy + 1 PDF	Access Consulting Group
3 Copies + 1 PDF	Alexco Keno Hill Mining Corp.

*PDF = digital version of report on CD



Alexco Keno Hill Mining Corp.

Type A Water Use Application & Quartz Mining Licence Application

Bellekeno Mine Development

Keno Hill Silver District, Yukon Territory

PROJECT CONTACT LIST

ALEXCO KENO HILL MINING CORP. Suite 1150 – 200 Granville Street Vancouver, British Columbia V6C 1S4 Telephone: (604) 633-4888 Fax: (604) 633-4887 Website: www.alexcoresource.com	Contact: Brad Thrall, Chief Operating Officer Email: bthrall@alexcoresource.com Contact: Clynton Nauman, President & CEO Email: cnauman@alexcoresource.com
ACCESS CONSULTING GROUP #3 Calcite Business Centre 151 Industrial Road Whitehorse, Yukon Y1A 2V3 Telephone: (867) 668-6463 Fax: (867) 667-6680 Website: www.accessconsulting.ca	Contact: Dan Cornett, Environmental Assessment Manager Email: dan@accessconsulting.ca Contact: Rob McIntyre, Senior Technical Manager Email: rob@accessconsulting.ca

EXECUTIVE SUMMARY

The following presents an overview of the Bellekeno Mine Project.

Bellekeno Mine Project Overview	
Location	3 km. east of Keno City, 45 km. northeast of Mayo, 354 km. north of Whitehorse, YT. Located in the Traditional Territory of the First Nation of Nacho Nyak Dun within the McQuesten River Valley
Land Position	Alexco Resource Corp. and its wholly owned subsidiary Elsa Reclamation and Development Corp. owns 1,563 claims and leases covering an area of approximately 24,262 ha within the Keno Hill Silver District including the Bellekeno Mine project area. Two Fee Simple lots within the Bellekeno Mine project area total 59 ha (Lot 960 and Lot 956)
Mining Method	Year round underground narrow vein cut and fill mining
Mine Life	5 years
Total Project Life	15 years (0 – 6 years construction and mine operation; 7 – 15 years decommissioning and reclamation, closure, and post closure). Potential to extend the Bellekeno Mine life as well as additional mines within the Keno Hill Silver District.
Annual Production	Average annual production of 3,300,000 oz. Silver, 30,000,000 lbs. Lead, 24,500,000 lbs. Zinc. Based on current Preliminary Economic Assessment
Total Metal Production	Current Life of Mine production of 16,500,000 oz. Silver, 150,700,000 lbs. Lead, 122,400,000 lbs. Zinc. Based on current Preliminary Economic Assessment
Ore Production Rate	250 tonnes/day for Years 1-2 and 400 tonnes/day for Years 3-5
Mine Waste Rock	500,000 tonnes of waste rock produced from underground development
Ore Mining and Placement Schedule	Ore mining for 360 days/year; Mill Operation 360 day/year 100,000 tonnes of waste material placed on surface each year

Bellekeno Mine Project Overview	
Mill Recovery Process	Conventional flotation producing separate lead/silver concentrate and zinc concentrate shipped off site for smelting. Mill location at historic Mackeno Mill site located at Christal Lake. Dry stack tailings technology, 50% of dry tailings placed on surface and 50% placed underground as paste backfill. Pyrite removal circuit to remove pyrite from tailings and then placed underground as paste backfill.
Effluent Testing	Metal Mining Effluent Regulations
Work Force	~ 135 production and ongoing exploration; ~ 200 peak (construction)
Airstrip	Mayo, YT
Power	Hydro grid power Yukon Energy, diesel power backup
Water Supply and Use	Water use and discharge within 2 drainages, Lightning Creek and Christal Creek. 245 m³/day water use, 385 m³/day water discharge Lightning Creek drainage 68 m³/day fresh water use, 17 m³/day water discharge Christal Lake drainage Conventional lime precipitation water treatment
Climate Setting	945 m above sea level Annual Precipitation 413 mm Annual Lake Evaporation 460 mm
Environmental Baseline	Site Characterization Report 1996, ongoing data collection programs through current Type B Water License QZ06-074, QZ07-078, Class Mining Land Use Approval LQ00240
First Nations	First Nation of Na cho Nyak Dun

VOLUME 1

TABLE OF CONTENTS

EXECUTIVE SUMMARY	iii
1.0 INTRODUCTION	1-1
1.1 Proponent Information	1-1
1.2 Project Location	1-6
1.3 Project History	1-10
1.3.1 History of Development at the Bellekeno Mine	1-10
1.4 Previous Environmental and Socioeconomic Assessments	1-11
1.5 Required Environmental Assessment and Regulatory Approvals	1-13
1.5.1 YESAA Designated Office Assessment	1-13
1.5.2 Type A Water Licence	1-13
1.5.3 Mining Land Use Approval – Quartz Mining Licence	1-14
1.5.4 Navigable Waters	1-14
1.5.5 Scope of the Project	1-14
1.6 Assessment Scope	1-18
2.0 PROJECT DESCRIPTION	2-1
2.1 Current Advanced Exploration Program	2-1
2.2 Bellekeno Mine Development Program	2-1
2.2.1 Mineral Resource	2-3
2.2.2 Mine Plan and Development Schedule	2-4
2.2.3 Overview of Proposed Rock Excavation and Waste Rock Management	2-5
2.2.3.1 Rock Management Categories	2-5
2.2.3.2 Estimated Rock Quantities for Bellekeno Mine Development	2-6
2.2.3.3 Waste Rock Management	2-8
2.2.3.3.1 Non-AML Waste Rock	2-8
2.2.3.3.1.1 Non-AML Waste Rock Disposal Facility Conceptual Design	2-8
2.2.3.3.1.2 Non-AML Waste Rock Disposal Area Risks and Mitigations	2-11
2.2.3.3.2 Potentially-AML Waste Rock	2-11

TABLE OF CONTENTS (cont'd)

2.2.4	Mining Method Selection _____	2-12
2.2.5	Mine Access _____	2-18
2.2.6	Drilling _____	2-18
2.2.7	Blasting _____	2-19
2.2.8	Mucking _____	2-19
2.2.9	Electrical Power Requirements _____	2-19
2.2.10	Ventilation _____	2-22
2.2.11	Mine Site Communications _____	2-23
2.2.12	Transportation and Shipping _____	2-24
2.2.13	Milling _____	2-25
2.2.14	Mackeno Mill Site History _____	2-27
2.2.15	Mill Infrastructure _____	2-28
2.2.16	Mineralogical Processing _____	2-29
2.2.17	Design Criteria _____	2-30
2.2.18	Mill Process Description _____	2-34
2.2.18.1	Crushing and Screening _____	2-36
2.2.18.2	Grinding Circuit _____	2-36
2.2.18.3	Silver-Lead Flotation _____	2-36
2.2.18.4	Zinc Flotation _____	2-37
2.2.18.5	Pyrite Flotation _____	2-38
2.2.19	Concentrate Dewatering _____	2-38
2.2.20	Tailings and Pyrite Concentrate Dewatering and Handling _____	2-38
2.2.21	Paste Backfill Operations _____	2-39
2.2.22	Paste Fill _____	2-40
2.2.23	Reagent Handling and Storage _____	2-42
2.3	Ancillary Facilities _____	2-43
2.3.1	Water Supply and Distribution _____	2-43
2.3.1.1	Fresh Water Supply System _____	2-43
2.3.1.2	Process Water Supply System _____	2-43
2.3.2	Assay Laboratory _____	2-44
2.3.3	Temporary Construction Facilities _____	2-44
2.4	Haul Roads _____	2-44
2.5	Personnel Requirements & Accommodation _____	2-47
2.5.1	Labour Requirements during Mine Operation _____	2-48

TABLE OF CONTENTS (cont'd)

2.6	Human Health & Safety	2-50
2.6.1	Mine Safety	2-51
3.0	ENVIRONMENTAL BASELINE	3-1
3.1	General	3-1
3.2	Overview	3-1
3.3	Physical Environment	3-3
3.3.1	Climate	3-3
3.3.2	Geology and Topography	3-3
3.3.2.1	General Geology	3-3
3.3.2.2	Property Geology	3-5
3.3.2.3	Bellekeno Mineralization Occurrences	3-7
3.3.2.3.1	Bellekeno Geoenvironmental Characterization	3-9
3.3.2.4	Physiography and Surficial Geology	3-11
3.3.2.5	Soils	3-13
3.3.2.6	Permafrost	3-14
3.3.3	Water Resources	3-14
3.3.3.1	Surface Water Quality	3-14
3.3.3.2	Mass Loading	3-23
3.3.3.2.1	Hydrological Inputs	3-24
3.3.3.3	Bellekeno Current Water Balance	3-28
3.3.3.4	Stream Sediment Quality	3-31
3.3.3.5	Surface Hydrology	3-33
3.4	Biological Environment	3-34
3.4.1	Aquatic Resources	3-34
3.4.1.1	Christal Lake	3-35
3.4.1.2	Christal Creek	3-35
3.4.1.3	Flat Creek	3-36
3.4.1.4	Lightning Creek	3-37
3.4.1.5	South McQuesten River	3-38
3.4.1.6	Benthic invertebrates	3-38
3.4.1.7	Wildlife	3-40
3.4.1.8	Species at Risk	3-41
3.4.1.9	Vegetation	3-41

TABLE OF CONTENTS (cont'd)

4.0	SOCIO-ECONOMIC CONDITIONS	4-1
4.1	Heritage Resources	4-1
4.1.1	Heritage Resources Protection Plan	4-1
4.2	Land Uses	4-4
4.3	Socio-economic Conditions	4-9
4.3.1	Mayo	4-10
4.3.2	Keno City	4-12
4.4	NNDFN Exploration Cooperation Agreement	4-12
4.5	Consultation	4-15
5.0	POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	5-1
5.1	Introduction	5-1
5.2	Environmental Assessment Approach	5-2
5.3	Valued Environmental and Socio-Economic Components	5-7
5.4	Summary of Potential Environmental and Socio-Economic Effects and Proposed Mitigation	5-12
5.4.1	Water and Aquatic Resources	5-12
5.4.1.1	Potential Effects:	5-13
5.4.1.2	Mitigation:	5-13
5.4.1.2.1	Projected Mass Loading	5-15
5.4.2	Wildlife	5-22
5.4.2.1	Moose	5-22
5.4.2.2	Potential Effects	5-24
5.4.2.3	Mitigation Measures	5-24
5.4.3	Traditional and Local Land Uses	5-25
5.4.3.1	Potential Effects	5-26
5.4.3.2	Mitigation Measures	5-26
5.4.4	Keno City	5-27
5.4.4.1	Potential Effects	5-27
5.4.4.2	Mitigation Measures	5-27

TABLE OF CONTENTS (cont'd)

5.4.4.2.1	Keno City Socio-economic Mitigation Plan	5-28
5.4.5	Heritage Resources	5-33
5.4.5.1	Potential Effects	5-34
5.4.5.2	Mitigation Measures	5-34
5.4.6	Human Health & Safety	5-35
5.4.6.1	Potential Effects	5-35
5.4.6.2	Mitigation	5-35
5.4.7	Effects of the Environment on the Project	5-37
5.4.7.1	Potential Effects	5-37
5.4.7.2	Mitigation	5-37
5.4.8	Cumulative Effects	5-38
6.0	<i>Environmental Management Plans</i>	6-1
6.1	Water and Wastewater Management	6-1
6.1.1	Climate Overview	6-1
6.1.1.1	Precipitation and Evaporation	6-1
6.1.2	Total Water Usage	6-3
6.1.3	Water Sources	6-4
6.1.3.1	Flat Creek Camp	6-4
6.1.3.2	Bellekeno Mine Site	6-5
6.1.3.3	Christal Lake Mill Site	6-6
6.1.4	Water Use	6-8
6.1.4.1	Bellekeno Mine	6-8
6.1.4.2	Christal Lake Mill	6-10
6.1.5	Wastewater Treatment and Discharge	6-13
6.1.5.1	Bellekeno Mine	6-13
6.1.5.1.1	Bellekeno 625 Water Treatment System	6-13
6.1.5.2	Bellekeno Mine Contact Water Quality Characterization	6-20
6.1.5.3	Christal Lake	6-21
6.1.5.3.1	Christal Lake Mill Water Treatment Facilities	6-21
6.1.5.3.2	Christal Lake Mill Contact Water Quality Characterization	6-22
6.1.6	Effluent Discharge and Criteria	6-24
6.1.6.1	Bellekeno Mine	6-24
6.1.6.2	Christal Lake Mill	6-25
6.1.7	Potentially-AML Waste Rock Storage Facilities	6-26
6.1.8	Sewage	6-26

TABLE OF CONTENTS (cont'd)

6.2	Bellekeno Mine Waste Rock Management	6-27
6.2.1	Introduction	6-27
6.2.2	Purpose of Plan	6-28
6.2.3	Scope of Plan	6-28
6.2.4	Rock Characterization	6-29
6.2.4.1	Summary of Rock Characterization	6-29
6.2.4.2	Study Overview	6-29
6.2.4.3	Summary of Results	6-29
6.2.4.4	Potentially-AML Waste Rock Geochemical Screening Criteria	6-30
6.2.4.5	Estimated Proportions of AML and Non-AML Rock for Bellekeno	6-32
6.2.4.6	Waste Rock Field Screening Criteria	6-33
6.2.4.7	Rock Management During Operations	6-33
6.2.4.8	Rock Excavation Activities	6-35
6.2.4.9	Waste Rock Screening	6-35
6.2.4.10	Face Sampling Method	6-35
6.2.4.11	Evaluation and AML/non-AML Designation	6-38
6.2.4.12	Confirmatory Geochemical and ABA Testing	6-39
6.2.4.13	Confirmatory Testing Sampling Frequency and Schedule	6-40
6.2.4.13.1	ICP Sampling Frequency	6-40
6.2.4.13.1.1	ICP Feedback Sampling for Field Screening Methods	6-41
6.2.4.13.2	ABA Sampling Frequency	6-41
6.2.4.14	Time Lag	6-43
6.2.4.14.1	Time Lag between Excavation and Sampling	6-43
6.2.4.14.2	Time Lag between Excavation and Receipt of Analytical Data	6-43
6.2.4.14.2.1	Time Lag between Excavation and Receipt of ICP Data	6-43
6.2.4.14.2.2	Time Lag between Excavation and Receipt of ABA Data	6-44
6.2.4.15	Mine Wall Testing	6-44
6.2.4.15.1	Mine Wall Sampling for ICP and ABA Analysis	6-44
6.2.4.15.1.1	ICP samples sizes for mine wall testing	6-46
6.2.4.15.1.2	ABA samples sizes for mine wall testing	6-46
6.2.4.15.2	Time Lag	6-46
6.2.4.15.2.1	Time Lag between Excavation and Sampling	6-46
6.2.4.15.2.2	Time Lag between Excavation and Receipt of Analytical Data	6-46
6.2.4.16	Analytical Methods	6-47
6.2.4.16.1	ICP Analyses	6-47

TABLE OF CONTENTS (cont'd)

6.2.4.16.2	ABA Analyses	6-47
6.2.4.17	Waste Rock Monitoring	6-47
6.2.4.18	Physical Inspection Methods	6-48
6.2.4.19	Adaptive Management	6-49
6.2.4.20	Reporting	6-50
6.2.4.21	Closure and Reclamation	6-50
6.3	Tailings Management Plan	6-50
6.3.1	Tailings Handling	6-50
6.3.1.1	Dry Stack Tailings Disposal Procedure	6-50
6.3.1.1.1	DSTF Designs	6-51
6.3.1.2	Pyritic Tailings Fraction Disposal Procedure	6-51
7.0	ENVIRONMENTAL MONITORING PROGRAM AND SURVEILLANCE NETWORK	7-1
7.1	Introduction	7-1
7.2	Water Quality Surveillance Network	7-2
7.3	Physical Inspection Plan	7-6
7.4	Environmental Effects Monitoring (under MMER)	7-6
7.4.1	Final Discharge Points	7-7
7.4.2	Effluent Monitoring	7-7
7.4.3	Environmental Effects Monitoring (EEM) Program	7-8
7.5	Spill Contingency Plan	7-10
7.5.1	Spill Contingency Measures for Pyrite Tailings	7-10
7.6	Adaptive Management Plan Overview	7-11
7.6.1	Adaptive Management Plan Objectives	7-11
7.6.2	AMP Events Summary	7-12
7.6.3	AMP Approach	7-13
7.7	Reporting	7-17
8.0	DECOMMISSIONING AND RECLAMATION	8-1
8.1	Philosophy and Integration with District-Wide Closure Planning	8-1
8.1.1	Current Site Conditions	8-6

TABLE OF CONTENTS (cont'd)

8.1.2	Revegetation Measures	8-6
8.2	Decommissioning Measures	8-7
8.2.1	Access and Haul Roads	8-7
8.2.2	Bellekeno East Portal Site	8-8
8.2.3	200 Vent Raise	8-10
8.2.4	Bellekeno 625 Adit	8-10
8.2.5	Bellekeno 625 Water Treatment Facility	8-10
8.2.6	Potentially-AML Waste Rock Storage Facility	8-12
8.2.7	Non-AML Waste Rock Disposal Area	8-12
8.2.8	Ore Stockpile Pads	8-13
8.2.9	Dry Stack Tailings Facility	8-13
8.2.10	Mill Pad Area Ancillary Facilities	8-14
8.2.11	Camp Expansion	8-14
8.2.12	Post Closure Monitoring and Maintenance	8-15
8.2.13	Reclamation Security and Costing	8-16
9.0	ACKNOWLEDGEMENT AND CERTIFICATION	9-1
10.0	REFERENCES	10-1

LIST OF FIGURES

Figure 1-1 Project Location	1-7
Figure 1-2 Keno Hill Property Location Map	1-8
Figure 1-3 Bellekeno Location Map	1-9
Figure 1-4 Environmental Assessment Spatial Area.....	1-17
Figure 2-1 Bellekeno Mine	2-2
Figure 2-2 Bellekeno Non-AML Waste Rock Management Area Plan.....	2-9
Figure 2-3 Bellekeno Non-AML Waste Rock Management Area Cross Section	2-10
Figure 2-4 Overhand, Mechanized Cut & Fill Mining Method (from Atlas Copco)	2-14
Figure 2-5 Long Hole Mining Method (source: Atlas Copco)	2-15
Figure 2-6 Shrinkage Mining Method (source: Atlas Copco)	2-17
Figure 2-7 Ventilation Schematic for the Bellekeno Underground Workings	2-23
Figure 2-8 Mill Site Alternatives	2-26
Figure 2-9 Mill Site Layout	2-31
Figure 2-10 Preliminary Mill Layout.....	2-32
Figure 2-11 Bellekeno Project, Simplified Process Flowsheet.....	2-35
Figure 2-12 Typical Bridge Design for Lightning Creek	2-46
Figure 3-1 Surface Water Quality Monitoring Locations	3-16
Figure 3-2 Total Zinc Concentrations for Monthly Sampling Events at Lightning Creek Receiving Water Sites from February 27, 2005 to October 2, 2008	3-23
Figure 3-3 Current Lightning Creek Mass Loading Node Inputs and Metal Loading Schematic Showing Average 2008 Dissolved Zn Concentrations	3-29
Figure 3-4 Current Christal Creek Mass Loading Node Inputs and Metal Loading Schematic Showing Average 2008 Dissolved Zn Concentrations	3-30
Figure 4-1 Protocol for Site Remediation of Keno Hill Mine Sites.....	4-3
Figure 4-2 Land Use	4-8
Figure 5-1 Projected Lightning Creek Mass Loading Model Schematic Showing Node Inputs.....	5-18
Figure 5-2 Projected Christal Creek Mass Loading Model Schematic Showing Node Inputs.....	5-21
Figure 6-1 Lightning Creek Monthly Average Discharge and Water Use	6-6
Figure 6-2 Bellekeno Mine Water Use Schematic	6-10

LIST OF FIGURES (cont'd)

Figure 6-3	Christal Lake Mill Water Use Schematic.....	6-12
Figure 6-4	Total Zinc Concentrations of Bellekeno 625 Raw Adit water (KV-42) between May 1995 and October 1996	6-17
Figure 6-5	Monthly Average Total Zinc Concentrations of Bellekeno 625 Raw Adit Water (KV-42) and Treated Effluent (KV-43) between January 2004 and November 2008.....	6-18
Figure 6-6	Monthly Average pH Levels of Bellekeno 625 Raw Adit Water (KV-42) and Treated Effluent (KV-43) between January 2004 and November 2008	6-19
Figure 6-7	Final Dry Stack Configuration	6-23
Figure 6-8	Bellekeno Waste Rock Characterization Study – Components and Key Results	6-31
Figure 6-9	Face Sampling Method and Waste Rock Management	6-36
Figure 6-10	Example of Face Sampling Form	6-37
Figure 6-11	Face Photo of Bellekeno 625 By-Pass Showing Sampling According to Lithology and Calculated Sample Areas	6-40
Figure 6-12	Bellekeno Waste Rock Hypothetical Sampling Schedule	6-42
Figure 6-13	Final Dry Stack Configuration	6-53
Figure 7-1	Proposed Surface Water Quality Monitoring Locations	7-5
Figure 8-1	Closure Measures.....	8-5
Figure 8-2	Conceptual Bellekeno East Portal Closure Rock Pile.....	8-9
Figure 8-3	Conceptual Bellekeno 625 Closure Plug	8-11

LIST OF TABLES

Table 1-1	Previous Environmental Assessments, Past and Current Permits/ Licences.....	1-12
Table 2-1	Consolidated Mineral Resource Statement for the Bellekeno Deposit	2-4
Table 2-2	LOM Production Schedule	2-5
Table 2-3	Waste Rock Tonnage Estimates and AML Classification	2-7
Table 2-4	Non-AML WRDA Risk and Mitigation Summary	2-11
Table 2-5	Mining Method Selection.....	2-13
Table 2-6	Historical Production from the Mackeno (Yukeno) Mill, 1953-1957	2-28

LIST OF TABLES (cont'd)

Table 2-7 Summary of Metallurgical Recoveries	2-30
Table 2-8 Process Design Criteria	2-33
Table 2-9 Paste Fill Preliminary Material Estimate at Variable Binder Content	2-41
Table 2-10 Bellekeno Mine Labour Requirements.....	2-48
Table 2-11 Management and Technical Staff	2-49
Table 3-1 Keno Hill Silver District Setting Summary	3-2
Table 3-2 Lightning Creek Stations Water Quality	3-18
Table 3-3 Existing Water Quality Sample Station Locations Near Bellekeno	3-20
Table 3-4 Water Quality Data Summary for Receiving Water Stations in Lightning Creek.....	3-22
Table 3-5 Lightning Creek Drainage Mass Loading, 2006 - 2008.....	3-26
Table 3-6 Christal Creek Drainage Mass Loading, 2006 - 2008	3-27
Table 3-7 Comparison of Metals in Stream Sediments Sampled in 2004 and 2007 in Lightning Creek and Christal Creek Drainages	3-32
Table 3-8 Results of the Hydrological Update for Flat, Christal and Lightning Creeks.....	3-33
Table 4-1 List of Current Land Use Activities near Keno Hill Silver District	4-7
Table 4-2 Alexco Bellekeno Consultation Summary Table	4-17
Table 5-1 Significance of Effects Descriptors	5-5
Table 5-2 Summary of the Assessment of Potential Environmental Effects Resulting from Bellekeno Mine Development	5-6
Table 5-3 Identification of VCs	5-9
Table 5-4 VC Spatial and Temporal Boundaries.....	5-11
Table 5-5 Bellekeno Waste Rock Estimated Pore Water Volumes.....	5-16
Table 5-6 DSTF Estimated Zinc Loading	5-20
Table 5-7 Estimated Daily Traffic Count – Construction Phase	5-30
Table 5-8 Estimated Daily Traffic Count – Operations Phase.....	5-30
Table 6-1 Precipitation and Evapotranspiration at Select Keno Hill District Locations.....	6-2
Table 6-2 Water Source Flows around the Bellekeno Mine.....	6-5
Table 6-3 Christal Lake Inflows and Potential Mill Freshwater Makeup Sources	6-7
Table 6-5 Bellekeno Mine Water Balance	6-9
Table 6-6 Mill Water Balance	6-11

LIST OF TABLES (cont'd)

Table 6-7 Dry Stack Tailings Pore Water Assay	6-24
Table 6-8 Proposed Effluent Discharge Standards.....	6-25
Table 6-9 Proportion of Samples Filtered as Potentially-AML in Bellekeno Waste Rock Drillhole Database	6-32
Table 6-10 Waste Rock Management Categories	6-34
Table 6-11 Mine Wall Sampling Schedule	6-45
Table 7-1 Current Monitoring Program Summary within the Area of the Mill and Mine	7-3
Table 7-2 Proposed Monitoring Program Summary within the Area of the Mill and Mine	7-4
Table 7-3 MMER Standards.....	7-8
Table 7-4 Overall AMP Summary	7-14

LIST OF PLATES

Plate 1 Bellekeno 625, View Looking Upstream - Thunder Gulch	6-14
Plate 2 Bellekeno 625 Settling Ponds	6-14
Plate 3 Bellekeno 625 Lime Mix Tank.....	6-15

VOLUME 2

LIST OF APPENDICES

- Appendix A Listing of Alexco claims on the Keno Hill Property as of December 18, 2007
- Appendix B “*Review of Historic Keno Static Test Data to Define ARD/ML – Controlling and Correlating Factors*”, prepared by Altura Environmental Consultants Ltd., January 2008 Letter Report, on behalf of Access Consulting Group.
- Appendix C “*Geoenvironmental Rock Characterization, Bellekeno Zone*”, prepared by Altura Environmental Consultants, January 2008 Letter Report, on behalf of Access Consulting Group.
- Appendix D “*Typical Waste Containment Facility Design, Keno Hill Silver District, YT. Construction Specifications Issued for Use*”, prepared by EBA Engineering Consultants Ltd., July 2008 Report, on behalf of Alexco Resource Canada Corp.
- Appendix E “*Conceptual Tailings and Waste Rock Management Plans Bellekeno Project near Keno City, Yukon*”, Letter Report prepared by EBA Engineering Consultants Ltd., January 2008, for Alexco.
- Appendix F MSDS Data Sheets for Mill Chemicals
- Appendix G “*Alexco Resource Corp., Emergency Response Plan*”, prepared by Alexco Resource Corp., updated December 2008.
- Appendix H “*United Keno Hill Mines Limited, Site Characterization Report*”, Chapters 3, 6 and 8. Prepared by Access Mining Consultants Ltd., May 2006, on behalf of United Keno Hill Mines Limited.
- Appendix I “*Geotechnical Evaluation – Potential Mill Sites, Bellekeno Project near Keno City, Yukon*”, Letter Report prepared by EBA Engineering Consultants Ltd., December 2008, on behalf of Alexco Resource Canada Corp.
- Appendix J “*Conceptual Tailings Management Plan – Mackeno Upper Bench, Bellekeno Project Near Keno City, Yukon*”. Letter Report prepared by EBA Engineering Consultants Ltd., February 2009, on behalf of Alexco Resource Corp.

List of Acronyms Used throughout the Report

Acronym	Meaning
AAS	atomic absorption spectrophotometer
ABA	acid base accounting
AKHM	Alexco Keno Hill Mining Corp.
Alexco	Alexco Resource Corp.
AMP	Adaptive Management Plan
ANFO	ammonium nitrate / fuel oil
ARD	acid rock drainage
C&F	cut and fill
CCL	Clearwater Consultants Ltd.
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Act
COC	chain of custody
DDRP	detailed decommissioning and reclamation plan
DIAND	Department of Indian Affairs and Northern Development
DSTF	dry stack tailings facility
EARP	Environmental Assessment and Review Panel
EBA	EBA Engineering Consultants Ltd.
ERDC	Elsa Reclamation and Development Company
ESM	existing state of mine
FEARO	Federal Environmental Assessment Review Office
IBA	Impact Benefits Agreement
ICP	inductively coupled plasma
LES	Laberge Environmental Services
LH	longhole
LHD	longhole drilling
MAP	mean annual precipitation
MAR	mean annual runoff
ML	metal leachate
MMER	metal mining effluent regulations
MRRC	Mayo Renewable Resources Council
MSDS	mine safety data sheets
NNDDC	Nächo Nyak Dun Development Corporation
NNDFN	First Nation of Nä cho Nyak Dun
NWPA	Navigable Waters Protection Act
OCF	overhand cut and fill
PEA	Preliminary Economic Assessment
PRA	Process Research Associates
QMA	Quartz Mining Act
SRK	SRK Consultants
SWMF	solid waste management facility
UCF	underhand cut and fill
UKHM	United Keno Hill Mining Ltd.
VCs	Valued environmental and socio-economic components
Wardrop	Wardrop Engineering Inc.
WMEC	White Mountain Environmental Consultants
WRDA	waste rock disposal area
WRMP	waste rock management plan
WRSF	waste rock storage facility
YEC	Yukon Energy Corp.
YESAA	Yukon Environmental and Socio-Economic Assessment Act
YESAB	Yukon Environmental and Socio-Economic Assessment Board
YG OH&S	Government of Yukon, Occupational Health & Safety

1.0 INTRODUCTION

1.1 PROPONENT INFORMATION

Although the Keno Hill Silver District has seen numerous mining companies, syndicates, individual prospectors and miners over the past 80 years or so, United Keno Hill Mines Ltd. and UKH Minerals Ltd. (collectively “UKHM”) was the previous owner of the consolidated properties located on and around Galena Hill, Keno Hill and Sourdough Hill, collectively known as the Keno Hill Mining Property. In June 2005, Alexco Resource Corp. (Alexco) was selected as the preferred purchaser of the UKHM assets. In February 2006, following negotiation of a Subsidiary Agreement between the Government of Canada, the Government of Yukon and the Company, the Supreme Court of Yukon approved the purchase of the assets of UKHM by Alexco through its wholly owned subsidiary, Elsa Reclamation & Development Company Ltd. (ERDC). In December, 2007, Alexco registered the vesting order at the Mayo Mining Recorder Office, the Yukon Land Title Office and the Yukon Lands Branch (see Appendix A in Volume 2 for listing of Alexco claims on the Keno Hill Property as of December 18, 2007). This action brought to “Final Close” the acquisition by ERDC of the assets of UKHM, and followed the granting of Water Use Licence QZ06-074 to ERDC by the Yukon Water Board on November 14, 2007; WUL QZ06-074 specifically addresses environmental care and maintenance activities in the district.

Alexco and its wholly-owned subsidiaries, including Alexco Resource US Corp., Access Mining Consultants Ltd., and ERDC provide mine related environmental consulting services, reclamation and mine closure services, and environmental remediation technologies to both government and industry clients. Another subsidiary company, Alexco Keno Hill Mining Corp. (AKHM), has been incorporated for operation of mineral extraction in the Keno Hill Silver District.

Alexco's business is to unlock value and manage risk at mature, closed or abandoned mine sites through integration and implementation of the Company's core competencies which include management of environmental services, execution of mine reclamation and closure operations and if appropriate, rejuvenation of exploration and development activity.

Alexco's Environmental Policy and Practice Statement follows.

ALEXCO RESOURCE CORP.

Environmental Policy and Practice Statement

(Page 1 of 3)

It is the policy of Alexco Resource Corp. (“Alexco”) to protect people and the environment through safe and responsible operation of all of its projects. We are committed to manage the projects in accordance with all applicable laws and in accordance with prudent and ethical business practice. It is Alexco’s expectation that all those associated with the company, including employees, consultants, contractors, and visitors, will strive to implement Alexco Resource Corp.’s environmental policy (see Addendum A, which follows this text) in day to day operations. General requirements for employees, consultants, contractors and visitors are as follows:

1. **Provision of Environmental Safeguards:** Employees, consultants, contractors and visitors shall implement environmental safeguards equal to or better than industry standards. These include, for example, storing hazardous products within secondary containment, and maintaining an adequate inventory of spill response equipment capable of remediating spills of all hazardous products in inventory.
2. **Preventing Product Releases:** Employees, consultants, contractors and visitors will take measures to prevent spills of hazardous products to land or water. Should an accidental spill occur, all applicable regulations and permits shall be adhered to, and in addition, shall be immediately reported to the designated Alexco representative.
3. **Minimizing Disturbance:** Employees, consultants, contractors and visitors will ensure that disturbance to land, water, wildlife, and archeological remains are minimized. Any unexpected disturbance will be immediately reported to the designated Alexco representative.
4. **Good Housekeeping Practices:** All work areas will be maintained in a clean and tidy state.
5. **Education:** Contractors and visitors will ensure that all persons under their responsibility are aware of Alexco’s environmental policy and its importance.

(Page 2 of 3)

6. Training: Contractors and visitors will ensure that all persons under their responsibility are trained with respect to maintaining environmental compliance in all aspects of their operation.
7. Monitoring: Contractors and visitors will permit Alexco personnel to inspect their on-site facilities, and shall, in a timely manner, address any concerns brought forth.

Addendum A
Environmental Policy Statement

(Page 3 of 3)

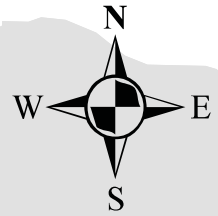
Alexco recognizes environmental management as a corporate priority. Alexco cares about preserving our environment for future generations, while also providing for safe, responsible, and profitable operations by developing our natural resources for the benefit our employees, shareholders, and community.

In adopting the following Statement of Principles throughout all stages of exploration, development, mining, and closure, Alexco intends to set and maintain standards of excellence for environmental performance at all our operations.

- I. Alexco will communicate our commitment to excellence in environmental performance to our subsidiaries, employees, contractors, other agents, and the community.
- II. All new activities and operations will be managed to ensure compliance with applicable laws and regulations. In the absence of regulation, best management practices will be applied to minimize environmental risk.
- III. Remediation and mitigation of historic mining impacts on properties acquired by Alexco will be managed through the cooperative involvement of Alexco with previous owners, government agencies, and the community.
- IV. In order to achieve our commitment to environmental excellence, Alexco will utilize an Environmental Management System that ensures prioritization, planning, implementation, monitoring, and honest reporting.
- V. Alexco will strive to minimize releases to the air, land, or water and will ensure appropriate treatment and disposal of waste.
- VI. Alexco will allocate the necessary resources to meet our reclamation and environmental obligations.
- VII. Alexco will continuously seek opportunities to improve our environmental performance through adherence to these principles. Alexco will regularly report progress to our employees, shareholders and the community.

1.2 PROJECT LOCATION

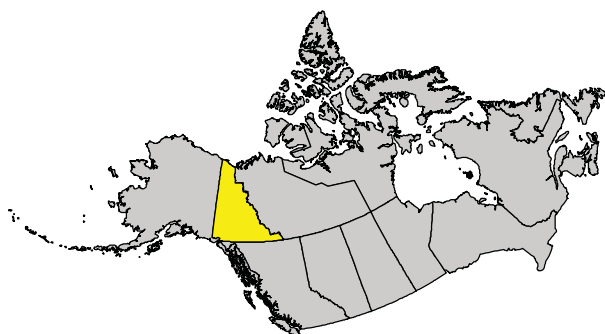
The Keno Hill Mining District is located in the vicinity of Keno City (63° 55'N, 135° 29'W), in central Yukon Territory, 354 km (by air) due north of Whitehorse. Access to the property is via a paved, two-lane highway from Whitehorse to Mayo (407 km) and an all-weather gravel road northeast from Mayo to Elsa (45 km); a total distance of 452 km. The property lies along the broad McQuesten River valley with three prominent hills to the south of the valley. Figure 1-1 shows the general project location within the Yukon Territory while Figure 1-2 shows the location on a smaller scale. The Bellekeno area is located about 3 km east of Keno City, while the Christal Lake Mill site is about 1.5 km to the northwest (Figure 1-3).



General Location Map of the Yukon Territory

Scale 1 : 6 000 000
50 0 50 100 150 200 250 300km

Project Location



ALEXCO

WATER USE LICENCE APPLICATION &
MINING LAND USE QUARTZ MINING LICENCE
APPLICATION REQUEST

BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT

PROJECT LOCATION

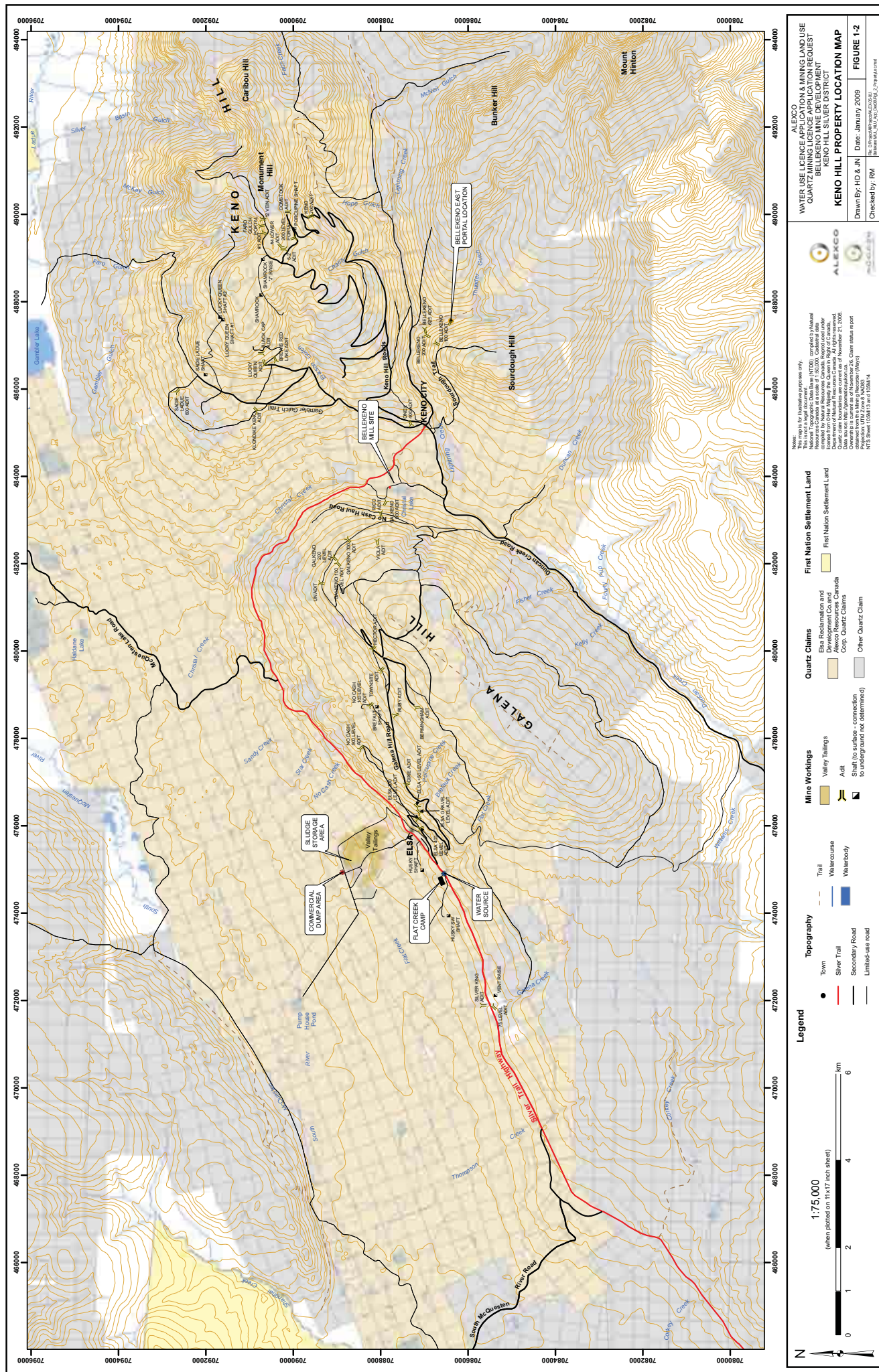
Drawn By: HD

FIGURE 1-1

Checked By: RM

Date: January 2009

File: D:\Project\AllProjects\ALEX-05-01\Bellekeno\WUL_MLU_App_Dec08\Fig1_1_GenLoc.mxd





Legend

	Adit
	Road
	Haul Road
	Proposed
	Contour
	Surface Water

Scale

1:15,000
(When plotted on 11x17 inch sheet)

0 100 200 400 600 800 1,000 1,200 m

North Arrow

N

Inset Map: Keno City Bypass Detail

Proposed Bridge Location
(See Figure 2-12 for Details)

Metadata

ALESCO
WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ VEIN MINING PROJECT
BELLEKENO SILVER DISTRICT
KENO HILL SILVER DISTRICT

BELLEKENO LOCATION MAP

DATE: 2/27/2009

FIGURE 1-3

Drawn By: HD & JN
Checked by: RM

RLE: Mine and/or Exploration Licence 65-134666-0001 (P.L. Reg. 00000001-3, P.L. 000001)

1.3 PROJECT HISTORY

1.3.1 History of Development at the Bellekeno Mine

Various mineralized zones within the Bellekeno ore deposit have seen commercial production from different operators over the years. Access to early production was from adits at the 100 and 200 levels, and later from the 625 adit. Operators have included Bellekeno Mines Ltd., Mayo Mines Ltd., and United Keno Hill Mines Ltd. Much of the ore from early mining was shipped out to smelters as direct-shipping ore, and in 1953 Mackeno Mines Ltd. constructed a flotation mill at Christal Lake to further concentrate the ore prior to shipping to smelters, including over 10,000 tons of ore produced from the Bellekeno Mine between 1953-1954.

The Bellekeno deposits' modern mining era began in 1984 with the development of the adit at the 625 level, which was collared and driven to cross-cut approximately 200 meters to the "48" vein. Over the years, the 625 level workings were connected to the 400 level and the 500 level. This was used to mine ore from the 500, 625, 700, 750 and 800 levels from 1984 through to 1989. Dewatering and rehabilitation of the 700 through 800 levels, from the 625 adit, began in 1994. Internal mechanized ramps were developed to reach the 700 and 800 levels and a mechanized ramp was driven towards but stopped short of the 500 level. The property was maintained until 2001, when it was declared abandoned. The lower Bellekeno workings were allowed to flood in 2003.

In 2006, Alexco initiated a broad surface exploration program (YESAA File Number 2006-0157 & Class 3 Mining Land Use Approval LQ00186) in the historic Keno Hill silver district with surface diamond drilling focused primarily toward systematic testing of numerous targets, validating and expanding historic mineral resources and acquiring a better understanding of the local geology and ore controls. Based on broadly successful 2006 results, Alexco in 2007 expanded its exploration to a two phase district exploration program; the first phase focused on following up prior results in the area of the historic Bellekeno mine and the second phase continuing the broad information gathering drill program elsewhere across the district. In 2008 Alexco conducted surface exploration at a number of targets throughout the district and proceeded with advanced underground exploration and development at Bellekeno (YESAA File Number 2008-0039, Mining

Land Use Approval LQ-00240, and Yukon Water Board Licence QZ07-078). On July 9, 2008, Alexco released a Preliminary Economic Assessment (PEA) of Bellekeno prepared by SRK Consulting (SRK, 2008). The positive economics suggested by the PEA have led Alexco to proceed with pursuance of a Quartz Mining Licence and a Type A Water Licence in anticipation of a positive development plan and ultimately a production decision.

1.4 PREVIOUS ENVIRONMENTAL AND SOCIOECONOMIC ASSESSMENTS

A number of environmental assessments have been performed on projects in the Keno Hill silver district since 1994. Past assessment activities, including those under the Environmental Assessment and Review Panel (EARP) and the Canadian Environmental Assessment Act (CEAA) are noted in Table 1-1.

Under the Yukon Environmental and Socioeconomic Assessment Act (YESAA), there have been three previous environmental and socioeconomic assessments.

- In 2006, Alexco's wholly owned subsidiary Alexco Resource Canada Corp. initiated a broad surface exploration program (YESAA File Number 2006-0157) in the historic Keno Hill silver district with surface diamond drilling focused primarily toward systematic testing of numerous targets, validating and expanding historic mineral resources and acquiring a better understanding of the local geology and ore controls.
- In 2007, Alexco's wholly owned subsidiary ERDC was assessed by Yukon Environmental and Socio-Economic Assessment Board (YESAB) (YESAA Project File No. 2006-0293) for its care and maintenance program (water treatment at five sites and maintenance throughout the District).
- In 2008 Alexco Resource Canada Corp. went through another YESAB screening for its Bellekeno Advanced Underground Exploration and Development Program (YESAA File Number 2008-0039).

Table 1-1 Previous Environmental Assessments, Past and Current Permits/Licences

Activity	Environmental Assessment	Period in Effect	Permit/Licence Issued
United Keno Hill Mines Adit De-Watering and Reserve Development Program	DIAND EARP screening and Decision Report	1994 to 1996	Type B Water Licence QZ94-001 (<i>expired</i>)
United Keno Hill Mines Interim Non Commercial Mine Operation	DIAND EARP screening Report	1996 to 1998	Type B Water Licence QZ94-002 (<i>expired</i>).
United Keno Hill Mines Interim Non Commercial Mine Operation	DIAND CEAA screening Report	1997 to 2003	Type A Water Licence QZ96-001 (<i>expired</i>)
Alexco Resource Canada Corp. (650399 BC Ltd.) Surface Exploration Program (diamond drilling, geophysics)	YESAA Project 2006- 0157	Jul. 5, 2006 to Jul. 4, 2011	Class 3 Mining Land Use Approval LQ00186 (<i>in effect</i>)
Elsa Reclamation and Development Company (ERDC) Care and Maintenance Program	YESAA Project 2006- 0293	Oct. 18, 2006 to Nov. 30, 2012	Type B Water Licence QZ06-074 (<i>in effect</i>)
Alexco Resource Canada Corp. Advanced Underground Exploration and Development Activities	YESAA Project 2008- 0039	June 17, 2008 to June 16, 2018	Type B Water Licence QZ07-078 (<i>in effect</i>)
		Oct. 3, 2008 to Sept. 3, 2018	Class 4 Mining Land Use Approval LQ00240 (<i>in effect</i>)

Previous assessments were consulted during the preparation of the current documentation, in particular past valued environmental and socio-economic components (VCs) and mitigative measures to reduce potential project effects. These past environmental assessment materials provide additional background information of particular importance for defining and addressing environmental effects, including cumulative environmental effects.

1.5 REQUIRED ENVIRONMENTAL ASSESSMENT AND REGULATORY APPROVALS

1.5.1 YESAA Designated Office Assessment

An assessment under the YESAA is required as activities related to moving into mine production at Bellekeno are listed within Schedule 1 of the YESAA *Assessable Activities, Exceptions and Executive Committee Projects Regulations*.

Because the mill is rated at a maximum capacity of 400 tonnes per day during its last three years of operation, the project lies well within the activity level which is screened at the Designated Office level (proposed mines greater than 1,500 tpd are reviewed by the Executive Committee).

Activities within the scope of the proposed mine and mill development program (described within Section 1.5.5 – *Scope of the Project*) also trigger the need for a Type A Water Licence and Quartz Mining Licence, as outlined in the following sections.

1.5.2 Type A Water Licence

The proposed mine development activities at Bellekeno will necessitate a Type A Water Licence for both direct use of water and deposit of a waste. The requirement for a Type A Water Licence under the Yukon Waters Act is outlined within Schedule 7 (Licencing Criteria for Quartz Mining Undertakings) of the *Waters Regulation* as follows:

- Direct water use for milling at a rate of 100 or more tonnes of ore per day;
- Deposit of waste water from milling at a rate of 100 tonnes or more of ore per day.

1.5.3 Mining Land Use Approval – Quartz Mining Licence

To authorize commercial production, Alexco Keno Hill Mining Corp. will require a Quartz Mining Licence as per the Quartz Mining Act (QMA), *Quartz Mining Land Use Regulations*. The requirement for a Quartz Mining Licence has been triggered by the advancement of the exploration program as follows:

- More than 10,000 tonnes of rock will be taken from the land for commercial purposes. Approximately 613,000 tonnes of mineralized rock will be extracted from the Bellekeno Mine over an estimated 5 year mine life at a rate of 250 tonnes per day for years 1 and 2, expanding to 400 tonnes per day during years 3-5.

1.5.4 Navigable Waters

Construction of a new bridge across Lightning Creek in order to detour the mine haul roads around Keno City will require approval from Transport Canada Navigable Waters Protection Program. The *Navigable Waters Protection Act* (NWPA) approves any works built or placed in, on, over, under, through or across navigable water in Canada prior to construction of the work(s).

1.5.5 Scope of the Project

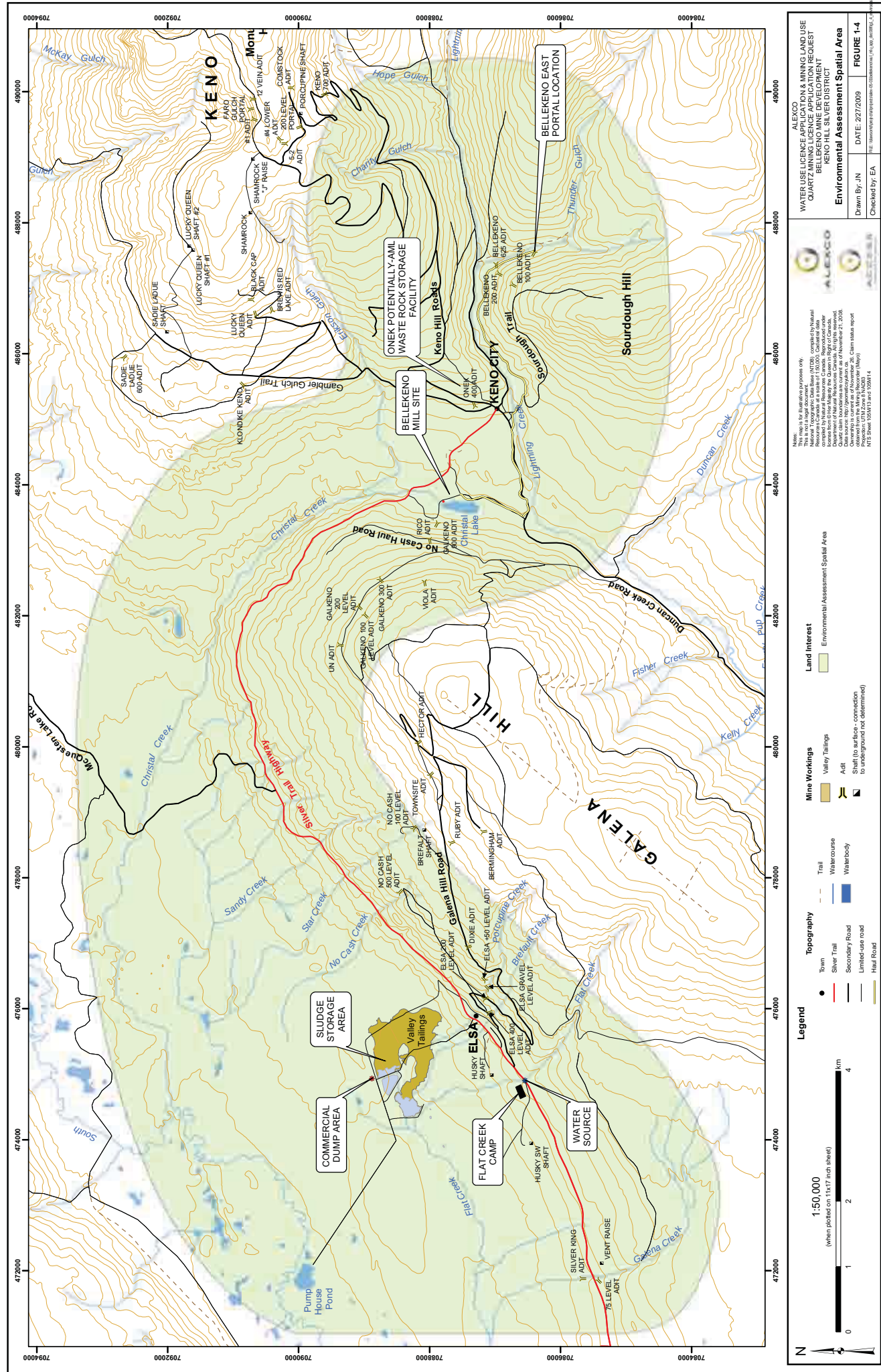
The principal mine development activities involve continued underground development and operations at Bellekeno and building a conventional flotation mill at the former Mackeno mill site adjacent to Christal Lake (hereafter, the Christal Lake Mill) for the processing and production of minerals from the Bellekeno mine. Bellekeno mine and mill development and operation activities include:

- Underground development and mining involving the movement of approximately 500,000 tonnes of waste rock and 600,000 tonnes of ore to the surface over the duration of the mine development program;

- Construction of a series of narrow, elongated waste rock storage areas near the Bellekeno 625 adit (downstream on left limit of Lightning Creek, some below the road and mostly above the power line haul road);
- Obtaining and using water from Lightning Creek or Thunder Gulch for dust suppression, cooling, and dry tailings rehydration for tailings backfill;
- Depositing Bellekeno mine waste water using existing water treatment facilities at Bellekeno 625;
- Construction of a conventional flotation mill near Christal Lake for processing ore and producing concentrate, approximately 250 tonnes per day for years one and two, ramping up to 400 tonnes per day for years three to five;
- Processing and production of approximately 25,500 tonnes of mill concentrate per year for the first two years of operation and 48,500 tonnes per year for years three to five;
- Use of mill chemicals;
- Temporary storage of mill tailings and mineralized rock in stock piles;
- Storage and disposal of mill tailings in a dry-stack tailings facility (DSTF) and placement of pyritic tailings below water level in the Bellekeno Mine;
- Construction of surface infrastructure to support the mill (coarse ore stockpile, plant services, fuel storage area, miners' dry area, offices, trailers, road, portal, settling ponds);
- Classifying waste rock as potentially-AML and non-AML as part of waste rock management plan;
- Haulage of ore to the Mill and, depending on classification, haulage of waste rock to the potentially-AML Waste Rock Storage Facility (WRSF), or non-AML Waste Rock Disposal Area (WRDA) haulage of dry tailings back to the Bellekeno Mine for use underground, and haulage of dry tailings to a dry stack tailings storage facility;
- Reconstruction/upgrading of the existing Bellekeno Mine 'power line haul road' and the existing Christal Lake haul road from Duncan Creek road to the mill site;

- Construction of a segment of new haul road around Keno City, including a new bridge across Lightning Creek for hauling ore and filtered tailings between the mine and mill;
- Shipping mill concentrate to various smelters;
- Installation of electrical power distribution system (power poles, transformers) to service the mill and ancillary buildings;
- Obtaining and using water from five potential sources for mill operation: the DSTF/mill pad collection pond “Mackeno Creek”, Christal Lake, local groundwater well(s), and Galkeno 900 adit water;
- Construction of water treatment facility to treat DSTF/mill pad runoff;
- Deposition of treated wastewater from Christal Lake mill site (including DSTF) to Christal Lake;
- Inspection and maintenance of water treatment infrastructure to ensure discharge standards are achieved;
- Environmental monitoring and sampling programs; and
- Expansion of the Flat Creek Camp from a capacity of 100 to approximately 150 personnel.

The temporal period for the Bellekeno mine and mill development covers 10 years from mine from construction through production, reclamation and closure. The spatial distribution of the impact area is shown in Figure 1-4, and includes the Bellekeno Mine site, Onek potentially-AML waste rock storage facility, the Christal Mill site, the Flat Creek camp, and the Thunder Gulch/Lightning Creek to where it joins with Duncan Creek, and the Christal Creek drainage to where Christal Creek joins the South McQuesten River. Effects potentially beyond these spatial boundaries which have been considered include wildlife habitat (e.g. moose, which may move in and out of the spatial boundaries). Also beyond the spatial boundaries presented in Figure 1-4, are regional socioeconomic effects, especially to the nearby community of Mayo.



This is not a legal document.
This map is for illustrative purposes only.
The information on this map is derived from the National Topographic Database (NTD), compiled by Natural Resources Canada, at a scale of 1:50,000. Contour lines are shown at 20 m intervals. The map is not a legal document and should not be used for legal purposes.
Quartz mining licence application for the Keno Hill Silver District.
Ownership is current as of November 21, 2008.
Production is UTM Zone 18N and 182003.
NTS Sheet 182003 and 182004

ALEXCO
WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ MINING LICENCE APPLICATION REQUEST
BELLEKENO MINE DISTRICT
KENO HILL SILVER DISTRICT

Environmental Assessment Spatial Area

Drawn By: JN DATE: 2/27/2009 **FIGURE 1-4**
Checked by: EA

2.0 PROJECT DESCRIPTION

2.1 CURRENT ADVANCED EXPLORATION PROGRAM

In June of 2008, Alexco commenced development of the Bellekeno East decline to support an underground drilling and development program in the historic Bellekeno underground workings, and to collect a 10,000 tonne bulk sample for metallurgical testing. The underground exploration program will provide information that is required to support a commercial production decision. The confirmatory underground diamond drilling will confirm assumptions made about tonnage and grade of the deposit as indicated by surface drilling. On December 4th, 2008, the Bellekeno East decline broke through to the old workings at the 625 level. In addition, the existing but dilapidated Bellekeno 625 adit is being rehabilitated by removal of timber support and replacing ground support using modern methods, and reinstalling the rail track system, ventilation, electrical and development of sumps for settling water in the adit prior to discharge to the existing treatment ponds. A new bypass (sized for tracked mining methods) has been driven to provide access around a cave in approximately 1,000 feet in the adit. These activities are authorized under the company's Mining Land Use and Water Use Licences.

2.2 BELLEKENO MINE DEVELOPMENT PROGRAM

Subject to a positive production decision being made by Alexco, this project involves the development of the Bellekeno deposit as the first of potentially many in the Keno Hill Silver District. Because the Bellekeno Mine involves the reopening of an existing underground mine, use of existing infrastructure such as water treatment facilities, and the reuse of previously impacted historic Mackeno mill site at Christal Lake and haul routes, 'new' environmental footprint is limited in scope. See Figure 2-1 for an overview of the Bellekeno Mine site, which includes access/haul roads, underground workings, proposed non-AML waste rock disposal area, and ancillary facilities.

Mining at Bellekeno will be undertaken at the same time as ERDC's care and maintenance and existing state of mine closure planning and implementation activities are undertaken throughout the district. Separate permitting and licensing already provides authority for those activities.



1:5,000
(when plotted on 11x17 inch sheet)

0 50 100 200 300 m

Legend

- Adit
- Main Surface Water Source
- Alternate Surface Water Source
- Haul Road
- Bellekeno Underground Workings
- Public Road



ALEXCO
WATER USE LICENCE APPLICATION &
MINING LAND USE QUARTZ MINING
LICENCE APPLICATION REQUEST
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT

BELLEKENO MINE

Drawn by: HD & JN **FIGURE 2-1**
Checked by: RM Date: January 2009

File: D:\Project\AIR\Projects\ALEX-05-01\Bellekeno
WUL_MLU_App_Dec08\Fig 2-1 MineSite.mxd

Surface exploration over the past few years has provided enough information to develop a PEA for the Bellekeno deposit. Alexco retained SRK Engineering Ltd. (SRK) and Wardrop Engineering Inc. (Wardrop) to undertake this comprehensive report on the engineering design details of the proposed Bellekeno Mine. Authors of that report were: D. Keller, P.Eng, J. Sedlacek, P.Eng., G. Doerksen, P.Eng., and H. Ghaffari, P.Eng., with contributions from D. Lister, P.Eng., of Altura Environmental Consulting.

Design details that were developed during the PEA development are used, as appropriate, in various places throughout this document. In certain cases, as appropriate, entire sections of that report are included in this document for ease of reference

2.2.1 Mineral Resource

In summary, combined mineral resources for the Bellekeno deposit, including previously disclosed mineral resources for the Bellekeno 99 zone, total **537,400 tonnes grading 1,016 g/t silver, 13.5 % lead and 10.7 % zinc for 17.6 Moz of contained silver or 38.3 Moz contained silver equivalent**, in three distinct mineralized zones. The consolidated mineral resource statement is presented in Table 2-1.

Table 2-1 Consolidated Mineral Resource Statement for the Bellekeno Deposit

(SRK Consulting, January 28, 2008)

Category	Zone	Tonnage (t)	Ag (g/t)	Pb (%)	Zn (%)	Au (g/t)	AgEq (g/t)
Inferred	99 [†]	55,700	1,593	11.1	5.5	0.0	2,375
	Southwest ^{†*}	302,100	1,357	20.4	5.5	0.4	2,494
	East ^{†**}	179,600	263	2.0	21.3	0.6	1,698
Total Inferred		537,400	1,016	13.5	10.7	0.4	2,216

* Mineral resources are not mineral reserves and do not have demonstrated economic viability. All figures have been rounded to reflect the relative accuracy of the estimates.

† Reported at a cut-off of 15 troy ounces per ton silver. Silver grades capped at 100 troy ounces per ton.

‡ Reported at a cut-off of 1000 grams per tonne silver equivalent. Grades not capped.

** Metal price and recovery factor assumptions for resource are: US\$8.00 Silver troy ounce, US\$1.00/kg (US\$0.45 per pound) Lead, US\$1.65/kg (US\$0.75 per pound) Zinc, metallurgical recovery factors have been assumed to be 100%. Gold was not used in silver equivalent calculation.

2.2.2 Mine Plan and Development Schedule

The Bellekeno project is comprised of a series of at least 11 veins in the Southwest, 99 and East zones. Most of the historical mining at Bellekeno occurred in the 99 zone. The veins have variable dip, strike and thickness. Dips range from 60° to 80° to the east or west. The average strike direction is approximately 030°. Vein thickness varies from a few centimetres to several metres.

Based on the preliminary geotechnical and physical characteristics of the veins, a mining method review was conducted and cut and fill, shrinkage stoping and long hole mining methods were considered the most appropriate at Bellekeno. Cut and fill and shrinkage stoping methods typically offer a high degree of selectivity that generally translates into high mineralization extraction and low waste dilution. Long hole mining is planned only for pillar extraction in certain areas.

The life of mine (LOM) planned tonnes and grades were estimated using a 14% dilution factor and a 100% extraction of the resource above the cut-off grade. These factors were applied universally for all mining methods and mining areas as there is not enough information currently available to do a detailed extraction and dilution analysis. The

factors used, increase the resource tonnage in the mine plan by 14% and decrease the resource grade by 12%.

Mine production is planned to be 250 t/d in the first two years of operation with mill feed coming from the SW and 99 zones. Planned production increases to 400 t/d when 150 t/d is added in years 3, 4 and 5 when mining in the East zone is scheduled. Table 2-2 shows the LOM production schedule.

Table 2-2 LOM Production Schedule

Source	Unit	Production Year					Total
		1	2	3	4	5	
SW and 99 Zone production	t	91,000	91,000	91,000	91,000	44,000	408,000
East Zone production	t	0	0	55,000	55,000	95,000	205,000
Total Mine production	t	91,000	91,000	146,000	146,000	139,000	613,000

The mine will be accessed from the new Bellekeno East decline completed in December 2008 and from the 625 portal (currently being rehabilitated). Personnel and material will be transported in and out of the mine using either the decline or the 625 level.

2.2.3 Overview of Proposed Rock Excavation and Waste Rock Management

2.2.3.1 Rock Management Categories

Waste rock excavated from the Bellekeno underground operations can be categorized into the following categories:

- Non-AML: rock of non-economic grade, expected to be comprised of over 85% Central Quartzite unit (quartzite typically intercalated with minor amounts of schist), and less than 15% Greenstone. As presented in Section 6.2, the majority

of the waste rock excavated is expected to be non-AML; rock field-classified as Non-AML will be stored in designated locations on site.

- Potentially-AML Waste Rock and Mineralized Waste Rock of no Economic Interest: Rocks field-classified as potentially-AML (mainly pyrite rich graphitic schist) will be stored in designated lined potentially-AML waste rock storage facilities. In addition to potentially-AML wall rocks, some vein material especially along the margins of zoned veins contain mostly gangue minerals such as siderite, pyrite and quartz but do not contain economic amounts of Ag, Zn, or Pb minerals and therefore are of no economic interest. Due to their increased likelihood for acidic or metal leaching, all such mineralized non-economic rock is considered to be potentially-AML and will be stored in potentially-AML waste rock storage facilities.
- Mineralized Rock of Economic Interest:
Vein material which contains significant Ag, Zn or Pb minerals but is not obviously economic may be temporarily stockpiled at the mine site or mill site on lined contained pads. Confirmatory assay will determine whether this rock is milled, or is sent to the potentially-AML waste rock storage facility or hauled back underground. This material will be temporarily stockpiled for a maximum of 30 days.

2.2.3.2 Estimated Rock Quantities for Bellekeno Mine Development

In addition to waste rock excavation as part of the Bellekeno Advanced Underground Exploration and Development Program, an estimated maximum of an additional 500,000 tonnes of rock may be excavated over the 5 year mine life. Preliminary calculations by SRK Consulting for the mine plan indicate the total amount of waste rock to be excavated during Bellekeno Mine development and operations to be approximately 350,000 tonnes. However, the conservative outside limit of 500,000 tonnes has been used for planning purposes, including sizing of the WRDA. It is estimated that this tonnage will be divided fairly evenly at approximately 100,000 tonnes annually over the projected 5 year mine life (see Table 2-3). This tonnage is expected to include 369,750 tonnes of non-AML waste rock, suitable for general site construction purposes, and 130,250 tonnes of potentially-AML waste rock.

Table 2-3 Waste Rock Tonnage Estimates and AML Classification

Basic Rock Type	Total estimated tonnage (metric tonnes)	Percentage of Unit Estimated to be characterized as potentially-AML producing	Tonnes potentially-AML (approx)	Fate of potentially-AML Material	Tonnes non-AML (for general site construction purposes)
Greenstone	10,000	2%	300	Onek Waste Rock Containment Facility or equivalent location on surface or underground	9,700
Schist	15,000	40%	6,000		9,000
Quartzite	65,000	15%	9,750		55,250
mineralized waste (gangue) material	10,000	100%	10,000		0
<i>Annual Total</i>	100,000		26,050		73,950
<i>Life of Mine Total (5 Yr)</i>	500,000		130,250		369,750

Rock types and potentially-AML/Non-AML distributions in Table 2-3 are based on the Bellekeno Waste Rock Database (Table 6-8, and Appendix B in Volume 2) and also on data obtained during the ongoing Advanced Underground Exploration and Development Program. The results of these data suggest that the quantity of AML rock predicted by the Geoenvironmental Characterization Study and cover hole drilling may have overestimated the quantity of potentially-AML during decline development. For example, although Alexco anticipated 25% of the total waste rock to be potentially-AML during the Advanced Underground Exploration and Development Program, during actual Bellekeno East Decline development, less than 5% potentially-AML rock was encountered.

Compared with the Advanced Underground Exploration and Development Program, Bellekeno Mine Development is expected to encounter more near vein material, which is more likely to be potentially-AML. Because of this, the conservative estimate of 25% potentially-AML is retained. The approximately 6,500 samples used in the Bellekeno geoenvironmental characterization report (Appendix C in Volume 2) are centralized over the Bellekeno vein zone, and thus more likely to accurately reflect the actual potentially-AML waste rock which will be encountered during mine development.

2.2.3.3 Waste Rock Management

Upon AML/non-AML determination (see Section 6.2 for details), directions will be given to the surface crew for hauling and use of the waste rock as follows:

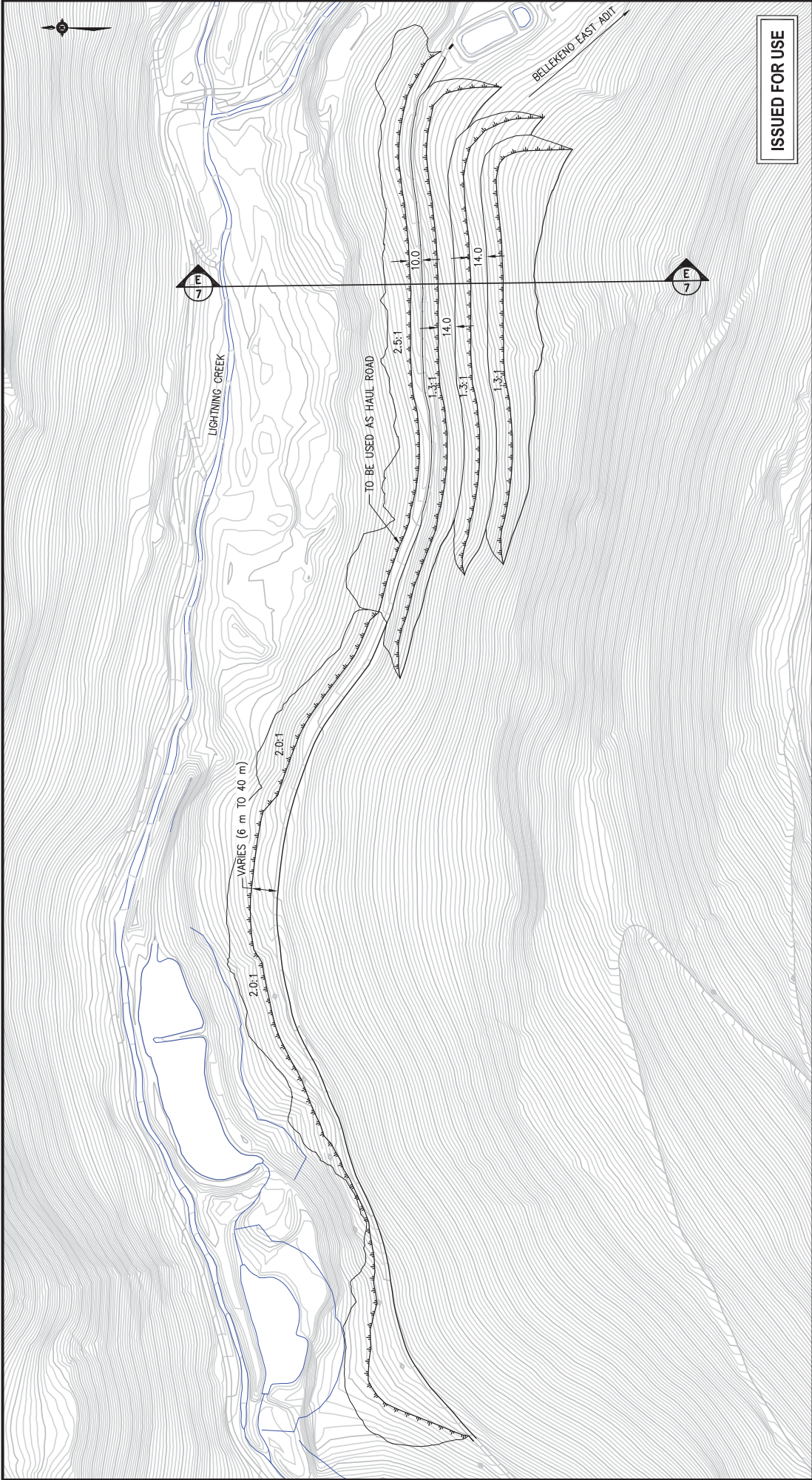
2.2.3.3.1 Non-AML Waste Rock

Rock that is not potentially acidic or metal leaching, or “non-AML” will be used for general construction including repairs and surface capping of the existing ‘power line road’ that runs along the north slope of Sourdough Hill, above the left limit of Lightning Creek and possibly as fill and construction for the mill and ancillary facilities including a toe berm for closure of the dry stack tailings facility. Additional non-AML waste rock will be deposited along the northeast flank of Sourdough Hill, northwest of the current Bellekeno 625 waste rock storage areas. See Figures 2-2 and 2-3 below from EBA Engineering Consultants Ltd. (EBA) for conceptual design of waste rock storage areas. See Appendix D in Volume 2 for the complete report from EBA.

2.2.3.3.1.1 Non-AML Waste Rock Disposal Facility Conceptual Design

The following has been taken from EBA’s report to Alexco on Conceptual Tailings and Waste Rock Management Plans, Bellekeno Project near Keno City, Yukon (see Appendix E in Volume 2 for the complete report).

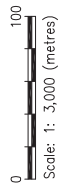
“The waste rock will be hauled from the Bellekeno adit directly to the WRDA. The WRDA will be constructed as a wrap around dump, so the lower benches will be constructed first. The lowest bench will follow the existing road alignment and have a slope to the existing ground surface of 2.5H:1V. The waste rock will be dumped in 10 m benches and allowed to fall to the bench below it at the natural angle of repose of the rock. The stability of the pile was checked using Geostudio 2007 – SlopeW module. The factors of safety calculated for the waste WRDA and the guidelines set forth by the BC Mine Waste Rock Pile Research Committee (1991) are summarized in Table [6-11]. The WRDA will not need re-contouring at closure as the long-term stability of the pile should meet the guidelines. Waste rock piles in the area have been standing at the natural angle of repose without significant stability problems for over 30 years.”



ISSUED FOR USE

WASTE ROCK VOLUME = 200,000 m³

NOTE:
BASE PLAN PROVIDED BY
ALEXCO RESOURCE CANADA CORP.





ALEXCO



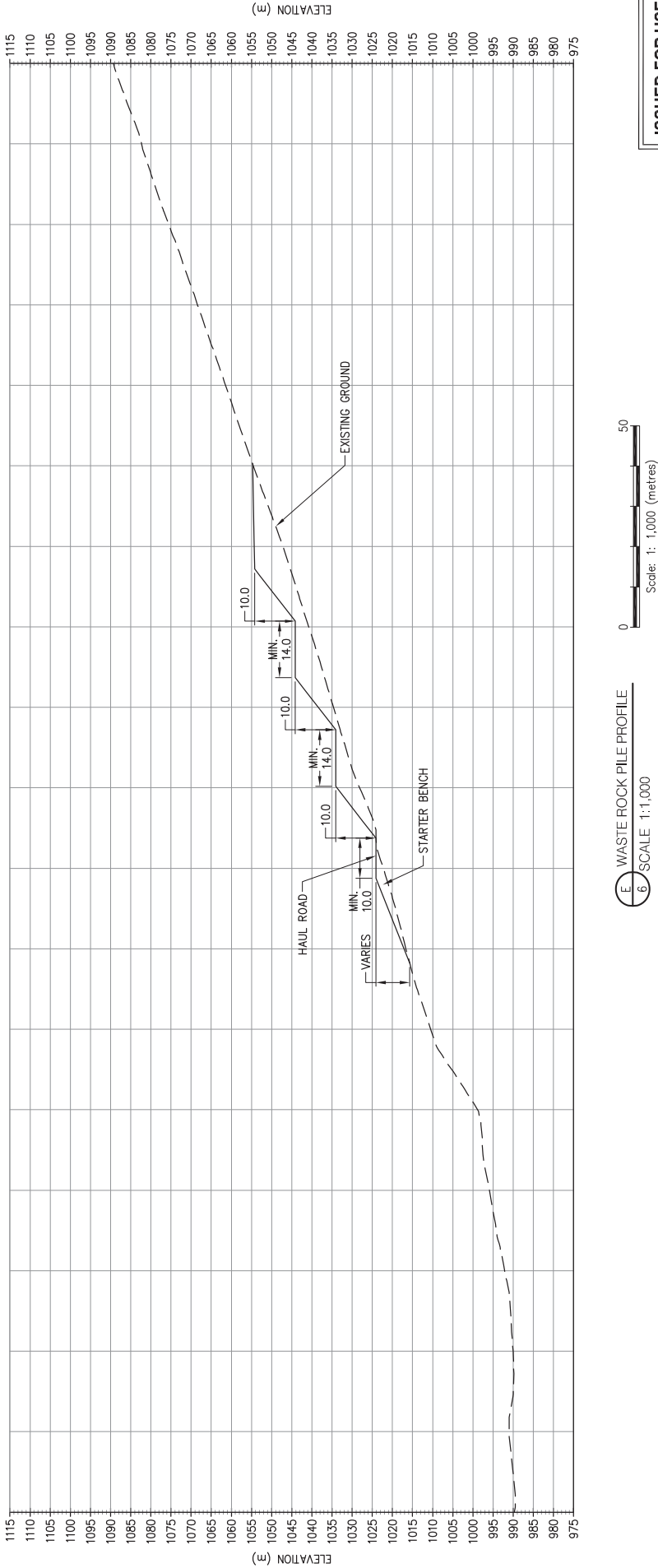
**EBA Engineering
Consultants Ltd.**

ENGINEERING SUPPORT SERVICES
BELLEFENO MINE PROJECT, YUKON

WASTE ROCK DISPOSAL AREA
PLAN

PROJECT NO.	DRAWN	CHECKED	REV
W14101178.001	KJT	CJD	1
OFFICE	DATE		
EBAW-HSE	DECEMBER 11, 2008		

Figure 2-2



ISSUED FOR USE

NOTE
1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED
2. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.



ALEXCO



EBA Engineering
Consultants Ltd.

ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON

WASTE ROCK DISPOSAL AREA
PROFILE

PROJECT NO.	DRAWN	CHECKED	REV.
W14101178.001	KJT	CJD	1
OFFICE	DATE		
EBA-WHSE	DECEMBER 11, 2008		

Figure 2-3

2.2.3.3.1.2 *Non-AML Waste Rock Disposal Area Risks and Mitigations*

The risks and associated mitigations of the Non-AML WRDA are summarized in Table 2-4 and are taken from EBA's report to Alexco on Conceptual Tailings and Waste Rock Management Plans, Bellekeno Project near Keno City, Yukon (see also Appendix E in Volume 2).

Table 2-4 Non-AML WRDA Risk and Mitigation Summary

Risk	Design Constraint	Mitigation	Discussion
Deep seated slope failure	Minimum FS = 1.3 (static); 1.0 (pseudo-static 1:500 year event)	Waste rock pile is designed to the applicable guidelines.	Probability of exceedance of the design seismic event is 10% in 50 years.
Surface slope failure	Minimum FS = 1.1 (static)	Waste rock pile is designed to the applicable guidelines.	Surface failures can be repaired without major effort.
Sediment transport	Setback distance of 30 m from water bodies	Pile location minimizes sediment from being transported into adjacent streams.	Sediment picked up by surface runoff can filter out in natural vegetation in the area prior to discharging into receiving water bodies.
Toe liquefaction	Consider liquefaction during conceptual design	The foundation soils not susceptible to liquefaction in frozen state.	Review of liquefaction potential will be conducted for unfrozen soils in detailed design.
Snow and ice buried during pile construction	Operational issue	Operational procedures will be developed to minimize this.	Buried snow and ice can affect the stability and capacity of the facility.
Contaminated waste rock	Operational issue	Waste rock containing contaminant will not be placed in waste rock pile.	Contaminated rock will be placed in the previously constructed contaminated waste rock facility.

2.2.3.3.2 *Potentially-AML Waste Rock*

Preliminary mine plan design by SRK Consulting indicate that approximately 25,000 tonnes of potentially-AML waste rock could be accommodated underground as backfill. Rock that is considered potentially-AML is currently trucked on existing haul roads across Lightning Creek onto Keno Hill for deposit into the lined Onek Waste Rock containment facility. The Onek potentially-AML rock storage facility has been built according to Typical Waste Containment Facility Design specifications (see Appendix D

in Volume 2). This design has a geosynthetic liner to allow for collection of drainage and is surface graded to divert any water flow around the storage area. The HDPE liner is covered by a 0.3 m protective sand and gravel overliner/drainage layer to permit rock dumping by truck or loader. Sumps are built into the low points of these storage facilities to allow for collection of any drainage or meteoric accumulation, which is conveyed to the Bellekeno 625 treatment facility. Upon closure, this facility will be covered with an evapotranspiration cover. See the conceptual decommissioning plan in Section 8 for additional details.

Using conservative geochemical predictions of waste rock type and quantitative, the Onek facility is projected to be able to accommodate approximately half of the potentially-AML waste rock to be generated during the life of mine. Three possibilities for accommodating the remainder of the potentially-AML waste rock to be generated during the life of the Bellekeno Mine have been considered. The first and preferred option is place more waste rock underground. The second option is to simply expand the current Onek facility to be able to accommodate the entire remainder of potentially-AML waste rock. A third option is to build another equivalent containment facility either at another location within the Onek Site or build it on Sourdough Hill on top of Non-AML waste rock disposal area near Bellekeno 625 (see above). Placing the potentially-AML facility on top of the Bellekeno 625 non-AML waste rock storage area would be subject to additional detailed geotechnical work. The liner design for this facility is included in Volume 2 Appendix D. Any additional facility would follow the same design, operation, and closure measures as the Onek potentially-AML waste rock storage facility.

2.2.4 Mining Method Selection

Mining method selection for Bellekeno is contingent on the characteristics of the deposit and must take into account, deposit geometry, geology, geotechnical characteristics, hydrogeology, and other variables.

Upon preliminary review of the deposit characteristics, three main mining methods were deemed suitable for different parts of the deposit. These methods consist of cut and fill (“C&F”), shrinkage stope and longhole (“LH”) stoping for pillar recovery. The actual

methods used, and variations of the methods applied, will depend on site specific conditions in each area of the deposit. A summary of the proposed methods is shown in Table 2-5.

Table 2-5 Mining Method Selection

Selected Mining Methods	Justification
Overhand or Underhand Cut and Fill	Selected for less competent rock, limited dilution and to allow for easier extraction of the remaining pillars
Shrinkage	Selected for the narrow vein sections with reasonably competent rock
Long Hole	Selected to extract the remaining C&F pillars towards the end of the mine life

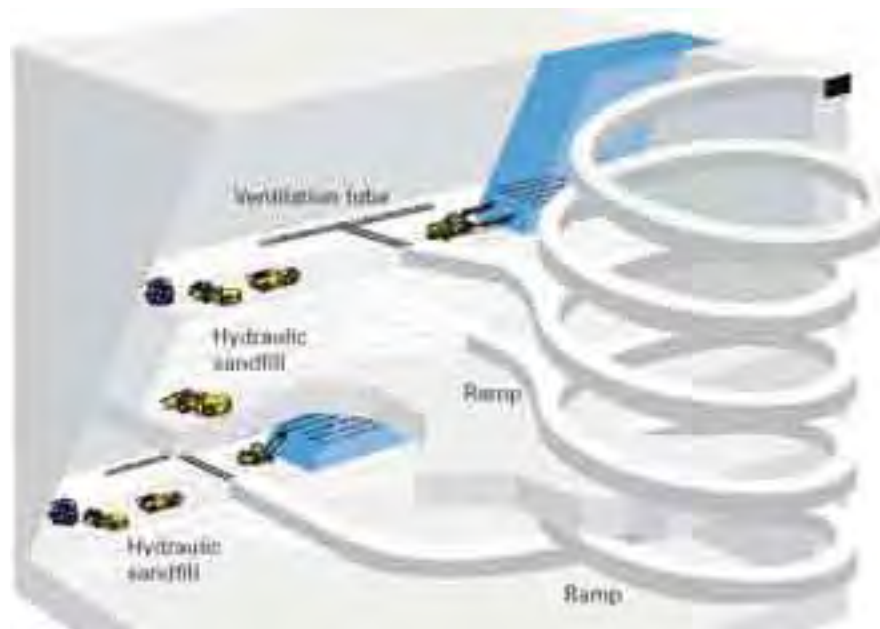
A brief description of each main mining method is given in the following pages.

Cut and Fill mining is a method of short hole mining used in a wide range of deposit geometries. There are two main methods of cut and fill (C&F) mining; overhand cut and fill (“OCF”) and underhand cut and fill (“UCF”).

OCF typically uses uncemented fill and mining begins at the bottom of a mining block and advances in “slices” of “lifts” upwards. Stopping begins from an access ramp driven off the main level to the bottom of the mineralized zone to be accessed. Using development mining techniques, a drift is driven through the mineralized zone to the defined limit of mining. Upon completion, the drift (or “cut”) is filled with cemented or uncemented back-fill. Once filled, another drift is driven on top of filled cut. This process continues until the top of the stope is reached. See Figure 2-4 for a typical C&F schematic.

UCF mining will be used when the backs and ribs of stopes are deemed not competent enough to economically allow OCF mining. UCF utilizes engineered, cemented backfill with mining beginning at the top of a mining block and advances downwards underneath the competent backfill. Each completed cut is filled with cemented backfill and then mining of the next lower cut proceeds under the cemented backfill once it has cured.

Figure 2-4 Overhand, Mechanized Cut & Fill Mining Method (from Atlas Copco)



Both UCF and OCF will be mechanized where mineralized envelopes are in excess of 2.1 metres wide and stopes can support capitalized development to access multiple lifts. The proposed layout for C&F mining will be to use 20 m vertical spacing between sill cuts. Each lift will be approximately 4 m vertical for a total of 5 lifts but will depend on vein thickness.

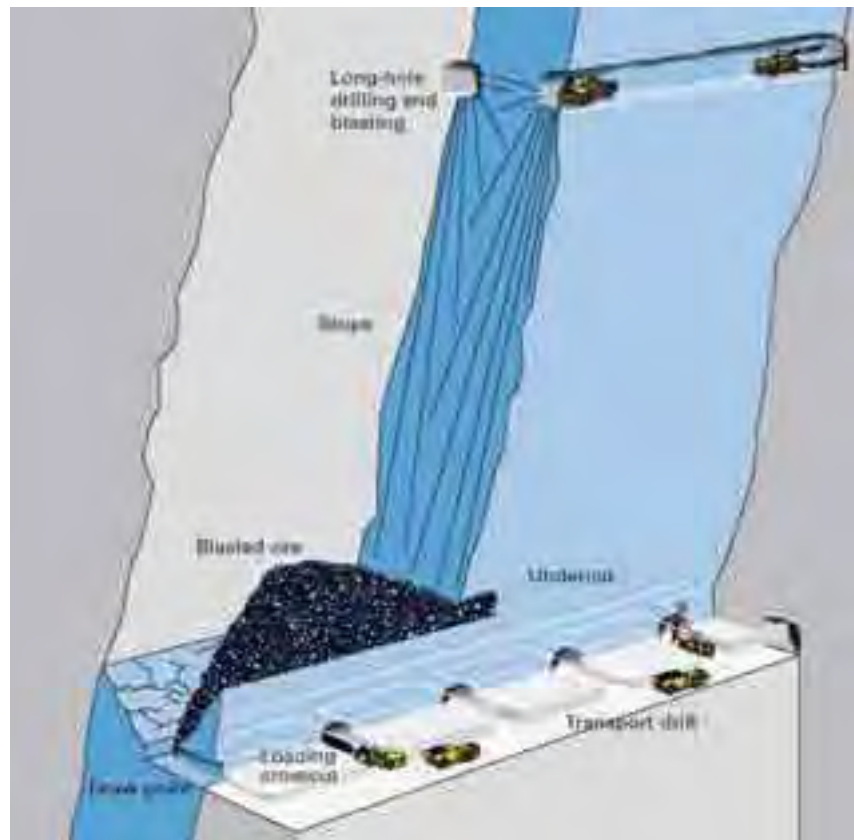
Long hole stoping (“LH”) is normally used where large blocks of continuous mineralization can be identified and the surrounding rock is reasonably strong (Figure 2-5). Access to the top and bottom of the mineralized block is provided with drifts. A vertical opening (slot raise) is created within the stope block from the top of the block to the bottom. Long holes are drilled to blast vertical slabs off the mineralized block which is then scooped from a lower drawpoint by LH drilling (LHD).

In the Bellekeno application, LH stoping will be used to recover pillars left behind from previous mining in the 99 zone. The depth on blast holes in the production sequence will be approximately 12-15 metres long. Blind raises or slot raises will be drilled with the LH drill unit, blasted and the stope block will be retreated out by drilling and blasting

successive rings. The current plan assumes full to partial fill. Typically LH blocks will be pulled last unless they are in an area that would not conflict with ongoing operations. They could also be filled if they are located too close to mine infrastructure.

Only 2% of the total tonnes from the mine are planned to come from this pillar recovery. Pillar recovery can be a challenging exercise and can lead to excessive dilution and low extraction if ground or fill conditions are poor as is often the case.

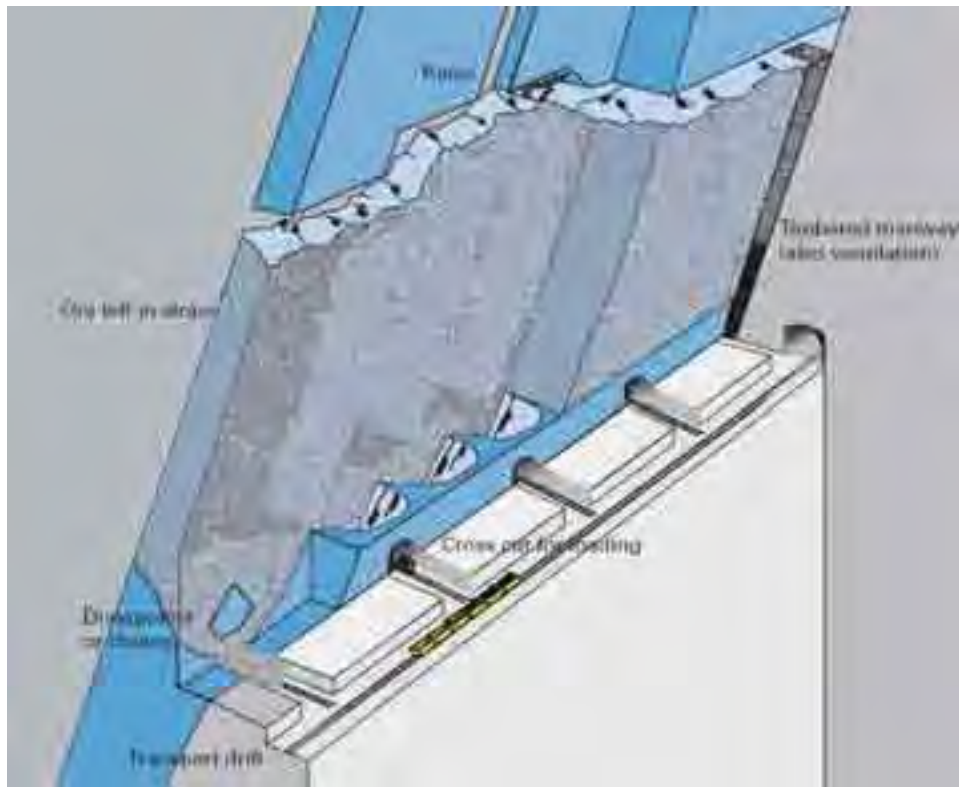
Figure 2-5 Long Hole Mining Method (source: Atlas Copco)



Shrinkage stoping (Figure 2-6) is used mainly in steeply dipping, relatively narrow mineralization with regular boundaries. Mineralized material and waste (both the hanging wall and the footwall) should be competent, and the mineralized rock should not be affected by storage in the stope. It is a flexible mining method that does not require backfill during stoping. Successive horizontal slices of ore, usually about 3 metres high, are taken along the length of a stope, in a manner similar to cut-and-fill. The broken rock is removed from the stope through drawpoints at the bottom horizon spaced about every 7.5 meters along strike. Only the swell after blasting is drawn from the stope to leave enough broken material in place to provide a floor for the next lift.

Shrinkage mining will be done on narrow <2 m wide veins where dilution is a concern. Typically the stope will be supported by an outside scram for mucking, then by a central raise through the zone for ingress-egress and ventilation. During the mining sequence approximately 40% of the rock will be mucked as swell. Stopes may be left open after draw down or the void utilized for waste deposition. An alternative to shrinkage is a modified shrinkage/conventional C&F scenario utilizing fill and mechanized access. Lifts are accessed via rubber tired equipment to the vein intersection. Once the vein is exposed conventional mining of the stopes will be done utilizing jacklegs, stopers and slushers. Broken muck is then slushed to the stope access where a scoop completes the mucking cycle. Stopes could be filled prior to taking the next lift with either paste or hydraulic fill.

Figure 2-6 Shrinkage Mining Method (source: Atlas Copco)



2.2.5 Mine Access

Access to underground mine will be accomplished via the new Bellekeno East decline driven at a grade of approximately -12.5%. The main decline will intersect the Bellekeno historical ramp at the 625 level. From this intersection of this ramp, the historical ramp will be accessed (99 and SW zones) and rehabilitated. To the north a new exploration ramp will be developed and extended contingent on depth definition of the East Ore. Secondary access will initially be to the north through the rehabilitated Bellekeno 625 level track drift.

Main development headings and associated cross-section dimensions are provided below.

• East Main New Decline	4.6 m W x 4.6 m H.
• Historical Ramp	4.0 m W x 4.0 m H.
• Ore Access	4.0 m W x 4.0 m H
• Track Drift	2.7 m W x 2.7 m H
• Misc. Development	5.0 m W x 4.0 m H (includes sumps, re-muck bays, substations, truck loop, LHD access, explosive magazine, etc.).

2.2.6 Drilling

A minimum of two jumbos will be necessary to meet production targets. One jumbo will be dedicated to development of new ramps and accesses and the second jumbo will be dedicated to drilling in the cut and fill stopes. A third, smaller, micro jumbo will be used in small headings and as a back-up for when a jumbo is broken down.

For the relatively small tonnage of LH stopes (16,000 t planned), the contracting of a drill and skilled operator will be considered. Sill development and mined slot raises can be completed in advance of the LHD to minimize the contract cost.

2.2.7 Blasting

Due to the weak nature of the mineralized rock, a powder factor of 0.25 kg/t for shrinkage or C&F mining was assumed. The LH method would use up to 0.4 kg per broken tonne. These factors must be verified with trial mining. The blasting product will be ammonium nitrate / fuel oil (ANFO) and augmented with stick powder where needed. Detonators will be non-electric and tied in with detonator cord. Powder and cap magazines will be located on surface and proximal to the Bellekeno East portal. Explosives and detonators will be conveyed to the working headings on as need basis in transported via approved day boxes. Excess explosives will be returned to the magazine at the end of the shift. A log book will be maintained in the magazine as required by Government of Yukon, Occupational Health & Safety (YT OH&S).

2.2.8 Mucking

One 4.6 m³ LHD and two 2.5 m³ LHDs will be able to meet production targets. The 4.6 m³ LHD will be used for primary development as well as fill placement. One 2.5 m³ LHD will be dedicated to production from the stopes and fill placement. The second 2.5 m³ LHD will be used for mineralized and waste rock mucking and fill placement when the other LHDs are unavailable. A 1 m³ LHD will be used where mechanized mucking in narrow veins is needed.

2.2.9 Electrical Power Requirements

At the present time, the Keno Hill district obtains electrical power from a hydroelectric plant near Mayo. In the past, this facility had sufficient capacity to supply electricity to the mill and all of the various mines. However, after the closure of UKHM, Yukon Energy Corp. (YEC) built a transmission line from Mayo to Dawson City and now the hydroelectric plant has only one megawatt surplus. It is estimated that although possibly enough for the first two years of operation, one megawatt will not be enough electrical power to support the final throughput (400 tonnes per day) at years 3,4, and 5.

The following are the estimated annual electrical power requirements for the Bellekeno project:

Year 1-2

Mill 600 kw (5,256 MWh/yr)

Mine 750 kw (6,570 MWh/yr)

Camp/Admin/Water treatment sites 250 kw (2,190 MWh/yr)

Total 1600 kw (14,020 MWh/yr)

Year 3-5

Mill 1200 kw (10,512 MWh/yr)

Mine 750 kw (6,570 MWh/yr)

Camp/Admin/Water treatment sites 250 kw (2,190 MWh/yr)

Total 2200 kw (19,270 MWh/yr)

YEC has recently completed extension of the southern hydroelectric grid from Carmacks to Pelly Crossing (106 kilometres) and to Capstone Copper's Minto Mine. This extension has put Pelly Crossing and the Minto Mine on the main power grid connected to Whitehorse. A further extension from Pelly Crossing to Stewart Crossing would only be 72 km at which point a connection to the Mayo to Dawson City transmission line could be made, tying Elsa and Keno City into the main Yukon grid. The extension of the Pelly Crossing to Stewart Crossing transmission line has already undergone environmental assessment and has recently been announced by the Government of Yukon as a project for infrastructure development.

Therefore once the planned interconnect of the northern and southern grids has been completed by YEC, hydro grid power will be used in years 3-5 to supplement the need for additional power. Alexco has entered into negotiations towards a Power Purchase Agreement (PPA) with YEC.

Currently the power for Bellekeno is stepped down at Onek Substation from 69KV to 6.9KV; the capacity of this substation is 999 KVA. The power then travels over aerial lines to the Bellekeno substation at 6.9KV. The Bellekeno Substation consists of two banks of transformers. One bank of transformers steps the voltage from 6.9KV to 2.3KV, the capacity of this bank is 450 KVA. The other bank of transformers steps the

power from 6.9 KV to 600V the capacity of this bank is 600 KVA. The capacity of the Bellekeno Substation is limited by the capacity of the Onek Substation at 999KVA.

The 600V side of the Bellekeno Substation is routed over aerial lines to the generation shed. This allows the generators to power the 600 V side in the event of a power outage. From the generation shed power flows towards the portal for distribution. Total available power is approximately 600 KW on this circuit. The 2300V side of the Bellekeno Substation is routed into a trailer mounted disconnect for line protection and then proceeds underground where it is connected to step down transformers/switchgear to be distributed at lower voltage underground. Total available power is approximately 450KW on this circuit.

Alexco owns several substations in the district, including the Elsa Substation, the Onek Substation, and the Bellekeno 625 Portal Substation. It also owns the transmission line connecting the latter two. All substations, especially the Onek Substation, will undergo thorough inspections and assessments before any substantial use is made of them, with replacement parts and modernization undertaken as required.

The entire line between the Onek substation and the Bellekeno 625 Portal substation was replaced in late 2008 to bring up to modern safety and operational requirements.

Diesel powered generators will be used as a source of back up power at the BK East Portal and the new underground workings until the road is completed to the Bellekeno 625 Portal.

There is diesel generation at Elsa capable of backup power generation consisting of:

- 1 ea. 400 kW, 500 kW and 600 kW in 2-1940 vintage Rustons generators and a 500kW Caterpillar genset.
- In addition there are three smaller gensets 2-350 kW, 1-325 kW and 1-250 kW.

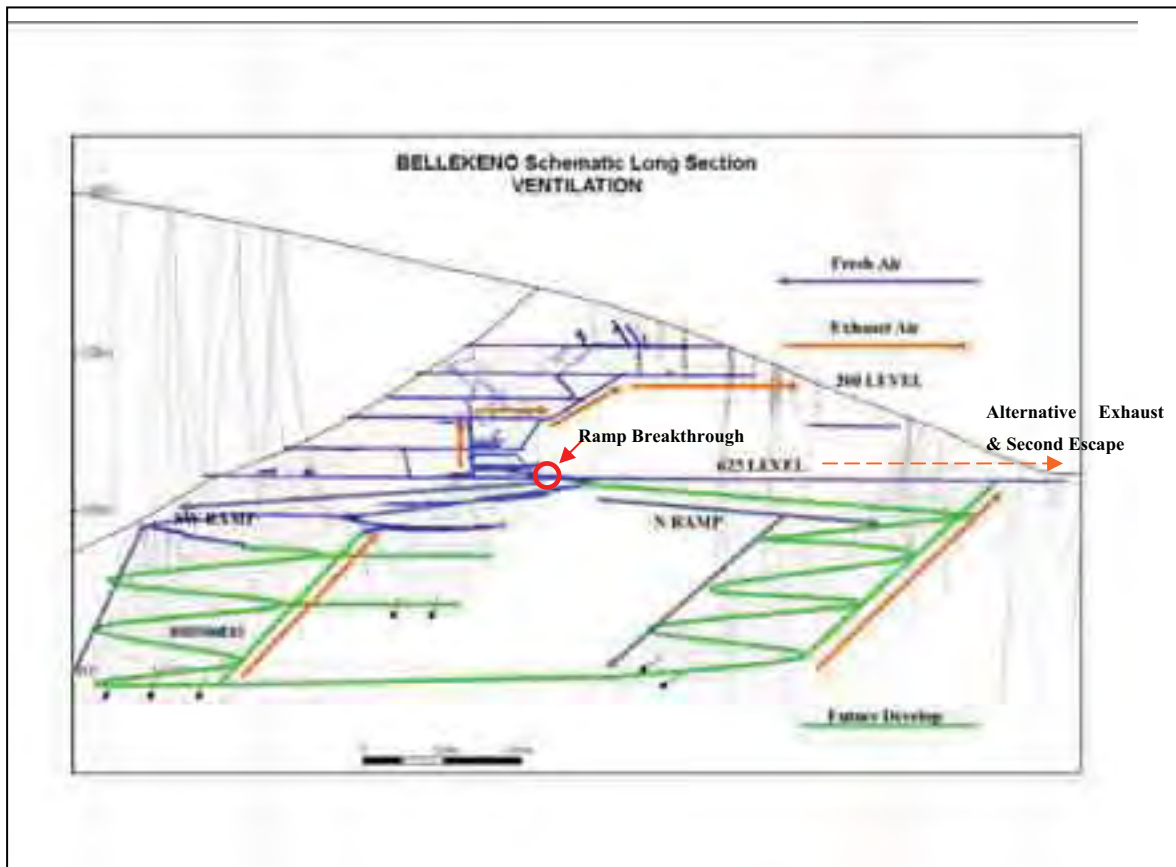
2.2.10 Ventilation

Initially ventilation will be in-cast (forced) into the new Bellekeno East portal via a 75 - 100 hp fan. With breakthrough into the 625 level complete, air will be routed down the 99, SW and BK north declines. As new development advances below the existing declines, exhaust ventilation / secondary escape raises will connect the decline to the 625 level. From the 625 level exhaust will either be routed up through the 99 raises and eventually exhaust out the 200 level or out the Bellekeno 625 portal. The Bellekeno 200 portal and tunnel may have to be rehabilitated for ventilation flows. If the historic Bellekeno ventilation system has not been compromised since closure an exhaust fan may be installed to enhance overall mine ventilation.

Secondary ingress / egress will be maintained via the original 625 level tracked drift and portal. The exhaust raises in the 99, SW and North Ramp will also serve the dual purpose of exhaust and secondary escape way. The raise(s) will be inclined at $<60^{\circ}$ and equipped with steel ladders and cage. Located in the ramps at approximately 500 m intervals will be refuge chambers equipped with mine page phones, plumbed air and water, potable water, cylinder air, sealant, first aid and CO₂ purge valve.

Figure 2-7 presents a ventilation schematic for the Bellekeno underground workings.

Figure 2-7 Ventilation Schematic for the Bellekeno Underground Workings



2.2.11 Mine Site Communications

Telephone communications at Elsa are via NorthwesTel "land" line. The system connects Elsa to a microwave station at the top of Galena Hill. Two lines are available on this system. VOIP (Voice Over Internet Protocol) is available in Elsa. This system is reasonably portable and can be moved to locations that have power and a good "view" of the southern sky. It is possible that a VOIP system will operate at Bellekeno, but this has not been confirmed.

A satellite telephone is available for emergency communications. This system is unreliable in northern latitudes and mountainous terrain. FM radio communications are fair in the Keno Hill District. The FM facilities have been upgraded to include two repeaters which will allow a more consistent radio link between Elsa and Bellekeno and

other parts of the district. Internet is available via the voice over internet protocol (VOIP) system. Reasonable quality internet service is available at Elsa, and if VOIP service is established at the Bellekeno Mine, both phone and internet will be available at the mine site.

2.2.12 Transportation and Shipping

Given the relatively good road network, transportation of goods and personnel is relatively straight forward, however, there are few transportation contractors operating between Whitehorse to Elsa.

All personnel working on the Keno Hill Project are on various rotation schedules. Schedules will be standardized as necessary to coordinate efficient rotations and transportation. Currently, personnel living in Whitehorse (and southern Yukon) and out-of-Territory are flown via charter aircraft between Whitehorse and Mayo every fifth day. These flights, (approximately 70 minutes one-way), are scheduled to meet in-coming/out-going commercial flights to Whitehorse. The rotating crews then drive company vehicles to/from Elsa (45 minutes one-way). During the winter and inclement weather, rotating crews drive between Elsa and Whitehorse (approximately 5 hours one way).

Currently, personnel transportation between Mayo and Elsa is being provided by contract to the Nä cho N'yak Dun Development Corporation (NNDDC). Initially, it is envisioned that NNDDC will utilize a 24-passenger bus to transport local workers between Mayo and Elsa. This service will expand to meeting charter aircraft and possibly beyond.

Although many freight lines operate through Whitehorse, only one provides scheduled freight service to Mayo. During the summer months, this is a daily service, but during the winter, service is limited to packages with heavy items delivered on a fortnightly schedule. Blindheim Trucking offers “on-request” freight service, and is used quite regularly to haul “less-than-truckload” and full loads between Elsa and Vancouver and

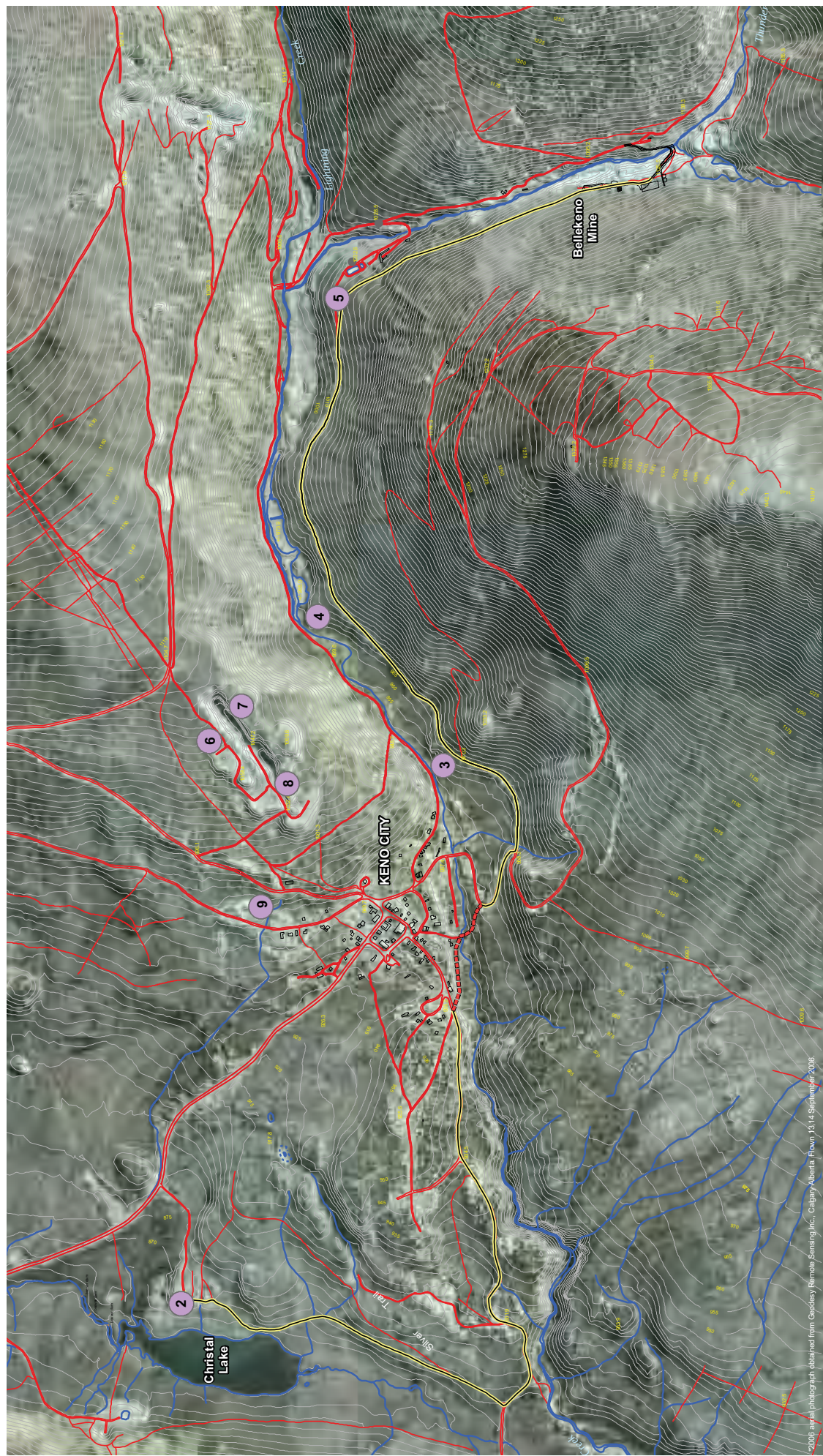
elsewhere. Alexco's expeditor brings freight from Whitehorse to Elsa twice a week and hauls core samples and other freight from Elsa to Whitehorse.

2.2.13 Milling

Initially, Alexco considered nine possible locations for the mill (See Figure 2-8), and undertook an in house preliminary engineering review to rank these nine sites. This exercise narrowed the choices to three possible locations, which were then subjected to a more detailed engineering trade-off study conducted by Wardrop.

The first nine potential mill site alternatives were as follows:

1. Elsa – various;
2. Crystal Lake (Mackeno);
3. Bellekeno Power Line Road 1;
4. Bellekeno Power Line Road 2;
5. Thunder Gulch (BK 625);
6. Onek NE;
7. Onek SE;
8. Onek Pit;
9. Onek 400 adit site; and
10. Thunder Gulch (BK 625) mill site + tailings to Onek.



Legend

-----	Keno City Bypass	-----	Road
---	Adit	-----	Contour
---	Haul Road	---	Surface Water

Scale

1:11,992
(when plotted on 11x17 inch sheet)

0 100 200 400 600 800 m

North Arrow

N

ALTA

ALTA CONSULTING

ALTA

ALTA CONSULTING

ALTA
WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ MINING LICENCE APPLICATION REQUEST
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT

Drawn By: HD & JN
Checked By: RM

DATE: 2/27/2009

FIGURE 2-3

Mitigation Alternatives

These sites were ranked based on the following engineering, economic and environmental and socioeconomic criteria:

- proximity to hydro power;
- haul distance from mine to portal (haul costs);
- location suitability for future mines;
- community/NNDFN impact;
- environmental impact/footprint;
- dry stack tailings location suitability;
- availability of reliable water source; and
- geotechnical suitability / site preparation required.

Three sites were deemed best rated in the above criteria: Onek (pit), Thunder Gulch (Bellekeno 625), and Christal Lake (Mackeno).

These three were then subjected to geotechnical evaluation for site stability and geotechnical ground conditions (see Appendix I in Volume 2). In conjunction with this geotechnical assessment, Wardrop completed a detailed mill site alternative trade off study. Their recommendation, accepted by Alexco, was the Christal Lake Site.

2.2.14 Mackeno Mill Site History

The Christal Lake site was once previously the site of a small custom mill, built in a joint venture between Mackeno Mines Ltd. Yukeno Mines Ltd and Bibis Yukon, and operated between 1953 and 1957 (Aho, 2006). The mill was actually known as the Yukeno Custom Mill (Debicki, 1983), although Yukeno Mines Ltd. suspended its operations in July, 1953. Over 122,000 tons of ore were milled at the Mackeno (Yukeno) Mill site with over 10,000 tons of this produced from the upper levels of the Bellekeno Mine and the remainder from Galkeno (McLeod vein). See Table 2-6 below for detailed record of milling and production at the Mackeno Mill. Mackeno Mines Ltd. changed its name to Galkeno Mines Ltd in 1956 but was forced to suspend its operations in September 1957 due to unfavourable metal prices. In 1958, UKHM purchased the assets of Galkeno Mines, Ltd, and began to incorporate workings on the Galkeno property into its mining developments on adjacent properties.

Table 2-6 Historical Production from the Mackeno (Yukeno) Mill, 1953-1957

Galkeno Production								
Year	Ore (tons)	Ag-Pb Con. (tons)	Zn-Cd Con. (tons)	Ag (oz)	Pb (lbs)	Zn (lbs)	Cd (lbs)	Au (Oz)
1953	32,816	3,501	812	803,880	4,572,000	1,274,000	10,192	
1954	22,527	3,527	1,632	986,848	4,501,674	2,037,096	7,714	71
1955	5,567	662	496	11,758	839,458	112,753	8,065	24
1956	34,146	6,146		1,143,853	4,996,588	4,746,020	48,565	49
1957	17,679	1,983		590,047	2,300,904	2,540,844	9,205	
Total	112,735	15,819	2,940	3,536,386	17,210,624	10,710,713	83,741	144
Bellekeno Production								
1953	6,020	814.67		304,509	1,490,420			
1954	4,062	565		171,352	507,338			
1955								
1956								
1957								
Total	10,082	1,379		475,861	1,997,758			
Total Ore Milled at the Mackeno (Yukeno) Custom Mill								
	122,817	17,199	2,940	4,012,247	19,208,382	10,710,713	83,741	144

2.2.15 Mill Infrastructure

An assessment of the opportunity to reuse the existing mill facilities near the town of Elsa indicated that the majority of existing buildings at the existing Elsa Mill Site displayed signs of settlement and deformation with excessive wear due to weathering and, in some cases, collapse of structural components. These buildings are considered unsalvageable and will be dealt with during Closure Planning of the entire site. District wide closure planning for the Keno Hill Silver District is being undertaken separately from this initiative and is therefore not covered in this document. Four buildings identified at Elsa to be potentially salvaged or utilized are as follows: Thaw shed; refining furnace building; warehouse/truck shop; and administration building (old curling rink).

The administration building is currently being used and requires no further upgrade for continued use. Upgrades and maintenance are required to bring the other buildings to up-to-date operational conditions. The warehouse/truck shop and administration building will be used as support for the Bellekeno mine and mill operation.

2.2.16 Mineralogical Processing

Test results indicate that the mineralization of the Bellekeno deposit responds well to a lead and zinc differential flotation process using a cyanide-free zinc mineral suppression regime. Silver minerals are intimately associated with lead minerals and will be recovered as a silver-lead concentrate. A separate zinc concentrate will also be produced from the Bellekeno operation.

The design capacity of the process plant will be 408 tonnes per day (“t/d”). Overall plant availability is estimated to be 92%. Run-of-mine (ROM) material from different mineralized zones is planned to be processed by conventional crushing, grinding, and flotation followed by concentrate dewatering.

Metallurgical testwork has been completed by SGS Lakefield in 2007 and by Process Research Associates (“PRA”) in 1996 and 2008 (PRA, 2009). Table 2-7 shows the assumed metallurgical recoveries used in this report.

Table 2-7 Summary of Metallurgical Recoveries

Mineralization Zone	Product	Grade				Recovery			
		Ag (g/t)	Pb (%)	Zn (%)	Au (g/t)	Ag (%)	Pb (%)	Zn (%)	Au (%)
99 and Southwest Zones	Pb/Ag Conc	4,782	72.0	1.5	0.6	87.1	96.5	6.9	50.0
	Zn Conc	1,159	2.6	52.0	0.5	8.0	1.3	90.2	17.0
	Tailing	87	0.5	0.2	0.1	4.9	2.2	2.9	33.0
	Feed	1,221	16.6	4.9	0.3	100.0	100.0	100.0	100.0
East Zone	Pb/Ag Conc	7,021	60.0	6.0	10.5	72.2	80.0	0.8	41.5
	Zn Conc	60	0.4	55.0	0.3	8.5	7.4	96.0	18.1
	Tailing	69	0.3	1.0	0.4	19.3	12.6	3.2	40.4
	Feed	232	1.8	19.0	0.6	100.0	100.0	100.0	100.0

2.2.17 Design Criteria

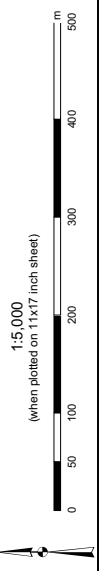
The design criteria used for the mill design are based on an average process rate of 408 t/d or 149,000 t/y. The key design criteria are shown in Table 2-8. Although the mill will operate at 250 tpd for years 1-2, the initial construction will include equipment sized for the full 400 tpd.

Figure 2-9 shows the proposed mill site location along with the DSTF and ancillary facilities. Figure 2-10 presents the current mill building configuration design. This configuration will continue to be optimized as detailed engineering progresses.



2008 aerial photograph obtained from Geodesy Remote Sensing Inc. on 14 September 2009.

Legend



- Adit
- Potential Mill Fresh Water Makeup
- Existing Rehabilitated Haul Road
- Public Road
- Exploration roads
- Contour



ALEXCO
WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ MINING LICENCE APPLICATION REQUEST
BENNETT MINE
KENO HILL SILVER DISTRICT
MILL SITE LOCATION
Drawn By: HD & JN
Checked by: RM
DATE: 3/2/2009
FIGURE 2-9

Table 2-8 Process Design Criteria

Description	Unit	Value	Source
Type Of Deposit	Silver/Lead/Zinc sulphide mineralization		
Ore Characteristics			
Specific Gravity	g/cm³	3.46	6
Bulk Density	t/m³	1.6	TBD
Moisture Content	%	5.0	1
Abrasion Index (Average)	g	0.046	6
Operating Schedule			
Crusher Plant			
Shift/Day		1	1
Hours/Shift	h	12	1
Hours/Day	h	12	1
Grinding and Flotation Plant			
Shift(s)/Day		2	1
Hours/Shift	h	12	1
Hours/Day	h	24	1
Days/Year	day	365	1
Plant Availability/Utilization			
Overall Plant Feed	t/a	149,000	3
Overall Plant Feed	t/d	408	1
Crusher Plant Availability	%	80.0	1
Grinding and Flotation Plant Availability	%	92.0	1
Crushing Process Rate	t/h	63.8	3
Grinding/Flotation Process Rate	t/h	18.5	3
Head Grades (LOM)	% Pb	11.60	1
	% Zn	9.60	1
	g/t Au	0.30	1
	g/t Ag	890	1
Recovery (LOM)	% Pb	95.6	6
	% Zn	94.0	6
Recovery (LOM) including in Pb & Zn concentrates	% Au	63.0	6
Recovery (LOM) including in Pb & Zn concentrates	% Ag	93.8	6
Silver-Lead Concentrate Grade (LOM)	% Pb	71.4	6
	% Zn	1.7	6
	g/t Au	1.0	6
	g/t Ag	4,442	6
Zinc Concentrate Grade (LOM)	% Pb	1.1	6
	% Zn	54.0	6
	g/t Au	0.4	6
	g/t Ag	390	6
Silver-Lead Concentrate Mass Recovery (LOM)	%	15.53	3
Silver-Lead Concentrate Production (LOM)	t/a	23,143	3
Zinc Concentrate Mass Recovery (LOM)	%	16.71	3
Zinc Concentrate Production (LOM)	t/a	24,900	3
Source Legend: 1 = Client, 2 = Industry, 3 = Calculation, 4 = Mass Balance 5 = Rescan, 6 =			

2.2.18 Mill Process Description

The proposed process will employ conventional crushing, grinding, flotation, and dewatering processes. Main valuable sulphides in the mill feed will be recovered by conventional differential flotation with a cyanide-free zinc suppressing regime. Silver and lead minerals will be recovered together to produce a silver-lead bulk concentrate and zinc minerals will be recovered to a separate zinc concentrate.

The final tailings from the zinc flotation circuit will be further floated to remove any pyrite before being dewatered and backfilled in the underground mine. The pyrite concentrate will be hauled to the Bellekeno mine and used as backfill below the static water level in the mine. This removes a source of potential environmental contaminant from the Dry Stack Tailings Facility and places the material in a stable, secure location. The process flow sheet will include the following main unit operations:

- A mobile crushing unit consisting of a jaw crusher, cone crusher, and screen;
- Primary grinding circuit;
- Silver-lead flotation and concentrate regrinding circuit;
- Zinc flotation circuit;
- Pyrite flotation unit;
- Concentrate dewatering circuit; and
- Tailings dewatering and storage including underground backfill or dry stacking storage.

The Bellekeno project simplified process flowsheet is presented in Figure 2-11. The basic elements of the process are as follows:

2.2.18.1 Crushing and Screening

ROM mill feed will be delivered by haul trucks from the mine site and dumped directly into a mobile crushing unit or ROM stockpile. This crushing unit will consist of one jaw crusher, one cone crusher, and one vibrating screen in a closed circuit. The crushed material (-13 mm) will be conveyed to a fine mill feed storage stockpile with 500 tonnes live capacity. The crushed material from the fine mill feed stockpile will be withdrawn through a vibrating feeder onto a ball mill feed conveyor.

2.2.18.2 Grinding Circuit

The crushed mill feed from the fine mill feed bin will be conveyed to the primary grinding circuit at a rate of 18.5 tonnes per hour. The circuit will consist of a ball mill and hydrocyclones in a closed circuit. The grinding mill is a ball mill, 2,134 mm in diameter and 2,743 mm long, with an installed power of 186 kW.

The mill discharge will be pumped to classification hydrocyclones. The underflow of the cyclones with 70% solids will return to the ball mill. The overflow, with a particle size of 80% passing 174 µm, will gravity-flow to the flotation circuit.

2.2.18.3 Silver-Lead Flotation

The cyclone overflow from the primary grinding circuit will be further conditioned in an agitated tank with lime (to a pH of 8.5) and lead collectors (namely Aero 3418A and SIPX). The conditioned slurry will flow by gravity to the silver-lead rougher/scavenger flotation circuit consisting of six 8-m³ flotation cells. Silver-lead rougher concentrate and scavenger concentrate will be pumped to the silver-lead regrind circuit. Silver-lead rougher scavenger tailings will be pumped to the zinc flotation circuit.

Silver-lead bulk rougher concentrate and scavenger concentrate will be reground in a 112 kW regrind ball mill operating in a closed circuit with two 150-mm cyclones. Cyclone overflow will flow by gravity to the first lead cleaner flotation cells. The regrinding prior to cleaner flotation will further liberate silver and lead minerals from gangues and other sulphide minerals to improve product quality and metal recovery. The target regrind

particle size will be 80% passing 20 μm . Zinc sulphate will be added to the circuit to improve the rejection of zinc minerals in subsequent upgrading processes.

The final silver-lead concentrate from the third lead cleaner flotation will be pumped to the lead concentrate thickener for dewatering. The major equipment used in the lead flotation circuit will include the following:

- Six 8-m³ conventional flotation cells for rougher and scavenger flotation;
- Three 3-m³ conventional flotation cells for first cleaner flotation;
- Two 3-m³ conventional flotation cells for second and third cleaner flotation; and
- One 112-kW regrind ball mill.

2.2.18.4 Zinc Flotation

Prior to zinc flotation, lead flotation tailings will be conditioned with copper sulphate to activate depressed zinc minerals, and lime to suppress pyrite. The flotation will generate a zinc rougher concentrate in four 8-m³ flotation cells and subsequently rougher scavengers concentrate in one same size cell. SIPX will be used as zinc mineral collector.

The scavenger concentrate will return to the zinc circuit head conditioning tank while the scavenger flotation tailings will feed to the pyrite flotation circuit. The rougher flotation concentrate will be further upgraded by three stages of cleaner flotation in six 3-m³ conventional flotation cells. The first cleaner flotation tailings will be pumped back to the zinc circuit head conditioning tank. The second and third cleaner tailings will be recycled to the preceding cleaning stages. The third cleaner concentrate will be the final zinc concentrate, which will be dewatered prior to shipping. Zinc flotation reagents will include lime, copper sulphite, SIPX, and DF250.

2.2.18.5 Pyrite Flotation

The mill process flow sheet calls for a pyrite flotation circuit to be incorporated in the flow sheet. Zinc flotation tailings will be conditioned with sulphuric acid, followed by pyrite flotation with SIPX. The pyrite concentrate will be stored underground below the static water level in the mine by paste backfill together with a portion of the final tailings.

2.2.19 Concentrate Dewatering

The silver-lead concentrate will be pumped to a 3 m diameter high rate thickener. The underflow of the thickener will have a solid density of approximately 60%. A 23 m³ holding tank will hold the thickener underflow concentrate prior to dewatering to approximately 8% moisture by a pressure filter. The dewatered concentrate will discharge to the lead concentrate stockpile, which will have a storage capacity for 7 days of lead concentrate production.

Filtrate from the pressure filter will be pumped back to thickener feed as well as dilution water. The concentrate thickener overflow will be distributed to the lead flotation circuit as process water.

The zinc concentrate will be pumped to a 3 m diameter separate high rate thickener. The underflow of the thickener, with a solid density of 60%, will be further dewatered to approximately 8% moisture by a pressure filter. Prior to the filtration, a 23 m³ holding tank will retain the thickened concentrate in order to reduce potential interruption of filtration operation. The dewatered concentrate will be discharged onto the zinc concentrate stockpile, which will have a 7-day storage capacity.

2.2.20 Tailings and Pyrite Concentrate Dewatering and Handling

Final tailings will be thickened in a 5 m diameter high-rate thickener. Thickener underflow will be further dewatered by a pressure filter; filtrate will return to the tailings thickener feed well. Thickener overflow will be recycled as mill make-up water together with surface run-off water, mine water, and overflows from the two concentrate thickeners. The water in the polishing pond will be recycled back to the mill as makeup water.

Pyrite concentrate will be dewatered by a 1 m thickener and stored in a holding tank prior to further dewatering by a pressure filter, which will be used for final tailings filtration.

The dewatered pyrite flotation concentrate and a portion of the dewatered tailings will be trucked to the Bellekeno mine site and mixed with binder (cement) and water to generate backfill paste with approximately 77% solids. The paste backfill will be delivered to an underground pumping and distribution system for backfill of mined out stopes.

The rest of the dewatered tailings, with ~15% moisture, will be transported by trucks to the dry stack tailings storage facility located adjacent to the mill site.

The major equipment for tailings management includes:

- 5.0 m diameter tailings thickener;
- 1 m diameter pyrite concentrate thickener;
- Pressure filter;
- Cement silo with dust collector;
- Twin screw paste mixer; and
- Variable speed positive displacement paste pumps.

2.2.21 Paste Backfill Operations

One stream of low-pyrite and one stream of high-pyrite tailings will be produced at the mill. The low-pyrite and high-pyrite tailings will be pumped into the designated thickeners for dewatering to 58% solids. Both thickened tailings streams will then be pumped into stock tanks before being fed into the filter.

A disc filter will dewater both low-pyrite and high-pyrite tailings to approximately 85% solids on a batch basis, producing material for conventional dry stack tailings (low-pyrite tailings) and paste fill material (low-pyrite and high-pyrite tailings) for underground disposal. The amount of low-pyrite tailings is estimated to be 10.6 t/h at 85% solids, and the amount high-pyrite tailings is estimated to be 1.9 t/h at 85% solids.

The dewatered tailings will be discharged onto a conveyor belt, and into two separate stockpiles before being loaded onto a truck for surface deposition as dry stack or to the underground backfill plant. Only low-pyrite tailings (approximately 50% of the total tailings amount) will be deposited as dry stack. These tailings will be placed and compacted according to the surface deposition engineering specifications. All the high-pyrite tailings together with the remaining low-pyrite tailings will be deposited underground for use in paste backfill.

Cement (or binder) and water (for paste fill) will be added into the tailings at the prescribed dosing rate determined by the desired final fill strength.

2.2.22 Paste Fill

The constituents for paste fill are similar to those of cemented dry tailings. However, to ensure the paste fill can be pumped, water must be added to reach approximately 77% solids.

The dewatered tailings will be mixed with binder at the rate prescribed by the fill strength requirements. The paste fill will be composed of low- and high-pyrite tailings, water and binder. The paste fill plant will be strategically located allowing gravity to deliver paste to mine stopes. Pumping will be required beyond the gravity distribution zone, at an exact location yet to be determined.

Table 2-9 outlines the preliminary estimate of material for paste fill at variable binder addition.

Table 2-9 Paste Fill Preliminary Material Estimate at Variable Binder Content

Binder Addition		3%	4%	6%	
Paste Plant Operating Hours		22	22	22	
Pyrite Concentrate	Pyrite Conc. Parameters				
	Solid Tailings (per hour)	1.90	1.90	1.90	dry t/h
	Density of Solid Tailings	4.00	4.00	4.00	t/m ³
	Solid Tailings (Dry)	0.48	0.48	0.48	m ³ /h
	Percentage Solids of Tailings (Filtered)	85%	85%	85%	
	Water in Tailings	0.34	0.34	0.34	m ³ /h or t/h
	Tailings Pulp (Tonnage)	2.24	2.24	2.24	t/h
	Density of Tailings Pulp	2.76	2.76	2.76	
Final Tailings	Final Tailings Parameters				
	Solid Tailings (per hour)	5.3	5.3	5.3	dry t/h
	Density of Solid Tailings	3.80	3.80	3.80	t/m ³
	Solid Tailings (Dry)	1.39	1.39	1.39	m ³ /h
	Percentage Solids of Tailings (Filtered)	85%	85%	85%	
	Water in Tailings	0.94	0.94	0.94	m ³ /h or t/h
	Tailings Pulp (Tonnage)	6.24	6.24	6.24	t/h
Total Tailings	Total Tailings				
	Solid Tailings (per hour)	7.20	7.20	7.20	dry t/h
	Density of Solid Tailings	3.85	3.85	3.85	t/m ³
	Solid Tailings (Dry)	1.87	1.87	1.87	m ³ /h
	Percentage Solids of Tailings (Filtered)	85%	85%	85%	
	Water in Tailings	1.27	1.27	1.27	m ³ /h or t/h
	Tailings Pulp (Tonnage)	8.47	8.47	8.47	t/h
Cement (Binder) Parameters	Cement Parameters				
	Density of Cement	3.15	3.15	3.15	t/m ³
	Binder Addition Estimated	3%	4%	6%	
	Binder Consumption (t/h)	0.2	0.2	0.3	dry t/hr
	Binder Consumption per day (time to fill)	3.6	4.9	7.4	t/day
	Binder Consumption (vol./h)	0.05	0.07	0.11	m ³ /h
	Binder Consumption (vol./d)	1.14	1.54	2.36	m ³ /d
Pastefill Parameters	Pastefill Parameters				
	Solid of Pastefill (per hour)	7.4	7.4	7.5	dry t/h
	Density of Solid Pastefill	3.83	3.83	3.81	t/m ³
	Solid Tailings	1.92	1.94	1.98	m ³ /h
	Water in Pastefill	1.27	1.27	1.27	m ³ /h or t/h
	Percentage Solids of Pastefill	77%	77%	77%	Target Percentage
	Water Addition to yield Target Solids Density	0.93	0.95	0.98	m ³ /h or t/h
	Pastefill (Pulp Tonnage)	9.73	9.86	10.13	t/hr
	Pastefill density (Pulp)	2.67	2.68	2.70	
	Pastefill (vol./h)	3.65	3.68	3.75	

2.2.23 Reagent Handling and Storage

All the reagents will be prepared in a separate reagent preparation and storage facility in a containment area inside the mill building. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during normal operation. Appropriate ventilation and fire and safety protection will be provided at the facility.

All solid reagents such as copper sulphate, zinc sulphate, sodium sulphite, and SIPX will be dissolved, mixed, and diluted prior to being transferred into separate holding tanks from where the reagents will be distributed to various addition points.

Lime will be stored in a dedicated silo. It will be retrieved from the silo by a screw conveyor and mixed with water to produce a lime slurry. The slurry will be stored in a 3 m diameter by 3.5 m high agitated tank and distributed to addition points via a pressurized lime loop. Alternative, lime solution may be transported from the Elsa mixing facility and delivered into the lime solution storage tank.

Liquid collectors and frother will be stored in separate holding tanks prior to being pumped in undiluted form to various addition points. Anti-scale chemicals may be required to minimize scale build-up in the reclaim or recycle water lines. This reagent will be delivered in liquid form and metered directly into the reclaim water tank.

Please see Material Safety Data Sheets (MSDS), presented as Appendix F in Volume 2, for detailed toxicological as well as human health and safety considerations for all proposed mill reagents. Emergency response planning and medical considerations are presented in Section 2.6, *Human Health & Safety*.

2.3 ANCILLARY FACILITIES

2.3.1 Water Supply and Distribution

Domestic water for the Elsa camp is currently pumped from a cistern buried in Flat Creek via insulated-heat traced pipeline to a water treatment facility about 100 meters to the north. The treatment plant consists of 5,000 litres of storage, a water softener, UV treatment and chlorination. Monthly samples are submitted for analyses for bacteriological parameters and tested periodically for other chemical constituents. The camp water use is permitted under Water Use Licence QZ07-078.

Alexco has two sewer permits at Elsa; one for the Flat Creek Camp and one for the four houses. Waste water is treated in septic tanks and released via drain fields. There is currently a permit to store sewage in holding tanks at the Administration Building. These tanks are periodically pumped and transported to the Mayo waste water treatment plant for disposal.

2.3.1.1 Fresh Water Supply System

Fresh water makeup for the mill will be supplied to a 10 m diameter by 10 m high storage tank. This water will come from one or more of five possible fresh water makeup sources including the the DSTF and mill pad runoff collection and treatment pond, Mackeno Creek, Christal Lake, groundwater wells, and Galkeno 900 treatment pond (see Figure 2-9 for locations). Fresh water will be used primarily for firewater for emergency use, gland water for mill pumps and lubrication system, and for general mill water supply. By design, the fresh water tank will be designed to provide sufficient firewater in an emergency. Potable water for mill employees will be delivered to the mill from the camp.

2.3.1.2 Process Water Supply System

Mill process water will consist primarily of reclaim water from the water polishing pond, fresh water makeup, and thickener overflow. The reclaimed water will be directed to a 7 m diameter by 7 m high process water storage tank, from where the water will be dispersed to the distribution lines in the process plant. Approximately 52.7 m³/h of water

will be necessary for the process operation including water from thickener overflow. The majority of this water is internal recycled water. See Section 6.1 on Water Management for mill water balance table and schematic (Table 6-5, Figure 6-3, respectively).

2.3.2 Assay Laboratory

A metallurgical & assay laboratory will conduct daily mine, mill and environmental quality control and optimize process performance. The assay laboratory will be equipped with necessary analytical instruments to provide all routine assays for the mine, the plant, and environmental monitoring. The main analytical tool will be an atomic absorption spectrophotometer (AAS). The metallurgical laboratory will undertake all basic test work to monitor metallurgical performance and to improve process flow sheet and efficiency. The laboratory will be equipped with laboratory crushers, ball mills, particle size analysis devices, flotation cells, filtering devices, balances, and pH metres.

2.3.3 Temporary Construction Facilities

A construction office complex supplied with temporary power, water supply, and sewage disposal will be used at the plant site to support construction for the project.

A construction lay down area, a contract aggregate screening plant, and a batch plant will be required. A suitable amount of aggregate material to supply construction is available from nearby sources; in particular, the Bardusan Placer Mine on Lightning Creek is a ready source of aggregates of various particle sizes.

2.4 HAUL ROADS

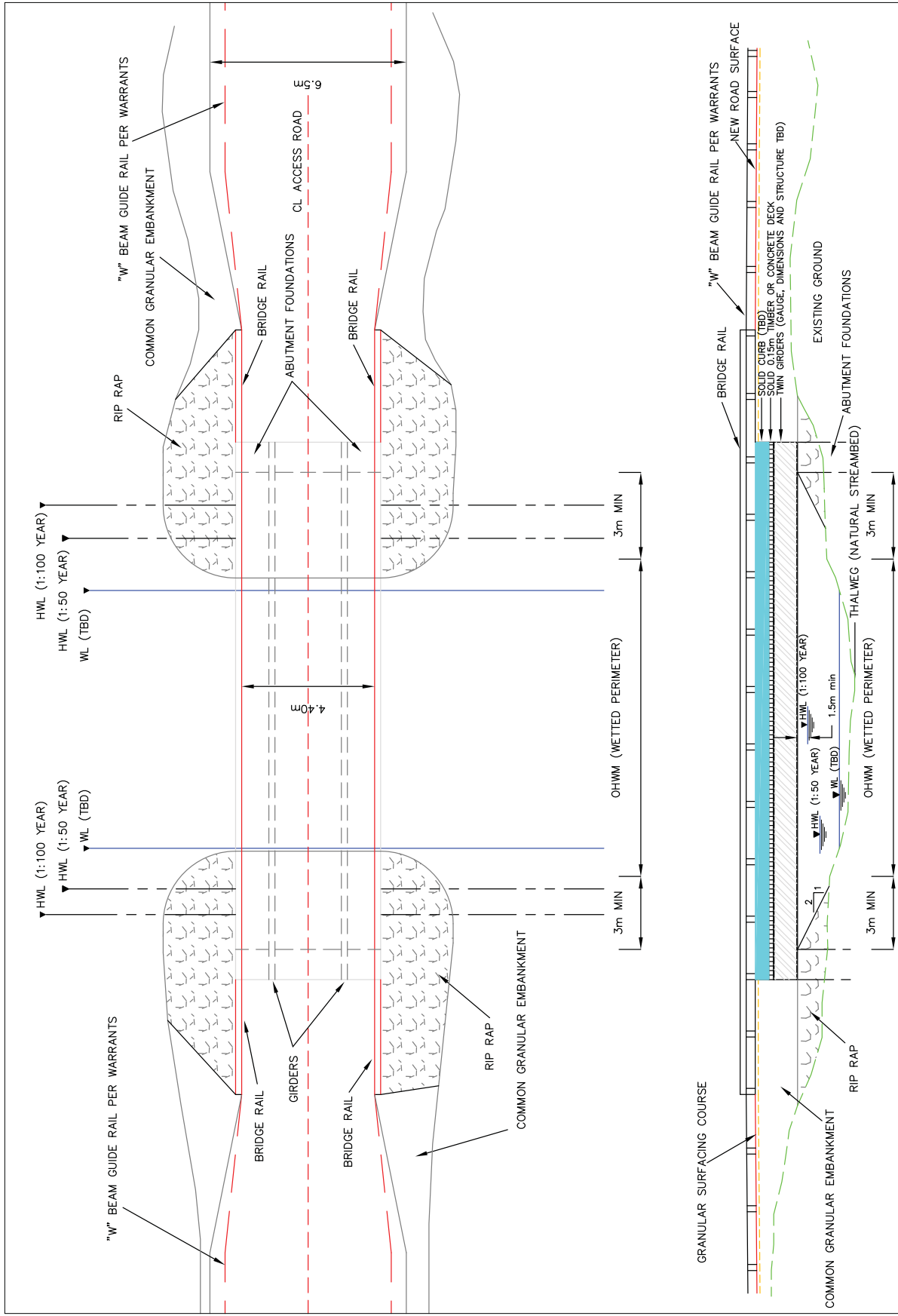
Figure 1-3 shows Haul Roads between the Bellekeno Mine and the mill site at Christal Lake. This road will be used to haul run of mine ore from the Bellekeno East Portal to the Christal Lake Mill for processing. Filtered tailings will be backhauled using this road for backfill underground.

The majority of this road is former haul road but will be upgraded and rehabilitated as needed. The haul road from the Bellekeno mine is along an existing haul road built along the power line to the mine. An existing haul road from the mill site to the Duncan

Creek road will be upgraded to enable truck traffic to bypass Keno City. As a result of consultation with Keno City (see Section 4.5, *Consultation*) Alexco plans to build a new segment of Haul Road (see inset on Figure 1-3) including a new bridge across Lightning Creek which will bypass Keno City. A title search on Lot 128 (through which the bypass goes) has revealed that it is crown land. Figure 2-12 provides the design details for the Lightning Creek Bridge. This mitigative measure was brought forward to address community concerns about haulage through town.

NOTES:

1. BRIDGE ELEVATION, LENGTH AND ABUTMENT POSITIONS TO BE DETERMINED BY CONTRIBUTING DRAINAGE AREA CALCULATIONS TO A 1:100 YEAR FLOOD EVENT. GOVERNING CRITERIA FOR THE HEIGHT OF THE BOTTOM OF THE BRIDGE GIRDERS (THE LOWEST OBSTACLE OVER THE STREAM) WAS PROVIDED BY TRANSPORT CANADA. MARINE SAFETY WHO REQUIRES THAT THIS ELEVATION BE AT LEAST 1.5m ABOVE THE 1:100 YEAR FLOOD EVENT ELEVATION. (TBD)
2. RIP RAP GRADATION TO BE CONFIRMED SUBJECT TO MAXIMUM STREAM VELOCITY CALCULATIONS AT A 1:100 YEAR FLOOD EVENT. STREAM VELOCITY BASED ON AVAILABLE INFORMATION ANTICIPATED AT 1.5 TO 2.5 m/s.
3. ABUTMENT TYPE AND FOUNDATION DESIGN TO BE DETERMINED SUBJECT TO GEOTECHNICAL INVESTIGATIONS AND RECOMMENDATIONS.
4. SILT FENCING TO BE EMPLOYED DURING INSTALLATION AS REQUIRED.
5. NO MACHINE CLEARING TO BE EMPLOYED WITHIN 30m OF THE WETTED PERIMETER (OHWM).
6. DETAILED DESIGNS WILL BE SEALED BY A PROFESSIONAL ENGINEER REGISTERED IN THE YUKON, AND SUBMITTED TO THE APPROPRIATE AGENCIES PRIOR TO CONSTRUCTION.



LIGHTNING CREEK
ALL WEATHER ACCESS ROAD
TYPICAL BRIDGE CROSSING

2.5 PERSONNEL REQUIREMENTS & ACCOMMODATION

Alexco owns two trailer camps at Flat Creek, located approximately one kilometer southwest of Elsa (see Figure 1-2). The 36 person trailer camp was approved under MLU Approval LQ00186, and an additional 41 person trailer camp unit was added under MLU Approval LQ00240. Water use and waste water disposal is Licence QZ07-078 and approved YG Environmental Health septic system. The trailer camp facilities have individual rooms, washroom facilities, laundry rooms and a TV-recreation room.

A kitchen/dining facility is also located at the Flat Creek camp. The kitchen and storage are equipped to feed approximately 20% more than are planned to utilize the facility. The dining facility will seat approximately 35 persons at one time.

Four five-bedroom houses located in Elsa were remodeled in 2007. These houses are used for senior personnel and more permanent staff. Each house is equipped with full kitchens and laundry facilities; however, persons living in these houses generally eat at the Flat Creek kitchen. A total of 20 persons can be comfortably accommodated in these houses, while maximum occupancy is about 28.

A small fitness/health center which features weights and fitness equipment has been set up during summer months at the old Elsa fire hall. During the winter, the equipment has been moved to the main geology/administration building.

The current total housing capacity including the Flat Creek trailer camps and the houses at Elsa is approximately 105. Currently, the number of personnel working on advanced underground exploration has increased to approximately 90.

2.5.1 Labour Requirements during Mine Operation

Table 2-10 outlines the anticipated mine and mill operations group required to staff a single shift. A minimum of three crews are required if a 4 weeks in, 2 weeks out rotation is used. In addition there will be up to 24 people associated with managerial and technical duties for the mining operation as indicated in the Table 2-11.

Table 2-10 Bellekeno Mine Labour Requirements

Department/Job	Year				
	1	2	3	4	5
Development					
Development Crew including Stope Accesses	9	9	9	9	9
Longhole Drill & Blast Crew	-	-	-	-	-
Waste Truck Drivers	-	-	-	-	-
Construction Crew	3	3	3	3	3
Subtotal Labour – Development	12	12	12	12	12
Backfill					
Stope Prep Crew	3	3	4	4	4
Pump Crew	3	3	3	3	3
Subtotal Labour – Backfill	6	6	7	7	7
Production					
Stope Crew	9	12	12	12	12
Scram Level Loader Operators	-	-	-	-	-
Haulage Level Loader Operators	-	-	-	-	-
Ore / Waste Truck Drivers	3	3	3	3	3
Service Crew	3	3	3	3	3
Mill Operators	6	6	6	6	6
Subtotal Labour – Production	21	24	24	24	24
Maintenance					
Fixed Plant Mechanics	3	3	3	3	3
Mobile Mechanics	6	6	6	6	6
Electricians & Instrumentations	3	3	3	3	3
Mill Maintenance	3	3	3	3	3
Subtotal Labour – Maintenance	15	15	15	15	15
TOTAL LABOUR	54	57	58	58	58

Table 2-11 Management and Technical Staff

Department/Job	Year				
	1	2	3	4	5
Mine Management					
Mine Manager	1	1	1	1	1
Mine Tech / Recorder	1	1	1	1	1
Mine Superintendent - Production	1	1	1	1	1
Mine Shift Supervisors	3	3	3	3	3
Mill Management and Supervisors	5	5	5	5	5
Safety and Training Superintendent	1	1	2	1	1
Maintenance Management					
Maintenance Superintendent / Foreman	5	5	5	5	5
Maintenance Administration Officer	-	-	-	-	-
Maintenance Planner – Electro-mechanical	2	2	2	2	2
Maintenance Supervisor	3	3	3	3	3
Technical Services					
Chief Mine Engineer	1	1	1	1	1
Senior Mining Engineer	-	-	-	-	-
Mining Engineer	2	2	2	2	2
Surveyor	2	2	2	2	2
Geotechnical Engineer	-	-	-	-	-
Senior Geologist	1	1	1	1	1
Geologist	2	2	2	2	2
Mine Technicians	2	2	2	2	2
Total - Mine Management & Technical	32	32	33	32	32

In addition to the personnel required to operate the mine and mill (Tables 2-9 and 2-10 above), up to 50 people will be employed over a 6 to 8 month period during mill construction. Also, a continued district wide exploration program, care and maintenance operations, and additional support staff will need accommodation at the Flat Creek Camp. This requirement is estimated at approximately 135 employees. During construction, up to 200 personnel may require housing. To meet these needs, Alexco plans to add one or more additional trailer camp units at the Flat Creek camp to bring the

camp capacity to approximately 150 rooms. Other more temporary camps may be set up if additional housing is required for the 6-8 month construction period.

The existing authorized commercial dump (No. 81-012) and incinerator (Air Emission Permit No. 4201-60-026) are capable of supporting the camp expansion. Special wastes are also authorized to be generated and stored under Permit No. 41-199. The existing septic system at the Flat Creek camp will need to be expanded when the camp is expanded. See Section 6.1.8 of the Water Management Plan for additional details.

2.6 HUMAN HEALTH & SAFETY

A Nursing Station is located in Mayo, approximately 68 kilometers from the Bellekeno Mine. This facility is staffed by two full-time nurses and an occasional physician / specialist. There is an ambulance at the Nursing Station, which is staffed by volunteers. All serious accidents/illness are stabilized in Mayo, and then taken by Air Ambulance to Whitehorse for further treatment.

At the present time, Alexco provides 24 hour per day first aid coverage. Alexco owns two ambulances; one that is stationed at Elsa, with another ambulance stationed at the Bellekeno 625 Portal. This ambulance is staffed by the first aid attendants and driven by Alexco employee volunteers. In event of an injury, patients would be stabilized, and then transported to Mayo in Alexco's ambulance. For serious accidents/illnesses, dispatch of the ambulances are coordinated so that there is a transfer from the Alexco ambulance to the Mayo ambulance (if available) about halfway between Mayo and Elsa.

The purpose of the Emergency Response Plan provided in Appendix G in Volume 2 is to minimize effects of environmental disturbances and the resultant hazard to people, aquatic systems, and wildlife. In addition the Emergency Response Plan outlines response protocols for spills of potentially hazardous substances that may be used during exploration and development activities. Spill response kits will be stationed at Bellekeno 625, Bellekeno East, and the Christal Lake Mill site.

2.6.1 Mine Safety

All personnel and Contractors will meet the standards outlined in the OH&S Legislation, Mine Safety Rules, and Regulations of the YG Worker's Compensation Board.

Alexco has in place a formal health and safety program for achieving and maintaining a healthy and safe workplace. The Elsa mine site will have emergency first aid responders providing 24-hour service. There is a first aid room and ambulance on the site.

Procon is presently the contracted company working the underground site, currently employing approximately 25 people. Each shift includes approximately 11 tradesmen consisting of miners, labourers, mechanics, electricians the supervisor and safety person on dayshift and on-call for night shift. OH&S regulations require that a first aid responder and emergency vehicle also be on site. The safety officer on site will also serve as the first aid responder. Communication and support between the mine contractor and Alexco safety and first aid personnel is necessary and is promoted.

OH&S legislation requires all underground employees have medical examinations within a short time of starting their employment and to have check-ups at consistent and regular intervals thereafter dependent upon the hazards they are exposed to. All employees will be fully equipped with the proper personal protective equipment standard for working underground, taking into consideration hazards caused by noise level, airborne particulates and confined work space.

All new employees will have an orientation at the Elsa mine site and another orientation of the underground work site. Regular safety meetings with supervisors, safety officer and employees are mandated. Any changes in procedures, equipment, or hazards require immediate notification to employees.

Underground contractors, Alexco personnel and others will have to comply with the YG OH&S regulations in addition to Alexco and contractors in-house standards.

A Safety Coordinator/Officer specific for the underground operation will ensure all workers are oriented to all aspects of the work site including hazard identification, protective equipment requirements, that medical and health requirements are followed according to legislation. The Safety Coordinator/Officer position is also charged with ensuring continued training and skill development for all personnel.

3.0 ENVIRONMENTAL BASELINE

3.1 GENERAL

Existing environmental data collected and submitted as part of the environmental assessment and permitting process for the UKHM 1996 Type A Water Licence Application, as well as ERDC's care and maintenance Water Licence QZ06-074, have been brought forward to support Alexco's environmental assessment and permitting for mine development and production activities at Bellekeno. On October 3rd 2008, Alexco received Water Licence QZ07-078 for the purpose of underground exploration. There has not been a sufficient amount of time to collect data under Water Licence QZ07-078 to be used in this application.

The regional setting descriptions are not intended to provide baseline environmental conditions for the area prior to mining as the area has undergone nearly a century of mining activities. The collection of data to describe baseline environmental conditions was not a consideration during early mining development; as such, very little baseline data has been documented.

It should also be recognized that over the course of time the local ecosystem has changed, and in some areas adjusted or even adapted to reflect current mining activities in the area. This has complicated the establishment of "baseline" conditions necessary to measure and assess the impacts that have occurred. The regional setting for the area is therefore based on the environmental conditions as reported in 1996, with updated data provided where possible.

3.2 OVERVIEW

Table 3-1 summarizes existing environmental conditions in the Keno Hill project area. The information was compiled from various published and unpublished reports. This table is not intended to provide a thorough reflection of the environmental setting of the project area, but rather a succinct overview of the key environmental parameters. A detailed description of the environmental conditions in the Keno Hill Silver District was compiled and presented as part of the environmental assessment and licensing process

associated with the UKHM 1996 Water Licence application including the *Site Characterization Report* (Access Mining Consultants Ltd., 1996). The following sections summarize the information presented in the *Site Characterization Report* as well as present more recent information. Chapter 3 from the *Site Characterization Report* – Regional Setting, is presented in Appendix H in Volume 2.

Table 3-1 Keno Hill Silver District Setting Summary

Region:	Yukon
Topographic Map Sheets:	- NTS 105M/14 & 105M/13
Geographic Location Name Code:	- Keno City
Latitude:	- 63° 54' 32" N
Longitude:	- 135° 19' 18" W
Drainage Region:	- Stewart River drainage region
Significant Watersheds:	- McQuesten River, Lightning Creek and Stewart River Watershed, Mayo River
Nearest Communities:	- Mayo, Keno City
Road Access:	- Silver Trail Highway
First Nations Traditional Territory:	- Nā cho N'yak Dun
Surrounding Land Status:	- YG Land
Special Designations:	- None
Ecoregion:	- Yukon Plateau (North)
Study Area Elevation:	- 945 m asl (Above Sea Level)
Vegetation Communities:	- Northern boreal forests occupy lower slopes and valley bottoms spruce, pine and alder - Grasses and sedges, mosses occupy forest floor - Heavy moss and lichen growth resident as ground cover understory of shrub willow, - Open and forest fringe areas of willow and scrub birch, and various flowering plant species
Wildlife Species:	- Caribou, grizzly and black bear, moose, dall sheep, beaver, wolf, lynx, marten, wolverine, western tanager, magnolia warbler, white-throated sparrow, bald eagle, furbearers and small animals
Fish Species:	- Bering and Beaufort Sea salmonids and freshwater species, including: Arctic grayling, Arctic char, lake trout, trout perch, lake whitefish, broad whitefish, burbot, inconnu, Arctic Cisco, Northern pike
Valued Environmental and Socio-economic Components (VC)	Water and sediment quality, aquatic resources (i.e. fish), wildlife (moose), heritage resources, human health and safety, trapping, traditional harvesting, quality of life, recreational use & tourism.

3.3 PHYSICAL ENVIRONMENT

3.3.1 Climate

Two climatic variables were assessed to develop an overall water balance for the Keno Hill Silver District. The two variables are average precipitation and average evaporation. These two variables were considered the key parameters in developing the water balance for the site.

Data from various climate stations were used to characterize the climate of the Keno Hill Property. A discussion of this data including mean annual precipitation and rates of evaporation are provided in Section 3.6 of the *Site Characterization Report* (see Appendix H in Volume 2).

As part of closure planning studies, a meteorological station was established on Galena Hill in summer 2007. A Yukon Government monitored snow course station also exists in the area. This site data will be used to update meteorological/hydrological information for the project area.

3.3.2 Geology and Topography

The Keno Silver District lies within the Yukon Plateau, just south of the rugged Wernecke Mountains. The terrain consists of concordant, rolling, upland areas separated by wide valleys. Alpine mountain peaks extend above the uplands locally. The area has been influenced by the latest glaciation but shows more subtle evidence of an earlier event as well.

Further description of terrain, bedrock geology, and physiography is provided in Sections 3.1 and 3.2 of the *Site Characterization Report* (see Appendix H in Volume 2).

3.3.2.1 General Geology

The Keno Hill Silver District is located in the western part of the Selwyn Basin in an area dominated by deformed and metamorphosed Upper Proterozoic to Mississippian sedimentary rocks formed at the edge of a continental margin. During the Jurassic and

Cretaceous, the area was subjected to compressional tectonic forces producing two major thrust sheets (Robert Service and Tombstone) and widespread folding. Early large scale deformation produced recumbent folds, resulting in local structural thickening of strata. A second (and possibly third) deformational event produced gentle south westerly plunging syn- and antiform pairs.

The Robert Service Thrust Sheet in the south is composed of Late Proterozoic to Cambrian sandstone, locally with interbedded limestone and argillite, a Cambrian to Middle Devonian succession of siltstone, limestone and chert, and Upper Devonian argillite, chert, and chert pebble conglomerate. The latter unit uncomfortably overlies the lower units.

The Tombstone Thrust Sheet to the north consists of Devonian phyllite, felsic meta-tuffs and metaclastic rocks, overlain by Carboniferous quartzite. This latter rock unit is locally thickened due to folding and or thrusting and hosts the mineralization of the Keno Hill Silver District.

Intrusive rocks formed during four episodes of plutonism. Early Paleozoic fine-grained diabase occurs as metre-scale dikes and sills in the Upper Proterozoic to Lower Cambrian rocks. During the Mid-Triassic, gabbros to diorites formed pods of various sizes, primarily in the Devonian and Mississippian rocks of the Tombstone thrust sheet. A third phase of plutonism took place around ninety-two million years ago in the early Cretaceous and resulted in widespread and voluminous Tombstone intrusions of commonly granitic to granodioritic composition. The youngest magmatic activity occurred around sixty-five million years ago in the Upper Cretaceous and resulted in the formation of peraluminous megacrystic potassium feldspar granite.

In addition to where polymetallic veins were exploited, the area hosts a number of occurrences, and showings of tungsten, copper, gold, lead, zinc, antimony and barite. Tin, tungsten, and molybdenite occurrences are possibly related to the suite of Cretaceous intrusion, whereas lead, zinc, and barite occur in stratiform calcareous sedimentary rocks of early to mid-Paleozoic age typical of sediment-hosted deposits.

3.3.2.2 *Property Geology*

The Keno Hill District is underlain primarily by Yukon Group metasedimentary rocks, locally divided into three formations; Upper Schist, Central Quartzite and Lower Schist. The Upper Schist (Hyland Group, pre-Cambrian to Cambrian age) overlies the quartzite in what is inferred to be a thrust contact (Robert Service Thrust) and consists of quartz-mica schist, quartzite, graphitic schist and minor limestone. The Central Quartzite (Keno Hill Quartzite, Mississippian age) contains thick-and thin-bedded quartzite, massive quartzite, graphitic phyllite, graphitic schist, calcareous schist and minor Triassic greenstone. This unit is approximately 700 m thick and is host to most of the past producing ore bodies. Structurally juxtaposed below the quartzite is the Lower Schist which has been correlated with the Devonian-Mississippian Earn Group. The Lower Schist includes graphitic schist, argillite, thin-bedded quartzite, calcareous schist, phyllite, slate, sericite schist, minor thick-bedded quartzite and locally significant intervals of Triassic greenstone. The greenstone forms sills and / or boudins and consists of metadiorite and metagabbro. The sills and boudins form bodies up to one kilometre long and thirty metres thick. Regional, greenschist facies metamorphism of all units is believed to have occurred in the Middle Cretaceous, about 105 million years ago.

A number of quartz-feldspar porphyritic sills have intruded the stratigraphy parallel to schistosity. The sills are most common in the Lower and Upper Schists and can reach thicknesses of up to fifty metres; reports of occurrences in the Central Quartzite are inconclusive and vague. The quartz-porphyry sills are believed to be of Cretaceous age.

Structurally, the property is characterized by four sets of faults; many of which have been filled by hydrothermal minerals, forming veins. The oldest fault set consists of south dipping structures that are generally parallel to foliation and are apparently associated with the Tombstone Thrust Fault since movement was contemporaneous or slightly later. Locally, brittle deformation has been observed along these structures. A second fault set, known as “longitudinal veins” strikes north east to east northeast and dips steeply southeast. The latest movement along these faults is sinistral with offsets locally reaching more than 150 metres; however, more than one episode of movement commonly is indicated. Depending on the competency of the host rock, longitudinal

veins can be up to thirty metres wide in an anatomising system of sub-veins. Essentially all mineralized rock was mined from these longitudinal veins. A third set of faults, known as “transverse faults”, is north-west striking and dips steeply to the north. Transverse faults typically do not contain silver and lead mineralization but are commonly filled by quartz with trace to minor arsenopyrite, pyrite and jamesonite.

A younger set of faults, known as cross faults, strike north to north east with a dip of sixty degrees west to south west and offset vein or longitudinal faults by up to 2,000 metres. In the western part of the property, dextral movement is the most recent event along these structures, whereas in the eastern part of the property sinistral movement with less magnitude prevails.

At Keno Hill, the largest accumulation of ore minerals occurred in structurally prepared competent rocks, such as the Central Quartzite, resulting in areas of increased fluid flow. Incompetent rocks like phyllites tend to produce fewer and smaller, if any, open spaces, limiting fluid flow and resulting mineral precipitation.

Mineralization in the Keno Hill Silver District is of the polymetallic silver-lead-zinc vein type. In general, common gangue minerals include manganiferous siderite and to a lesser extent quartz and quartz breccia as well as calcite and other carbonates. Silver occurs in argentiferous galena and argentiferous tetrahedrite (freibergite). In supergene assemblages, silver is further found as native silver, in polybasite, stephanite, and pyrargyrite. Lead occurs in galena and zinc in sphalerite, which is iron-rich. Other sulphides include pyrite, arsenopyrite (locally gold-bearing) and chalcopyrite.

The veins of the Keno Hill Silver District display characteristics associated with both mesothermal and epithermal deposits and it is not clear if a continuum exists or if separate and distinct mineralizing events are involved. The most prominent examples of epithermal style mineralization are found in the western part of the district, although the Lucky Queen mine on Keno Hill produced native silver and ruby silver in quantity. Proximity to a magmatic heat source has often been called upon to explain the district zonation, though this is by no means a complete explanation.

Mineral zonation is common within base metal-rich veins (zinc-rich margin and silver/lead-rich center). Changes in mineralogy within individual oreshoots is less clearly documented, although there has long been a conviction that silver and lead rich zones occur higher in the veins while zinc becomes dominant at depth. Anecdotal evidence suggests that vertically stacked oreshoots may repeatedly show zoning of lead rich upper portions to zinc dominant roots, but data confirming this has not been found. In general, Pb-Zn mineralization appears to be nearly contemporaneous in age.

Mechanisms triggering deposition of ore and gangue minerals have been suggested by district wide studies of fluid inclusions and light stable isotopes. Fluid boiling appears to have been ubiquitous and some evidence exists for fluid mixing. The hydrothermal fluids responsible for mineral deposition contained significant quantities of CO₂ which may have “boiled” during abrupt changes in pressure produced during fluid movement from confined fractures to more open conduits formed in quartzite.

Irrespective of stratigraphic formations or regional map units only a few major rock types are commonly encountered in the area of the old mine workings. These are:

- schists and phyllites with variable carbon content;
- chloritic phyllites or schists;
- quartzites and phyllitic quartzites;
- sericite-quartz phyllites; and,
- greenstones.

3.3.2.3 Bellekeno Mineralization Occurrences

Sourdough Hill is capped by Upper Schist rocks which effectively mask the mineralized vein zones developed in the more favorable Central Quartzite beneath. Near the schist-quartzite contact greenstone sills have been emplaced, with a particularly large body occupying the section about 250 m below the schist contact.

The most important of the Bellekeno veins is the “48” Vein which contains all of the mineral resources thus far defined. Other veins such as the Ram, Eureka, Tundra and

“50” have seen very limited exploration but continue to have reasonable potential for the discovery of new ore deposits.

The “48” vein traverses both the quartzite and greenstone but appears to rapidly die out in the Upper Schist. Dips are consistently to the southeast but at varying angles possibly due to changes in lithology i.e. quartzite to greenstone to schist. The vein itself occupies a fault zone which appears to have normal movement on the order of about 20 m. In quartzite the vein-fault is typically a zone of fracturing and local brecciation with or without significant fault gouge. Evidence of fluid movement is usually present either in the form of deposited ore and gangue minerals or as a subtle “bleached” appearance. From historic mapping, the vein, when crossing greenstone, appears to narrow drastically and possibly show the effects of weak argillization. Likewise upon entering schist, the vein becomes less well defined and eventually dissipates.

Mineral deposition within the vein is sporadic, but definitely occurs in shoots which show a decided pitch to the SW. Three shoots of potentially ore grade mineralization have been outlined by underground openings and drill holes and have been designated the East Zone, 99 Zone and the SW Zone. All show similar characteristics which include: gentle pitch to SW mimicking the attitude of lithologic units such as the greenstone and Upper Schist; mineralogy consisting of crudely banded coarse grained galena, sphalerite and siderite; subsidiary vein splits along strike and dip are fairly common although most die out rapidly.

A more detailed description of the ore shoots is as follows:

East Zone – A major cross fault appears to offset the “48” vein forming the eastern boundary of the East Zone. Wide spaced drilling suggests that the mineralized zone pitches at an angle of about 25° to the SW maintaining an offset of about 80 m from the footwall of the main greenstone sill. It is not clear whether the mineralization abruptly stops at the bounds of the ore shoot or undergoes a more gradual reduction. Beyond the ore shoot the structure continues with only small amounts of vein minerals present. Sphalerite is the dominant mineral within the vein followed by siderite and sporadic galena. One vein split has been identified and given the name “49” vein.

99 Zone – Ore has been developed immediately above the main greenstone sill, a possible control being a vein split at this location. Ore grade mineralization does not appear to extent into the greenstone. Galena is much more abundant in the “99” zone compared to the East Zone.

SW Zone – An abrupt change in vein strike separates the SW Zone from the “99” Zone where the flexure apparently produced a short segment of tight, barren vein. The upper limit on the ore shoot is the contact of the overlying Upper Schist which also tends to impart an apparent pitch to the southwest. Splits occur in the vein, possibly accounting for areas of particularly high grade and great width. Limited drilling suggests that at depth the vein splits into two distinct strands and the grade diminishes rapidly. Some sections of vein show evidence of post-mineral brecciation sub-parallel to the vein strike which could lead to doubling of the vein width or conversely gaps devoid of mineralization. Mineralogically the SW Zone shows relatively more galena than other zones, although thick bands of sphalerite often occur on the footwall.

For further discussion on geology, mineralogy, and ore deposits, please refer to Section 3.0 of the *Site Characterization Report* (see Appendix H in Volume 2).

3.3.2.3.1 Bellekeno Geoenvironmental Characterization

In reflection of its commitment to environmentally responsible development, Alexco has made a concerted effort to understand the geoenvironmental characteristics of the Keno Hill Silver District as a whole and in particular the Sourdough Hill/Bellekeno deposit. In addition to looking at historical analytical data including rock and water quality analyses, environmental studies on geoenvironmental characterization and the potential for Acid Rock Drainage (ARD) / Metal Leaching (ML) of the Bellekeno deposit have been carried out on behalf of Alexco by Altura Environmental Consulting (see Appendix B and Appendix C in Volume 2). Research on metal transport and attenuation in the Keno Hill District has also been consulted.(MacGregor, D. 2002; Kwong, et al, 1994 and 1997). A number of insights have been gained from this work, which have enabled careful waste rock and tailings management programs to be designed. Some key points include:

- In comparison with most other mineral deposit types, Keno Hill mineral deposits have a relatively low acid generating potential. Raw adit drainage waters have been monitored for decades over the district, and although several Keno Hill deposits produce weakly acidic drainage, mine contact water from most adit drainages are very rarely below pH 7 (neutral). Specifically for Bellekeno, mean pH of monthly averages from January 1987 – December 2008 for raw untreated water from the 625 adit (KV-42) was 7.53. The major reasons for the low acid generating potential of Keno Hill deposits is their relatively low pyrite content and the ample buffering capacity due to generally abundant calcium carbonate (see Kwong et al., 1996). One of the biggest environmental concerns with ARD is not the acidity itself, but rather that acidity results in much greater solubility and mobilization of metals (metal leaching) which are toxic to many organisms. Of additional concern is the exothermic nature of sulphide oxidation reactions, which may result in positive feedback loop, particularly if thermal gradients and convective flow is developed in porous material (see U.S. EPA Technical Document on Acid Mine Drainage Prediction, 1994). Because of the low acid generating potential and ample buffering capacity of the majority of the rocks at Bellekeno, these ARD issues are less likely to occur compared with other deposit types. A carefully designed WRMP and TMP (see Section 6.2 and 6.3, respectively) have been designed to prevent ARD/ML at Bellekeno.
- The Keno Hill Silver District has very different geology, and mineralogy as well as a unique depositional model which give it very different geoenvironmental ARD/ML characteristics from more ARD prone deposit types such as SEDEX (Sedimentary Massive Sulphide) e.g. Faro, Sullivan, Tom (YT); VMS (Volcanogenic Massive Sulphide) e.g. Windy Craggy (BC), Marg (YT). These deposit types and their geoenvironmental characteristics are so different from Keno Hill that comparing them is generally not useful.
- The biggest environmental concern when developing Keno Hill Silver District deposits, including Bellekeno, is metal-rich neutral drainage. Although the Keno Hill Silver District rocks have a low acid generating potential, some metals, particularly zinc, is still relatively soluble at neutral and even slightly alkaline conditions. Also, galvanic reactions (like a battery) between sulphide minerals

can also result in additional liberation of metal ions, causing zinc concentrations in untreated water to sometimes exceed discharge standards. Alexco has been successfully treating adit discharge water through its care and maintenance program for a number of years using hydrated lime to raise the pH and precipitate the metals before the water is released to the environment. Other treatment methodologies are being investigated and tested as part of the district wide closure plan (see Section 8).

3.3.2.4 *Physiography and Surficial Geology*

The Keno Hill Silver District lies within the northeastern part of the Yukon Plateau, and the terrain is mountainous with elevations ranging from 1,848 m (Summit of Keno Hill) to 610 m (McQuesten River valley). The area has been profoundly influenced by the latest glaciation but shows more subtle evidence of an earlier event as well.

The lower slopes of Galena Hill show clear evidence of ice marginal deposits such as kame terraces related to the glacial lobes occupying the major valley. The retreat of the Cordilleran ice sheet has had a major impact on the south McQuesten valley. Till blankets much of the valley and glacio-fluvial deposits are widespread. Glacio-lacustrine deposits formed in ice marginal lakes occur in the deeper part of the valley. Large meltwater streams have left huge meander scars. Boyle (1965) provides the following additional description of the physiography and glacial deposits in the area.

Galena Hill trends northeast between Duncan Creek and the McQuesten River valley. It has an elevation of 4,740 feet, a moderately steep southwestern slope, and steeper north, northwestern, and southeastern slopes. The terrain above 4,300 feet is relatively flat and rolling, and marked by several level grassy meadows. The north, northwestern, and southeastern slopes of the hill are crossed by several streams that have cut steep gulches into the rock strata. The principal streams responsible for these gulches are Galena, Flat, Brefalt, and Sandy Creeks and Porcupine Gulch on the northwestern slope and Hinton and Fisher Creeks on the eastern and southeastern slopes.

Keno Hill and Sourdough Hill are adjacent hills separated by Lightning Creek. Keno Hill trends northeast and lies between the Keno Ladue-McQuesten River valley and Allen, Faith, Lightning, and Christal Creeks. The hill has relatively gentle southern and southeastern slopes and a precipitous northern slope, marked by two cirques, Faro Gulch and Silver Basin Gulch. The terrain above 4,500 feet is relatively flat and rolling with five prominent rocky knolls known as Keno, Minto, Monument (the highest point on Keno Hill, elevation 6,065 feet), Caribou, and Beauvette. On the slopes of the hill several streams follow steep gulches in the rock strata, the principal ones being Gambler, Faro, McKay, and Silver Basin on the northern slope, Faith, Hope, and Charity on the northeastern and southern slopes, and Erickson on the western slope.

Sourdough Hill lies southwest of Keno Hill and trends north between Thunder, Lightning, and Duncan Creeks. The part of the hill described in this report is on the northern and northwestern slopes, which are gentle up to 4,200 feet and from there rise abruptly to a steep rocky hogsback that trends southwest for some 6,000 feet.

Extensive rock outcrops are uncommon on Galena, Keno, and Sourdough Hills, and with the exception of the gulches and cirques where relatively good geological sections are present, detailed mapping can only be done by observing float. Below an elevation of 4,400 feet rock outcrops are sparse, and the slopes are covered with till, soil, rock debris, much, and muskeg, in which conifers, birch, aspen, Arctic black-birch, and other vegetation grow abundantly. Above this elevation the soil is thin, outcrops are more numerous, the ground is covered with local rock float, the terrain is treeless, and the vegetation is limited to alpine species and grassy meadows.

The lower slopes of the hills were severely glaciated during Pleistocene time by ice-sheets that spread, from the east, over the entire area. Glacial till, gravel, and other debris lie in a series of benches on the slopes of the hills and floor the valleys. The deposits are generally 5 feet to 20 feet thick, but in some areas as on the southern slope of Keno Hill facing Lightning Creek and north of Christal Lake, they are 30 feet to 50 feet thick or more.

The Keno Hill-Galena Hill area is in the region of permanently frozen ground. The permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden, amount of vegetative cover, and presence of flowing underground and surface water. At high elevations and on slopes with a northern exposure it is generally present. Thus, on Keno Hill, the mine workings on the top of the hill and on the northern slope encountered permafrost some 400 feet below the surface. On the northern slopes of Sourdough Hill and Galena Hill a similar situation prevails, and frost and ice lenses have been encountered at depths of 250 feet or more in the mine workings. On the lower southern slope of Keno Hill, however, the workings of the Onek and Mount Keno mines show little evidence of permafrost. In places where surface and underground water are flowing the permafrost has been thawed out and frost free windows and strips are present. These provide access and egress for waters that are oxidizing the lodes.

The effects of frost action, soil creep, and slope wash are marked on the hills, particularly at the higher elevations. Frost action is responsible for features such as stone rings and stripes, and produces a general 'boiling action' that brings rock float, mineralized float, and soil from deeper layers to the surface, thus facilitating the mapping of both the underlying bedrock and the tracing of vein faults. On steep slopes, however, frost action and land creep have transported float downhill places, 100 feet or more, making the accurate mapping of contacts and vein faults difficult.

3.3.2.5 Soils

Except for a few localized areas, the soils are not strongly weathered or deeply leaching. They also exhibit a poor profile development, particularly those underlain by permafrost. The soils in the area can be conveniently classified into two general types: (1) residual, and (2) muck peat, and half-bog. Residual soils were formed principally from the weathering of the various types of bedrocks, or as is evident in some places, particularly in the vicinity of Dublin Gulch, from the decomposition of a till that predates the last glaciation. Refer to Section 3.3 of the *Site Characterization Report* for further description of soil in the Keno Hill area (see Appendix H in Volume 2).

3.3.2.6 *Permafrost*

The Keno Hill-Galena Hill area is in the region of permanently frozen ground. The permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden, soil types, amount of vegetative cover, and presence of flowing underground and surface water. At high elevations and on slopes with a northern exposure it is generally present. The Bellekeno East decline is collared in a permafrost face. Further information on permafrost conditions is provided in Section 3.2.3, *Physiography and Surficial Geology of the Site Characterization Report* (see Appendix H in Volume 2).

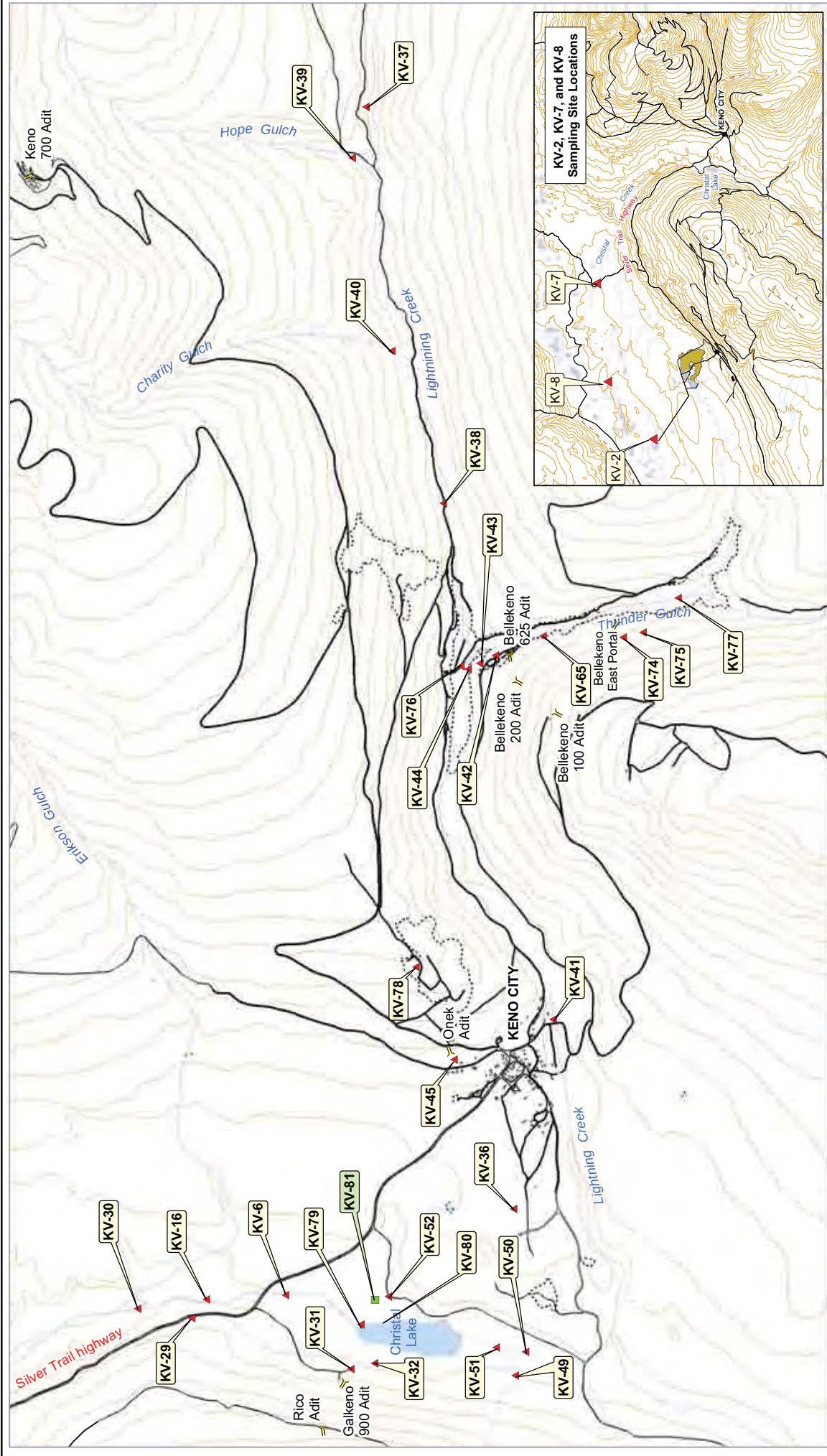
3.3.3 *Water Resources*

3.3.3.1 *Surface Water Quality*

A detailed discussion of site water chemistry and flow for each of the mine areas and sampling stations is provided within the *Site Characterization Report* – Chapter 6. Selected historic data pertaining to the Lightning Creek, Christal Creek and Onek drainages have been updated and are provided below. Key objectives in the data analysis performed within the *Site Characterization Report* were to determine or understand:

- Trends in adit discharge water quality over time to anticipate future water quality concerns;
- Comparison between data sets and appropriateness of each for interpreting site geochemistry;
- Changes in water chemistry along a flow path to identify and to some extent, quantify natural and anthropogenic sources and sinks; and
- Relationships between parameters such as chemistry and flow to identify mechanisms controlling water chemistry – particularly where a physical mechanism such as the extent of flushing and the water flow path may dominate the water chemistry, rather than the geochemical processes.

The Bellekeno mine site is near the confluence of Thunder Gulch with Lightning Creek, a stream flowing from the north side of Sourdough Hill (Figure 3-1). Lightning Creek eventually flows into Duncan Creek, which drains into the Mayo River. All of these basins have undergone extensive placer mining activities both now and in the past. Both the Mackeno tailings and proposed Christal Lake Mill location are located near the northwest shore of Christal Lake at a previously used mill site. Christal Lake drains into Christal Creek, which is fed by Erikson Gulch and eventually drains into the South McQuesten River.



Legend

Water Quality

- Surface Water
- Quality Station
- Proposed Surface Water
- Quality Station

Mine Workings

- Adit
- Pit/Placer

Topography

- Road
- Contour
- Watercourse
- Waterbody

Scale

0 250 500 1,000 1,500 m

North Arrow

Notes:

This map is for illustrative purposes only. It is not intended to be used for legal or regulatory purposes. The map is based on data provided by the Keno Mine and the Keno Mine Development. The map is not a substitute for a site visit or a detailed survey. The map is not a substitute for a detailed survey. The map is not a substitute for a detailed survey.

Figure 3-1

DATE: January 2009

Drawn By: HDPI

Checked by: KN



ALEXCO
WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ MINING LICENCE APPLICATION REQUEST
BELLEKENO MINE DEVELOPMENT
SURFACE WATER QUALITY
MONITORING LOCATIONS
FIGURE 3-1
Date: January 2009
Drawn By: HDPI
Checked by: KN

Water quality sampling has been carried out at a number of sampling stations in this area including the old Mackeno mill site, Onek Adit, the Bellekeno mine, and along Lightning Creek and its tributaries. A summary of conclusions from field studies and existing data for the area is as follows:

- Lightning Creek is characterized by a narrow valley with a steep gradient, which drains Hope Gulch, Charity Gulch, and Thunder Gulch;
- Lightning Creek is located both upstream and downstream of extensive placer and some hardrock mining activities. The drainage has been affected by these and other anthropogenic activities;
- Arctic grayling utilize Lightning Creek with adult fish seeking clear upstream waters and juveniles located in more turbid waters downstream;
- Mean monthly total zinc concentrations for 2008 have, in general, decreased from historical concentrations in most stations in the Lightning Creek watershed (see Table 3-2), particularly at KV-41, the last station before water exits the property;
- Four stations in the Lightning Creek watershed have seen increases in total zinc concentrations from historical levels, notably including KV-37, the station where Lightning Creek waters enter the Keno Hill property;
- A number of contaminant sources drain directly to Christal Lake and the Christal Creek watershed, including: Galkeno 900, Galkeno 300, Onek Adit, UN Adit, and the old Mackeno tailings which are situated near the Northwest shore of Christal Lake;
- The Onek Adit discharged an average 58.60 mg/L total Zn in 2008; and
- Mean zinc concentrations of the Onek Adit discharge from data collected between 1997 and 2008 were 84.65 mg/L with a flow of 2.786 L/s.

Table 3-2 Lightning Creek Stations Water Quality

Monitoring Station	Site Description	All Monthly Total Zn Concentrations, mean (mg/L)	Historical* Monthly Total Zn Concentrations, mean (mg/L)	2008 Monthly Total Zn Concentrations, mean (mg/L)	% increase or decrease in 2008 values from historical values
KV-37	Lightning Creek u/s Hope Gulch	0.022	0.008	0.083	+877%
KV-38	Lightning Creek u/s Thunder Gulch	0.027	0.027	0.027	-3%
KV-39	Hope Gulch u/s Lightning Creek	0.286	0.294	0.278	-5%
KV-40	Charity Gulch u/s Lightning Creek	0.010	0.006	0.014	+138%
KV-41	Lightning Creek u/s bridge at Keno City	0.066	0.078	0.043	-45%
KV-42	Bellekeno 625 Adit	4.611	3.893	7.484	+92%
KV-43	Bellekeno 625 Treatment Pond Decant	0.912	1.147	0.209	-82%
KV-44	Bellekeno 625 Seep	2.467	3.633	0.136	-96%
KV-65	Thunder Gulch Upstream of Bellekeno	0.007	0.0045	0.008	+78%
KV-74	Bellekeno East – Decline	0.080	n/a	0.080	n/a
KV-75	Bellekeno East – Settling Pond Decant	0.015	n/a	0.015	n/a
KV-76	Thunder Gulch d/s of Bellekeno 625 adit	0.035	n/a	0.035	n/a
KV-77	Thunder Gulch upstream of Bellekeno East	0.299	n/a	0.299	n/a

*Denotes the period between 1994 - 2007, inclusive, when available

The 1996 *Site Characterization Report*, Figure 8-14, shows that mean annual zinc concentrations (with treatment at Bellekeno 625) are 0.008 mg/L in Lightning Creek upstream of Hope Gulch (KV-37) and 0.05 mg/L at Keno City (KV-41). Recent data is generally consistent with these observations. However, the March 2008 sampling event recorded an unusually high sampling result (0.239mg/L) which has drawn the 2008 average upwards. These sampling results indicate that the station at KV-37 is below the Canadian Council of Ministers of the Environment (CCME) guidelines (1999) for zinc while the downstream station at KV-41 is slightly above the CCME guidelines.

It should be noted that Lightning Creek and Thunder Gulch have been affected by nearby placer mining activities, which contribute metal loads to Lightning Creek, though it is uncertain approximately what those loads might be.

Table 3-3 below provides site designations, descriptions and locations for the water quality surveillance network currently being monitored in the vicinity of the Bellekeno mine, Onek and the old Mackeno mill site and tailings as part of the overall care and maintenance, closure programs and exploration for the site.

Table 3-3 Existing Water Quality Sample Station Locations Near Bellekeno

Monitoring Station	Site Description	Easting	Northing	Monitoring Program*
Bellekeno				
KV-37	Lightning Creek u/s Hope Gulch	490343	7087765	C&M/Exploration
KV-38	Lightning Creek u/s Thunder Gulch	488188	7087345	C&M/Exploration
KV-39	Hope Gulch u/s Lightning Creek	490068	7087840	C&M
KV-40	Charity Gulch u/s Lightning Creek	489017	7087624	Closure
KV-41	Lightning Creek u/s bridge at Keno City	485382	7086748	C&M/Exploration
KV-42	Bellekeno 625 Adit	487428	7086944	C&M/Exploration
KV-43	Bellekeno 625 Treatment Pond Decant	487419	7087052	C&M/Exploration
KV-44	Bellekeno 625 Seep	487464	7087151	Exploration/Closure
KV-65	Thunder Gulch Upstream of Bellekeno	487466	7086803	C&M/Exploration
KV-74	Bellekeno East – Decline	487459	7086367	Exploration/Closure
KV-75	Bellekeno East – Settling Pond Decant	487487	7086258	Exploration/Closure
KV-76	Thunder Gulch d/s of Bellekeno 625 adit	487304	7087249	Exploration/Closure
KV-77	Thunder Gulch upstream of Bellekeno East	487677	7086069	Exploration/Closure
Onek				
KV-45	Onek Adit	485101	7087288	C&M/Exploration
KV-78	Onek Waste Rock Storage Facility	485666	7087494	Exploration/Closure
Old Mackeno Mill Site and Tailings				
KV-1	South McQuesten River u/s Christal Creek	474078	7092956	C&M
KV-2	South McQuesten River @ Pumphouse	472076	7092790	C&M
KV-6	Christal Creek at Keno Highway	483882	7088204	C&M
KV-7	Christal Creek @ Hanson Road	478657	7092413	C&M
KV-8	Christal Creek @ Mouth	474585	7091944	C&M
KV-16	Christal Creek 600 m d/s Silver Trail	483861	7088634	Closure
KV-29	Silver Trail Culvert #4	483757	7088713	C&M
KV-30	Christal Creek 825m d/s Silver Trail	483811	7089007	Closure
KV-31	Galkeno 900 Adit	483454	7087809	C&M
KV-32	Galkeno 900 treatment Pond Decant	483512	7087719	C&M
KV-36	Flame and Moth	484352	7086963	C&M
KV-49	Hinton Creek u/s Christal Creek	483445	7086954	C&M
KV-50	Christal Creek u/s Hinton Creek	483575	7086897	C&M
KV-51	Christal Creek d/s Hinton Creek	483601	7087058	C&M
KV-52	Natural Spring to Christal Lake at Old Mackeno pump house	483756	7087870	C&M
KV-79	Christal Creek d/s Mackeno tailings	483809	7088054	Closure
KV-80	Christal Creek u/s Mackeno tailings	483827	7088132	Closure

* Environmental monitoring programs for the site are currently conducted under Care and Maintenance (C&M) Water Use Licence QZ06-074, the advanced exploration Water Licence QZ07-078 dated October 3rd 2008 and closure monitoring planning.

Baseline information on Lightning Creek, upstream of all existing mine workings is collected at station KV-37. Two creeks, Hope Gulch and Charity Gulch, flow from the south side of Keno Hill into Lightning Creek upstream of Thunder Gulch and the Bellekeno adit flow. These creeks are sampled upstream of the confluence with Lightning Creek (stations KV-39 and KV-40 respectively). A water quality sampling site on Thunder Gulch upstream of all current mining activities (KV-77) also provides baseline information on the quality of water flowing into Lightning Creek. A second water quality monitoring site on Lightning Creek (KV-38) is located downstream of Hope Gulch and Charity Gulch but upstream of Thunder Gulch and a placer operation on Lightning Creek. A third station on Lightning Creek (KV-41) downstream of the Bellekeno 625 adit flow, Thunder Gulch and the placer operation gives an indication of the combined influence of these inputs and activities. There has not been a sufficient amount of time to collect data under the Water Licence QZ07-078 dated October 3, 2008 to be used in this application.

Table 3-4 provides a summary of water quality data collected from sample stations for Lightning Creek, Christal Creek and Onek shown on Figure 3-1. A range of data collected for select parameters is provided as well as the number of samples collected at each of the sites.

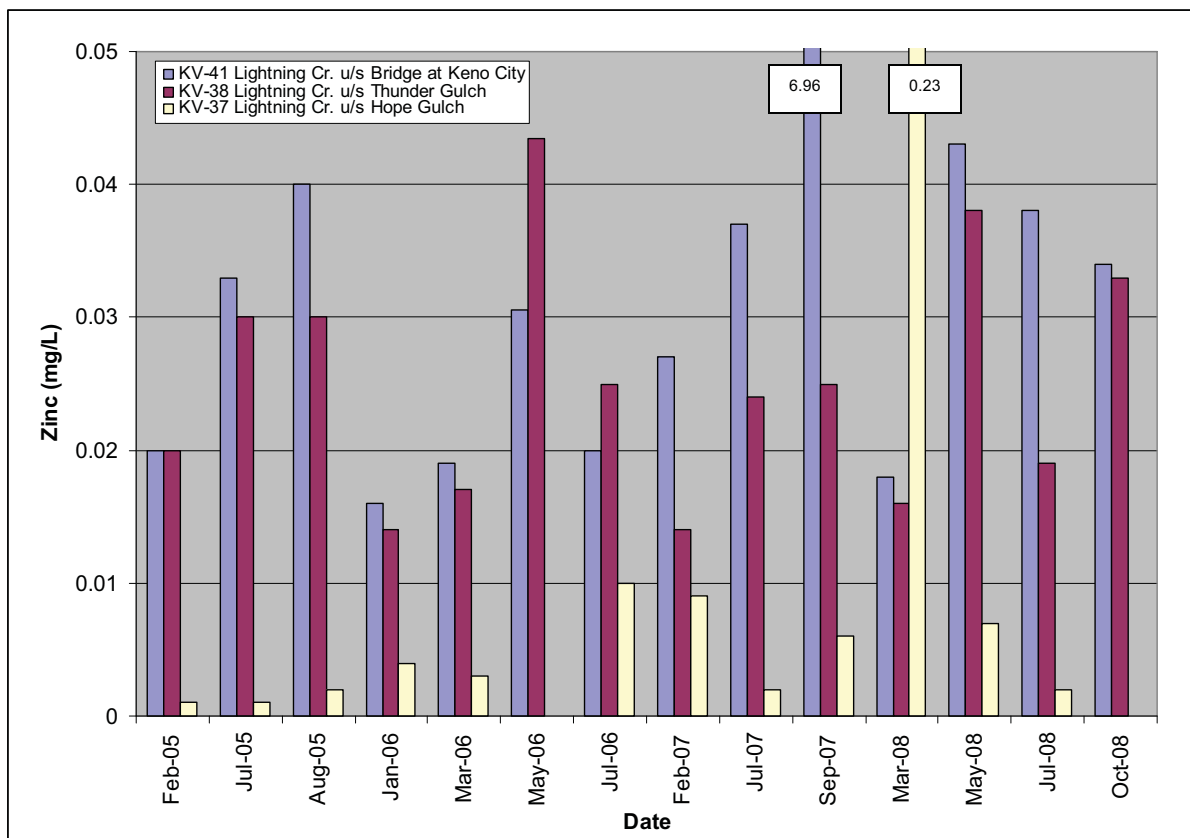
Figure 3-2 shows zinc concentrations observed within the Lightning Creek receiving waters (KV-37, KV-38 and KV-41), between 2005 and 2008.

Table 3-4 Water Quality Data Summary for Receiving Water Stations in Lightning Creek

Site ID	Location	Dates	Flow (m ³ /sec)			Conductivity (mg/L)			pH			Total Zinc (mg/L)			Total Arsenic (mg/L)			Total Cadmium (mg/L)			Total Lead (mg/L)									
			Min.	Max.	Avg.	N	Min.	Max.	Avg.	N	Min.	Max.	Avg.	N	Min.	Max.	Avg.	N	Min.	Max.	Avg.	N								
KV-37	Lightning Cr.u/s Hope Gulch	1997-2008	0.301	0.589	0.437	3	51	446	148	15	6.94	7.94	7.53	15	BD	0.239	0.022	18	BD	0.05	0.009	18	BD	0.02	0.006	18	BD	0.05	0.007	18
KV-38	Lightning Creek u/s Thunder Gulch	2003-2007	0.482	0.836	0.656	3	82	200	158	15	7.01	7.83	7.57	15	0.014	0.051	0.027	16	BD	0.0039	0.082	16	BD	0.0005	0.0002	16	BD	0.002	0.001	16
KV-41	Lightning Cr. at Keno City	1996-2008	0.063	1.526	0.701	13	91	1600	252	22	7.23	7.98	7.71	21	0.004	6.960	0.324	27	BD	0.0758	0.0157	24	BD	0.0145	0.0011	24	BD	0.259	0.021	25

Notes: N = # samples
BD=results below detection

Figure 3-2 Total Zinc Concentrations for Monthly Sampling Events at Lightning Creek Receiving Water Sites from February 27, 2005 to October 2, 2008



3.3.3.2 Mass Loading

In 1996, the climate and hydrology of the Keno Hills property were characterized during a site-wide baseline characterization. A water balance was constructed for the Keno Hill property at that time. To develop the water balance, flow characteristics of the mine site streams were inferred from stream flow data collected by the network of government gauging stations. This was supplemented with climatic water balances which were derived from climate stations either at or near the Keno property. The 1996 water balance was updated in 2008 by Clearwater Consultants Ltd. (CCL, 2008), and this updated version forms the basis for constructing load balances that examine the present-day generation, movement and attenuation of contaminants at the mine site and in the receiving environment.

A review by Clearwater Consultants Ltd. confirmed the methods used in the original 1996 hydrology study to define hydrological inputs for the loading model.

3.3.3.2.1 Hydrological Inputs

The 1996 hydrological baseline study determined relative catchment volumes and flows based on an empirical relationship between median catchment elevation and mean annual runoff. These relative baseline flows are coupled with current water quality results captured from a network of sampling stations at Keno Hill to provide hydrologic inputs to the model. The network is designed to provide water quality at input (and output) nodes where surface water is contributed to watershed basins.

The loading balance for the site is calculated based on the flows and analytical results described above. Loads are calculated for dissolved zinc and a tracer element, dissolved silicon. Dissolved metals are used instead of total metals as they may more accurately represent the movement of metals and attenuation properties of the individual basins. This is especially important at the Keno Hill Silver District where the attenuation capacity of the site is extraordinarily high.

Tables 3-5 and 3-6 present the annual dissolved zinc loading balance for the Lightning Creek and Christal Creek drainages, respectively. Zinc has been identified as the primary contaminant released from the Keno Hill Silver District to the receiving environment. These tables provide annual loading balance calculations for zinc in the years from 2006-2008.

Zinc, which has been shown to be an indicator of water quality, is soluble over a wider range of pH conditions than other metals of interest. This is not meant to downplay the importance the mass loading of other metals such as cadmium, lead or copper; however, water sampling in the area shows that these metals are much less widely dispersed than zinc and present in receiving waters at much lower concentrations even relative to their well-known greater toxicity.

An extensive water quality surveillance network is in place at the site and monitoring will continue during care and maintenance, and exploration and development to update site data and provide further information for closure planning. As part of the closure planning, the water balance and mass loading calculations will be continually re-visited and updated.

Table 3-5 Lightning Creek Drainage Mass Loading, 2006-2008

Element 1, Lightning Creek above KV-37 (before entry to Alexco property)					Zinc (dissolved)	
	2006	2007	2008	Source of Data/Comment		
Flow (1000m3/yr)	10407	10407	10407	Estimated using regional hydrology study		
Concentration (mg/L)	0.006	0.009	0.060	Average observed concentrations		
Load (kg/yr)	57.24	93.66	624.41	Computed (flow times concentration)		
OUTFLOWS						
Flow (1000m3/yr)	10407	10407	10407	Estimated using regional hydrology study		
Concentration (mg/L)	0.006	0.009	0.060	Average observed concentrations		
Load (kg/yr)	57.24	93.66	624.41	Computed (flow times concentration)		
Element 2, Hope Gulch above KV-39						
	2006	2007	2008	Source of Data/Comment		
Flow (1000m3/yr)	1658	1658	1658	Estimated using regional hydrology study		
Concentration (mg/L)	0.22	0.06	-0.04	Computed (load divided by flow)		
Load (kg/yr)	370.71	106.40	-62.47	Difference between observed outflow and total inputs		
INFLOWS						
Flow (1000m3/yr)	266	266	266	Estimated using regional hydrology study		
Concentration (mg/L)	1.25	1.41	1.58	Average observed concentrations		
Load (kg/yr)	331.44	374.53	420.28	Computed (flow times concentration)		
OUTFLOWS						
Flow (1000m3/yr)	1924	1924	1924	Computed (total of all inflows to element)		
Concentration (mg/L)	0.365	0.250	0.186	Average observed concentrations		
Load (kg/yr)	702.15	480.92	357.81	Computed (flow times concentration)		
Element 3, Lightning Creek above KV-41						
	2006	2007	2008	Source of Data/Comment		
Flow (1000m3/yr)	3558	3527	3471	Estimated using regional hydrology study		
Concentration (mg/L)	-0.098	-0.055	-0.202	Computed (load divided by flow)		
Load (kg/yr)	-349.58	-193.96	-700.97			
INFLOWS						
Flow (1000m3/yr)	10407	10407	10407	Element 1		
Concentration (mg/L)	0.006	0.009	0.060	Element 1		
Load (kg/yr)	57.24	93.66	624.41	Element 1		
Flow (1000m3/yr)	1924	1924	1924	Element 2		
Concentration (mg/L)	0.365	0.250	0.186	Element 2		
Load (kg/yr)	702.15	480.92	357.81	Element 2		
Discharge from KV-40	-	-	-	Negligible load contribution		
Flow (1000m3/yr)	6	37	93	Estimated using regional hydrology study		
Concentration (mg/L)	0.17	0.25	0.04	Average observed concentrations		
Load (kg/yr)	0.99	9.29	3.71	Computed (flow times concentration)		
Flow (1000m3/yr)	5172	5172	5172	Estimated using regional hydrology study		
Concentration (mg/L)	0.000	0.002	0.006	Average observed concentrations		
Load (kg/yr)	-	10.34	31.03	Computed (flow times concentration)		
Flow (1000m3/yr)						
Concentration (mg/L)						
Load (kg/yr)						
Bellekeno Waste Rock Pile						
Flow (1000m3/yr)	17508	17540	17595	Computed (total of all inflows to element)		
Concentration (mg/L)	0.043	0.034	0.058	Computed (load divided by flow)		
Load (kg/yr)	760.37	594.22	1016.97	Computed sum		
OUTFLOWS						
Flow (1000m3/yr)	21066	21066	21066	Estimated using regional hydrology study		
Concentration (mg/L)	0.020	0.019	0.015	Measured at KV-41		
Load (kg/yr)	410.79	400.25	315.99	Computed (flow times concentration)		
Flow at KV-41						

*Where the incremental catchment runoff shows negative concentrations and loads, this indicates that, overall, the basin had a positive attenuation capacity for Zn in that year (i.e. the sum of measured Zn inputs loads was greater than the Zn load measured at the outflow station). Attenuation capacity refers to the basin's ability to absorb waterborne Zn.

Table 3-6 Christal Creek Drainage Mass Loading, 2006-2008

Element 1, Christal Creek above KV-6					Zinc (dissolved)	
	2006	2007	2008	Source of Data/Comment		
Flow (1000m3/yr)	1618	1613	1696	Estimated using regional hydrology study		
Concentration (mg/L)	-3.017	-2.507	-0.275	Computed (load divided by flow)		
Load (kg/yr)	-4883	-4044	-466	Computed (load at KV-6 minus loads at adits and spring)		
INFLOWS						
Flow (1000m3/yr)	78.89	78.89	78.89	Average of two spot measurements taken in 1995		
Concentration (mg/L)	5.00	5.00	5.00	Average observed concentration at LES-66		
Load (kg/yr)	394.47	394.47	394.47	Computed (flow times concentration)		
Flow (1000m3/yr)	322.52	315.58	258.77	Average of measured flows (ERDC/Access data)		
Concentration (mg/L)	13.56	9.56	0.16	Average observed concentration at KV-28 based on full-time treatment		
Load (kg/yr)	4352.39	3017.22	40.37	Computed (flow times concentration)		
Flow (1000m3/yr)	101.97	114.55	88.36	Average of measured flows (ERDC/Access data)		
Concentration (mg/L)	0.01	0.10	0.09	Average observed concentrations at KV-32		
Load (kg/yr)	1.43	11.34	8.13	Computed (flow times concentration)		
Flow (1000m3/yr)	9.78	9.78	9.78	Estimated using regional hydrology study		
Concentration (mg/L)	61.00	99.60	58.60	Average observed concentration at KV-45		
Load (kg/yr)	596.75	974.37	573.28	Computed (flow times concentration)		
Flow (1000m3/yr)						
Concentration (mg/L)						
Load (kg/yr)						
Natural Spring into Christal Lake @ old MacKenno pumphouse Will become Mill water						
Flow (1000m3/yr)						
Concentration (mg/L)						
Load (kg/yr)						
Bellekeno Tailings						
Flow (1000m3/yr)	513.17	518.81	435.81	Computed (total of all inflows to element)		
Concentration (mg/L)	10.42	8.48	2.33	Computed (load divided by flow)		
Load (kg/yr)	5345.04	4397.41	1016.24	Computed load at Station KV-6		
INFLOW Totals						
OUTFLOWS						
Flow (1000m3/yr)	2131.48	2131.48	2131.48	Computed (total of all inflows to element)		
Concentration (mg/L)	0.217	0.166	0.258	Average observed concentrations		
Load (kg/yr)	462.53	353.83	549.92	Computed (flow times concentration)		
Flow at KV-6						
Element 2, Christal Creek between KV-6 and KV-7						
	2006	2007	2008	Source of Data/Comment	Zinc (dissolved)	
Flow (1000m3/yr)	8173	8173	8173	Estimated using regional hydrology study		
Concentration (mg/L)	0.150	0.158	0.097	Computed (load divided by flow)		
Load (kg/yr)	1228	1295	790	Computed (load at KV-7 minus loads at KV-53 and adits)		
INFLOWS						
Flow (1000m3/yr)	2131.48	2131.48	2131.48	From Element 1		
Concentration (mg/L)	0.22	0.17	0.26	From Element 1		
Load (kg/yr)	462.53	353.83	549.92	From Element 1		
Flow (1000m3/yr)	0.00	0.00	0.00	Average of measured flows (ERDC/Access data)		
Concentration (mg/L)	0.00	0.02	0.00	Average observed concentration at KV-53		
Load (kg/yr)	0.00	0.00	0.00	Computed (flow times concentration)		
Flow (1000m3/yr)	2131.48	2131.48	2131.48	Computed (total of all inflows to element)		
Concentration (mg/L)	0.22	0.17	0.26	Computed (load divided by flow)		
Load (kg/yr)	462.53	353.83	549.92	Computed load at Station KV-7		
OUTFLOWS						
Flow (1000m3/yr)	10304.68	10304.68	10304.68	Computed (total of all inflows to element)		
Concentration (mg/L)	0.164	0.160	0.130	Average observed concentrations		
Load (kg/yr)	1689.97	1648.75	1339.61	Computed load (flow times concentration)		
Flow at KV-7						

3.3.3.3 Bellekeno Current Water Balance

The Bellekeno Mine will utilize water from two basins within the Keno Hill watershed: that of Lightning and Christal Creeks, including Christal Lake. Presently, sources of adit and surface water addition occur at four nodes in the Lightning Creek watershed (Figure 3-3), and six on the Christal Creek watershed (Figure 3-4).

At Lightning Creek, inputs include the Keno 700 Adit via Hope Gulch; also, Charity Gulch, Thunder Gulch and the water treatment facility at the Bellekeno 625 Adit. Charity Gulch is not included as an input to this model as contributions of neither water nor contaminants are significant.

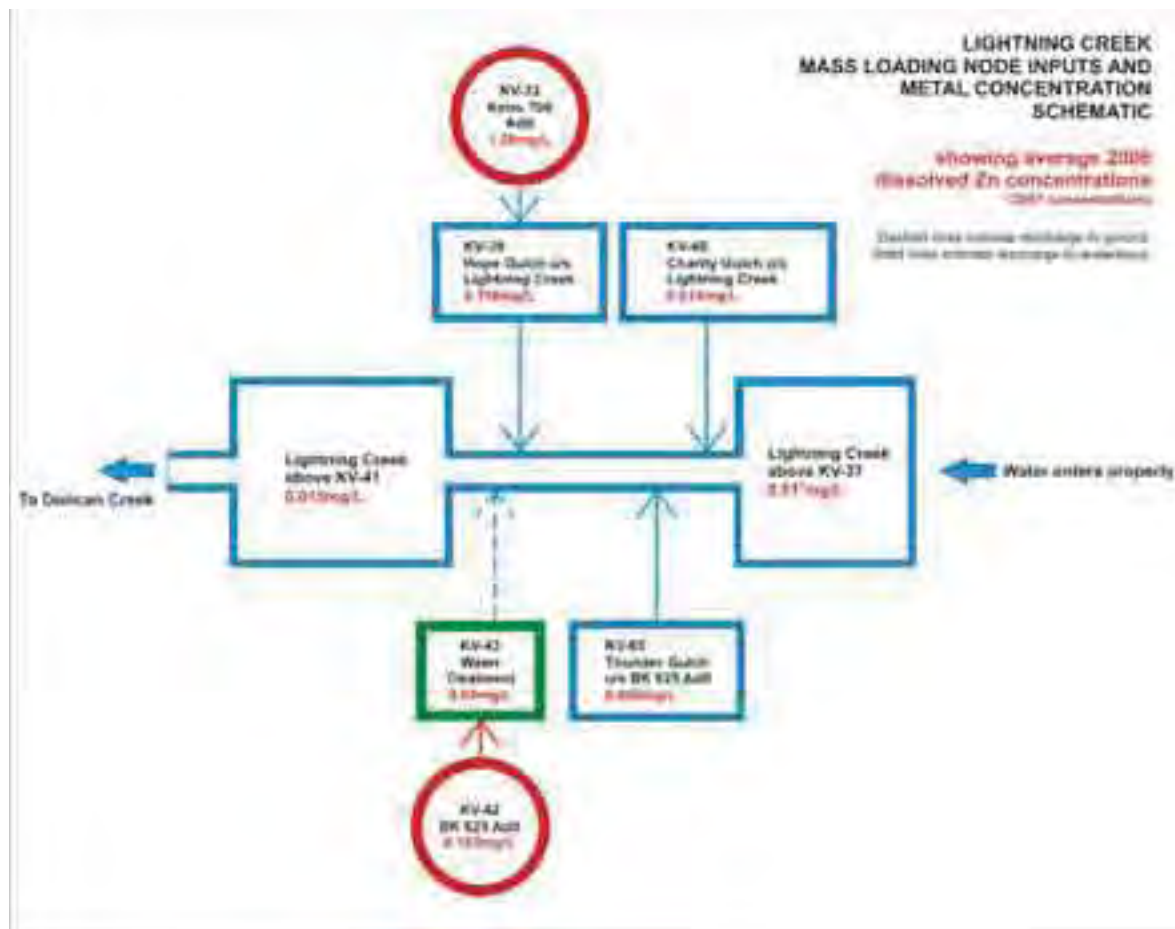
The Lightning Creek basin is measured via the outlet node station at the bridge at Keno City (KV-41). Annual dissolved zinc loads at this station measure on the order of 400 Kg/yr. Variation within the last three years is minimal (Figure 3-4). Within the Lightning Creek drainage mass balance, the most significant input is the node at Hope Gulch, which drains the Keno 700 Adit. This load is on the order of a few hundreds of kilograms of zinc per year. Lesser loads occur at Lightning Creek upstream of Hope Gulch (where water enters the Alexco property), at the Bellekeno 625 Treatment Site (where loads are very small in part because of treatment), and at Thunder Gulch.

At Christal Creek, inputs include the natural spring at Duncan Creek Road, Onek Adit, UN Adit, and the treatment facilities at the Galkeno 300 and 900 adits.

The Christal Creek basin drains a number of adits in the vicinity of Christal Lake. Christal Creek water is monitored via two stations: Christal Creek at Keno Highway (KV-6) and at Hanson Road (KV-7). KV-6 drains most of the adit water in this basin, as well as Christal Lake. KV-7 is roughly 7.5 kilometres downstream of KV-6, an interval into which only UN Adit drains. While most point sources of contaminants enter the Christal Creek drainage above KV-6, the station typically measures a few hundreds of kilograms of zinc per year, while KV-7 measures on the order of tens of thousands. This indicates that the path along which Christal Creek travels is a significant contributor of

contaminants. Historic releases of tailings from the old Mackeno tailings site and downstream migration of this metal load is thought to be the major contributor.

Figure 3-3 Current Lightning Creek Mass Loading Node Inputs and Metal Loading Schematic Showing Average 2008 Dissolved Zn Concentrations



3.3.3.4 *Stream Sediment Quality*

Composite sediment samples were collected at the Keno Hill Property in 2004 and 2007 in the Lightning Creek and Christal Creek drainages. Sample sites were selected from an exposed area of the stream bank, generally characterized by the finest grain size evident at the site. As part of the 2004 Keno Valley receiving water monitoring program, Laberge Environmental Services sampled stream sediments. Results of this sampling program are found within the report entitled “*Keno Valley Receiving Water Monitoring Program, 2004/2005*” prepared by Laberge Environmental Services (LES, 2005).

Sediment sampling was also conducted in by Laberge Environmental Services in 2007. See “*Keno Valley Sediment and Benthic Invertebrate Monitoring Programs, 2007*” (LES, 2008). Table 3-7 provides a summary of sediment quality data collected in 2004 and 2007 at the receiving water sites within the Lightning and Christal Creek Drainages.

**Table 3-7 Comparison of Metals in Stream Sediments Sampled in 2004 and 2007 in
Lightning Creek and Christal Creek Drainages**

STATION NUMBER		ARSENIC (ug/g)		CADMIUM (ug/g)		COPPER (ug/g)		LEAD (ug/g)		ZINC (ug/g)	
		2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
KV-37	Lightning Creek u/s Hope Gulch	55.9	115.4	0.538	2.7	19.7	41.6	27.2	40.0	61.6	125
KV-38	Lightning Creek u/s Thunder Gulch	72.2	433.3	10.81	31.2	28.6	56.0	222.7	642.0	535	1637
KV-41	Lightning Creek u/s bridge at Keno City	35.4	62.5	3.96	3.4	21.7	33.8	76.7	82.2	226	247
KV-6	Christal Creek at Silver Trail	1,643	284	145	28.2	83.3	41.3	4,067	954	12,140	1,483
KV-7	Christal Creek at Hanson Road	83.1	35	21.2	3.7	23.3	26.6	413	56	3,130	404
CCME Guidelines	Interim Freshwater Sediment Quality Guidelines	5.9		0.6		35.7		35		123	
	Probable Effect Levels	17.0		3.5		197.0		91.3		315	

Note: Values represent the mean for triplicate samples.

At KV-37, which is the background station on Lightning Creek as it is located upstream of existing mine workings, sediment metals levels have roughly doubled since 2004. At KV-38 (Lightning Creek above Thunder Gulch) metals levels have more than doubled. At the third station on Lightning Creek, KV-41 at the Keno City Bridge, metals levels increased since 2004 but not dramatically as at KV-37 and KV-38. At KV-41, the concentration of cadmium decreased from 2004 levels. As noted earlier the area is subjected to local placer mining activities and this may be influencing stream metal concentrations.

At Christal Creek, metal levels at both KV-6 and KV-7 have decreased between 2004 and 2007. Although Christal Creek has not been subject to placer mining activities, the dominant influence on sediment metal levels is the tailings produced by the historic Mackeno Mill at Christal Lake, which operated between 1953 -1957 and processed over 120,000 tons of ore and deposited tailings directly into Christal Lake and Christal Creek. See Section 2.2.14 for additional details on the history of the Mackeno Mill Site at Christal Lake. Considerable quantities of tailings still remain along the northeast shoreline of Christal Lake and are periodically remobilized in response to seasonal water level changes and beaver activity etc. Cleanup and environmental mitigation measures for these tailings will be included in district wide closure planning.

3.3.3.5 Surface Hydrology

Surface hydrology is discussed within Section 3.7 of the *Site Characterization Report*, which has been included within Appendix H in Volume 2 of this document. A more recent discussion of site hydrology was prepared for DIAND by Access Consulting Group in 2000 within the report entitled “*Compilation of Non-Mining Land Use & Water Quality Hydrology Information*”.

In 2008 Clearwater Consultants Ltd. were retained to update and refine the understanding of site hydrologic conditions that was developed in 1996. Analysis of streamflow gauging station data for Christal Creek, Flat Creek and Lightning Creek (KV7, KV9 and KV41 respectively) was conducted to produce a mean annual runoff (MAR) for each of the stations. Table 3-8 presents specific catchment areas, MAR, and runoff depth for the three gauging stations.

Table 3-8 Results of the Hydrological Update for Flat, Christal and Lightning Creeks

Site	Catchment Area	MAR	Average Runoff Depth
	km ²	m ³ /s	mm
KV-7	43.5	0.304	221
KV-9	56.5	0.304 - 0.352	170 - 197
KV-41	59.1	0.645	344

Based on comparisons with the latest site data, the original techniques and hydrological inputs used in 1996 were deemed appropriate in deriving site hydrological conditions.

3.4 BIOLOGICAL ENVIRONMENT

3.4.1 Aquatic Resources

Under contract to Access Consulting Group, White Mountain Environmental Consulting (WMEC) conducted fisheries investigations in the waters influenced by mining near the Keno Hill property between August of 1994 and August of 1995. The goal of these preliminary investigations was to obtain current data in order to assess habitat availability and utilization. Comprehensive studies on the fish resources in this area had not been conducted previous to this investigation. The only other information was reports of fish occurrence from Department of Fisheries and Oceans (DFO) files.

Fisheries surveys conducted in 1994 and 1995 for Lightning Creek indicate that Arctic grayling utilize the drainage with adult grayling preferential to clearer waters located upstream of Thunder Gulch. Further discussion of the results from the 1994 – 1995 fisheries investigations is found in Section 3.8.2 of the *Site Characterization Report*.

In 2006 WMEC conducted another fisheries investigation within fish bearing waters influenced by the mining on the Keno Hill property. This investigation involved the collection and identification of fish species as well as fish tissue studies. An excerpt from the report prepared by WMEC reads:

“Habitats in Lightning Creek have been subject to placer mining influences and are generally of poor quality. Limited utilization by Arctic grayling occurs in the fast flowing reaches with populations of sub adults and adults moving into placer created turbidity. The lower reaches of Lightning Creek, near Duncan Creek support populations of Arctic grayling, slimy sculpin and adult round whitefish, these fish likely winter in the stronger flows downstream of Duncan Creek.”

An investigation into fish and fish habitat in the vicinity pertaining to the Bellekeno project for proposed mining activities was conducted by Access Consulting Group in September of 2008. The 2008 study investigated fish and fish habitat at numerous sites including Christal Lake, multiple sites on Christal Creek, two sites on Lightning Creek and one site on Flat Creek. These investigations confirmed the presence of slimy sculpins (*Cottus cognatus*), Arctic grayling (*Thymallus arcticus*), and one juvenile northern pike (*Esox lucius*). Suitable sites were assessed via minnow traps and electrofishing, when possible.

Fish samples were collected and retained for metal analyses from three sites. Sediment samples from the Christal Lake outlet area were also collected for metal analyses. Due to recent prolonged rainfall, all streams encountered were experiencing increased flow, velocity and turbidity, making effective sampling less efficient than would normally be expected. In addition, one area of Christal Creek was evaluated for the presence of potential barriers to fish movement, in the form of old wooden bridges, as had been reported in previous investigations. A summary of results from the 1995, 2006 and 2008 fisheries investigations is provided in the following sections.

3.4.1.1 Christal Lake

Christal Lake is a small, shallow sub-alpine lake with a silt bottom covered with vegetation. Beaver activity at the lake outlet controls water levels in the lake. An old tailings pile (Mackeno tailings) is located on the north east corner of the lake with some tailings submerged in the lake. During each of the three investigations, slimy sculpin was the only fish species observed in Christal Lake.

3.4.1.2 Christal Creek

In 2008 three locations along Christal Creek were investigated including at the Keno Road Crossing (KV6), the Hanson Lake Road Crossing (KV7) and at a walk-in site accessed via a gravel pit off the Hanson Lake Road (C4). These sites were also investigated in 1995 and 2006 as well as an additional site at the mouth of Christal

Creek where it joins with the South McQuesten River. This site was not revisited in 2008.

Slimy sculpin was the only fish species recorded in Christal Creek at the Keno Road Crossing (KV6) in 1995 and 2006 and were observed in relative abundance. In 2008 no fish were captured at this location. It is worth noting that due to an extended period of precipitation all streams in September 2008 were experiencing high, fast flow with increased turbidity during the investigation, which had some impact on the effectiveness of sampling at the time.

Investigations at site KV7 in Christal Creek at the Hanson Lake Road crossing resulted in no fish observed in 2006 and 2008. A single Arctic grayling juvenile was recorded at this site in 1995.

Site C4, accessed off the Hanson Lake Road is located approximately 4.7 km downstream of Christal Lake. A number of fish barriers have been observed upstream of this site, three of which remain and appear to completely block upstream fish movement. No fish were captured at this location in 2008 while Arctic grayling were observed below the barriers in 2006, although were less common and more widely dispersed than in 1995.

Christal Creek at the mouth (site KV8) was investigated in 1995 and 2006. In 1995 and 2006, slimy sculpin, Arctic grayling, and burbot were recorded in this area, although no fish were recorded during spring investigations likely due to high water levels.

3.4.1.3 Flat Creek

Fish utilization in Flat Creek (KV9) has been reported as being low subsequent to assessments performed in 1974 and 1995. In 1995, Arctic grayling, burbot, and slimy sculpin were recorded during summer and fall investigations with no fish observed during spring investigations.

During 2006 no fish were captured in the spring with a few slimy sculpin caught during August. During the summer months the lower reach of the creek had been colonized by slimy sculpin, burbot, Arctic grayling and northern pike. Juvenile Arctic grayling were more common in 1995 than in 2006. By September very few sculpin remained and no other species were present. Adult sculpin were recorded near the Shangai Road during all 2006 sample periods indicating the presence of some over-winter habitat further from the South McQuesten River confluence. During 2008 a single northern pike was captured.

3.4.1.4 *Lightning Creek*

Lightning Creek continues to undergo significant channel changes as a result of placer mining. For this reason the sample location used in 1995 could not be revisited in 2006 and two new locations were selected to allow more representative sampling of Lightning Creek. These sites were revisited in 2008.

In 1995 the reach of Lightning Creek surveyed extended from just downstream of Keno City to approximately 200 m above the influence of Thunder Gulch, which was being placer mined. Adult Arctic grayling were found upstream of turbid water from Thunder Gulch and sub-adult Arctic grayling were observed in the turbid waters downstream of Thunder Gulch.

In 2006, two new stations were situated adjacent to the Keno City campground (LgT K) and just upstream of the confluence with Duncan Creek (LgT D). Both sites had been placer mined in the past and have man made channels. The fast flowing waters of LgT K contained Arctic grayling while the slower waters of LgT D had greater species diversity with slimy sculpin, round whitefish, and Arctic grayling common in August and September.

In 2008 no fish were observed in Lightning Creek adjacent to the Keno City campground while slimy sculpin and Arctic grayling were observed upstream of the confluence with Duncan Creek.

3.4.1.5 *South McQuesten River*

Fisheries investigations were conducted on the South McQuesten River in 1995 and 2006. In 2006, five sites along the river were sampled between McQuesten Lake and downstream of Haggart Creek and covered strategic locations such as downstream of the confluences with Flat and Christal Creeks.

Arctic grayling captured near the Haggart Creek confluence in June were assessed for maturity and spawn timing, which was determined to be around May 27. On July 31, Chinook salmon were also observed near the confluence with Haggart Creek. Fish utilization of the South McQuesten River was found to generally be higher downstream of the confluence of Haggart Creek both in terms of number of fish and species diversity. Other fish species observed in 2006 include slimy sculpin, round whitefish, northern pike, Arctic lamprey and burbot.

3.4.1.6 *Benthic invertebrates*

Benthic invertebrate sampling has taken place sporadically over the years, dating back to 1975. Environmental Protection Services carried out biological monitoring in the area in 1975, 1985 and 1990. In compliance with past water licences, various consultants carried out benthic sampling annually between 1986 and 1990 at four locations. As part of a biological monitoring survey conducted in 1994 by LES, benthic invertebrate sampling was also conducted. LES also conducted stream sediment and benthic invertebrate monitoring in 2007. All study methodologies used artificial substrate samplers with a colonization period of five to six weeks with triplicate samples collected at each site. As the same methodologies were employed for the various sample events, legitimate comparisons can be made. LES has conducted this comparison within the report entitled "*Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007*" prepared in March 2008 (LES, 2008).

There is a data gap for several years for the upstream sites, KV-1 and KV-6. Only KV-1 (South McQuesten River u/s of Christal Creek) represents a true background site. Populations were very low here in the first years of sampling but were far greater in recent years. It is not known why populations were so depressed in 1975 and 1985.

Populations at Flat Creek (KV-9) and South McQuesten River d/s of Flat Creek (KV-4) were depressed during the latter years of operation of the mine (operations ceased in 1989). Populations at both sites appear to have recovered somewhat in 1994 and 2005. Populations fluctuated at South McQuesten River u/s of Flat Creek (KV-3) over time with higher populations documented during the recent surveys. Populations increased significantly in Christal Creek near the Keno highway (KV-6) in recent studies as well.

Diversity has fluctuated at the sites. The communities on the South McQuesten River generally are more diverse than those on Christal and Flat Creeks. The diversity of the communities at KV-3 and KV-4 has been relatively uniform in recent years.

Diptera has usually been the dominant order at all of the sites over time. Plecoptera shared dominance at KV-3, South McQuesten River u/s Flat Creek, on several occasions. There has been a shift in recent studies at KV-1 where Ephemeroptera has also been dominant. The community at Flat Creek at the mouth, KV-9, saw the greatest shift in dominance over the years. Homoptera (true bugs) and Oligochaeta (aquatic earthworms) have shared dominance here during some of the surveys. Based on the numbers, diversity and the composition of the community, Flat Creek is the most impacted site of those examined in Table 3-3.

In summary with the limited data available, it appears that benthic populations were negatively affected during the years of mine operation, and have significantly recovered since. Without corresponding data from the background site (KV-1) during this time period it can not be stated definitively if this was a result of mining, or if natural regional conditions caused the depressed populations.

LES (2008) offers the following summary of benthic invertebrate sampling in 2007:

Benthic invertebrate populations were robust and healthy in the South McQuesten River and Lightning Creek drainages. There was good representation from the groups of insects that are known to be sensitive to chemical pollution, indicating healthy environments in these areas. There was a very high population at Christal Creek u/s of Keno Hwy, KV-6; however, the

community was the least diverse of those studied. Populations at the other two sites on Christal Creek and at Flat Creek, KV-9, were depressed. It appears that the high concentrations of metals in the stream sediments at Flat and Christal Creeks are negatively impacting the health of the benthos communities located on these drainages.

3.4.1.7 Wildlife

The Keno Hill Silver District supports a variety of wildlife including ungulates, fur-bearers, small mammals, upland game birds and waterfowl. Results of moose surveys conducted between 1993 and 2006 as well as an annual ground based monitoring program (2001 – 2006) generally indicate that the density of moose in the Mayo-Elsa-Keno area is higher than the Yukon average. Small mammals common to the area include muskrat, beaver, ground squirrel, red squirrel, varying hare, fox, mink, weasel, vole and shrew. Less common are porcupine, river otter and chipmunk. Alpine areas have local populations of hoary marmot and pika as well as a unique population of butterflies. Large carnivores include black bear, grizzly bear, lynx and timber wolf. This area is included in the range of the Mayo woodland caribou herd, although only anecdotal information on the herd is available. Caribou and sheep are also observed on rare occasion.

A summary of the key terrestrial resources and resources utilization within the regional area is provided:

- the area is characterized by widespread discontinuous permafrost with a variety of habitat types including low wetland areas to scree dominated mountainous areas;
- a wide variety of wildlife is supported (above);
- the area has a long history of resources utilization by local communities and first nations with exploitation of local wildlife populations; and
- local observations indicate that wildlife habitat is regenerating and wildlife populations are being maintained.

This information has been summarized from government reports and with previous meetings held between UKHM, the NNDFN, Mayo Renewable Resource Council and the community. Local traditional knowledge was previously documented and utilized. Refer to Section 3.5 of the *Site Characterization Report* (see Appendix H in Volume 2) for further discussion on wildlife in the Keno Hill area.

3.4.1.8 Species at Risk

A review of the species at risk in Yukon was considered in accordance with the Species at Risk Act (2002) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2004). Species at risk in the Yukon and all of Canada, as listed on the YG, Department of Environment web site:

<http://environmentyukon.gov.yk.ca/wildlifebiodiversity/speciesrisk.php>

and whose ranges could conceivably overlap within the study area include:

- peregrine falcon *Anatum* subspecies (Threatened);
- grizzly bear, wolverine, short-eared owl (Special Concern); and
- mule deer, elk, cougar (At risk in Yukon but not elsewhere).

No wildlife species at risk have been observed within the area nor were any key habitats for these species at risk encountered.

3.4.1.9 Vegetation

The Keno Hill Silver District is located within the Yukon Plateau-North ecoregion. The region is characterized by discontinuous widespread permafrost, with much of the area poorly drained and underlain by perennially frozen ground. Many valleys include peatlands, palsas, fens and meadows of sedge tussocks. Upper slopes may be covered with scree material, with treeline occurring at 1,350 to 1,500 meters.

Predominant tree cover in the area consists of white spruce (*Picea glauca*), black spruce (*Picea mariana*) and willows (*Salix spp.*). Less commonly occurring trees are trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white birch (*Betula papyrifera*). Alpine fir (*Abies lasiocarpa*) is common at higher elevations and alder (*Alnus crispa*) occurs along creek banks and in disturbed areas. Isolated pockets of lodgepole pine (*Pinus contorta*) can also be found.

Most south-facing slopes are covered with white spruce along with aspen, balsam poplar and willows, while north-facing slopes are underlain by permafrost and covered with stunted black spruce. Much of the drier south-facing slopes have been burned at some point.

The shrub layer on the north facing slopes and peatbog areas consists of dwarf birch (*Betula glandulosa*), willows (*Salix spp.*), shrubby cinquefoil (*Potentilla fruticosa*), crowberry (*Empetrum nigrum*), cloudberry (*Rubus chamaemorus*) and dwarf raspberry (*Rubus acaulis*), as well as ericaceous shrubs such as Labrador tea (*Ledum decumbens*), bearberry (*Arctostaphylos rubra*), blueberry (*Vaccinium uliginosum*), cranberry (*Vaccinium vitis-idaea*) and bog cranberry (*Oxycoccus microcarpus*). The drier south-facing slopes have a shrub layer which includes rose (*Rosa acicularis*), twinflower (*Linnaea borealis*), and gooseberry (*Ribes oxycanthoides*).

Alpine areas support a variety of plant communities. The low ground vegetation mainly consists of mat forming plants such as moss campion (*Silene acaulis*) and ericaceous shrubs such as heather (*Cassiope spp.*). A variety of alpine flowering forb species are also found. Dry areas, particularly well-drained rocky alpine sites, have extensive lichen development.

Wetland species are mostly graminoids, including sedges such as *Carex aquatilis* and *Carex lugens*, cotton-grass sedges (*Eriophorum augustifolium*, *Eriophorum russeolum* and *Eriophorum vaginatum*), and grasses such as reed-bentgrass (*Calamagrostis canadensis*). Forb species such as Sudeten lousewort (*Pedicularis sudetica*), wintergreen (*Pyrola spp.*) and coltsfoot (*Petasites spp.*) are also scattered throughout wetland areas.

Aquatic plants commonly found in the area include water-milfoil (*Myriophyllum exalbescent*), pondweed (*Potamogeton richardsonii*), mare's-tail (*Hippuris vulgaris*) and bur-reed (*Sparganium spp.*).

Common horsetail (*Equisetum arvense*) is the predominant species of vegetation occurring on the unsubmerged portion of the Elsa tailings impoundment. Squirrel-tail grass (*Hordeum jubatum*) is found in large patches in the higher, drier areas. Hairgrass (*Deschampsia caespitosa*) and willows (*Salix spp.*) are scattered throughout. Sedge (*Carex aquatilis*) is the predominant plant in the wetter tailings and shallow water, along with occasional occurrences of willow, water horsetail (*Equisetum arvense*) and sloughgrass (*Beckmannia syzigachne*).

4.0 SOCIO-ECONOMIC CONDITIONS

4.1 HERITAGE RESOURCES

The Keno Hill Silver District includes numerous old historic mine workings, the old company town of Elsa and the hamlet of Keno City. ERDC's closure plan for the property will recognize the heritage potential of a number of these older historic workings and are not specifically addressed here. NNDFN has interests of some specific areas, but primarily the entire region of the Keno Hill Silver District is of importance as it has been a major factor in the shaping of the local communities (Mayo and Keno City). The NNDFN Traditional Knowledge Policy assists in the further development and strengthening of the protection and preservation of traditional knowledge. Through our cooperation agreement, Alexco is working with NNDFN on ensuring that NNDFN Traditional Knowledge is integrated into ERDC's closure plan for the district.

Alexco has had discussions with the local Silver Trail Tourism Association, YG Heritage Branch and NNDFN regarding the status of these older mine workings and the tourism potential. Older historic mining sites which are of interest have been identified. The Company is prepared to work with the Silver Trail Tourism Association, local Chamber of Commerce, NNDFN and YG Heritage Branch to select sites for restoration and possible tourism potential. In partnership with the Department of Indian Affairs and Northern Development (DIAND) and YG, Alexco has initiated a program of remediating high level physical hazards risks throughout the Keno Hill district. The NNDFN has been involved in these discussions and are routinely updated of onsite activities. Alexco plans to support these initiatives, while maintaining adequate public safety and closure objectives for the property. Please refer Section 4.1.1 for discussion of a heritage resources protection plan.

4.1.1 Heritage Resources Protection Plan

Alexco recognizes the importance of the historic and heritage values that characterize this historic mining district. In fact, the historic and heritage aspects of the Keno Hill Silver District certainly enhance our pride and enjoyment of the area while we pursue the

economic revitalization of the District. As miners, we naturally hold historic mining evidence and artifacts in high regard.

Consideration of heritage resources is an important component of the District wide Closure Plan being developed by Alexco and the governments of Canada and Yukon and the NNDFN. Multi-stakeholder heritage assessment of Keno Hill last year, as a component of our Physical Hazards Reduction Program, identifying specific elements of the Keno 700 mine site, as well as Comstock-Keno, the Keno 200, and the Porcupine Mine. Although much of these sites will be remediated, there were several items of interest to various the stakeholder groups who participated in the preliminary assessment.

In general, the process developed in conjunction with Type II Abandoned Mine Sites and YG Heritage and NNDFN follows the protocol as presented as Figure 4-1 *“Protocol for Site Remediation of Keno Hill Mine Sites”*.

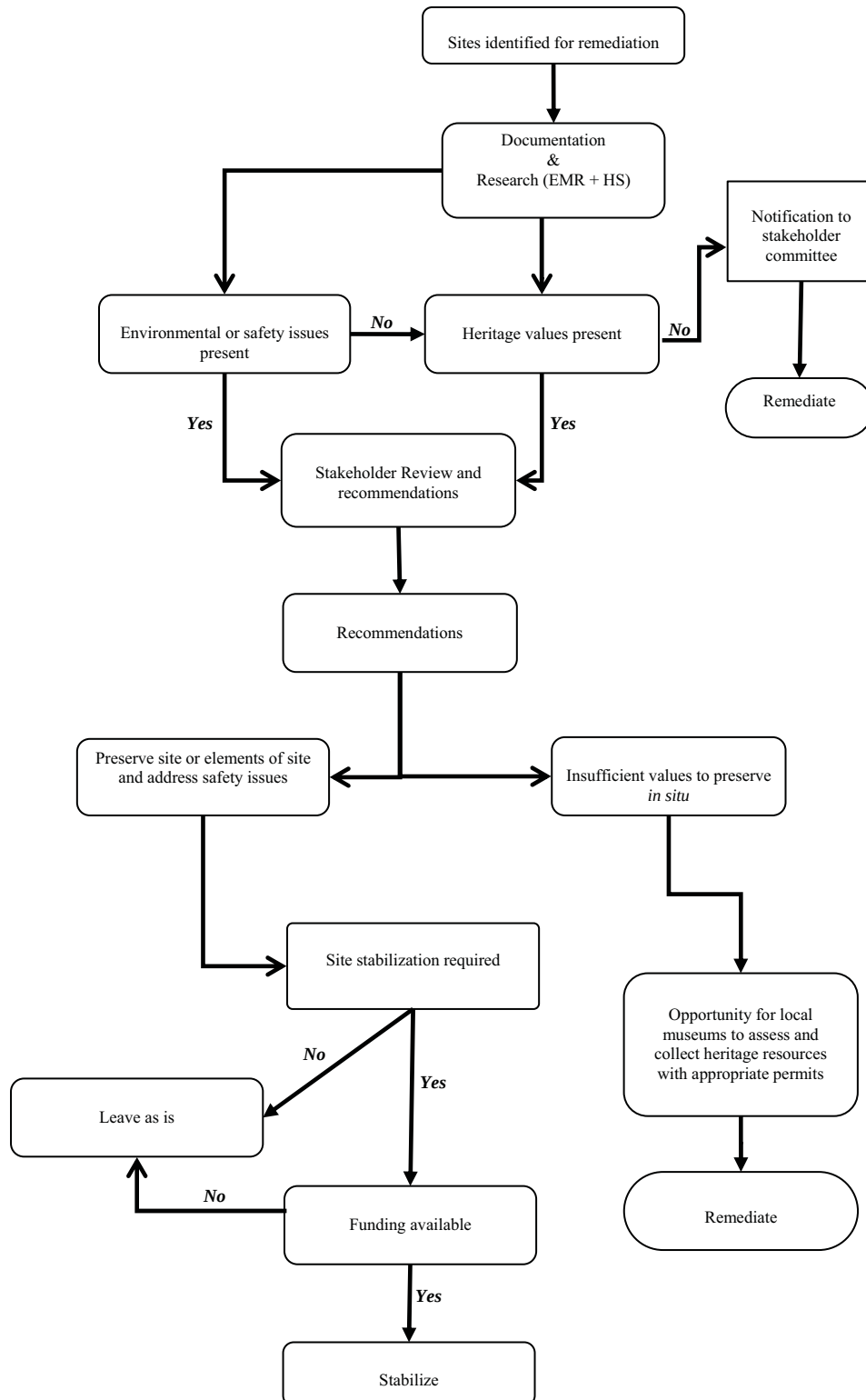
Documentation of sites includes: locating with GPS, photographs, cataloguing, initial condition, environmental and public safety assessment, historical research.

The Stakeholder Committee struck to oversee this work includes ERDC, First Nation of the Nacho Nyak Dun, the Silver Trail Association, YG – Yukon Type II Abandoned Mines staff, and Yukon Historic Sites staff.

Local Museums in the area are the Keno City Mining Museum in Keno or the Binet House in Mayo.

Removal of any heritage resource will require a Scientists and Explorers Permit from YG Department of Tourism and Culture.

Figure 4-1 Protocol for Site Remediation of Keno Hill Mine Sites



Alexco will prepare a detailed Heritage Resource Management Plan for the Bellekeno project area as part of detailed planning during the Quartz Mining Licencing stage. In general this plan will address the following:

- Protection of Historic, archaeological and Palaeontological resources;
- Development of a protocol to be followed during the discovery of these resources to ensure proper resource protection and reporting; and
- Heritage awareness training of employees.

4.2 LAND USES

The regional land use within the Keno Hill Silver District has evolved from a long history of occupation and development. Significant development activity and local population increases have historically occurred in the area. Historically, regional land use has been influenced by the following activities:

- the area has been utilized by First Nations for centuries;
- a variety of anthropogenic activities have occurred throughout the region including both hard rock and placer mining, forestry, hunting and gathering, transportation, recreation and residential;
- a total of 5 Trapline concessions (RTC#43, RTC#44, RTC#81, RTC#82 and RTC#85) fall entirely or partially within the regional area (currently there is some active trapping occurring on Galena Hill);
- numerous historic mining related building and structures exist on the property and are of interest to local community groups and government; and,
- the area is known and used for recreational pursuits and has potential for tourism development.

Today the Hamlet of Keno City is much smaller than it was historically and no major population influx is expected in this community. The maintenance of a dedicated community to support mining activity is now considered unnecessary and inappropriate for a mining company. An increase in development activity could affect the community of Mayo which is now considered the major population center for the area.

Historic increased human activity in the area may have negatively impacted local trapping concessions in the area. This is not considered a long term impact as local community populations have been reduced. Continued site remediation efforts to improve wildlife habitat will also improve trapping efforts.

It is expected that the area will continue to see both hardrock and placer exploration activities. Alexco's renewed exploration program with supporting camp at the Keno Hill Mine property near Elsa is expected to continue providing local employment opportunities.

A placer mine operated by Bardusan Placers Ltd. (headquartered in Mayo, Yukon) is located along Lightning Creek upstream of Thunder Gulch. The Water Licence that supports water use for this activity (PM04-408) expires May 1, 2013, and specifies that a maximum of 5,400 m³/day may be obtained from Seepage Pond, Lightning Creek and Thunder Gulch. Water / wastewater is discharged back into Lightning Creek and Thunder Gulch.

Alexco completed a Joint Use Agreement with Bardusan Placers Ltd. which includes road use and general agreements regarding exploration in the area.

Historic underground workings on the Keno Hill Silver District once supported numerous small scale logging operations mainly to provide timber for mine development. Local estimates for timber use in underground developments is approximately 5 million board feet. The potential for further logging exists as the area has regenerated over the years, however Alexco's local timber requirement will be limited due to the newer mining method which reduces timber use.

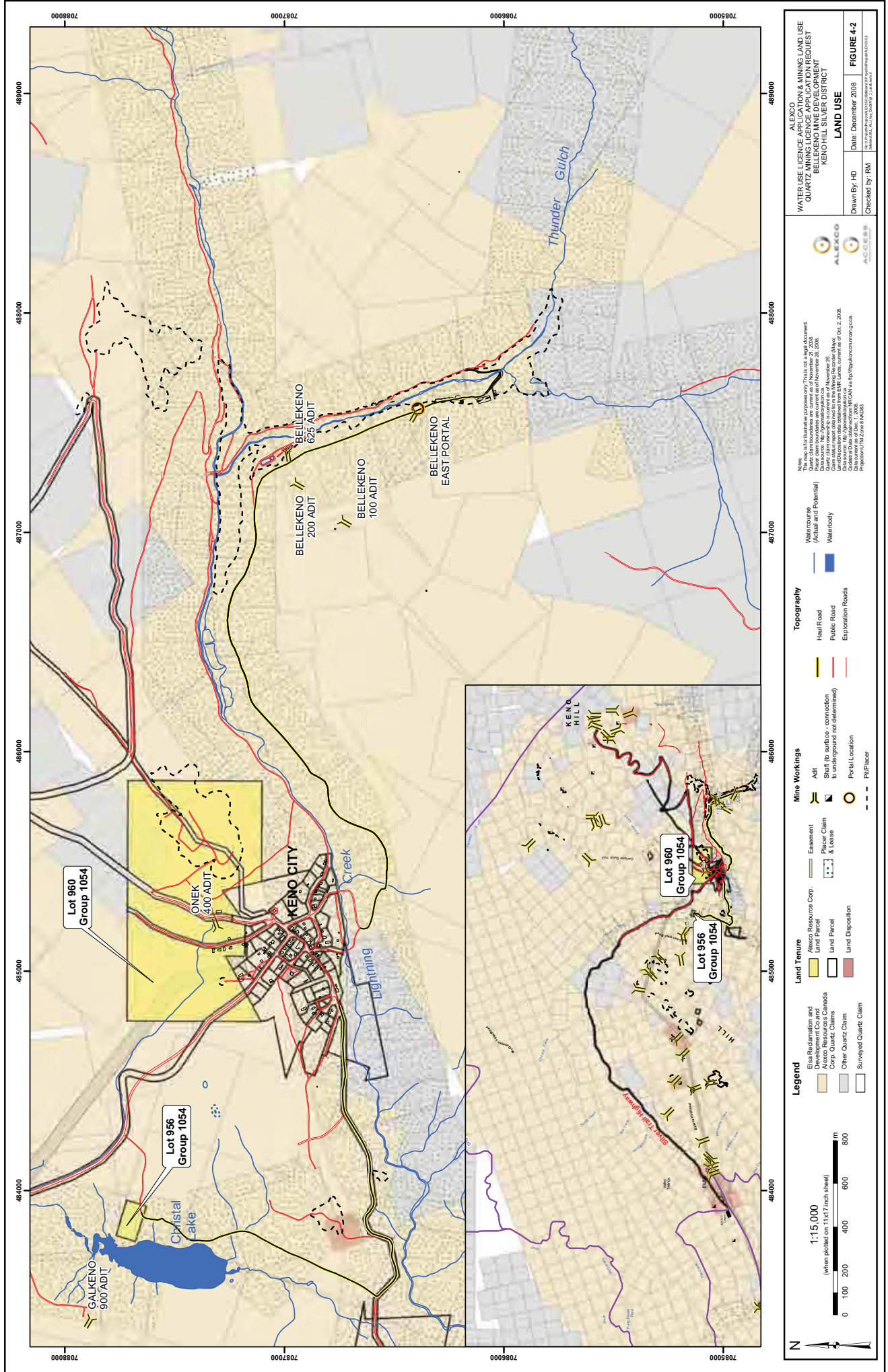
It is also expected that the area will continue to see both tourism and recreational uses. The local tourism association is actively pursuing options for development in the area. The remnants of past mining activities could enhance some of these initiatives in this regard.

Alexco is aware of and supports recent work conducted by the Silver Trail Historical Association in documenting heritage potential for the area. Alexco Resource Corp. recently contributed financially to the republication of Dr. A. Aho's book "*Hills of Silver – The Story of the Mighty Keno Hill Mine*" (Aho, 2006).

The Keno Hill Property is located within the NNDFN traditional territory. The NNDFN R-Block 20B is situated northwest of the project area. Land tenure in the study area is composed of various mining claims and leases, and commercial, recreational, and residential surface properties (leases, titled fee simple and crown grants, etc.). There are several other quartz and placer claim holders in the area, many of which lie within or adjacent to the area being explored. Regional land status and current land use in the area is described in Table 4-1 and presented visually in Figure 4-2 for the Bellekeno area.

Table 4-1 List of Current Land Use Activities near Keno Hill Silver District

Current Land Use Activities near Keno Hill District		
General Area		
Activity Type	Holder/Operator	Comments
Outfitting		
ROC #4	Alan Young	Midnight Sun Outfitting Ltd. - Whitehorse
ROC #7	Fred Lackie	Rogue River Outfitters Ltd. - Duncan, BC
Tourism		
Charter Air Service	Mayo Flying Service	Sport Fishing Excursions
Charter Air Service	Black Sheep Aviation	Sport Fishing Excursions
Charter Air Service	Action Aviation	Sport Fishing Excursions
Camping		
Recreational	YTG	Hanson Lake (Lease #2973, 0.81ha.)
Campground	YTG	Land Lease #1241 Campground at Hanson Lake (Lot 1064, Group 1054, Hanson Lake 49.30ha.)
Keno Valley West (NTS Quad. 105 M/13)		
Activity Type	Holder/Operator	Comments
Trapping Concessions		
RTC #43	Alvin Peterson, Peter Hart	
RTC #44	Keith Hepner, Rafe Hepner, Sonia Stange	Includes 1.0 ha. Trappers Residence on Cache Creek, 1km south of McQuesten Lake
RTC #82	No Listing, not settled	Concession Transfer Pending Estate Settlement (Current Holder Deceased)
RTC #85	Dennis Buyck	Resident of Mayo
RTC# 81	Bruce MacGregor, Mary Beattie	
Land Tenure		
Lease #1679	ERDC	Elsa Campsite (56.16ha.)
Lease #1734	ERDC	In Vicinity of Elsa Camp (26.82 ha.)
Other	ERDC	Two other surface Leases East of Elsa at Hector Calumet Adit and No Cash Adit (see Figure 3)
Keno Valley East (NTS Quad. 105 M/14)		
Activity Type	Holder/Operator	Comments
Tourism		
Historic Interpretation	Mike Mancini	Keno City Mining Museum
Hiking and Scenic Viewing	Silver Trail Tourism Association	Various hiking trails and scenic viewing area in around Keno City and along the Silver Trail
Outdoor Adventure Guiding	Dick Brost	Subarctic Wilderness Tours - Keno City
Outdoor Adventure Guiding	Keno City Packers	Keno City Packers
Camping		
Keno City Community Campground	Keno City Community Club	Vicinity of Keno City at Lightning Creek
Trapping Concessions		
RTC #83	Christine Hager	Registered Category 1 (NND authorized)
RTC #86	Michael Arden	
Land Tenure		
Lease #1660	ERDC	Galena Hill (41.81ha.)
Lease #1672	ERDC	Lot 24, Group 1054, (18.55ha.)
Lease #1661	ERDC	Lot 223, Group 1054, (18.29ha.)
Other	ERDC	Two other surface Leases at Keno 700 Adit and Keno Summit (see Figure 4)
Block Land Transfer	YTG	Keno City PC 1987-1703 (Various fee simple properties, YTG - Fire Hall reserve, YTG- communications reserve Northwest Tel/Canadian Broadcasting Company)



4.3 SOCIO-ECONOMIC CONDITIONS

The study area has been the focus of intensive and wide spread mining and mining related activities that affect NNDFN for the past eighty or so years. Consequently, the intervening years can be characterized as a time when mining and related activities have replaced virtually all other activities in the area. Similarly, and in spite of the fact that there will be an effort to improve the general quality of the area, it is extremely unlikely that any interest will be developed in the establishment of outfitter or hunting and fishing camps in the immediate project area. Currently, the land use is primarily for mining, trapping and hunting by members of the local community.

With the shutdown of the mining operations in the 1980's, there was an evacuation of the population of the Hamlet of Elsa, its housing stock, and much of the domestic infrastructure that was in place when the community flourished. Road access to Keno City has not changed, nor has the power and other services to Keno City. Road access to the workings on Galena Hill, Sourdough Hill and Keno Hill is currently maintained as required for care and maintenance, other exploration and access for other legitimate mining interests should not be impaired. Access for potential users of other resources in the area such as forestry, recreation, and the like, is available since access through the property to Keno City and beyond, or to the Hanson Lakes and beyond, is mostly on government roads. Access to some areas may or may not be restricted depending on interest requirements. Long term site access will be addressed as part of the closure plans. Present Mining Land Use Permit for Bellekeno exploration required an access management plan which Alexco is currently working on with the local community and NNDFN.

Alexco's activities on the Keno Hill property in the future are expected to bring about an economic upswing in the local area. Increasing expenditures for exploration, development and production, as well as reclamation work are expected to be significant in the future (next 1-25 years). In addition, continued care and maintenance expenditures will benefit the local economy. Currently six employees work on a rotation full time basis for the care and maintenance program. All of these full time care and maintenance employees reside in Whitehorse, Dawson City, Keno City, or Mayo.

Seasonally the number of employees has increased to forty-five during the exploration season and will increase to approximately 150 during production/exploration.

Public awareness and transparency of proposed mine development in the Keno district is integral to Alexco's operations. The office in Elsa is open to local visitors and general inquiries.

4.3.1 Mayo

The following socio-economic information for Mayo has been summarized from the "Yukon Community Profiles" website, which was produced by Human Resources Development Canada in partnership with the Yukon Chamber of Commerce:

Website address: <http://www.yukoncommunities.yk.ca>

The community of Mayo is located at the confluence of the Mayo and Stewart Rivers, about 400 km northwest of Whitehorse, serves as a distribution and service centre for the surrounding area. Mayo is also the administrative centre for the NNDFN. In addition to being a tourist destination, the community is a base for wilderness and mining tourism, canoeing, hiking, big-game hunting and fly-in fishing.

In 2003, the average population of Mayo was 409, which is down from an average of 504 in 1997. The NNDFN comprise 60 % – 70% of the community population. In Mayo more people are over the age of 65 (11%), compared to the Yukon average of 7%. There are fewer people proportionally in the 25 to 44 age group, which reflects some movement out of the area by people looking for work elsewhere.

In cooperation with industry (developers/companies), the NNDDC is establishing a number of training, work, and apprenticeship programs in the community. The First Nation works toward participation in land developments in their traditional territory and employs approximately 60 people.

The economy of Mayo is linked to the provision of services to the people of Mayo and the surrounding areas. One third of the jobs in the community are related to government services, including First Nation and territorial administration. Placer mining and mineral exploration also provide an economic base for the community. Construction is a variable sector, and provided a significant share of employment in 2001. Tourism in the Mayo area is a growing industry. Accommodations, food services, recreation services (i.e. guiding and outfitting) and retail cater to tourists provide work for local residents. Tourist attractions in the area have to do with the history of mining around Mayo and Keno City including a mining museum and interpretive centre. Camping and hiking, hunting and fishing, and other outdoor pursuits comprise the activities undertaken by tourists in the area.

Some of the community services in Mayo include:

- NNDFN main administrative offices including NNDFN lands/environment office;
- J.V. Clark elementary level to post secondary level school with Yukon College Mayo Campus;
- Mayo Nursing Station;
- RCMP detachment;
- Community social services (GY Health and Social Services, Yukon Housing Corporation, Yukon Family Services (Dawson City), NNDFN social services);
- Village of Mayo community and municipal services (volunteer firefighting services, recreation and leisure services, etc.);
- Ambulance services (provided by community volunteers in partnership with GY);
- YEC supplies electric power from the Mayo hydroelectric dam;
- Mayo airport with weather station;
- GY Department of Environment office, Energy, Mines and Resources office, and a Mining Recorder's office;
- YESAB Designated Office;
- Post office;
- Internet services;
- Banking services;

- Tourist services (two motels, three campgrounds, two restaurants; two service stations, a store, businesses catering to wilderness tours and fishing);
- Helicopter, float-plane and taxi services; and
- The Silver Trail Area, including Keno, offers a lodge, cabins and eating facilities for tourists.

4.3.2 Keno City

Keno City is located within the Keno Hill Silver District and has approximately 12 permanent residents. Keno City has a small but steady seasonal tourism economy based on recreational use of the area. In addition to a comprehensive mining museum, which provides excellent historical perspective on the Keno Hill Silver District, a population of butterflies also exists in the region and attracts interested individuals. The “signpost” viewpoint on Keno Hill Summit also attracts numerous tourists throughout the summer months. In recognition of this, significant efforts have been made by Alexco to ensure public safety around historic sites. Alexco has also designed its operations specifically aimed at minimizing impacts to this community. For example, by designing the mill facility away from the community and using existing access and roads thus will reduce the impacts on Keno City.

4.4 NNDFN EXPLORATION COOPERATION AGREEMENT

On September 25, 2007 Alexco and the NNDFN announced that they had entered into a Negotiation Agreement relating to the activities of Alexco's wholly owned subsidiary, ERDC on and around the former United Keno Hill Mine property. The Negotiation Agreement provided for the negotiation and settlement of two further agreements between Alexco and the NNDFN (an Exploration Cooperative Agreement and an IBA).

The Negotiation Agreement provides for collaboration by Alexco and the NNDFN as well as support in principle by the NNDFN in relation to current activities at the property. It contemplates that Alexco and the NNDFN will work collaboratively in good faith with one another in order to facilitate and ensure the meaningful participation of the NNDFN in site activities and regulatory processes concerning the Keno Hill Project. Under the

Negotiation Agreement, Alexco has provided funding to the NNDFN to cover their costs of negotiation expenses.

An Exploration Cooperative Agreement concerning the care and maintenance and exploration activities currently undertaken by Alexco has been negotiated and was signed May 22, 2008. The Agreement provides the following joint commitments:

- **Project Certainty** – in exchange for commitments set out in the Agreement, NNDFN commits to support the Keno Hill Silver District project, including participating constructively in all current and future permitting & regulatory initiatives.
- **Relationship Building** – the Agreement not only provides the groundwork for current employee and community relations, but also sets the stage for future agreements as Alexco advances the project to production;
- Establishes the **Cooperative Engagement Process** – as a new and mutually beneficial consultation process that provides for continual engagement on all aspects of the project;
- Mandates the development and implementation of a comprehensive **Drug and Alcohol Policy** and Employee Assistance Program to ensure a safe and healthy working environment;
- Establishes the framework for our **Business Development Commitment** by both parties to jointly identify and pursue contracting and partnering opportunities as the project progresses. The commitment is given life through quarterly business meetings between senior site staff and NND Liaison/NND Development Corp to discuss forecasted contracting opportunities as well as potential partnering opportunities;
- Assurances for **Employment and Training** to enhance the socioeconomic development of NND citizens. NND will establish a **Human Resource Inventory** to facilitate hiring of qualified NND Citizens. Alexco will preferentially hire NND citizens who are qualified to take employment at the minesite. On the job training

- will be provided to those citizens in order to enhance their ability to progress to more advanced positions;
- Ensures **NND involvement in all environmental and wildlife protection measures** and activities that will be undertaken;
 - **Funds NND participation** in implementing the agreement – reaffirming the commitment to implement the agreement. Alexco will make annual contributions towards a NND liaison, technical reviews of permit application and provide a scholarship fund to be set up by the parties.
 - **Ensures compliance** with the agreement by formalizing regular communication mechanisms (e.g. quarterly business opportunities meetings), and sets out a dispute resolution procedure.
 - The agreement pertains to **Care & Maintenance activities, exploration - including advanced underground Exploration and Development, Closure Planning studies, and Closure Plan development and implementation**. The agreement contemplates the procedure for transitioning to a Comprehensive Cooperation and Benefits Agreement should the project move forward to production.

Through the cooperative engagement process, Alexco has consulted with NNDFN throughout the development of the Bellekeno Mine Development project proposal. The project proposal was reviewed by NNDFN and their technical consultant prior to submission. NNDFN's comments or issues were discussed and addressed directly in the proposal. Alexco has benefited significantly from NNDFN's reviews and involvement in the project proposal development and plans to continue working closely with NNDFN in the future.

The second agreement between Alexco and NNDFN is an IBA to be concluded if as a result of exploration activities, any portion of Alexco's property is developed into a mine operation. Contingent on a positive production decision by Alexco for the Bellekeno Mine, the negotiation of this agreement between Alexco and NNDFN will commence in early 2009.

On June 6th 2008, NNDFN released an engagement process and a set of best practices codes for industry within the Traditional Territory of the NNDFN. The Cooperative Engagement Process for Economic Activities Proposed in the Traditional Territory of the NNDFN outlines the relationship between industry in the Traditional Territory of NNDFN and the Chief and Council of NNDFN. Guiding Principles towards Best Practices Codes for Mineral Interested within NNDFN Traditional Territory has been prepared for mineral exploration and mining companies who are planning activities on lands within the Traditional Territory of NNDFN. Alexco is committed to following these processes and codes outlined by NNDFN and understand they are an integral component of the working relationship for all parties involved in permitting the Bellekeno mine development program.

4.5 CONSULTATION

As part of its comprehensive campaign of production, exploration, care and maintenance and reclamation in the Keno Hill Silver District, Alexco will continue its multi-faceted consultation efforts. Having recently received the advanced exploration Water Use Licence, Alexco has embarked on a consultation effort towards Bellekeno mine production. Due to the company's consultation efforts, the public and NNDFN are becoming more aware of Alexco, and have developed a greater familiarity with the Company's approach to the Keno Hill Silver District. Alexco and NNDFN have been in ongoing conversations regarding the development of this project proposal. Specifically, Alexco and NNDFN have a Cooperation Agreement and NNDFN has been involved in the review and development of this project proposal prior to submission.

Public engagement directed specifically with regards to the Bellekeno mine production commenced in August 2008 and will continue at appropriate intervals throughout the project. The company has met specifically with the Keno City Advisory Committee and community members respecting the mine development to understand community concerns and proposed mitigative measures to address these concerns. Table 4-2 summarizes the consultation that has taken place to date with respect to this Project Proposal.

Alexco will support its commitment to the local communities of Mayo and Keno City and to the NNDFN by routinely providing opportunities for discussion about the project (Exploration Cooperation Agreement and IBA). It is important to distinguish the public consultation that will be occurring as part of this application, from other consultation processes associated with the development of the district-wide Existing State of Mine (ESM) Closure Plan that will be undertaken during roughly the same time period.

Table 4-2 Alexco Bellekeno Consultation Summary Table

Date	Method of Communication	Parties Represented	Individuals Involved	Topic of Discussion
July 21-24, 2008	Meeting	AXR	Rob McIntyre	Onek Waste Rock Cells, Heritage meeting
August 19, 2009	Meeting	AXR	Rob McIntyre	YG water Resources meeting site inspection followup
August 22, 2008	Meeting	YG Water Resources	Rob McIntyre	Heritage meeting
August 26, 2008	Open House	AXR/ERDC	Rob McIntyre	AXR/ERDC Open House
September 15, 2008	Meeting	AXR	Rob McIntyre, Ethan Allen, Kurt Neunherz	Cooperative Engagement Process Meeting. Discussed CEP and Bellekeno project proposal and NND's involvement.
September 26, 2008	Meeting	NND	Dennis Buyck, Bill Slater, Tom Lie	
		AXR	Rob McIntyre, Ethan Allen	Bellekeno Mine Permitting Timeline
		YWB	Carola Scheu, Kelly Boutlier, Joelle Janes, Diane Mueller	
		AXR	Rob McIntyre, Ethan Allen, Jim Muntzert, Dan Cornett, Kurt Neunherz	
		YG EMR	Gladish, Robert Holmes, Neil Salvin, Hugh Copeland	
		YG DOE	Randy Lamb, Matt Clarke, Wayne Kettley, Pat Paslawski	
October 15, 2008	Meeting	INAC	Karen Ballantyne	Assessors, Regulators and NND meeting RE Bellekeno Mine Development
		Federal DOE	Eric Soprovich, John Miller	
		DFO	Jody Mackenzie-Grieve	
		Yukon Water Board	Carola Scheu, Kelly Boutlier, Joelle Janes, Diane Mueller	
		NND/N	Steve Buyck, Bill Slater	
		Mayo YESAB	Loralee Johnstone	
October 30, 2008	Meeting	AXR	Rob McIntyre, Ethan Allen	Cooperative Engagement Process Meeting. Discussed Mill site location, roads, power options, technical support budget, and NND's review of project proposal.
November 21, 2008	Meeting	NND/N	Dennis Buyck, Bill Slater, Tom Lie	YESAA review BK permitting
		AXR	Rob McIntyre	
		YESAB	Loralee Johnstone	
November 21, 2008	Meeting	AXR	Rob McIntyre	Bellekeno Mine Permitting
		YG MLU	Arlene Kyle	
December 9, 2008	Meeting	AXR	Rob McIntyre, Ethan Allen, David Petkovich	Discussed when MMER will apply to Bellekeno and a reference point for EEM. Also discussed DSTF location and fisheries issues with Mackeno Creek
		Environment Canada	Eric Soprovich, John Miller	
December 18, 2008	Meeting	AXR	Rob McIntyre, Ethan Allen	Discussed DSTF tailings location issues, NND's review of key management plans including WRMP and Water Management Plan.
		NND/N	Steven Buyck, Bill Slater	
January 28, 2009	Meeting	AXR	Brad Thrall, Rob McIntyre, Dan Cornett	Discussed community concerns regarding Christal Lake Mill site and presented
		Keno City Advisory Committee	Matthias, Bob; Insa; Dirk; Tracy; Jim	
January 28, 2009	Meeting	AXR	Brad Thrall, Rob McIntyre, Dan Cornett	Discussed community concerns regarding Christal Lake Mill site and presented
		Keno City Community	Local residents	

Due the very nature of the Keno Hill Silver District, we expect that realization of the economic potential of the property will require multiple permitting events over the years, as exploration continues to make new discoveries.

Alexco publishes a quarterly newsletter as well as contributes to the volunteer newsletter Stuart Valley Voice as another way to inform the public of activity in the Keno Hill area. This helps to ensure local residents (our neighbors) are fully apprised of our planned activities well in advance, as our revitalization of the Keno Hill Silver District continues into the future.

5.0 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

5.1 INTRODUCTION

The following section comprises the assessment of potential effects resulting from Bellekeno mine/mill development and operations. As care and maintenance of the property has been ongoing for a number of years, the assessment reflects the use of information from other reports and actual site data to help guide the environmental assessment (EA). EAs were previously completed for both previous mine exploration and development as well as the current care and maintenance activities. Information supporting previous EAs was discussed in Section 1.4 of this report.

YESAA assessments have also been conducted for the Class 3 exploration program (YESAA Project File Number 2006-0157), care & maintenance activities at the site (YESAA Project File Number 2006-0293) and Bellekeno advanced underground exploration and development, Keno Hill Silver District (YESAA Project File Number 2008-0039). More detailed overview of the previous YESAA assessments are presented in Section 1.4 of this report. The EA presented below builds on the information discussed and presented in these previously assessed projects in the Keno Hill Silver District.

This section discusses the effects of mine development at Bellekeno on VCs. The previous chapters have summarized the property history and a detailed project description. These, with the environmental monitoring discussed in the subsequent sections provide the basis for the effects assessment.

As the Keno Hill Silver District is a historically mined area, the approach taken for the effects assessment is unique to this site. The assessment recognizes and uses local property history, field studies and existing site information to establish present environmental conditions. The Bellekeno mine/mill development and operation is assessed in relation to the existing site conditions and an overall effects assessment

provided. Cumulative effects assessment considers the effects that have already occurred and are ongoing from other existing activities including those programs initiated by Alexco.

The emphasis in this EA has been placed on understanding and assessing effects on water quality and thus the effect on aquatic resources. Experience at other mine sites has indicated that while terrestrial and other resources users' effects may be significant, the effects are limited to a local area. The potential effects associated with surface water quality contamination and aquatic resources are more widespread. Water and contaminant loading balances have been previously prepared and used as the basis for evaluating aquatic effects.

This EA for mine/mill development and operation at Bellekeno considers VCs and presents mitigation measures for potential effects. Guidance documents provided by YESAB, the *Proponents Guide to Project Proposal Submission to a Designated Office*, (2005) and the *Assessor's Guide to the Assessment of Environmental Effects* (2006) were relied upon. A cumulative effect assessment is also presented.

5.2 ENVIRONMENTAL ASSESSMENT APPROACH

The environmental and socio-economic assessment has relied upon previous EAs and documentation and includes the identification of VCs and an assessment to determine whether or not the project is predicted to cause significant adverse environmental effects on identified VCs after the implementation of appropriate mitigation measures. Alexco's internal risk assessment process rates potential consequences to human health and safety as well as the natural environment and serves as the basis to develop mitigation measures that have the highest probability of success.

To determine whether or not the potential adverse environmental effects were considered significant, six criteria were taken into consideration. These descriptors follow the YESAB *Assessor's Guide to the Assessment of Environmental Effects* and are similar to those presented in *The Responsible Authority's Guide to the Canadian*

Environmental Assessment Act prepared by the Federal Environmental Assessment Review Office (FEARO) in 1994.

- **Magnitude** of the adverse environmental effect, where magnitude refers to severity. Minor or inconsequential effects may not be significant, but effects that are major or catastrophic will be significant;
- **Geographic extent** of the potential environmental effect. Localized effects may not be significant while widespread effects are more likely to be significant;
- **Duration and Frequency** of the potential environmental effect. Long-term and/or frequent adverse effects may be significant; however, those of a short term and/or temporary nature should not be significant. The occurrence may be once, rarely, or even continuously;
- **Reversibility:** Degree to which the adverse effect is reversible or irreversible. Reversible adverse environmental effects may be less significant than effects that are irreversible;
- **Economic and Social Context:** The adverse effects of projects may be significant if they occur in areas or regions that have already been adversely affected by human activities and/or are economically or socially fragile and have little resilience to imposed stresses or changes; and
- **Direction:** The adverse effect may be negative, beneficial or neutral.
- **Likelihood Determination:** To identify effects that are reasonably likely to occur within the spatial and temporal scopes of the assessment, two concepts for likelihood determination were used:
 - o Probability: The chance or possibility that a specific event will occur.
 - o Uncertainty: The possible error or range of error that may exist within assumptions.

The ratings system used to determine the significance of potential environmental effects is shown in Table 5-1. Table 5-2 provides a summary of the assessment of potential environmental and socio-economic effects, a summary listing of mitigation measures, and a determination of the significance of the potential effects using quantifiable measures. The VCs that were evaluated for potential environmental effects include: water quality, aquatic resources (i.e. fish), wildlife, traditional and heritage resources, quality of life, human health and safety as well as training and employment opportunities (see Table 5-3 in Section 5.3 below).

Subsequent sections present the determination of VCs, the details of the effects assessment and mitigation measures for various environmental and socio-economic conditions, as well as a cumulative effects assessment.

Table 5-1 Significance of Effects Descriptors

Descriptor	Direction	Duration	Geographic Extent	Magnitude	Reversibility *	Economic & Social Context	Frequency	Significance
Very low (1)	+ = <i>Beneficial Effect</i>	<1 to 5 years (1)	<1 ha (1)	negligible effects to surrounding environment (1)	90-100% (1)	Community with very good economic and social fitness and a very high degree of resilience (1)	Occurs once (1)	Not significant adverse environmental effect (NS)
Low (2)	n = <i>neutral effect</i>	5 to 10 years (2)	1-75 ha (2)	low effects to surrounding environment (2)	70-90% (2)	Community with good economic and social fitness and a high degree of resilience (2)	Occurs Rarely and at Sporadic Intervals (2)	Positive environmental effect (P)
Moderate (3)	- = <i>negative effect</i>	10 to 25 years (3)	75-200 ha (3)	moderate effects to surrounding environment (3)	40-70% (3)	Community with moderate economic and social fitness and a moderate degree of resilience (3)	Occurs on a regular basis and a regular interval (3)	Significant adverse environmental effect (S)
High (4)	+/- = <i>beneficial and negative effect</i>	25 to 100 years (4)	200-300 ha (4)	extreme effects to surrounding environment (4)	<40% (4)	Community with a poor economic and social fitness and low degree of resilience (4)	Continuous (4)	

Notes: Numbers in parenthesis () equals numerical weighting value. * Descriptors for reversibility are opposite to the effects descriptors.

Likelihood:

Probability of Occurrence:

Based on professional judgment

- 1 = None
- 2 = Low probability of occurrence
- 3 = Medium probability of occurrence
- 4 = High probability of occurrence

NA = Not Applicable

Uncertainty:

Based on scientific information, social research or professional judgment

- 1 = Low level of confidence
- 2 = Medium level of confidence
- 3 = High level of confidence

Table 5-2 Summary of the Assessment of Potential Environmental Effects Resulting from Bellekeno Mine Development

Parameters	Development/Operation	Consequence and Effect	Mitigation	Significance of Effects						Significance	Likelihood		
				Direction	Duration	Geographic Extent	Magnitude	Reversibility	Economic & Social Context		Frequency	Overall Rating	Probability
Water Quality	WTP	Increased metals and sediments loading, change in pH	Maintain and use existing mine water treatment system operations, construct new mill treatment facilities to settle out metals and sediment. Controlled add/dewatering. Ensure site stability, monitor and track potential effects.	–	10 to 25 yrs moderate	low	low	moderate	moderate	mod	low to mod	3	2
	ALL	Increased metals and sediments loading, change in pH	Use existing and new WTP facilities and disturbed area, add/mill water reuse & recycle.	–	10 to 25 yrs moderate	mod	mod	moderate	moderate	low	mod	2	2
	AR	Increased metals and sediments loading	Use existing roads and maintain. Non AML rock type for road use.	–	10 to 25 yrs moderate	mod	mod	moderate	moderate	low	low	2	3
	MILL	Increased metals and sediments loading	Dry stack tailings, mill water reuse and recycle	–	10 to 25 yrs moderate	low	low	moderate	moderate	low	low	3	3
	ALL	Permafrost Degradation	Minimal disturbance of the vegetation mat, cover to allow freezing	–	10 to 25 yrs moderate	low	low	moderate	moderate	low	low	3	3
Aquatic Resources	WTP	Increased metals and sediments loading, change in pH	Maintain and use existing water treatment system operations, construct new treatment facilities to settle out metals and sediment. Controlled add/dewatering. Ensure site stability, monitor, track potential effects and reusing of water.	–	10 to 25 yrs moderate	low	low	moderate	moderate	mod	low to mod	2	2
	ALL	Increased metals and sediments loading, change in pH	Use existing facilities and disturbed area, add/mill water reuse & recycling, screen intakes.	–	10 to 25 yrs moderate	low	low	moderate	moderate	mod	mod	2	2
	ALL	Increased metals and sediments loading	Use existing roads and maintain. Follow DFO Operational procedures.	–	10 to 25 yrs moderate	mod	mod	moderate	moderate	low	mod	2	2
	MILL	Increased metals and sediments loading	Dry stack tailings, mill water reuse and recycle	–	10 to 25 yrs moderate	low	low	moderate	moderate	low	low	3	3
	ALL	decrease in surface flows	Water add/mill reuse & recycling, use of existing facilities, monitor surface flows.	–	10 to 25 yrs moderate	mod	mod	moderate	moderate	mod	mod	2	2
Wildlife	ALL	Indirect habitat loss, avoidance, habitat fragmentation	Use existing facilities, fenced settling ponds.	–	10 to 25 yrs moderate	mod	low	moderate	moderate	low	low to mod	2	3
	ALL	Harassment	No hunting policy, employee education, participate in wildlife management. Monitor site stability.	n	10 yrs-low	low	very low	moderate	moderate	low	low	2	3
	AR	Road kills, hunting & poaching pressure	No hunting policy, participate in wildlife management plan.	n	10 yrs-low	low/mod.	low	moderate	moderate	low	low	2	3
Traditional Land & Historic Use													
	Trapping	Decrease in wildlife populations, decrease trapping success	Trapper use maintained. No disturbance of trails	n	10 to 25 yrs moderate	mod	low	moderate	moderate	low	low	2	3
	Traditional Harvest	Decrease in access to wildlife and cultural pursuits	Provide continued access to harvest areas.	n	10 yrs-low	low	low	moderate	moderate	low	low	2	3
	Heritage Resources	Loss of historic structures	Consultation with local community groups prior to infrastructure removal. Limited historic buildings in area.	n	10 yrs-low	low	low	moderate	moderate	low	low	2	3
Recreation & Tourism	ALL	Reduction in recreational use and conflict with tourism	Consultation with local community groups.	–	10 yrs-low	low/mod	low	moderate	moderate	low	low	2	3
Socioeconomic Effects													
	Human Health & Safety (Accidents)	Effects of health/livelihood/community	Health & safety plans, training, safety briefings, inspections and monitoring.	n	10 to 25 yrs moderate	mod	mod	moderate/low	moderate	low	mod	2	3
	Employment Opportunity and Training	Effects of health/livelihood/community	Training programs, employment opportunities, Exploration Cooperative Agreement and an Impact Benefits Agreement	+	10 to 25 yrs moderate	mod	mod	moderate/low	moderate	low	mod	3	3
	Keno City	Effects of Quality of Life	Minimize impacts, initiate a socioeconomic impact avoidance plan with input from the community	n	10 to 25 yrs moderate	mod	mod	moderate/low	moderate	low	mod	3	3
WTP=mill and mine water treatment plant, AR=access and haul roads, ALL=all Bellekeno mine and mill development activities, MILL= mill development and operation activities													

Those parameters that have not been impacted are not presented in this table

5.3 VALUED ENVIRONMENTAL AND SOCIO-ECONOMIC COMPONENTS

Valued environmental and socio-economic components (VCs) are defined as elements of the environment, which are valued for environmental, scientific, social, aesthetic or cultural reasons. Selecting project specific VCs or indicators are essential for focusing the effects assessment and determination of significance of effects.

VCs for the area and associated activities have been previously identified through the YESAA assessments of the exploration program (YESAA Project File Number 2006-0157), care and maintenance activities at the site (YESAA Project File Number 2006-0293) and Bellekeno advanced underground exploration and development, Keno Hill silver district (YESAA Project File Number 2008-0039). These VCs include water and sediment quality, aquatic resources (i.e. fish), heritage resources, soil stability, wildlife including furbearers, harvesting berries including medicinal plants and human health and safety as well as training and employment opportunities.

The process for identifying VCs for this EA included a review of previous EA screenings and site EAs, consultations with regulatory agencies, other stakeholders, and in particular, the local First Nations. Baseline research, literature review, species vulnerability, community consultations, and other initiatives are also considered.

Examples of attributes that influenced the selection of VCs are noted below and in Table 5-3 (coded):

- Ecological Importance (EI);
- Focal Species and/or Habitat (FS);
- Socio-economic Importance (existing and potential) (SI);
- Cultural Importance (CI);
- First Nation/ Resident/Community Values or Concerns (V);
- Aesthetic Value (AV);
- Rare or Endangered (R);
- Special Elements (SE); and
- Responsiveness to Impacts or Stress (RS).

The types of VCs selected for this project has included, First Nation/ Resident/ Community and commercially important wildlife and fish species such as moose or Arctic grayling; surface water quality; important cultural or heritage sites; traditional uses; trapping; and recreational use. A summary of the VCs for the project is listed in Table 5-3.

Table 5-3 Identification of VCs

Component Type	Identified Group/Rationale for Selection/Attribute
Environmental	
Surface Water Quality	Identified by FN, G, OP. Mayo River and the South McQuesten River are local receiving waters and support aquatic resources. Water quality is representative of ecological process and of concern to community members. Lightning Creek and Christal Creek are also of concern to community members. Soil Stability effects erosion into waters Attributes include EI, V, SE, RS.
Aquatic Resources Chinook Salmon	Identified by FN, G, OP. Sensitive fish species; important commercial and native food fisheries. Attributes include EI, FS, SI, CI, V, SE, RS.
Arctic Grayling	Species of importance for First Nations and sport fisheries; downstream indicator, focal species. Attributes include EI, FS, CI, V, SE, RS.
Vegetation Berries, medicinal plants	Identified by FN, G, OP. Is important socially, culturally, economically, and highly valued by the community. Key components harvesting. Attributes include EI, FS, SI, CI, V, SE, RS.
Wildlife Moose, furbearers	Identified by FN, G, OP. This species is a focal species and important socially, culturally, economically, and highly valued by the community. Key components for trapping and harvesting attributes include EI, FS, SI, CI, V, SE, RS.
Soil Permafrost	Identified by FN, G, OP. Sensitive to degradation after vegetation matt disturbance and can effect soil stability altering habitat and water quality. Attributes include EI, FS, V, AV, SE, RS.
Socio-economic/Cultural	
Traditional Use – Trapping (furbearers)	Identified by FN, G. Trapping concession provides employment benefits and sustenance lifestyle. Attributes include SI, CI, V.
Traditional Use – Harvesting	Identified by FN, G, OP. Wildlife, fish, berries, plant harvesting support sustenance lifestyle and cultural pursuits (medicinal plants). Attributes include SI, CI, V.
Heritage Resources	Identified by OP, FN, G. Known historic sites in Keno Hill Silver District; Attributes include CI, V, SE.
Community Quality of Life	Identified by OP, FN, G. Current quality of life very important to local residents; Attributes include CI, V, SI, AV.
Recreational Use & Tourism	Identified by OP, G. Area known for recreational use and tourism potential. Historic buildings attraction. Attributes include SI, CI, V, RS.
Human Health and Safety as well as training and employment opportunities	Identified by FN, G, OP. Worker health and safety on the C&M program. Training and employment opportunities. Public health and safety. Attributes include SI, V, RS

Notes: FN = First Nation; G = Government; OP = Other Public

The approximate spatial boundaries for identifying VCs are more regional in context as these VCs have been identified for the Keno Hill Silver District. Wildlife species, such as moose, will move into and out of the area and water quality downstream is also regional in context. The identification of socio-economic/cultural VCs is presented in a regional context, including Keno, Elsa, Mayo and the entire Yukon. Input from the public including traditional knowledge has contributed to the identification of VCs.

Table 5-3 provides a complete list of the VCs within the EA study area and within a regional context that will be affected by the project and rationale for their selection, including who identified them and their attributes. Consultation with FN, the public and regulatory agencies, knowledge of local environmental conditions and best professional judgment lead to the selection of the project VCs.

Potential effects on each VC were examined within specified spatial and temporal extents, which are defined below in Table 5-4.

Table 5-4 VC Spatial and Temporal Boundaries

Valued Component	Spatial Boundaries	Rationale	Temporal Boundaries	Rationale
Environmental				
Surface Water Quality	Mayo River and the South McQuesten watershed, Lightning Creek and Christal Creek watersheds	Project receiving waters.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Existing water quality data collected during all project phases to ensure continued environmental protection.
Fisheries Resources (grayling)	Lightning Creek / Mayo River drainage Christal Creek / South McQuesten	Fish bearing receiving waters.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Existing water quality data collected during all project phases to ensure continued environmental protection. Known fisheries utilization (Lightning Creek).
Wildlife Resources (Moose)	Regional Context	Range of wildlife resources is not confined to a specific area.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Direct effects to wildlife likely to occur during these project phases.
Socio-economic/ Cultural				
Traditional Use – Trapping	Actively Trapped Areas and concession holder areas. Regional context.	Trapping activities affected in the actively trapped areas and concession holder areas.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Potential effects to wildlife likely to occur during these project phases.
Traditional Use – Harvesting	Regional Context	Traditional use of the land not confined to a specific area.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Traditional activities potentially affected during these project phases.
Heritage Resources	Within Footprint of Project Area (i.e. old historic sites/buildings)	Potential for disturbances of historic buildings.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Limited potential for disturbances of historic buildings during these project phases.
Community Quality of Life (Keno City)	Regional Context	Current quality of life standard is very important to local residents	Christal Lake Mill Development and operations - 5 yrs	Potential for diminishing quality of life in Keno City during Mill operations at the old Mackeno mill/tailings area.
Recreational & Tourism	Regional Context	Recreational and Tourism activities/ effects not confined to a specific area.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Potential for effects to occur during all project phases.
Human Health and Safety	Within Project Area, along Access Roads, within the mill site and mine development.	Company accountable for worker and public health and safety at site and along access roads.	Bellekeno mine/mill Development and operations - 5 to 25 yrs	Potential for effects to occur during all project phases.

5.4 SUMMARY OF POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS AND PROPOSED MITIGATION

This section summarizes key potential environmental and socio-economic effects for the project and proposed mitigation measures. Table 5-2 presented in a preceding section provides a tabular summary of the significance assessment and proposed mitigation presented in the following sections. Table 5-2 characterizes the effects to VCs (Table 5-3) and provides a description of planned mitigation measures for potential adverse effects. The direction of effects and an assessment of the residual environmental and socio-economic effects using criteria presented in Section 5.2 are also provided. A significance determination is made along with a determination of the likelihood of occurrence based on probability and uncertainty of effects.

5.4.1 Water and Aquatic Resources

An objective of the Bellekeno mine/milling development and operation project is the protection of surface water quality that supports aquatic resources, which can be achieved by alleviating contaminant loadings to the receiving environment, in particular Lightning Creek which makes its way to the Mayo River as well as Christal Creek which eventually feeds into the South McQuesten River. As such the EA discussion and mitigation measures presented below are for the VCs surface water quality, and aquatic resources.

In evaluating the effects of the Bellekeno mine/milling development and operation project on the environment, it is instructive to consider historic activities that have occurred in the area and the response of the environment to these activities. The Lightning Creek and Thunder Gulch drainages have been historically affected from localized placer mining and quartz mining activities. Christal Creek and Christal Lake have also been affected by historical mining operations, including a former mill site located close to the shore of Christal Lake. No fisheries resources have been identified in Thunder Gulch. Mine adit drainages from Bellekeno 625 and Keno 700 working eventually report to the Lightning Creek drainage. The loadings from these sources are considered marginal compared with sediment and metals loadings from other anthropogenic activities,

considering that wastewater from the Bellekeno 625 adit is presently being treated as part of the care and maintenance and advanced exploration activities.

5.4.1.1 *Potential Effects:*

- Altering water chemistry and aquatic resources productivity;
- Elevated levels of Contaminants of Concern (COCs) compared to what is outlined in the Water Licences; and
- Erosion (caused by poor soil stability) of physical works or roads causing sedimentation.

5.4.1.2 *Mitigation:*

The following presents a summary of mitigation measures planned for Bellekeno mine/mill development and operation activities:

- Implement Water and Wastewater Management Plans (Section 6.1);
- Implement Waste Rock Management Plan (Section 6.2);
- Implement Tailings Management Plan (Section 6.3);
- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186);
- Maintain and use existing water treatment system. Construct, as necessary, new water treatment and retention infrastructure in order to not release non compliant water. Settlement ponds will be used to settle out metals and sediment;
- Construct dry stack tailing storage area for water reuse and recycle. Place pyritic tailings underground in Bellekeno 625 below water static level to eliminate metal loads if conditions allow;
- Control adit water use activities to ensure capacity of water treatment facilities and discharge requirements are met;
- Adit water reuse and recycle. Freshwater intakes will be screened as per DFO “*Freshwater Intake End-of-Pipe Fish Screen Guideline*” (DFO, 1995);
- Applicable DFO Operational Statements adhered to (i.e. Culvert Maintenance);

- Ensure site stability by following the physical inspection plan as submitted under QZ07-078;
- Routine inspections, monitoring and maintenance of treatment facilities;
- Periodic de-sludging of settling ponds and disposal in existing sludge storage areas;
- Conduct routine receiving water quality sampling in accordance with monitoring programs (Section 6 and 7) to inform mitigation measures and control metal levels;
- Implement adaptive management plans and contingency measures for water treatment system operations as required ensuring continued system operations including for discharge water exceeding applicable criteria;
- Use of existing roads, trails and disturbed areas where practical. Non-AML rock type for road use;
- Specialized handling of potentially-AML rock in accordance with the Waste Rock Management Plan (Section 6.2),
- Routinely monitor and inspect all surface expressions of Bellekeno underground workings for early detection of subsidence and drainage changes;
- Potential for clean up and reprocessing of old Mackeno tailings (planning developed under Existing State of Mine Closure Plan);
- No disturbance of riparian area along watercourses;
- No drilling is planned within 30 meters of a fish-bearing stream. DFO will be consulted on a case-by-case basis if questions arise regarding exploration activity near a stream;
- Conduct routine physical inspections and water quality and flow monitoring at Bellekeno mine workings to ensure physical stability and chemical stability;
- Proper transport, storage, handling and disposal of all chemicals, reagents, and fuels and a response team for implementing the Emergency Response Plan (see Appendix G in Volume 2);
- Hazardous materials stored away from watercourses in a controlled area; and
- Proper handling and storage of waste materials. Solid waste disposal within commercial dump.

Based on the potential effects and mitigation measures listed above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. Potentially adverse effects to VCs surface water quality and aquatic resources are considered to be moderate as the duration is moderate (10 to 25 years), geographic extent is low to moderate, magnitude is low to moderate, reversibility is moderate, economic and social context is moderate, and frequency is low to moderate. The potential residual adverse effects are not considered significant based on a low probability of occurrence and a high degree of confidence. Continued site remediation (i.e. Mackeno tailings) of historic environmental liabilities under the district wide closure plan is also expected to improve local water quality by directly removing the metal load into Christal Lake/Creek. A summary of the potential environmental effects for the Bellekeno mine/mill development and operation program is provided in Table 5-2.

5.4.1.2.1 Projected Mass Loading

Operations at the Bellekeno Mine and mill development will result in modifications to present characteristics in both the Lightning Creek and Christal Creek watersheds. These modifications are reflected in new water and loading balances at Lightning and Christal Creeks.

At Lightning Creek, a new input from the Bellekeno waste rock storage area is required (Figure 5-1). Due to careful screening procedures (see Section 6.2) the Bellekeno waste rock storage area will be non-acid-generating and not a source of ARD. Moreover, any precipitation that contacts the waste rock pile will report to ground, and not directly to Lightning Creek or any other watercourse. Based on field inspections of all of the waste rock storage areas throughout the district, no surface toe seepage is evident from waste rock but rather seepage and meteoric water from the piles infiltrates into the ground beneath the piles (SRK Consulting 2007, 2009). This condition is expected to be the same with the new waste rock storage pile constructed as part of the Bellekeno mine. It has been demonstrated that the attenuation properties of the site are very high (see Section 3, Tables 3-5 and 3-6, SRK Consulting 2009) and as such it is anticipated that upwards of 90% of the zinc load from the Bellekeno waste rock pile will be attenuated

through various mechanisms before it reaches Lightning Creek. The soluble load of zinc from the Bellekeno waste rock pile is estimated in Year 1 to be approximately 7.9 kg/yr increasing to 39.5 kg/year in Year 5 after the pile is fully constructed. These loading values again do not take into account attenuation and are not the expected loads to enter the Lightning Creek receiving environment.

The soluble zinc load from the Bellekeno Mine WRDA has been estimated on an annual basis. These estimates are based on a moisture content of 4% in the waste when it is deposited into the WRDA and then a further required increase to 8.4% moisture in the waste rock pile before any meteoric water begins to migrate through the pile and mobilize soluble zinc. As summarized in Table 5-5, the moisture content in the WRDA will be below 8.4% until year 6, at which time net annual precipitation (258 mm) will allow moisture in waste rock to migrate into subsoils underneath the WRDA. The migration of moisture from the waste rock is estimated to be 6,230 m³ of pore fluids.

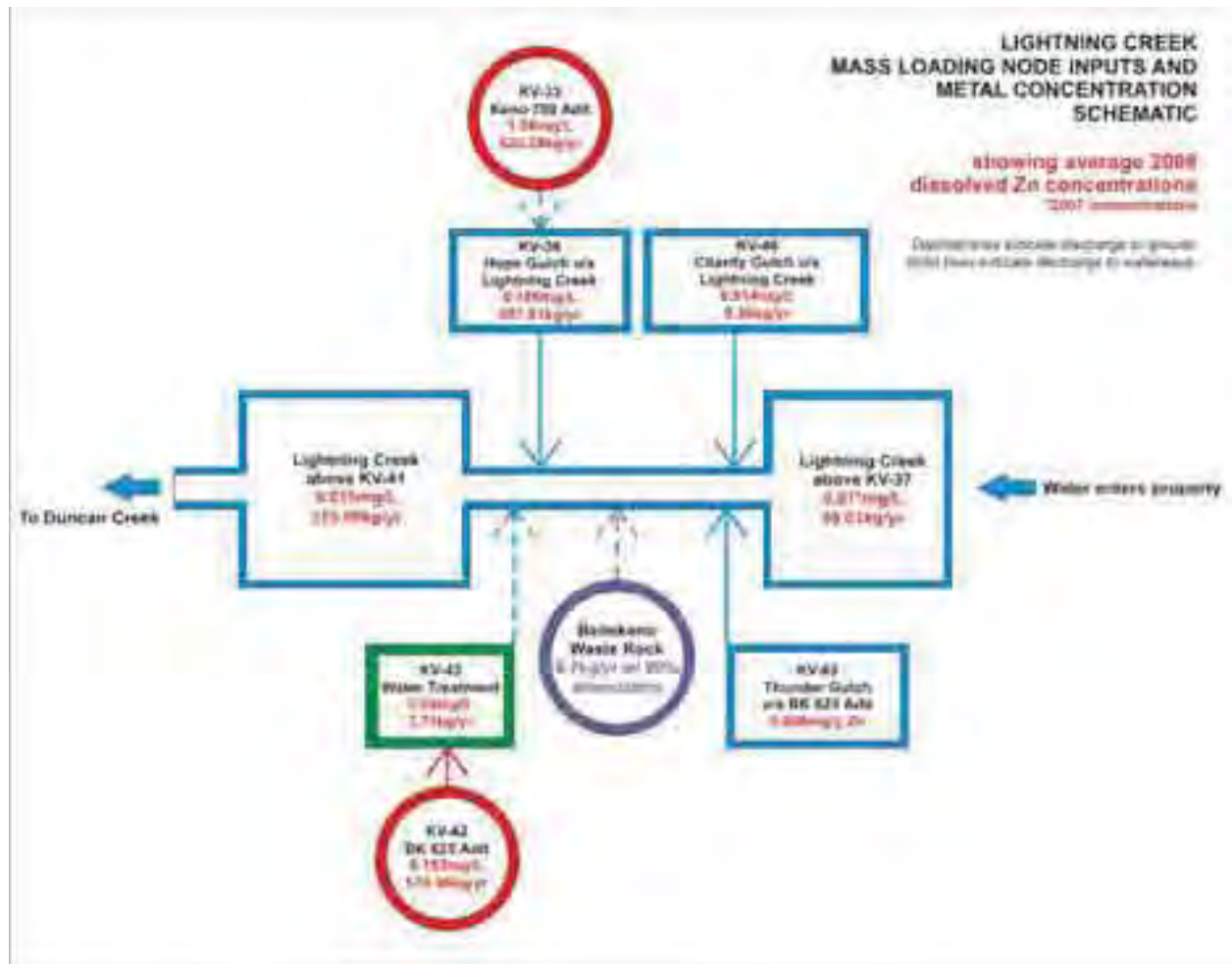
Table 5-5 Bellekeno Waste Rock Estimated Pore Water Volumes

Year	Annual Production	Cumulative	Initial Moisture	Net Annual Precipitation	Moisture Content
	tonnes	tonnes	tonnes	tonnes	%
Year 1	100,000	100,000	4,000	1246.14	5.25%
Year 2	100,000	200,000	8,000	2492.28	5.87%
Year 3	100,000	300,000	12,000	3738.42	6.49%
Year 4	100,000	400,000	16,000	4984.56	7.12%
Year 5	100,000	500,000	20,000	6230.7	7.74%
Years 6+		500,000	20,000	6230.7	8.98%

Two approaches can be used to evaluate the potential zinc concentration in the pore fluid leaving the WRDA. Waste rock samples from the Keno Hills mining district were analyzed for their sulfur content, their total zinc content, and the leachable zinc content. As summarized in Appendix B and C in Volume 2, leachable zinc in samples with the characteristics of the WRDA had average leachable zinc of 0.91 mg/kg, with a median value of 0.079 mg/kg. If 6,230 tonnes of moisture enters and subsequently leaves the pile as pore fluids, up to 67 kg/year (calculated with the average value or Approach 1) or 5.9 kg/year (calculated with the median value or Approach 2) will leave the pile and

migrate into the subsoils. The attenuation of soluble constituents in the subsoils will substantially reduce the migration of zinc that could eventually reach Lightning Creek. With 90% attenuation and using the higher soluble load calculated in Approach 1, approximately 6.7 kg zinc/yr will enter Lightning Creek. Using Approach 2, less than 0.6 kg zinc/yr will enter Lightning Creek. Assuming the actual load is likely between these two approaches, the additional zinc load from the Bellekeno waste rock will be approximately 1.5% of the current load to Lightning Creek by the time it reaches KV-41.

Figure 5-1 Projected Lightning Creek Mass Loading Model Schematic Showing Node Inputs



The mill and ancillary facilities will take up water from the Christal Creek watershed. Any excess water from the mill will be treated and discharged back into the Christal Creek drainage to Christal Lake (Figure 5-2). There are a number of proposed sources to make up the water requirements for the mill. Recycling of runoff collection from the DSTF and mill pad is the preferred water source. Mackeno Creek, potential new water wells, treated water from Galkeno 900, or Christal Lake itself are additional possibilities (see Section 6.1.3.3 for more information). The Christal Creek drainage will also receive input from the mill tailings as they will be situated within this watershed (Figure 5-2). The dry stack tailings facility will be designed so that any surface runoff is diverted to a collection pond at the toe which is shared with the mill pad runoff. See Section 6-3 for the Tailings Management Plan and Appendix J (Volume 2) from EBA for dry stack tailings facility conceptual design. The DSTF runoff water will be treated if necessary to meet water quality specifications (see Table 6-7 for proposed discharge standards under MMER)

Two approaches can be made to estimate the amount of zinc load entering the Christal Lake receiving environment as a result of the dry stacked tailings and mill operations. The first approach is an estimate of the total soluble load within the DSTF over time as presented in Table 5-6. The annual estimate is based on a measured zinc concentration in tailings porewater from testwork (Process Research Associates 2009) of 20.31 mg/L zinc, with the assumption that infiltrated precipitation of approximately 1,900 m³ would displace porewater with that concentration. Similar to the approach made with the WRDA, this estimated load is not directly released into the receiving environment as it will be attenuated.

Table 5-6 DSTF Estimated Zinc Loading

Year	Milling Rate (t/d)	Volume in DSTF m ³	Tailings Area m ²	Net Annual Precipitation m	Precipitation DSTF m ³	Net Infiltration	Infiltrated Precipitation m ³	Annual Zinc from DSTF kg
Year 1	250	18,859	6,143	0.209	1,283.9	20%	256.8	5.2
Year 2	250	37,717	12,286	0.209	2,567.7	20%	513.5	10.4
Year 3	400	71,662	23,343	0.209	4,878.6	20%	975.7	19.8
Year 4	400	105,607	34,400	0.209	7,189.5	20%	1,437.9	29.2
Year 5	400	139,552	45,500	0.209	9,509.5	20%	1,901.9	38.6

Based on this approach (displacement of pore water from the tailings), an estimated 38.4 kg zinc/yr would be produced. Assuming 90% attenuation, this amounts to less than 4 kg zinc/year to Christal Creek.

For the purposes of updating the mass balance, the second more conservative approach has been presented which assumes that the highest discharge volume in the water balance (43.87 m³/day) is captured in the mill pond and treated to < 0.5 mg/l. The 43.87 m³/day includes all mill pad runoff, excess mill water during processing and that all DSTF infiltrated water enters the mill pond. This conservative approach results in 8 kg/year Zn which is approximately 0.5% of the load at KV-7.

Figure 5-2 Projected Christal Creek Mass Loading Model Schematic Showing Node Inputs



5.4.2 Wildlife

There is no question that past anthropogenic activities have altered the local landscape and affected local wildlife populations. However, observations of these effects over time have indicated the environment's natural capacity to regenerate habitat and sustain wildlife and waterfowl populations in the face of past development and occupation pressures. With the Bellekeno mine/mill development and operation activities, it is expected that there will be minimal loss of wildlife habitat or displacement of local wildlife due to the Bellekeno mine/mill development operation. Some areas within the mill site and tailing areas have been previously disturbed with many facilities already in existence on the sites (Mackeno is a previously disturbed area).

5.4.2.1 Moose

Results from surveys conducted by Gamberg Consulting between 1993 and 2006 and the annual ground based monitoring program in the fall from 2001 – 2006 indicate that, in general, the density of moose in the Mayo-Elsa-Keno area is about 205 moose per 1,000 km², which is higher than the Yukon average (about 150 moose per 1,000 km²). Recruitment has varied from year to year, as is normal, and over the long term it has been adequate to sustain moose populations with normal levels of natural and harvest mortality.

Based on results from censuses, moose numbers increased in the Mayo area between 1993 and 1998, and stayed about the same between 1998 and 2006. The 2006 census showed good calf survival in 2006, fairly low numbers of yearlings, and a low sex ratio. The number of bulls compared to cows is especially low in the Gustavus Range (the mountains southeast, east, and northeast of Keno), and this is likely due to the easy access provided by mining roads for hunters on 4-wheelers.

Additional access routes constructed for the purposes of mining and exploration activities often create easy access routes to wildlife habitat and ultimately wildlife. New access to wildlife habitat and wildlife potentially increases hunter success and reduces survival success to wildlife. Increased harvest in areas nearing harvest thresholds can

lead to significant adverse effects on moose and other species. This project proposal does not include any additional access in the area and therefore it is unlikely that there will be any significant adverse effects on moose population as a result of the creation of new access for hunters.

Results from winter survey work done in the project area shows that Mount Hinton, to the east of Keno City and Mount Cameron to the north show high moose density during winter. Late winter after rut is when moose, particularly bulls are recovering from the rut and require high quality forage. Moose have been recorded at the Valley Tailings Area and throughout the project area year round. Willow is present throughout the project area and a main food source for moose. Information from the project proposal and submissions from experts and interested persons speak to metal loading in the soils throughout the project area. Willow absorbs some of the metals present in the adits and potentially could bio-accumulate in moose utilizing the plants as a food source. Metals can also be consumed by moose that drink from affected water sources and eat aquatic vegetation from tailings ponds and untreated water sources (Gamberg, 1999).

Ongoing research by Gamberg on contaminants in Yukon caribou and moose provided the opportunity to compare contaminant results between the project area and the rest of the Yukon on a suite of 23 elements. Moose sampled in the five sub-zones overlapping with the project area were compared to those sampled throughout the rest of the Yukon. All elements were compared and most of them were not statistically significantly different between the project area and the rest of the Yukon. Exceptions were arsenic and barium which are higher in moose in the project area.

High concentrations of barium can have significant adverse health effects on animals. Results from the Yukon wide study show higher barium concentrations in the Keno area moose than the Yukon average. These concentrations were, however, well below levels of concern and therefore are not considered significant.

Arsenic can be absorbed by ingestion, inhalation and permeation of the skin or mucous membrane and accumulates in the liver, kidney, spleen, muscle, skin and hair. Toxic effects include respiratory cancer, peripheral nervous system disorders and dermatitis.

The main sources of arsenic to the environment are mine tailings, smelter waste and natural mineralization. The levels of arsenic in the moose in the project area when compared to normal levels in beef fit for consumption were below normal range.

5.4.2.2 *Potential Effects*

- Indirect habitat loss, avoidance and habitat fragmentation;
- Direct habitat loss due to access roads, mill pads, waste rock piles, storage area and tailings;
- Camp facilities and waste storage and disposal odors as an attractant for bears;
- Harassment of animals and;
- Direct mortality due to injury due to mining debris, road kill, hunting pressure and poaching.

5.4.2.3 *Mitigation Measures*

The following mitigation measures will be implemented:

- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186);
- Adhere to provisions of Commercial Dump Permit No: 81-012. Camp will be kept clean and combustible waste will be incinerated completely on a daily basis to eliminate odors that may attract wildlife. See dump location on Figure 1-2, Section 1;
- Camp compound will be fenced and gated;
- If wildlife becomes a nuisance or problem a portable electric fence will be installed around the perimeter of the camp. All nuisances / problems with wildlife will be reported to the local conservation officer immediately for assistance in further effective means of reducing wildlife mortality;
- Use of existing facilities where possible and minimize new disturbance of lands;
- Restricted access to ponds (gates and/or fencing) and adits;
- No hunting policy for project employees will be adhered to;
- Firearms banned from the mine site except as authorized for protection of employees in the field;

- Prohibit the use of non company all-terrain vehicles by employees at the mine site;
- Vehicle-animal encounters may be prevented by employees following posted speed limits;
- Employees are encouraged to fill out the Company's posted wildlife log;
- The Company will participate in education and awareness programs of wildlife through presentations by local residents, members of the Mayo Renewable Resource Council (MRRC), NNDFN, and regional Fish and Wildlife conservation personnel. For example in summer 2007 and 2008, all Elsa employees attended Bear Awareness Workshop presented by YG Fish and Wildlife Conservation Officer;
- Participate in MRRC Big Game Management Planning.

Based on the potential effects and mitigation measures list above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. Potentially adverse effects to wildlife are considered to be low to moderate as the duration is low to moderate (10 to 25 years), geographic extent is low to moderate, magnitude is low, reversibility is moderate, economic and social context is moderate, and frequency is low. The potential residual adverse effects are not considered significant based on a low probability of occurrence and a high degree of confidence. A summary of the potential environmental effects for the Bellekeno mine/mill development and operations program is provided in Table 5-2.

5.4.3 Traditional and Local Land Uses

Significant development activity and local population increases have occurred in the area in the past which have altered traditional use patterns and harvest activities. These historic activities are now the source of many of the historic resources in the area. It is recognized cumulative effects are ongoing and continue to occur. Local First Nations continue to utilize the area for traditional harvesting activities. Trapping is ongoing, with only minor conflicts with existing trap line uses. As noted above, local wildlife populations are thought to be stable and we are not aware of specific local management practices that have been implemented by wildlife managers. Wildlife habitat is naturally regenerating in the area based on local observations of natural revegetation of previously disturbed areas. This in turn has reversed some historic effects to traditional

use of the area. This was the basis for determining that effects on traditional use and harvest can be reversed in the future. Continued implementation of mitigation and closure planning for the entire district is expected to further improve traditional use and harvesting pursuits.

5.4.3.1 *Potential Effects*

- Decrease in wildlife resources or access to harvesting areas for recreational or traditional pursuits;
- Decrease in plants/vegetation for cultural harvest; and
- Reduction in recreational or tourism opportunities.

5.4.3.2 *Mitigation Measures*

- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186);
- Reduce new disturbances, use of previously disturbed areas;
- No disturbance of trap line trails and trapping areas;
- Provide continued access to traditional harvest areas;
- Ongoing communication with NNDFN to ensure that exploration and preliminary development activities are understood and interactions planned for; and
- Ongoing community consultations and communication to ensure awareness of local recreation and tourism activities.

Based on the potential effects and mitigation measures list above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. Potentially adverse effects to traditional land uses (trapping, traditional harvest, recreation and tourism) are considered to be moderate as the duration is moderate (10 to 25 years), geographic extent is moderate, magnitude is low, reversibility is moderate provided traditional knowledge related to these uses are not lost, economic and social context is moderate, and frequency is low. The potential residual adverse effects are not considered significant based on a low probability of occurrence and a high degree of confidence. A summary of the potential

environmental effects for the Bellekeno mine/mill development and operations program is provided in Table 5-2.

5.4.4 Keno City

Keno City has a small but steady tourism economy based on recreational use of the area and the historic mining heritage. Alexco realizes the importance of Keno City as an old mining town as well as how paramount the quality of life is to its residents. Alexco has met with the Keno City Community Advisory Committee to present the project and understand potential issues. In recognition of this, significant efforts have been made to incorporate design elements and mitigative strategies that will minimize the impacts on Keno City residents and their quality of life, and to ensure public health and safety.

5.4.4.1 Potential Effects

- Increased Traffic, Traffic Safety and Effects to Roads;
- Noise pollution;
- Dust;
- Visual;
- Environmental;
- Public Safety;
- Tourism Industry;
- Cumulative Effects of Other Development Activities; and
- Diminishing of the current quality of life.

5.4.4.2 Mitigation Measures

Based on discussions with the Keno City Community Advisory Committee and local residents, a Keno City Socio-Economic Mitigation Plan has been developed to address local residents' concerns with the mine development proposal and effects to local socio-economic and environmental conditions. Alexco recognizes that the community supports mining activities and the fact that local residents' existing presence in the area have sustained area infrastructure and thus made it easier for Alexco to continue its

operations. Keno City has made considerable efforts towards developing a viable tourism industry that revolves around the historic mining heritage in the area. Alexco believes that this is an important initiative that the community has undertaken and a real opportunity exists for the company and the community to enhance and optimize the mining/tourism/heritage aspects of the area. Alexco will continue to work with the community to ensure that adequate communication protocols are in place regarding its development activities, and to continue discussions with the community to look at opportunities to enhance the project and support mining heritage opportunities so that the company is viewed as a good corporate citizen and neighbor.

5.4.4.2.1 Keno City Socio-economic Mitigation Plan

This mitigation plan has been specifically developed to address the community concerns that have been brought forward by the Keno City Community Advisory Committee and local residents. The plan is intended to address and mitigate potential effects as identified by the community and to maintain the quality of life presently experienced by the community.

1. Communication Protocol

- Implementation of a communication protocol for events, both planned and unplanned. This protocol will ensure that direct communications with the local community continues and provides a mechanism where the community can be apprised of company activities and present issues for identification and resolution. Senior company management will meet with the Advisory Committee as required and provide activity updates and information sharing as determined by the protocol.

2. Access Management and Traffic

- Mine traffic will be redirected around Keno City to ensure that direct haulage traffic is routed around the community and interference with the local community is minimized. Figure 1-3 shows the proposed routing of traffic around the

- community. There will be occasional light vehicle traffic within Keno City but all ore haul traffic will be redirected at the commencement of production;
- 20 km/hr speed limit within or near the town;
 - No use of engine retarder brakes in town limits; and
 - Review of highway access, signage and sign placement with YG Highways.

Tables 5-7 and 5-8 summarize the estimated volume of traffic in the Keno City area for both the construction and operations phases.

Table 5-7 Estimated Daily Traffic Count – Construction Phase

Traffic Type	Load Category	Month							
		1	2	3	4	5	6	7	8
Mobilize mining equipment	H	1	1						
Construction camp installation	H	1	1						
Mobilize earthworks equipment	H	1							
Major earthworks (roads, diversion, etc)	H	15	15	15					
De-mobilize earthworks equipment	H			1					
Mobilize construction support equipment	H	1	1	1	1	1	1	1	1
De-mobilize construction equipment	H							1	1
Import structural steel, plate work, rebar	H		1	1					
Major mechanical & Electrical Equipment	H		1	1	1				
Bulk materials	H		1	1	1	1	1	1	1
Sub-total - Heavy > 10 tons		19	21	20	3	2	2	3	3
Personnel transport (pickups, autos)	L	10	10	10	10	10	10	10	10
Buses	L	2	2	2	2	2	2	2	2
Light Service Trucks (< 10 t)	L	2	2	2	2	2	2	2	2
Sub-total - Light < 10 tons		14	14	14	14	14	14	14	14
Grand Total		33	35	34	17	16	16	17	17

Table 5-8 Estimated Daily Traffic Count – Operations Phase

	Travel Direction	Shift Change	Day Shift	Shift Change	Night Shift
		6:00 AM	7:00 AM	4:00 PM	7:00 PM
Vehicle Type - One way traffic count		8:00 AM	7:00 PM	6:00 PM	7:00 PM
Light Trucks (< 1 ton) and Autos	Elsa to mine/mill	4	8	4	6
Buses	Elsa to mine/mill	2		2	
Heavy Trucks (> 5 tonne), bulk materials	Elsa to mine/mill		8		
Ore Trucks (>20 tonne) hauling ore	mine to mill		14		
Ore Trucks (>20 tonne) hauling tailings or empty	mill to mine		14		
Total round trips per day		6	44	6	6

Notes:

- 1) Warehouse receiving and shipping normally confined to hours between 8:00 AM and 4:00 PM. This will minimize heavy truck traffic during shift changes. Normally no heavy truck deliveries on night shift.
- 2) Bulk materials includes fuel, reagents, materials and supplies and concentrate haulage.
- 3) Above values are considered typical of daily traffic anticipated during operations. Variations up to 50 % are possible on any given day.
- 4) Based on 408 t/d production rate which results in highest ore haulage traffic count

3. Noise, Dust, Visual Abatement

Increased noise from the Christal Lake mill site has been expressed as a concern for Keno City residents.

Noise is measured in terms of decibels. On the **decibel scale**, the smallest audible sound (near total silence) is 0 dB. A sound 10 times more powerful is 10 dB. A sound 100 times more powerful than near total silence is 20 dB. A sound 1,000 times more powerful than near total silence is 30 dB. Here are some common sounds and their decibel ratings:

Near total silence - 0 dB

A whisper - 15 dB

Normal conversation - 60 dB

A lawnmower - 90 dB

A car horn - 110 dB

A rock concert or a jet engine - 120 dB

A gunshot or firecracker - 140 dB

All of these decibel examples are from the position of standing next to the source of the noise. The level of the noise coming from the crushing plant at Christal Lake site is estimated to be approximately 90 dB (noise level standing next to the crushing plant ~10 feet). With the construction of noise sound barrier walls or panels around the crushing facility, the noise directly on the outside of the noise sound barrier (~10 feet) is estimated to be reduced by approximately 10 times or 10 dB. The intensity of sound diminishes greatly the further a person is from the source of the noise. Sound intensity reduces inversely to the distance away from the source. If the distance from the source of the noise is doubled (i.e. from 10 feet to 20 feet) the intensity of the noise is reduced by 4 times. If the distance from the noise goes from 10 feet to 100 feet, the intensity of the noise is reduced by 100 times. The distance from Keno City to the Christal Lake mill

location is approximately 1.5 km (4,920 feet). The decrease in noise level from a distance of 10 meters from the crushing plant to Keno City is calculated as approximately -44 dB. This results in an estimated noise level in Keno City from the crushing facility of ~36 dB.

The crushing facility has a throughput capacity of 65 tph. Although the crusher is oversized compared to the daily ore tonnes, this is the smallest type of crushing plant available. Since the crushing facility can process significantly more ore tonnes than will be mined it will not operate continuously, even during the day shift hours. At the higher mining rate of 400 t/d, the crushing plant will need to process ore for approximately 6 hours per day on day shift only. This results in a sporadic crushing operation and will not create a continuous 24/7 additional background noise condition.

Specific mitigation measures include:

- Mill location greater than 1.5 km from the center of the community;
- Ore haulage to/from Bellekeno and the Christal Lake Mill will be conducted on day shift only (7 am – 7 pm);
- Equipment backup indicators will be modified with strobe light for night time operation;
- Orientation of the mill doors away from the community and sound baffling;
- Minimize clearing around mill site to limit mill view;
- Limit employee/contractor interaction with Keno City;
- Water spraying or other use of dust suppressants as appropriate;
- Incorporation of light pollution abatement measures;
- The crushing facility will only be operated during the day shift (7 am – 7 pm);
- Insulate the mill building for noise reduction; and
- Sound abatement panels or walls constructed around the crushing facility to reduce noise.

4. Environment

- Use previously disturbed area to minimize environmental effects;
- Waste and water management plans to mitigate environmental effects;
- Environmental monitoring plan to monitor effectiveness of mitigation measures;
- Adaptive Management Plan to provide for contingency mitigative measures and responses; and
- In conjunction with Existing State of Mine Closure Plan develop clean up plan for old Mackeno tailings.

5. Tourism

- Develop Access Management Plan for local area as part of Existing State of Mine Closure Plan
- Work with local community to establish mining heritage tourism potential opportunities;
- Through Keno City Mining Museum conduct mill facility tours to facilitate public education of mining industry; and
- Financial contribution to establish mining heritage tourism opportunities or facilities.

Based on the potential effects and mitigation measures listed above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. A summary of the potential environmental effects for the Bellekeno mine/mill development and operations program on Keno City is provided in Table 5-2.

5.4.5 Heritage Resources

The Company is aware of local community groups' interest in historic resources and understands that a historic resource assessment is being completed by government (work being done as part of closure plan). The effects from physical cleanup of historic building can destroy heritage resources. However in the Bellekeno mine/mill

development and operation area there are limited historic resources. As part of closure planning, the company will continue to work with local groups and YG Heritage to ensure protection of importance heritage resources. Alexco is in full support of the Wernecke house restoration project currently being undertaken by the Keno City Community Club and the Friends of Keno City. We expect to continue to provide support for this project as it continues.

5.4.5.1 *Potential Effects*

- Destroy or disrupt artefacts or historic resources.

5.4.5.2 *Mitigation Measures*

- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186);
- Adhere to Heritage Resources Protection Plan (Section 4.1.1)
- All discoveries of heritage resources will be reported to NNDFN government's heritage department and YG Heritage Branch;
- Consultation with local community groups including the NNDFN and YG Heritage Branch prior to infrastructure removal (limited historic buildings in area).

Based on the potential effects and mitigation measures listed above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. Potentially adverse effects to heritage resources are considered to be low as the duration is low (10 years), geographic extent is low, magnitude is low, reversibility is moderate, economic and social context is moderate, and frequency is low. The potential residual adverse effects are not considered significant based on a low probability of occurrence and a high degree of confidence. A summary of the potential environmental effects for the Bellekeno mine development program is provided in Table 5-2.

5.4.6 Human Health & Safety

Mine development activities have the potential to effect human health and safety. Potential conflict with wildlife is addressed in the wildlife component of Section 5. Alexco has an environmental and health and safety policy to adhere to as well as numerous employee training programs in place.

5.4.6.1 Potential Effects

- Accidents and malfunctions related to use of heavy machinery, managing large piles of tailings or waste rock, use of petroleum products, working in and around underground structures, drilling and blasting and operation of water treatment facilities;
- Public access into the site;
- Increased road traffic;
- Industrial illness;
- Worker illness from poor sanitation; and
- Alcohol/drug abuse.

5.4.6.2 Mitigation

- Occupational Health and Safety Act and Occupational Health and Safety Regulations will be enforced for all personnel on the site;
- Employees will be educated on the potential risks associated with their position and be properly trained;
- Emergency Response Plan which includes the Spill Contingency Plan (see Appendix G in Volume 2) will be posted and implemented as necessary;
- Implement proper Emergency Response Plan training;
- Training provided to all staff on general safety and safe vehicle operations;
- Supervisors and emergency personnel on site at all times to address accidents/malfunctions. First aid attendant on site with first class facility;
- Site orientations for all employees and visitors;
- Weekly staff safety and education meetings;
- Safety Committee;

- Medical and emergency response equipment and trained personnel will be on site 24 hours a day during operations;
- Site and mobile communications provided;
- Radio controlled areas;
- Employees are covered by Workers Compensation;
- Traffic will be controlled on mine access road. Communication and notification of hazardous materials transport to the site;
- Mine and mill site access road is gate restricted and public access to the site is discouraged. Physical restriction and security monitoring will ensure that the public is not exposed to project site accidents or malfunctions;
- Mine workers will be transported using a company bus to reduce traffic;
- Vehicles will be equipped for winter travel and will carry emergency first aid kits;
- All highway regulations will be followed for speed limits and use of air brakes;
- Treatment contingency measures and back-up systems to minimize accidents and malfunctions;
- Potable water will be analyzed, filtered and treated by UV to meet Public Health Act Camp Sanitation Regulations requirements;
- Grey and black water treated and disposed of in an approved and permitted engineered septic system;
- Alcohol and drug screening as a pre-employment condition;
- Consumption of alcohol and 'recreational' drugs will not be allowed on site by employees; and
- Monitoring and maintenance to ensure facility and worker safety and equipment integrity.

Based on the potential effects and mitigation measures list above, an assessment of the residual environmental effects, significance assessment and determination of the likelihood of the effect was completed. Potentially adverse effects to human health and safety are considered to be moderate as the duration is moderate (10 to 25 years), geographic extent is moderate, magnitude is moderate, reversibility is moderate, economic and social context is moderate, and frequency is low. The potential residual adverse effects are not considered significant based on a low probability of occurrence

and a high degree of confidence. A summary of the potential environmental effects for the Bellekeno mine development program is provided in Table 5-2.

5.4.7 Effects of the Environment on the Project

5.4.7.1 Potential Effects

- Extreme climatic conditions can cause process upsets;
- Unusually cold weather;
- Reduced visibility due to winter storms and blowing snow can restrict access to or from the site;
- Floods, heavy rains; and
- Earthquakes.

5.4.7.2 Mitigation

- Settling facilities freeboard maintained and decant structures routinely inspected;
- The use of diversion ditches for overflow when necessary;
- Regulated engineered systems will be used;
- The mill dry stack structures and underground workings will be engineered for stability (i.e. earth quake);
- Redundant systems in place to ensure pumping, power and wastewater treatment systems operational during extreme events;
- Spare parts and equipment to ensure equipment failures are replaced and repaired and ensure continued treatment system operations;
- Trained personnel onsite to maintain redundant systems during emergency situations;
- Monitoring of climatic conditions to forecast storage requirements;
- Facilities and equipment design has been previously proven and personnel are trained to work under Arctic conditions;
- Snow clearing equipment will be available on site to maintain mine access road;
- Radio telephone or satellite phones will be on site to ensure communication links;
- and

- Trained first aid staff will be on site at all times during operations.

Potentially adverse effects of the environment on the project are considered to be low and not significant based on implementation of mitigation measures.

5.4.8 Cumulative Effects

Cumulative effects refer to those effects on the environment that result from effects of a project when combined with those of other past, existing, and imminent projects and activities. To address cumulative effects, a project's activities must be considered in context to actual or potential effects on the environment from other sources.

The Keno Hill mining district has a long history of activity and development. Within the area, a number of projects or project activities already exist including the community of Keno City and the abandoned Elsa townsite. Cumulative effects are evident in a number of areas on the property. Cumulative effects assessment considers the effects that have already occurred and are ongoing from other existing activities including those programs initiated by Alexco. These effects are associated with drainage water chemistry/loadings, aquatic resources and terrestrial resources.

Within the Lightning Creek drainage, the Company's operations are upstream of existing placer mines and hardrock exploration activities in the Thunder Gulch drainage. Cumulative effects can also be seen in the water chemistry and contaminant loading in the Lightning Creek drainage as a result of current placer mining and other historic hard rock mining activity in the area. The continued operation of the Bellekeno 625 water treatment facility will control water chemistry and metal loadings in the drainage as existing mine effluents will be treated. Dewatering in the Bellekeno 625 workings will be controlled and treated through the existing water treatment facilities. New settling ponds were constructed as part of the Bellekeno East exploration and development to ensure that contaminant loads have been controlled. This cumulative effect is not considered a significant adverse effect to the drainage as indicated by the existing site water treatment chemistry released from the Bellekeno 625 adit.

The Onek pit has been previously disturbed from open pit mining activity. Large piles of waste rock and open pits are evident throughout the area. There are no significant surficial water flows near the Onek waste rock storage facility. The mill location (Mackeno) near Christal Creek and Christal Lake have also been effected by historical mining operations, including a former mill site locate close the shore of Christal Lake.

Cumulative effects are seen in the watersheds, as a result of historic mining activities distributed throughout the drainages. Water chemistry within the watersheds is expected to improve with continued care and maintenance activities and planned closure. Improved water chemistry and metals loading and aquatic ecosystem health is anticipated in downstream receiving waters.

Cumulative effects on local wildlife populations are expected to be minimal. However, potential effects are possible as a result of increased resource utilization from population influxes to the area and increased hunting pressure. Other local mining exploration programs in the area could exacerbate this effect. The Mayo area in the vicinity of Elsa is routinely canvassed by Government of Yukon, Environment, for moose abundance and composition and historic information on moose populations exists. The Company has identified mitigation measures to minimize effects on wildlife resources from ongoing exploration activities. The Company will cooperate with the local Renewable Resources Council and governments and participate in wildlife management activities to address potential cumulative effects on local wildlife populations.

With the implementation of mitigation measures, significant adverse cumulative effects are to be minimal with Bellekeno mine development activities.

6.0 ENVIRONMENTAL MANAGEMENT PLANS

6.1 WATER AND WASTEWATER MANAGEMENT

This section describes the plans for water use and wastewater management and treatment for the Bellekeno Mine and Mill Development and Operations Program. This includes plans for ongoing water use and wastewater management at the Bellekeno Mine site, the Christal Lake Mill and the Flat Creek Camp.

6.1.1 Climate Overview

This section presents an overview of basic variables which affect the water balance at each of the three points of water use and discharge in this project. Data from two historical Environment Canada Atmospheric Environment Service weather stations in the Keno Hill area (Elsa townsite from 1948-1965, and 1974-1989; and Keno Hill from 1974-1982) were used to predict climactic parameters for the three site locations within the Bellekeno Mine and Mill development project.

The most important variables are average precipitation and average evaporation. These two parameters were considered the key parameters in developing the water balance for the Keno Hill area as a whole, which was presented in the 1996 Site Characterization Report prepared by Access Mining Consultants for United Keno Hill Mines (please see Appendix H in Volume 2).

6.1.1.1 Precipitation and Evaporation

Mean annual precipitation (MAP) has been shown within the Keno Hill Silver District to increase with increasing elevation. The significant relief over which the Keno Hill area spans is well represented by the two historical weather stations with Elsa at 814 m and the Keno Hill weather station at 1472 m. This spread facilitated derivation of the relationship between elevation and precipitation for the site (see Appendix H, Volume 2). In combination with site evapotranspiration, calculations have been used to predict annual precipitation, evapotranspiration, and net precipitation for the Bellekeno Mine and

Christal Lake Mill (See Table 6-1 below). The close proximity and similar elevation allow Elsa to be a proxy for the Flat Creek Camp.

Table 6-1 Precipitation and Evapotranspiration at Select Keno Hill District Locations

Site	Mean Annual Precipitation (mm)	Mean Annual Evapotranspiration (mm)	Annual Net Precipitation (mm)	Data Source
Keno Hill (1472 m Elevation)	585	205	380	AES Climate Station, UKHM Site Characterization Report, 1996
Elsa Townsite (814 m Elevation)	420	230	190	AES Climate Station, UKHM Site Characterization Report, 1996
Bellekeno Mine (1050 m Elevation)	479	221	258	Calculated based on site elevation-precipitation relationship
Christal Lake Mill (880m Elevation)	437	227	209	Calculated based on site elevation-precipitation relationship

These precipitation and evapotranspiration estimates have been compared to recent work done by Clearwater Consultants Ltd. (CCL, 2008) on behalf of Alexco to update the 1996 study on Hydrology for the Keno Hill Silver district (CCL, 2008). CCL found that using the latest site flow data, hydrologic inputs for their new site-wide water balance could be estimated using the original techniques presented in the 1996 Hydrology Study, provided the influences of adit flows on local hydrology were accounted for. A direct comparison between the annual net precipitation for the Christal Lake Mill Site (209 mm) with the 2004-2007 MAR of the Christal Creek catchment area based on KV-7 flow data (221 mm) shows close agreement. Comparison between the estimated Bellekeno Mine Site annual net precipitation and MAR from the Lightning Creek catchment area above KV-41 shows a considerable difference (258 mm vs. 344 mm, respectively). This can be explained in the fact that the Bellekeno Mine site is quite low within the Lightning Creek catchment, and therefore receives below average precipitation for the catchment area.

6.1.2 Total Water Usage

This project will require water use for the exploration camp and underground development and drilling, and mill operations. As discussed in Section 2, mine production is planned to begin at 250 tonnes/day during years 1-2 and increase to 400 tonnes per day during years 3-5. These two production rates affect water use and discharge at each site. The highest water use rates (including contingencies) during the mine life for the purposes listed below are estimated as follows:

- Exploration Camp: 42.75 m³/day. Based on current camp use at the site and experience at other camps a predicted use of 228 liters per person per day has been selected. For a 150 man camp this translates to 34.2 m³/day. This is consistent with YG Environmental Health guidance figures of 200 liters per person per day. With a 25% increase in use for fire protection, total camp water use requirements are estimated at 42.75 m³/day.
- Underground Development and Production: 165.5 m³/day. Daily water usage during ongoing underground mine development is estimated at 113,562 liters/day (113.4 m³/day). This water will be used to support activities including percussion drill water use, dust suppression and equipment cooling, and minor use for sanitation. Underground diamond drilling assuming two concurrently operating drills will require another 18,930 liters/day (19 m³/day). With a 25% increase for contingencies, total water usage for underground development, production and drilling is estimated at 165.5 m³/day. The source for underground development and drill water will be sourced from Lightning Creek with possible alternate draw points in Thunder Gulch. Mine pool water will be recycled as much as possible. Based on current water use during the advanced underground exploration and development program, this is estimated at 25% recycling.
- Tailings Backfill – up to 80 m³/day. 50% of mill tailings including all pyrite tailings will be trucked from the mill to a tailings backfill plant where tailings will be partially rehydrated to the required consistency for pumping underground. This is estimated based on raising dewatered tailings produced at the Christal Lake mill site from an estimated 15% moisture to ~50% moisture. This process may also utilize mine pool water provided mine pool water chemistry does not compromise the integrity of the backfill product.

- Mill Process (fresh water makeup): 85.5 m³/day. Water is used within the mill as process water for grinding, mixing, cooling and lubrication. Although mill process water is recycled and there is no systematic mill discharge, water is lost in the dewatered tailings, mill concentrate (~12% moisture), and to the septic system. The fresh water makeup to offset this loss is expected to be 68.4 m³/day. With a 25% contingency added for fire protection and potable water use, total usage for the mill is estimated at 85.5 m³/day. Annualized mill pad and Dry Stack Tailings Facility (DSTF) runoff is estimated at 26.1 m³/day. During summer months when this water is available, it will also be utilized from the collection pond as fresh water makeup.

Combined total water usage for the camp, mine and mill during Bellekeno Mine operation is therefore 373.75 m³ per day or 136,418.8 m³ per year.

6.1.3 Water Sources

6.1.3.1 Flat Creek Camp

Domestic water for the camp is currently pumped from a cistern buried in Flat Creek. It is piped via insulated-heat traced pipeline to a water treatment facility about 100 meters to the north, located in the existing camp facility. The treatment plant consists of 5,000 liters of storage, a water softener, UV treatment and chlorination. Monthly samples are submitted for analyses for bacteriological parameters and semi-annually for complete chemical analysis. See Figure 1-2 for Flat Creek Camp water source location.

As the camp is expanded for mine development and operations there will be a need for increased water usage. A planned water well to augment water usage from Flat Creek between Flat Creek and the camp near the old fire water storage building has not yet been drilled but will be drilled during 2009 in order to meet the needs of the expanded camp. Water will be pumped to existing storage and water treatment system.

6.1.3.2 Bellekeno Mine Site

For Bellekeno mine development and production, water for drilling purposes, dust suppression and tailings backfill operations will continue to be sourced from Lightning Creek with possible alternate draw points in Thunder Gulch using infiltration wells (1 m diameter inverted culvert placed beside the creek channel) fitted with portable pumps. The pump intakes are screened to prevent fish entrainment in accordance with DFO specifications. Water is reused or recycled from the Bellekeno East or the Bellekeno 625 underground workings or the water treatment plant settling ponds to the extent possible. Approximately 25%, of the water used in underground development will be recirculated from the mine pool. The remaining 75% fresh water will come from sources located in Thunder Gulch and Lightning Creek. See Figure 2-1 for main and alternate draw points from Lightning Creek and Thunder Gulch. See Table 6-2 for annual flow rates at points along Lightning Creek and the Bellekeno 625 Adit.

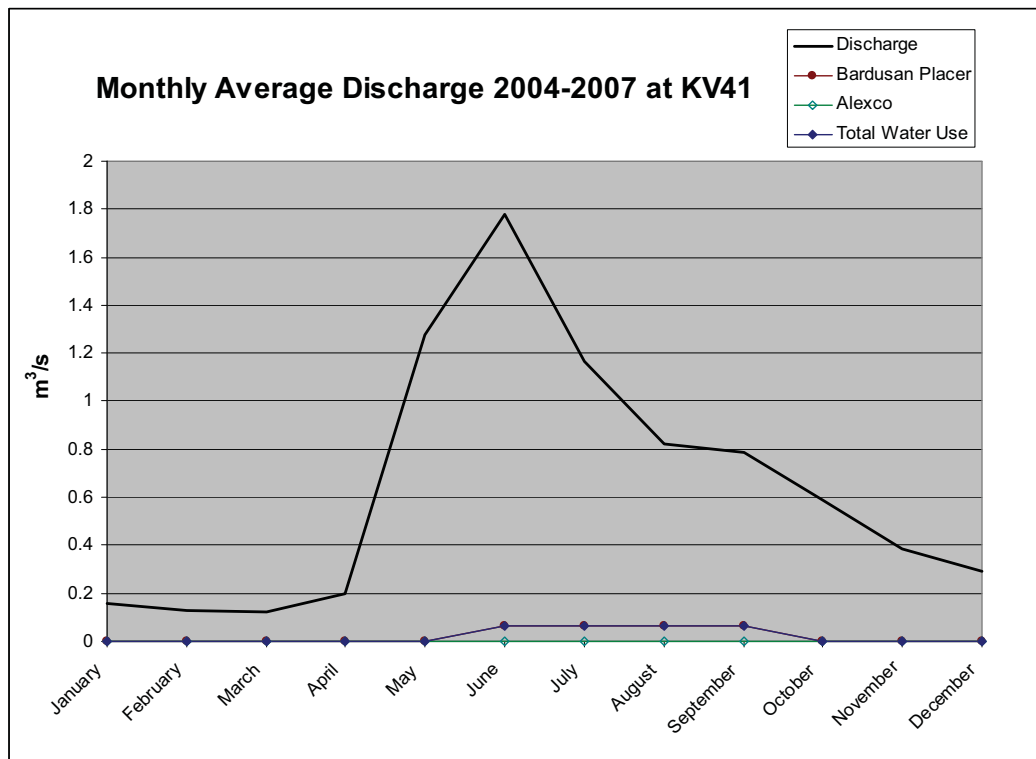
Table 6-2 Water Source Flows around the Bellekeno Mine

Input Nodes	Lightning Creek at KV-38	Lightning Creek at KV-41	Bellekeno 625 Adit Flow
Average Flow (m ³ /day)	50,000*	57,715	254.9

*Estimated flow. An average of available flow data from spring and summer months shows higher flow than KV-41.

Water use for both Alexco's Bellekeno Mine development and production and Bardusan Placer's water use is plotted on the graph of average discharge for KV-41(see Figure 3-1 for surface water quality locations) on Lightning Creek surveyed between 2004-2007 and is presented below in Figure 6-1.

Figure 6-1 Lightning Creek Monthly Average Discharge and Water Use



Alexco's projected water use of $165.5 m^3/day$ during Bellekeno Mine operations peaks as a proportion of total discharge during the month of March, when flow is lowest. This amounts to 1.53% of total Lightning Creek flow. Bardusan Placer is authorized to use significantly more water than Alexco, but their use is expected to correspond with summer months when discharge is high. The peak total water use including both Alexco and Bardusan Placer as a percentage of discharge occurs during the month of September, and is 8.2% of total discharge.

6.1.3.3 Christal Lake Mill Site

Fresh water makeup and potable water for the mill and ancillary facilities will be supplied to a 10 m by 10 m high storage tank. The potential sources to make up the estimated maximum usage of $85.5 m^3/day$ (with 25% contingency) during years 3-5 in the following order of priority are as follows:

- Water drawn from DSTF and mill pad runoff treatment pond;
- The infiltration well in the small stream (Mackeno Creek) below the historic Mackeno Mill, which was put in and used by Mackeno/Galkeno Mines for their milling operations between 1953 - 1957;
- One or more groundwater wells to be drilled near the mill site;
- Treated adit discharge water from Galkeno 900; and
- Christal Lake.

Rationales for the priority of the possible water sources for the Christal Lake Mill are as follows:

- Runoff water from the DSTF and mill pad runoff treatment pond will be priority freshwater makeup because this will directly reduce the quantity of water to be treated/discharge. Also, the pond is the closest water source to the mill; however, this source may only be to meet freshwater makeup needs of the mill on a seasonal basis depending on seasonal precipitation and winter freezing;
- Mackeno Creek carries a considerable zinc loading due to the fact that one of its sources is the Onek 400 adit discharge. Using this source as freshwater makeup followed by treatment prior to discharge may help reduce zinc loading to the Christal Creek system; and
- The three remaining water sources are considered of relatively equal merit and will be subject to more detailed scrutiny during detailed design.

Average annualized flow rates have been taken for various input nodes into Christal Lake and potential mill sources and are presented below in Table 6-3.

Table 6-3 Christal Lake Inflows and Potential Mill Freshwater Makeup Sources

Input Node	Christal Creek at KV-51	Christal Creek at KV-6	Galkeno 900 (KV-31)	Mackeno Creek at KV-52	DSTF Runoff	Groundwater Well
Average Flow (m ³ /day)	484	4,069	299	*3,648	26.1	Alternate

*Mackeno Creek flow rate taken from only one measurement on July 17, 2007. Monthly flow monitoring is now in place for this station.

6.1.4 Water Use

6.1.4.1 Bellekeno Mine

Sumps are constructed underground for temporary water storage and reuse and sediment settling of mine water. Sump location and relocation are contingent on mining / pumping efficiencies relative to mining, production and underground development rates. Two fixed sumps are located approximately 25 m from the portal entrance and the other main sump will be located at the Bellekeno North cross-cut intersection.

The existing Bellekeno 625 water treatment and settling ponds (pond 1 ~ 1,000 m³; pond 2 ~ 1,600 m³) will be used for water treatment during mine development and production to treat water with elevated metals levels (i.e. zinc). These treatment ponds will also be used as source water for the mine as a recycled water source. The existing water treatment system at the Bellekeno 625 adit is licensed under Water Licence QZ06-074 as part of the care and maintenance program. This facility has been licensed for use of water and deposit of wastewater for the advanced underground exploration and development program at Bellekeno and will be required for mine production.

Table 6-4 overviews water use and discharge during Bellekeno mine development and operations. See Figure 6-2 for a schematic representation of the Bellekeno mine water balance.

Table 6-4 Bellekeno Mine Water Balance

PROCESS DESCRIPTION	Years 1-2 (m ³ /day)	Years 3-5 (m ³ /day)
General Mine Development and Operations ¹	165.5	165.5
Tailings Backfill ²	50.0	80.0
Mine Pool Recharge ³	254.9	254.9
Potential process recycle water ⁴	up to 91.4	up to 121.4
Uptake from Lightning Creek	215.5	245.5
TOTAL WATER IN	470.4	500.4
Water to sewage ⁵	1.4	1.4
Water in Ore to Mill ⁶	14.6	23.3
Water in Waste Rock ⁷	19.0	19.0
Water used in Tailings Backfill ⁸	50.0	80
Mine Operations Discharge to Lightning Creek ⁹	130.5	121.8
Mine Pool Natural Discharge to Lightning Creek ³	254.9	254.9
Discharge to Lightning Creek	385.4	376.7
TOTAL WATER OUT	470.4	500.4

¹Includes water for sanitation and water lost in waste rock and in ore to mill

²Increases from 50 to 80 m³/day upon production rate increase during years 3-5

³Estimated based on annualized 2008 adit flow

⁴Assuming up to 25% recycling of general mine operations water and 100% of tailings backfill water; however, **no recycling** is assumed for water balance and water use estimates

⁵Subtracted from general mine development and operations

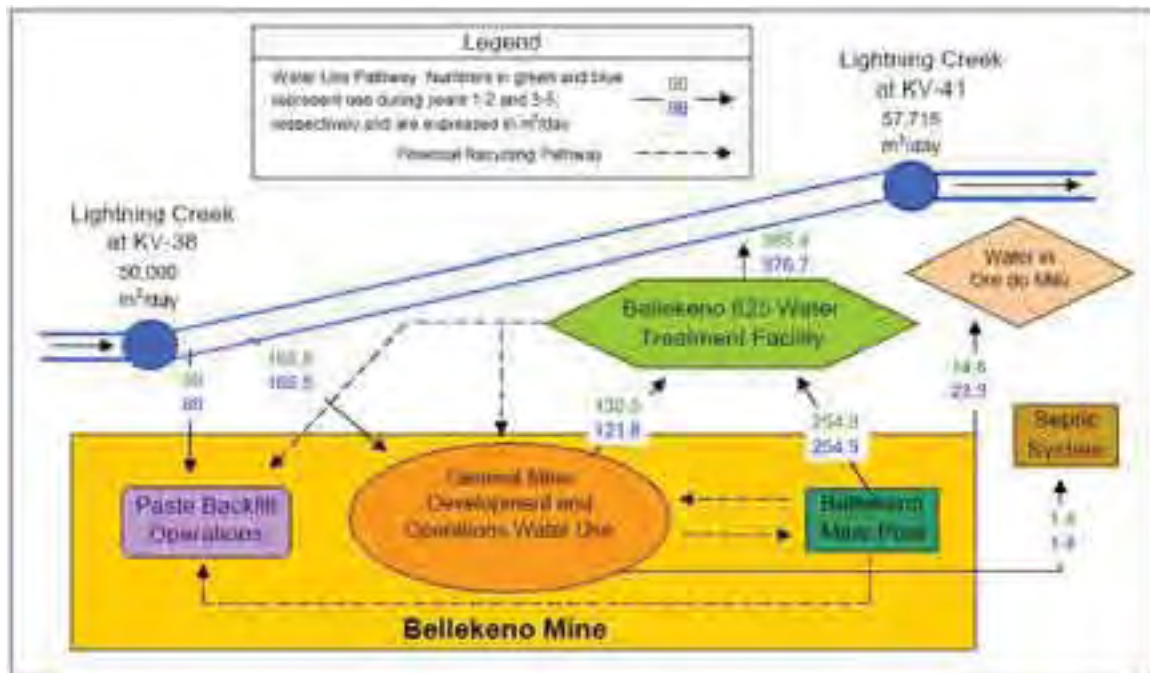
⁶Pore water in lost ore

⁷Pore water lost in waste rock

⁸Assuming 100% of backfill water is taken up in hydration reactions

⁹Mine operations water reporting through Bellekeno 625 treatment facility

Figure 6-2 Bellekeno Mine Water Use Schematic



6.1.4.2 Christal Lake Mill

See Table 6-5 for the Mill Water Balance and Figure 6-3 for a schematic of water use, flow rates, and potential water sources. Process water will consist primarily of recycling within the mill building from concentrate thickener overflow and reclaimed water from the water polishing pond (775 m³/day during years 1-2 and 1,264 m³/day during years 3-5). The reclaimed water will be redirected to a process water storage tank, from where the water will be dispersed to the distribution lines in the process plant.

Approximately 58.64 m³/day of freshwater makeup will be necessary to offset losses in water to sewage, filtered concentrate, and filtered tailings during years 1-2 and 68.4 m³/day during years 3-5.

Table 6-5 Mill Water Balance

PROCESS DESCRIPTION	Years 1-2 (m³/day)	Years 3-5 (m³/day)
Fresh Water to Gland Seals	42.48	42.48
Fresh Water for Reagent Mixing	1.18	1.92
General Plant Use (sanitation)	0.72	0.72
Water in Fresh Ore	14.26	23.28
TOTAL WATER IN	58.64	68.4
Process Recycled Water IN	775	1264.8
Water to Sewage	0.72	0.72
Water Leaving Plant in Filtered Concentrate	7.65	12.48
Water Leaving Plant in Filtered Tailings	32.5	53.04
Mill Discharge to Treatment	17.77	2.16
TOTAL WATER OUT	58.64	68.4
Process recycled water OUT	775	1264.8
Mill Pad + DSTF Runoff	26.1	26.1
Total Water Treated/Discharged to Christal Lake	43.87	28.26

6.1.5 Wastewater Treatment and Discharge

6.1.5.1 Bellekeno Mine

This section describes the wastewater treatment plans for the Bellekeno Mine development and operations.

6.1.5.1.1 Bellekeno 625 Water Treatment System

Existing water treatment at the Bellekeno 625 adit is licensed under Water Licence QZ06-074 and consists of conventional wastewater treatment technology using continual lime addition to treat mine portal effluent. Lime is mixed with fresh water (Flat Creek or Valley Tailings) at a central mixing facility in the town site of Elsa and delivered to the mine portal via a lime slurry tanker truck. A number of modifications were made to the Bellekeno treatment system in September to November 2007 in an effort to improve operating performance as well as address safety concerns and operating inefficiencies. Current operations of the modified treatment system include delivery of a lime slurry solution to a new 12,000 L (3,200 gallon) storage and mix tank located inside a new treatment building. An adjustable peristaltic pump that delivers lime solution to the untreated adit water as it enters and is mixed in a new Rapid Mix Tank located below the treatment building. The zinc in the adit water is converted to a zinc hydroxide and precipitates and settles in the two lined settling ponds (pond 1 ~ 1,000 m³ and pond 2 ~ 1,600 m³). The ponds at Bellekeno were upgraded in 2007 through reconfiguring and lining both ponds. The treated water discharges from the lined ponds into a drop box and pipeline and flows into natural ground and eventually into Thunder Gulch and Lightning Creek. The Bellekeno 625 adit and treatment area are shown on Figure 2-1 while Plates 1 through 3 show water treatment facilities at Bellekeno 625.

It is not anticipated that any additional work or modifications will be necessary to the current treatment system to treat the additional flow resulting from during Bellekeno mine development and production.



Plate 1 Bellekeno 625, View Looking Upstream - Thunder Gulch



Plate 2 Bellekeno 625 Settling Ponds

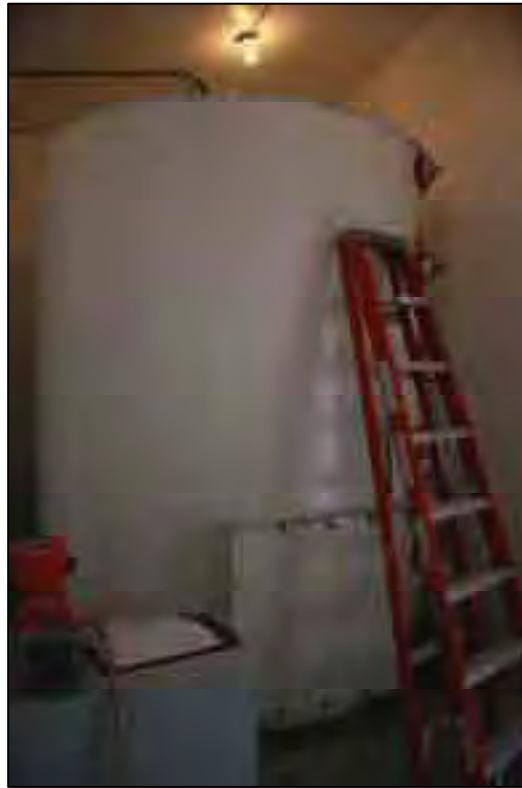


Plate 3 Bellekeno 625 Lime Mix Tank

The Bellekeno 625 raw adit is routinely measured for flow and water quality as part of the care and maintenance program and advanced underground exploration program. This monitoring will continue during mine production. Based on a review of the data, portal water flow at the Bellekeno 625 treatment facility averaged approximately 1.65 L/s in 2006 with a range in flow between 1.35 and 2.00 L/s. Data for 2007 indicates an average flow of 2.37 L/s ranging between 0.14 and about 10.00 L/s. Flow in 2008 averaged 2.95 L/s. The 2008 flow level is used in the Bellekeno Mine water balance calculations (Table 6-4) as it is the most conservative from a design standpoint. The untreated adit water pH is nominally 7.5 units. Between January 2005 and November 2008, the total zinc concentration in the raw adit water has averaged 7.47 mg/l (n=661) and ranged between 0.36 and 111 mg/l total zinc. The high total zinc is reflective of high TDS from underground development activities.

Because responsibility for the Bellekeno Mine discharge switched corporate hands several times in the last two decades, water quality and flow data from the Bellekeno 625 adit contains some major gaps. Enough data exists however, to enable a comparison between states when the mine was dewatered (pumped) and later when it was allowed to flood. This comparison has allowed Alexco to make predictions of water quality during mine production (dewatered) and also at closure upon flooding of the workings.

Figure 6-4 shows monthly zinc concentration measurements observed in raw adit water between May 1995 and November 1996 (the last time the Bellekeno mine was in a pumped down or dewatered condition). Figure 6-5 shows monthly averages of raw adit water and treated effluent at Bellekeno 625 between 2004 and 2008. Averages were calculated using data measured and analyzed on a daily basis at the site. It should be noted that during the period from September to October 2007 water treatment system improvements were under construction and the system commissioned. Treatment performance at the facility is now in hand.

Figure 6-4 Total Zinc Concentrations of Bellekeno 625 Raw Adit water (KV-42) between May 1995 and October 1996

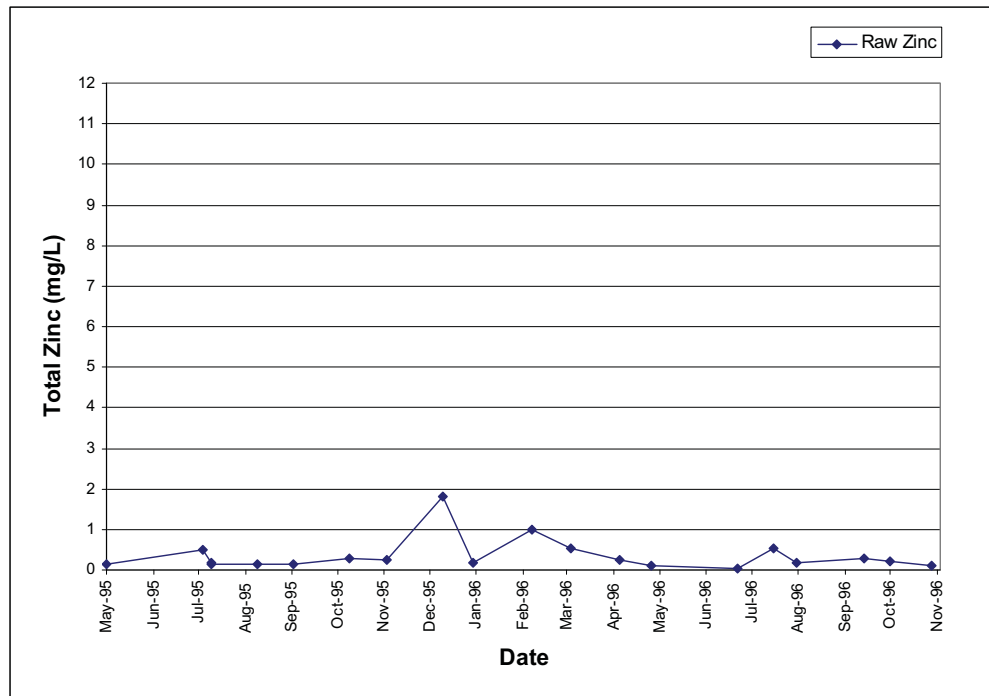


Figure 6-5 Monthly Average Total Zinc Concentrations of Bellekeno 625 Raw Adit Water (KV-42) and Treated Effluent (KV-43) between January 2004 and November 2008

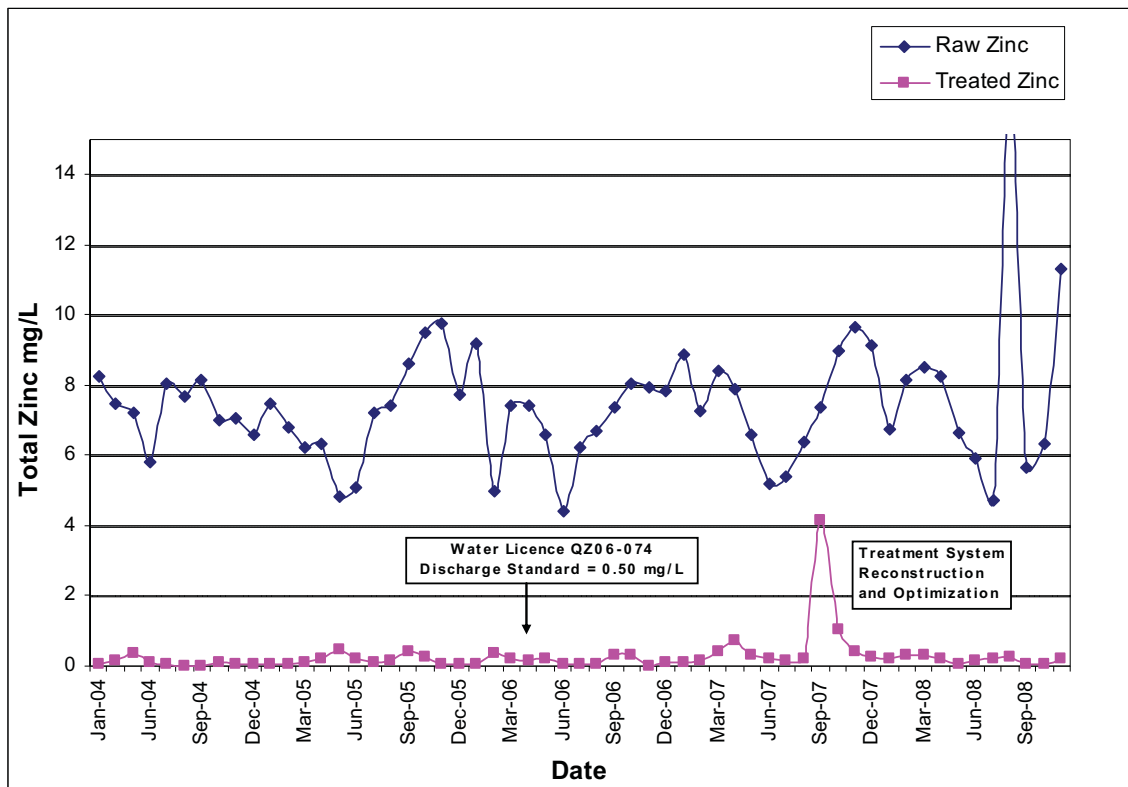
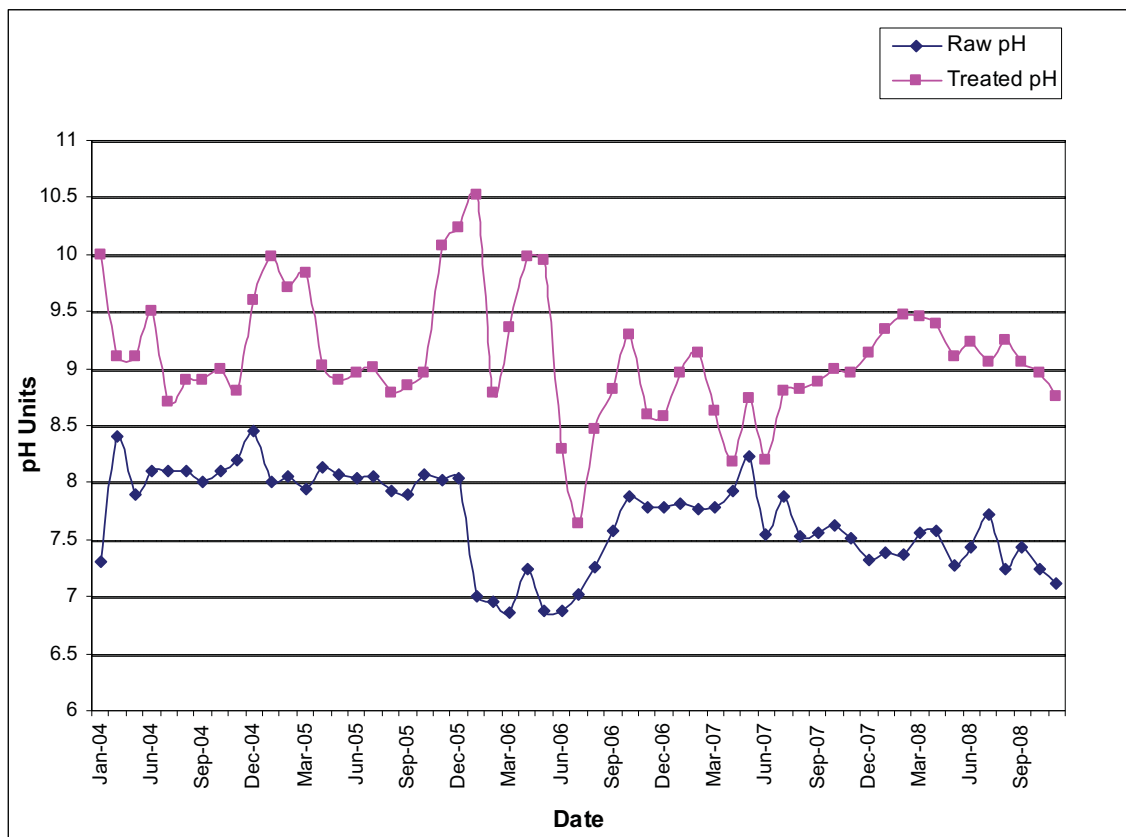


Figure 6-6 Monthly Average pH Levels of Bellekeno 625 Raw Adit Water (KV-42) and Treated Effluent (KV-43) between January 2004 and November 2008



Bellekeno 625 treatment facilities are capable of treating water resulting from mine development and operations. The existing Bellekeno 625 settling ponds have a combined retention capacity of 2,600 m³. Based on the historic flow data from the adit, spring flow rates as high as 10 L/s can be expected. This would translate into approximately 3 days of retention capacity with the existing Bellekeno 625 settling ponds. Typically one day's retention capacity is required to settle metal hydroxide waters. For a conservative estimate of assessing the existing Bellekeno 625 treatment capacity the following is assumed: based on a total daily water usage of 165.5 m³/day for mine development and operations and assuming no water recycling or reuse during the program and that all water reports as wastewater to the treatment system, an approximately 1.91 L/s outflow from the Bellekeno 625 portal is estimated. The current (2008) average discharge from the adit is 2.95 L/s; therefore, the 10 L/s capable existing

system has enough capacity (1.91 L/s proposed and 2.95 L/s existing sum to 4.86 L/s) to provide treatment and retention for mine operations.

6.1.5.2 Bellekeno Mine Contact Water Quality Characterization

A review of the historic water quality data for the Bellekeno 625 raw adit is instructive in understanding changes to the adit water quality resulting from previous dewatering operations and mine flooding. The following points have been observed:

- During intervals when Bellekeno was dewatered, zinc concentrations ranged from 0.12 to 1.8 mg/l (n=20, Figure 6-4 above);
- During previous dewatering operations at the Bellekeno 625 lower workings total zinc concentrations ranged from 0.428 to 1.27 mg/l (n=4, Sept. 1999 to Feb. 2001);
- After the lower Bellekeno workings were flooded and discharge reoccurred from the Bellekeno 625 adit monthly zinc concentration averages have ranged from an initial value of 8.11 mg/l (March 2003) to a low of 4.68 mg/l (June 2006) and averaged 7.98 mg/l (n=46);
- Recent spikes in zinc concentrations (August and November 2008) are interpreted to be due to mucking and disturbance of the Bellekeno 625 adit, which has resulted in increased zinc mobilization;
- The flooded workings contained nearly an order of magnitude higher zinc levels than the dewatered workings; and
- Dewatering Bellekeno has commenced, with samples of mine pool water to date averaging 8.85 mg/l zinc (n=12)

Based on these observations it is anticipated that the contact water of the Bellekeno Mine during operations (after dewatering) will have similar water quality to previous periods when the mine was dewatered (i.e. than 2 mg/L zinc). The dewatered workings are thus expected to show improved water over the currently flooded workings. The high zinc levels seen upon flooding of mine workings is interpreted to be due to remobilization of metal salts which oxidized on mine walls while the mine was

dewatered. While the mine is dewatered and being pumped, water seems to pick up less zinc from the mine workings.

The present water treatment system at the Bellekeno 625 (as well as at other treatment sites on the property) has successfully treated adit waters with current metal loading levels, and is expected to perform in a similar manner on the lower metal levels expected during Bellekeno Mine Development and operational activities.

Upon closure and flooding of the workings, it is anticipated that zinc levels will initially rise to between 5-8 mg/L zinc, similar to previous floodings. Although the data are unclear, there may be a weak trend towards gradual decrease in zinc levels as oxidized zinc minerals are gradually flushed out of the system. Treatment options upon closure are discussed in Section 8. The mine wall geochemical and ABA testing program described in Section 6.2 may also aid in water quality prediction.

6.1.5.3 Christal Lake

This section describes the wastewater treatment plans for Christal Lake mill site and DSTF during Bellekeno Mine development and operations.

6.1.5.3.1 Christal Lake Mill Water Treatment Facilities

The Christal Lake Mill is designed to minimize water use and release of waste water. This is accomplished primarily through recycling mill process water from thickener overflows to the beginning of the flotation circuit. Almost all of the maximum 58.64 m³/day water use is to make up for the small amount of water which is lost in the dewatered tailings and filtered concentrate (approximately 12% moisture). Thus, most of the effluent from the Christal Lake Mill Site will result from meteoric runoff from the mill pad and dry stack tailings facility, with a possible minor input from additional pore water loss from the dry stack tailings facility. The mill pad and DSTF are designed to drain a common treatment/polishing pond south of the mill. The runoff collection/polishing pond is also the first priority as a freshwater makeup source, which will further reduce discharge from the Christal Lake Facilities. See Figure 6-7 for an overview of proposed

dry stack tailings design and water diversion and collection systems. A common water collection/polishing pond is situated between the DSTF and mill pad. Sizing for this pond has been designed to accommodate the 1 in 200 year storm event. Detailed engineering design will review and confirm hydrological input parameter and sensitivity analyses to refine pond sizing for freshet events. In the event that pond expansion is required, the current site has considerable room for expansion. More details on the DSTF and water collection and diversion systems can be found in Volume 2 Appendix J. Prior to commencement of milling operations, conventional lime treatment facilities will be installed at the collection/polishing pond with the capacity to treat all runoff and effluent prior to discharge to Christal Lake.

6.1.5.3.2 Christal Lake Mill Contact Water Quality Characterization

Initial test work by Process Research Associates on tailings characteristics indicate that tailings pore water may contain zinc at around 20 mg/L (Table 6-6 below). Discussions with EBA regarding their experience with the dry stack tailings facility at Minto indicate that additional pore water loss from filtered tailings is negligible. Design specifications for filter presses to be used in the Christal Lake mill are for lower moisture content than those used at Minto. Should any pore water loss occur, it will report with meteoric runoff to the lower collection/polishing pond and be treated with lime to achieve discharge standards.

Table 6-6 Dry Stack Tailings Pore Water Assay

Elements	Units	LC1 Bulk Tails
Sb	mg/L	<0.1
As	mg/L	<0.2
Bi	mg/L	<0.1
Cd	mg/L	0.12
Ca	mg/L	145
Cr	mg/L	<0.01
Cu	mg/L	0.64
Fe	mg/L	4.77
Pb	mg/L	0.45
Ag	mg/L	<0.02
Zn	mg/L	20.31

6.1.6 Effluent Discharge and Criteria

6.1.6.1 Bellekeno Mine

Effluent discharge standards for current advanced underground exploration and development activities at Bellekeno under Water Use Licence (WUL) QZ07-078 are the same as those established for care & maintenance activities at the Keno Hill Property (QZ06-074), except that ammonia nitrogen was added to QZ07-078 due to the use of explosives. Although the discharge standards under QZ06-074 will continue to be in effect for care and maintenance activities throughout the Keno Hill Silver District, Bellekeno mining and milling development and operations will also become subject to the MMER, which specifies authorized discharge limits of deleterious substances for a number of set parameters. Thus, the new Type A water licence for mining and milling development and operations is expected to reflect MMER (Table 6-7). Additional parameters currently in WUL QZ07-078 that are not subject to the MMER include ammonia nitrogen, cadmium and silver.

Table 6-7 Proposed Effluent Discharge Standards

Parameter	Maximum Concentration		
	Monthly Mean	Composite	Grab Sample
pH	6.0 to 9.5 pH Units		
Suspended Solids	15 mg/L	22.5 mg/L	30 mg/L
Ammonia Nitrogen			5.0 mg/L
Arsenic (Total)	0.5 mg/L	0.75 mg/L	1.0 mg/L
Cadmium (Total)			0.05 mg/L
Copper (Total)	0.3 mg/L	0.45 mg/L	0.6 mg/L
Lead (Total)	0.2 mg/L	0.3 mg/L	0.4 mg/L
Nickel (Total)	0.5 mg/L	0.75 mg/L	1.0 mg/L
Radium 226	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
Silver (Total)			0.10 mg/L
Zinc (Total)	0.5 mg/L	0.75 mg/L	1.0 mg/L

Any discharge to a watercourse must meet a bioassay standard of a 96-hour at 100% LT₅₀ bioassay using rainbow trout, pH non-adjusted.

6.1.6.2 Christal Lake Mill

The Christal Lake Mill is designed to operate to minimize water use and release of waste water. All mill process water is recycled to the beginning of the flotation circuit. Almost all of the maximum 58.64 m³/day water use is to make up for the small amount of water which is lost in the dewatered tailings and filtered concentrate (approximately 12% moisture). Thus, the only wastewater effluent from the Christal Lake Mill Site will result from meteoric runoff from the mill pad and dry stack tailings facility, with a possible minor input from additional pore water loss from the dry stack tailings facility. Discussions with EBA regarding their experience with the dry stack tailings facility at Minto indicate that additional pore water loss from filtered tailings is negligible. All runoff water will be collected using berms to direct it to a collection pond and will be treated if necessary using conventional lime treatment methods in order to achieve discharge standards as shown in Table 6-7.

6.1.7 Potentially-AML Waste Rock Storage Facilities

The Onek Potentially-AML waste rock storage facility will be capped with an impermeable cover upon closure. Before this cap is in place, however, meteoric water may accumulate in these lined facilities. Should the need arise, accumulated water will be periodically educted using a vacuum truck and transported to either the Bellekeno 625 treatment facility or the Christal Lake Mill for discharge, and treatment if needed. It should be noted that the aforementioned two locations will be MMER discharge points.

6.1.8 Sewage

Alexco currently holds two (2) sewage disposal system permits at Elsa, issued by YG Environmental Health Services: one septic system permit for the Flat Creek Camp (Permit #3012) and a septic system for the four houses (Permit #3131) constructed in 2008. Sewage from the exploration and administrative building in Elsa is currently held in a tank, which is periodically pumped and transported to the Mayo municipal wastewater treatment station for disposal. Wastewater from the camp is pre-treated in septic tanks and released to a constructed drain field for final treatment as per conventional septic system design.

The Flat Creek camp expanded to 100 persons for the advanced underground exploration and development program. This required a septic system expansion and permit amendment. Further camp expansion of the Flat Creek camp to accommodate 200 persons for Bellekeno Development may require additional septic treatment capacity. One of the options that Alexco is looking into is a Rotating Bio-Reactor system. These systems have been permitted and used successfully in other locations in B.C. and the NWT. See http://www.seprotech.com/products/rotordisk_internals/ for additional details and specifications. The other option is an expansion of the existing septic field in accordance with engineering specialist design and terms and conditions of a new *Permit to Install a Sewage Disposal System*, from YG Environmental Health Services.

Additional septic systems may also be required at the Christal Lake Mill site, the Bellekeno East portal, the Elsa exploration and administrative office, and Bellekeno 625 in order to service the buildings there related to mine development. These systems will

be designed in accordance with engineering specialist design and terms & conditions of a new *Permit to Install a Sewage Disposal System*, from Government of Yukon, Environmental Health Services.

6.2 BELLEKENO MINE WASTE ROCK MANAGEMENT

6.2.1 Introduction

The Bellekeno Advanced Underground Exploration and Development Program, assessed under YESAB project number 2008-0039, presented a comprehensive Waste Rock Management Plan (WRMP) for the estimated 248,000 tonnes of waste rock to be excavated over 5 years. In addition to the WRMP assessed under YESAB project number 2008-0039, an additional Waste Rock Testing Plan, Mine Wall Sampling Plan, were submitted to the Yukon Water Board and Government of Yukon, Mining Land Use Department, under Sections 24 and 25 of Water Licence QZ07-078. These plans provided additional detail regarding geochemical and ABA testing of waste rock and mine walls exposed during excavation, and their essence incorporated into this plan. Under Section 23 of Water Licence QZ07-078, a Waste Rock Physical Inspection Plan was submitted. Additional supporting studies on Acid Rock Drainage/Metal Leachate (ARD/ML) controlling and correlating factors, and geoenvironmental characterization of the Bellekeno Zone were undertaken by Altura Environmental Consulting of Whitehorse, Yukon. These documents are attached as Appendix B and C in Volume 2, respectively.

During Bellekeno Mine development, an estimated additional 500,000 tonnes of waste rock may be excavated over the 5 year mine life. This additional waste rock is expected to be similar in lithology and AML/non-AML character to that encountered thus far during the Advanced Underground Exploration and Development Program. Thus, the Bellekeno Mine Waste Rock Management Plan is based on similar data, methodologies, and assumptions as were used in the Advanced Underground Exploration and Development Program developed under YESAB project number 2008-0039, including the Waste Rock Testing Program and Mine Wall Sampling Programs submitted for Water Use Licence QZ07-078.

6.2.2 Purpose of Plan

This plan outlines practices for management of waste rock to be excavated during the Bellekeno Mine Development, to be undertaken commencing in 2009 by Alexco.

The plan is intended to ensure that appropriate management procedures are followed during excavation activities in order to minimize impacts of stored rock to land and water resources. Monitoring following excavation activities is intended to assess the effectiveness of the management measures, ensure that adaptive management approaches are implemented and to ensure that appropriate information is obtained by Alexco to assist in closure planning.

6.2.3 Scope of Plan

Aspects included in this Plan are:

- Definition of rock categories based on potential for reactivity (specifically, acid generation and/or metal leaching);
- Estimation of quantities of each category to be excavated during the project;
- Operational categorization of excavated rock;
- Geochemical and ABA confirmatory testing;
- Mine wall geochemical and ABA testing;
- Control measures as required to mitigate effects of potential acid generation and/or metal leaching;
- Monitoring and physical inspection activities for waste rock storage areas;
- Reporting of waste rock management activities;
- Geotechnical design of waste rock storage areas and;
- Non-AML waste rock disposal area risks and mitigations.

6.2.4 Rock Characterization

6.2.4.1 Summary of Rock Characterization

Studies conducted throughout the Keno Hill camp and specifically within the Bellekeno zone, provide a foundation for correlating and understanding the weathering behaviour or 'geoenvironmental' tendencies of rock in the Keno area. Appendix B and Appendix C in Volume 2 provide full details of these geoenvironmental evaluations.

6.2.4.2 Study Overview

The geoenvironmental evaluations to support the Bellekeno Waste Rock Management Plan (WRMP) consisted of data analysis and integration of four specific data components:

- 1) site-wide studies on weathered rock (47 samples);
- 2) acid base accounting of 2006-2007 Bellekeno drill core (71 samples);
- 3) Bellekeno drillhole multi-element and lithology database (6,478 samples), and
- 4) mineralogy and alteration logging data on acid base accounting samples.

An overall flowchart of data review and synthesis as well as principal results are presented in Figure 6-8. Specifically, the studies have been used to derive the following components for the waste rock management plan:

- 1) AML geochemical screening criteria;
- 2) estimated proportions of potentially AML and Non-AML material by rock type for Bellekeno; and
- 3) field criteria for differentiating potentially AML and Non-AML rock during excavation activities.

6.2.4.3 Summary of Results

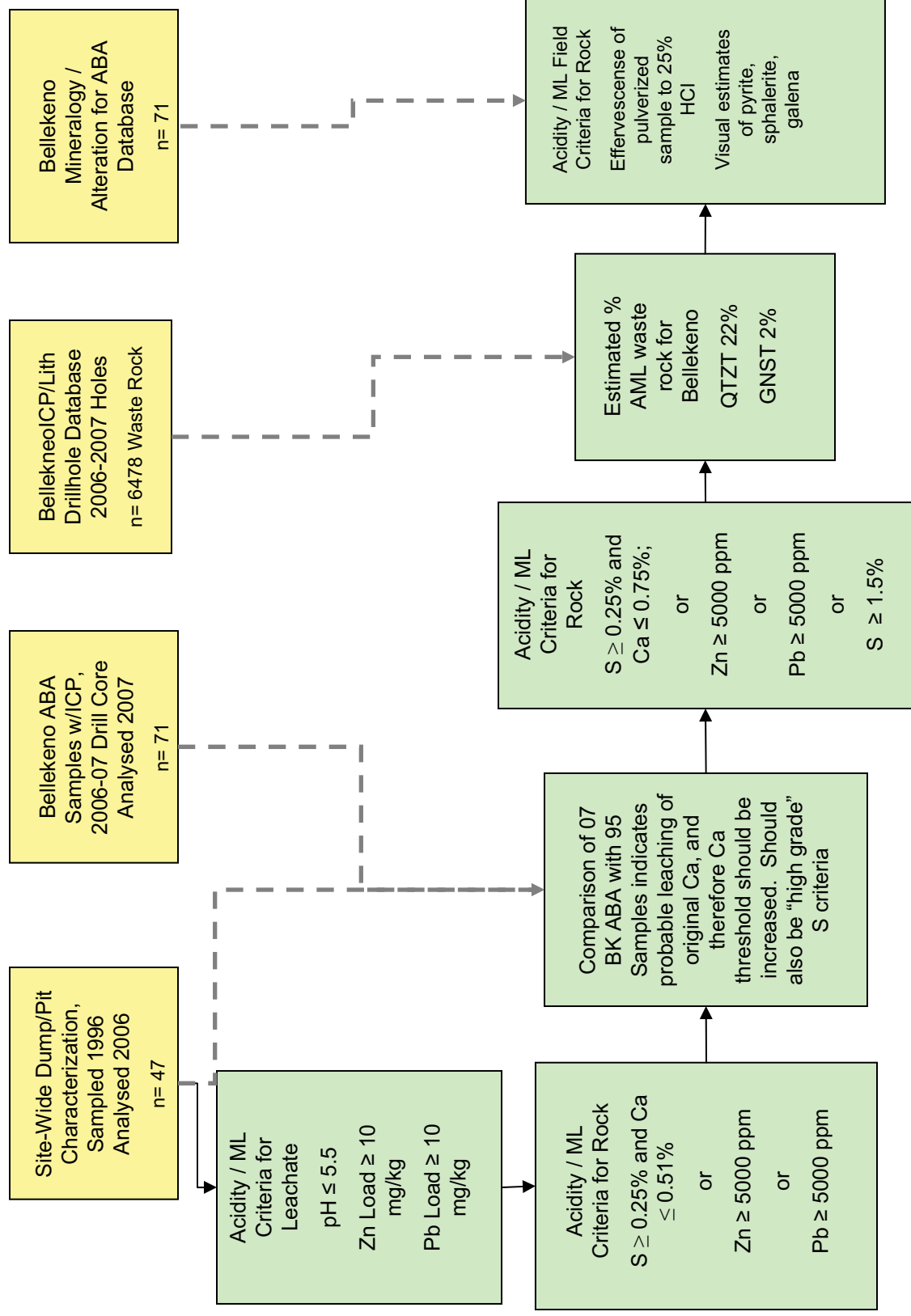
See Table 6-8 (located in Section 6.2.4.5 below) for a summary of waste rock management categories and physical and geochemical screening criteria, as well as usages and storage methods.

6.2.4.4 *Potentially-AML Waste Rock Geochemical Screening Criteria*

As discussed in Appendix C (in Volume 2), recommended geochemical screening criteria for identification of potentially-AML Bellekeno rock are as follows:

- a) $\text{Ca}\% \leq 0.75\%$ and $S_{\text{via ICP}} \geq 0.25\%$;
- b) or $S_{\text{via ICP}} \geq 1.50\%$;
- c) or $\text{Pb} \geq 5000 \text{ ppm}$; and
- d) or $\text{Zn} \geq 5000 \text{ ppm}$.

Figure 6-8 Bellekeno Waste Rock Characterization Study – Components and Key Results



6.2.4.5 *Estimated Proportions of AML and Non-AML Rock for Bellekeno*

Applying the geochemical screening criteria to the 6,478-sample waste rock drillhole database, Table 6-8 shows the proportions of potentially-AML rock identified for each lithology.

Table 6-8 Proportion of Samples Filtered as Potentially-AML in Bellekeno Waste Rock Drillhole Database

Lithology		Number of Samples in Database	Number of Samples Screened as Potentially-AML	Percentage of Samples Screened as Potentially-AML
Description	Code			
Chloritic Schist	CHSCH	222	27	12%
Calcareous Quartzite	CQTZT	505	54	11%
Greenstone	GNST	567	10	2%
Graphitic Schist	GSCH	870	562	65%
Quartzite	QTZT	3293	719	22%
Schist, Undifferentiated	SCH	775	299	39%
Sericitic Schist	SSCH	205	37	18%

As can be seen from Table 6-8, the most abundant lithologies at Bellekeno are quartzite and calcareous quartzite (intercalated with minor graphitic schist) with some greenstone, chlorite schist and sericite schist. These data were used to predict proportions of AML and non-AML rock which was excavated during the advanced underground development and exploration program and is also used as a predictor for the currently proposed mine development and operations.

6.2.4.6 Waste Rock Field Screening Criteria

One of the fundamental parts of the Bellekeno Mine Waste Rock Management Program is field screening of waste rock. Field screening criteria for identifying potentially-AML rock have been developed as follows:

- a) Slight or no effervescence of pulverized sample with 25% HCl (e.g. presence of none or only a few bubbles), and visual estimated pyrite >0.5%, or;
- b) Any sample with one or more of the following:
 - i. visual estimated sphalerite >0.75%;
 - ii. visual estimated galena >0.5%;
 - iii. visual estimated pyrite >2%;
 - iv. any vein material not deemed to be in “Mineralized” category; and
 - v. paste pH ≤ 6.0.

6.2.4.7 Rock Management During Operations

Table 6-9 summarizes key characteristics of the rock management categories:

- 1) Potentially-AML Waste Rock;
- 2) Non-AML Waste Rock;
- 3) Mineralized Rock

Included for each category are environmental characteristics, use and storage specifications, geochemical criteria, and field screening criteria. Tailings management is discussed in Section 6.3.

Table 6-9 Waste Rock Management Categories

	Potentially-AML Waste Rock	Non-AML Waste Rock	Mineralized Rock
Environmental Characteristics	Potentially acid-generating and/or metal leaching	Non- acid-generating and non-metal leaching	Ag, Pb, and Zn grades of economic interest. May contain minerals with potential for net acidity and/or metal leaching
Uses and Storage	Not suitable for general construction purposes. To be stored at the lined Onek waste rock storage facility or equivalent design (see Appendix D) or stored underground in the Bellekeno mine below static water level	May be used for general construction purposes	May be stockpiled temporarily on concrete lined pad at Bellekeno 625 or at the Christal Lake mill site, then either milled or sent to potentially-AML storage facility
Geochemical Criteria	1. Ca% $\leq$ 0.75% and $S_{ICP} \geq$ 0.25 % 2. or $S_{ICP} \geq$ 1.50 % 3. or Pb $\geq$ 5000 ppm 4. or Zn $\geq$ 5000 ppm	All waste rock samples not meeting AML criteria, namely: a) $S_{ICP} < 0.25$ % b) or Ca% $> 0.75\%$ and $S_{ICP} < 1.50$ % c) and Pb < 5000 ppm d) and Zn < 5000 ppm	a) Ag $\geq$ 100 ppm b) or Pb $\geq$ 10000 ppm c) or Zn $\geq$ 10000 ppm
Field Screening Criteria	a) Slight or no effervescence of pulverized sample with 25% HCl (e.g. presence of none or only a few bubbles), and visual estimated pyrite $>0.5\%$, or; b) Any sample with one or more of the following: i. visual estimated sphalerite $>0.75\%$ ii. visual estimated galena $>0.5\%$ iii. visual estimated pyrite $>2\%$ iv. any Vein material not deemed to be in "Mineralized" category v. paste pH $\leq$ 6.0	All waste rock samples not meeting AML criteria, namely: a) Virtually no visible pyrite under magnification, or if some sulphides present: i. Steady effervescence of pulverized sample with 25% HCl (continuous stream of bubbles and visual estimated pyrite $<2\%$ b) and visual estimated sphalerite $<0.75\%$ c) and visual estimated galena $<0.5\%$ d) paste pH >6	Visual estimation of galena, sphalerite and sulphosalt minerals followed by confirmatory assay.

6.2.4.8 *Rock Excavation Activities*

Additional details on rock excavation activities including tonnages expected, rock management categories, and waste rock management categories for non-AML and potentially-AML waste rock are discussed in Section 2.2.3.

6.2.4.9 *Waste Rock Screening*

Samples for both field screening and compositing for further geochemical and ABA confirmatory testwork are collected using the Face Sampling Method, which is used in all new mine working developments. This method was proposed in Section 2.5.1 of the Project Proposal for the Bellekeno Advanced Underground Exploration and Development Program, assessed under YESAB project number 2008-0039 and has been subsequently refined and put into practice over the 2008 season. This method ensures accurate, representative characterization of each blast round and allows field screening tests to be performed in a timely manner so that waste rock can be most efficiently treated according to the waste rock management categories (Table 6-9).

6.2.4.10 *Face Sampling Method*

The Face Sampling Method (summarized in Figure 6-9) has been developed into the following procedure:

First, the site geologist marks up the heading and center line of the development drive. The geologist demarks the side walls and back heights to be taken, then assesses the rock face by spray painting the boundaries between each lithology and paints the sample number of each lithology on the face. Next, the geologist makes a pencil sketch and takes a photograph of the face. The geologist then samples each lithology and visually estimates each lithology/sample for sulphide and carbonate content and records the data on the Face Sampling Form (see Figure 6-10).

After being collected, the samples then are taken to the geology field laboratory located at Bellekeno 625 where they are dried using a convection dryer, then crushed and pulverized by a geologist or lab technician. The pulverized samples are subjected to a fizz rating test and paste pH measurement.

Figure 6-9 Face Sampling Method and Waste Rock Management

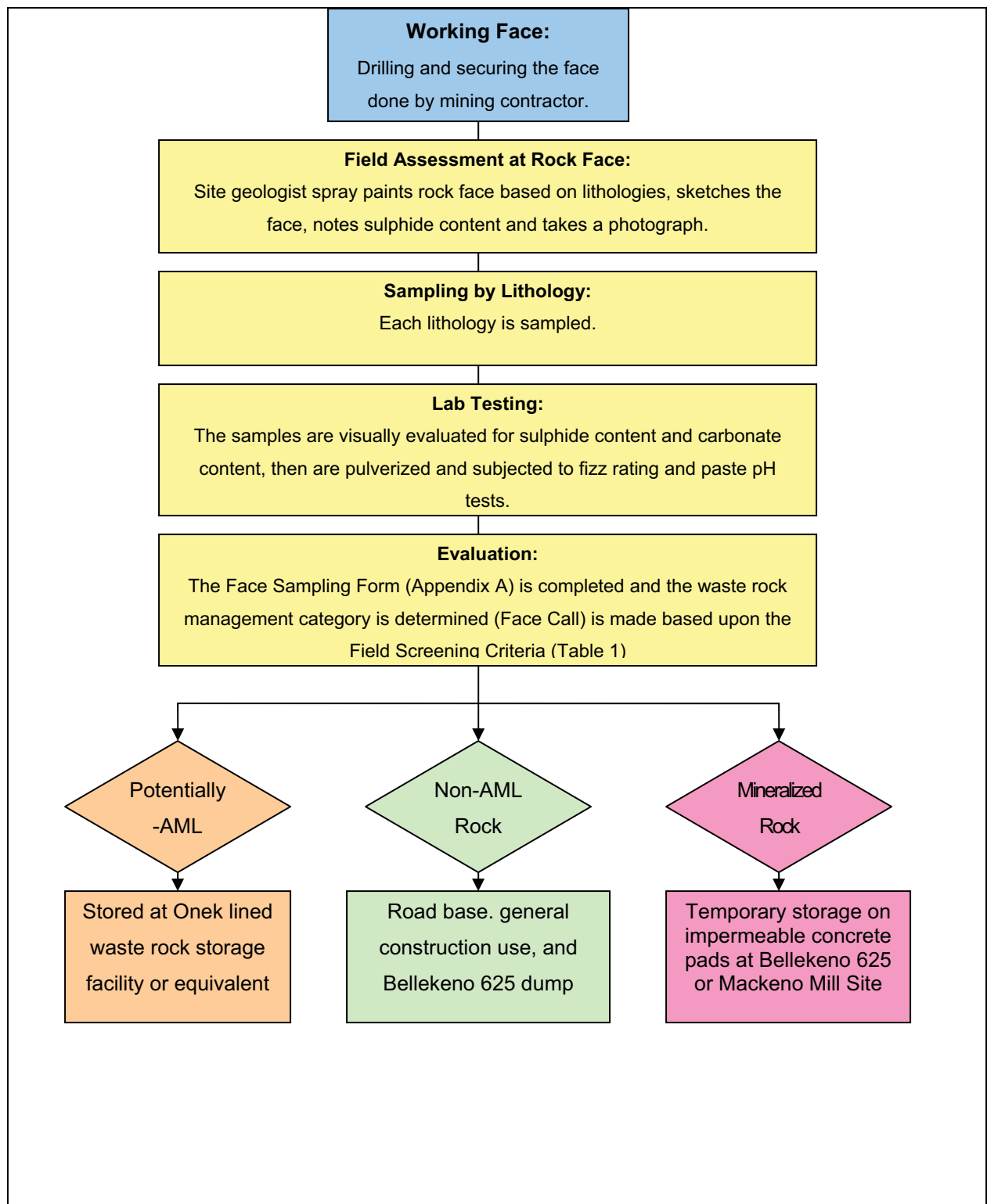


Figure 6-10 Example of Face Sampling Form

**ALEXCO RESOURCE CORP. KENO HILL PROJECT
FACE SAMPLING FORM**

Mine: RA 125 Geologist: TH / M.W Date: 19-04-05

Development: Waste Production: Waste Sample Type: CHIP

Face Location	Spill #	Dist. (m)	Direction	Face Dimensions	Width (m)	Height (m)	Length (m)
	<u>P27</u>	<u>7.3m</u>	<u>SW</u>		<u>2.4</u>	<u>2.2</u>	

Face Name: 1'27 SW 7.3m Lab Testing: Visual Estimate

Sample #	Primary Lithology	Paste gel	Flz Rating	%Pyrite	%Sulfate	%Galenite	%CaCO ₃	Area (m ²)
<u>5607059</u>	<u>COTET</u>	<u>9.65</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>20.75</u>	<u>2.48</u>
<u>499</u>	<u>GSCH</u>	<u>9.11</u>	<u>4</u>	<u>0.15</u>	<u>0</u>	<u>0</u>	<u>70.75</u>	<u>0.50</u>
<u>500</u>	<u>COTET</u>	<u>9.56</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>20.75</u>	<u>3.04</u>

Notes: PACT ON 2.45. Sulfate COTET - 0.35 m. 10m
THICK GROSS MINERAL FINE. MADE AS LONG DIST
COTET units both have strongly developed jointsets
w/ mod-heavy limonite staining. No visible Py
on freshly broken COTET. Minor JPg in GSCH band

ABA Classification: 1

PHOTO ID: 1

6.2.4.11 Evaluation and AML/non-AML Designation

The results of all screening criteria are evaluated according to the criteria presented in Section 6.2.4 and summarized in Table 6-9, and the entire round is designated to the appropriate waste rock management category (more commonly referred to as the “face call” or ABA classification, with 1 being non-AML, 2 being potentially-AML). A special case may occur when a given blast round contains a complex mixture of lithologies including both non-AML and potentially-AML units. If overall less than 30% of the working face is deemed as potentially-AML, and the remainder of the face consists of rock with a high neutralization potential (such as calcareous quartzite), the geologist *may* assign the entire blast round as non-AML. The rationale here is that upon blasting and transport, the rocks from all units are mixed and the small portion of potentially-AML rocks would be overwhelmed by the net neutralizing potential non-AML units, and bulk chemistry of the round would be non-AML. As an example, consider the following 240 tonne blast round which contains 30% graphitic schist (1.75% S, 1% Ca) intercalated with 70% calcareous quartzite (0.25% S, 2.8% Ca). This is an extreme example, as 1.75% sulfur is well above the 95th percentile for graphite schist analyses presented in the *Geoenvironmental Characterization, Bellekeno* in Appendix C (Volume 2). In contrast, Ca = 2.8% for the calcareous quartzite is the *average* value calcareous quartzite samples from analyses used in Appendix C (Volume 2). Thus, upon blasting and transport the 240-tonne muck pile of mixed lithology has a bulk chemical composition of the following:

For Sulfur	1.75%*0.3	For Ca	1%*0.3
	<u>+0.25%*0.7</u>		<u>+2.8%*0.7</u>
	0.7%		2.26%

The bulk composition of this blast round falls well within the non-AML criteria of having $S \leq 1.5\%$ and $Ca \geq 0.75\%$. Translating the geochemical data into the more industry standard NP:MPA ratio using the relationship derived in the *Geoenvironmental Characterization, Bellekeno* (Appendix C in Volume 2), $NP = 25.76[\%Ca] + 7.537$ and $MPA = \%S*31.25$. Using these relationships, the preceding example would have a

NP:MPA ratio of 3.0, which meets the 3:1 ratio above which samples are inferred to be unlikely to produce net acidity with no further testwork or study.

Some discretionary decisions on the part of the geologist are necessary; for example in a case of 20% of the working face comprised of a highly sulphidic zone in an otherwise benign working face, the geologist may opt to designate the entire round as AML due to the high concentration of AML potential in a small zone. It is also important to note that this scenario in which the blast face contains up to 30% potentially-AML rock is relatively uncommon, and in all cases, testing and determination is made on a conservative basis, meaning that the site geologist will only allow these potentially-AML containing blast rounds to be classified as non-AML if the remainder of the blast face is determined to have ample neutralization potential.

6.2.4.12 Confirmatory Geochemical and ABA Testing

Geochemical and ABA testing of waste rock forms an important component of the waste rock management program. The purpose of this testing is to provide additional verification of the effectiveness of the field screening criteria.

After initial field screening, samples are composited to ensure that they are representative of the blast rounds from which they are taken. First, samples from each face are combined based on their respective tonnages, which are calculated based on their areas on the digitized face photo (see Figure 6-10). These areas are multiplied by the length of the blast round to produce volumes. The volumes are then multiplied by average density according to their lithology to produce the tonnage represented by each sample. Sample composites are first made of each blast round (face), and are weighted according to their calculated tonnages. Additional compositing is done on these composite blast round samples depending on the analytical method and schedule, which is presented below. Where a number of blast rounds are composited, they are weighted to reflect the tonnage of each respective round.

Figure 6-11 Face Photo of Bellekeno 625 By-Pass Showing Sampling According to Lithology and Calculated Sample Areas



6.2.4.13 Confirmatory Testing Sampling Frequency and Schedule

Acid base accounting (ABA) and inductively coupled plasma (ICP) sampling frequencies are done at a minimum of 1 ABA sample per 10,000 tonnes and 1 ICP analysis per 1,000 tonnes in non-AML waste rock. In potentially-AML waste rock, the sampling density is increased to 1 ABA sample per 2,000 tonnes and 1 ICP analysis per 500 tonnes. These frequencies were proposed in the Bellekeno Advanced Underground Exploration and Development Program project proposal, and confirmed by Water Use Licence QZ07-078.

6.2.4.13.1 ICP Sampling Frequency

While meeting per tonnage sampling frequency, the more natural sampling unit is based on number of blast rounds (each represented by a face sample composite). This

tonnage depends on several variables including the length of the round, the dimension of the heading, and whether or not there is overblast. In the current most active heading (Bellekeno East), ICP sampling has been based upon 3 blast rounds per sample. As of October 8, 2008, the average sample size for the Bellekeno East ICP 3 round composite samples (all non-AML) has been 722.54 tonnes, which is well below the 1,000 tonne maximum for non-AML waste rock. In all headings where ICP sampling frequency is based on number of blast rounds, the sampling will fall within the per tonnage frequency committed to in Section 6.2.4.13.1. See Table 6-10 for a proposed sampling schedule in both non-AML and potentially-AML waste rock.

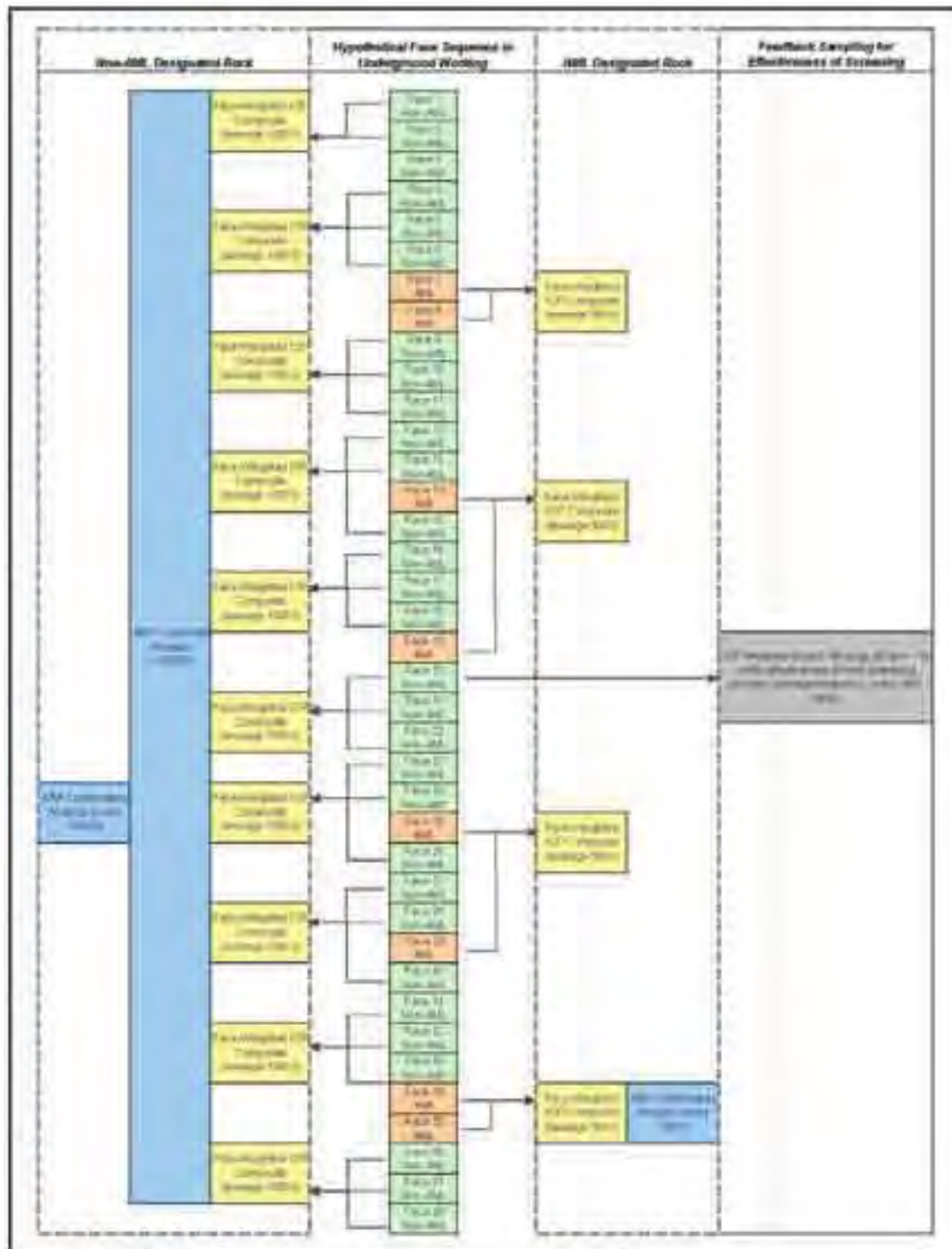
6.2.4.13.1.1 ICP Feedback Sampling for Field Screening Methods

In addition to routine, per tonnage frequency ICP composites described in 6.2.3.1, ICP samples will be analyzed for each sample of every 20th face. These results will be used as a feedback for the Face Sampling Method described in Section 6.2.4.10. The need for this provision will likely diminish after a reasonable data set is gathered.

6.2.4.13.2 ABA Sampling Frequency

Similar to ICP sample composites, ABA sampling will be composited based on the number of blast rounds and in accordance with per tonnage limits in order to be representative of the tonnage as a whole. With respect to the current Bellekeno East decline development, this amounts to approximately 40 blast rounds based on the average result of 240 tonnes per round. Figure 6-11 offers a more conservative approximation of 1 composite ABA sample per 37 blast rounds based upon a 4.6 x 4.6 meter heading. In addition to an ABA composite over the entire tonnage, an additional smaller composite over less than 1,000 tonnes will be taken within each 10,000 tonne composite. This provision is made as an additional check to test for anomalous rock which might otherwise be missed in the large composite sample. Bellekeno underground develop during development and production will involve headings of a variety of sizes (2x2, 3x3 and 4x4 meters) but the general principle of 1 composite ABA sample per 10,000 tonnes and 1 ~ 500 tonne composite will be taken regardless of blast round size.

Figure 6-12 Bellekeno Waste Rock Hypothetical Sampling Schedule



It is important to note that the above criteria represents a high sample density. This is in large part driven by the fact that the proposed work is the first rock excavation activity in the district under Alexco's management, and as such it is important to conduct relatively detailed monitoring to develop a sound information base for decision-making and enhancements to future waste rock management strategies. As the understanding increases, such a high sample density will likely no longer be justified.

6.2.4.14 Time Lag

6.2.4.14.1 Time Lag between Excavation and Sampling

The time between blasting and exposure of a new face to sampling and the Face Call (waste rock management category designation) for a given round shall not exceed 48 hours; notwithstanding unforeseen and extenuating circumstances such as breakdown of analytical or lab equipment.

6.2.4.14.2 Time Lag between Excavation and Receipt of Analytical Data

The total time between excavation and receipt of analytical data is dependent on a number of factors. First, the size of the composite sample being tested can extend the length of time between excavation and receipt of data especially for individual blast rounds near the beginning of the composite sample. For example, at a rate of development of two blast rounds per day at approximately 240 tonnes per round would take 21 days to accumulate the rock required to complete a composite ABA sample of 10,000 tonnes. Second, standard laboratory practices for individual analytical packages take varying amounts of time for completion (e.g. ABA analysis takes longer than ICP). In spite of these uncertainties we are able to suggest the following limits of time lag between excavation and receipt of analytical data for ABA and ICP analysis data.

6.2.4.14.2.1 Time Lag between Excavation and Receipt of ICP Data

The time between blasting and exposure of a new face to receipt of ICP analytical data shall not exceed two months; notwithstanding extenuating circumstances such as breakdown of lab equipment or delays at the analytical laboratory.

6.2.4.14.2.2 Time Lag between Excavation and Receipt of ABA Data

The time between blasting and exposure of a new face to receipt of ABA analytical data shall not exceed three months; notwithstanding extenuating circumstances such as breakdown of lab equipment, or delays at the analytical laboratory.

6.2.4.15 Mine Wall Testing

Monitoring in both the excavated areas and the rock storage areas forms an integral and vital component of any waste rock management program, as it determines the effectiveness of the management measures and provides valuable information for waste rock management strategies of future developments and closure measures. Mine wall testing at during the Bellekeno Mine Development will provide additional confirmation of the geochemical character mine walls through multi-element and acid-base accounting analysis.

6.2.4.15.1 Mine Wall Sampling for ICP and ABA Analysis

The mine walls will be sampled according to the per meter basis set out in the Bellekeno Advanced Underground Exploration and Development Program Project Proposal and confirmed in Water Use Licence QZ07-078. On average, one geochemical sample will be taken for each 10 lineal metres of underground working for analysis by routine multi-element ICP, including sulphur. Also on average, one acid base accounting sample will be taken for each 40 lineal metres of workings. The specific sampling method will be determined by the site geologist in order to obtain the most representative result. This provision is necessary because of the lithological complexity of the Keno Hill area and the tendency of ABA and geochemical characteristics of the rocks to vary widely between each lithological unit. Thus the sampling method must vary depending on the direction of the heading and how it cuts the metamorphic layering. For example, a drift or heading which cuts across the lithological layering might be most representatively sampled by doing a continuous chip sampling along the mine working. In a heading which parallels the lithological layering, the most representative sampling method might be vertical rib samples. With each sample taken, details of the sampling method used will be duly recorded. Table 6-10 shows a hypothetical mine wall sampling schedule.

Table 6-10 Mine Wall Sampling Schedule

ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	ABA sample over same interval
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	ABA sample over same interval
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	ABA sample over same interval
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	
ICP sample up to 10 m continuous sample	ABA sample over same interval

6.2.4.15.1.1 *ICP samples sizes for mine wall testing*

Although the specific sample method will depend on the mine heading, ICP sampling will be composited to a maximum of 10 m per sample.

6.2.4.15.1.2 *ABA samples sizes for mine wall testing*

Although the specific sample method will depend on the mine heading, ABA sampling will be composited to a maximum of 10 m per sample, and will duplicate every fourth ICP sample as confirmatory to the ICP sampling.

6.2.4.15.2 *Time Lag*

The confirmatory geochemical and ABA testing plan attempts to minimize the time lag between excavation of waste rock and receipt of analytical results. In contrast, a greater time lag between exposure of mine walls and sampling is deliberately pursued for this Mine Wall Testing Plan. The purpose for this is to allow for some natural oxidation and weathering to take place on the exposed rock in order to gain insight into possible changes in chemical or ABA characteristics of mine walls over time. This plan is designed to give the longest possible time lag between excavation and sampling while meeting the requirement of Section 25.c of Water Licence QZ07-078: “*at a minimum, the annual testing completed will be representative of all new excavation during that given year*”.

6.2.4.15.2.1 *Time Lag between Excavation and Sampling*

The time lag between excavation and sampling will be no less than six months and no more than nine months.

6.2.4.15.2.2 *Time Lag between Excavation and Receipt of Analytical Data*

Time lag between excavation and receipt of analytical data will not exceed one year; notwithstanding major delays caused by breakdown of lab equipment or delays at the analytical lab.

6.2.4.16 *Analytical Methods*

Samples for both confirmatory testing and mine wall sampling will be submitted to a certified laboratory and will be analysed according to the following protocols.

6.2.4.16.1.1 *ICP Analyses*

Samples submitted for ICP analysis will be pulverized and analysed for multi-elements via ICP-AES using either aqua regia, 4-acid, or strong acid digestion. Sulphur will be included in the analytical suite.

6.2.4.16.1.2 *ABA Analyses*

Samples submitted for acid base accounting will be pulverized and analysed via modified acid base accounting methods, including total sulphur via Leco furnace, sulphate via either sodium carbonate leach or HCl digestion, neutralization potential via modified method, total inorganic carbon, and paste pH at a 1:1 solids to water ratio conducted at a certified laboratory.

6.2.4.17 *Waste Rock Monitoring*

Programs for ongoing physical and water quality surveillance of waste rock storage facilities through inspections and drainage monitoring have been established as part of the Advanced Exploration Program. Physical surveillance of waste rock storage areas will occur on a weekly basis at the following locations:

- Onek lined potentially-AML waste rock storage facility or equivalents;
- All non-AML waste rock disposal areas including roads between Bellekeno East Portal and Bellekeno 625, the 'power line road' that runs along the north slope of Sourdough Hill, above the left limit of Lightning Creek, and the proposed waste rock storage area, and other locations where it is used as fill or construction material.

6.2.4.18 Physical Inspection Methods

The purpose of the physical inspection is to observe and record sufficient information to permit development of a course of action; repair or rehabilitation if it is required. Specifically:

- physical stability such as settling and excessive erosion (tension cracks, bulges at the toe; on waste rock road surfaces, washouts, rutting and culvert seating);
- evidence of permafrost degradation in any areas of physical disturbance;
- evidence of sulphide oxidation (such as snow melt areas, presence of oxidation products); and
- occurrence of drainage or seeps from rock storage areas. If drainage is noted, flow volume will be estimated and basic field parameters of pH and conductivity recorded. More detailed monitoring will be initiated as required and based on specific results if field monitoring results indicate:
 - i. pH significantly declining between measurements or dropping below 7.0, and/or
 - ii. conductivity showing a significant increasing trend or conductivity above 2000 $\mu\text{S}/\text{cm}$.

Inspection checklists will be filled out on a weekly basis to ensure structural integrity of mine components and that runoff and discharge is being appropriately managed (see Appendix E in Volume 2). The following rating system will be used in the field reporting to evaluate the structural integrity of the areas to be physically inspected:

Excellent	“As New” Condition.
Good	System or element is sound and performing its function; although it shows signs of use and may require some minor repairs, mostly routine.
Fair	System or element is still performing adequately at this time, but needs “priority” and/or “routine” repair to prevent future deterioration and to restore it to good condition. A fair rating will be reported to site manager after the inspection.

Poor System or element cannot be relied upon to continue to perform its original function without “immediate” and/or “priority” repairs. A poor rating will be reported to site manager after the inspection.

If issues are identified during the weekly inspections of waste rock storage areas, the site manager will be informed immediately and the appropriate mitigative measures will be implemented. An inspection by a qualified geotechnical engineer would be undertaken for physical stability if necessary. Additional erosion and sediment controls may need to be implemented as required. Appropriate mitigative measures will be implemented should acidic or metal rich drainage be detected in order to prevent adverse impacts to receiving waters.

If geotechnical inspections are required, they will be carried out during the summer months when the surface and sides of the various rock-fill structures are not obscured by snow.

The lined potentially-AML storage pad areas at Onek will be monitored for drainage volume with field parameters (pH and conductivity) measured on a monthly basis from May to October. Providing there is sufficient water accumulation, a full suite of water quality analyses will be conducted at least twice per year. The sumps at KV-78 (the Onek Waste Rock Storage Facility) will be monitored monthly using a Heron Instruments Dipper-T probe to determine the accumulation amount of water within the storage facility. Periodically, water will be hauled using a vacuum truck to Bellekeno 625 or the Christal Lake Mill for discharge, and treatment if required. Water from any additional potentially-AML waste rock storage facilities will be similarly treated. See also the Water Management Plan (Section 6.1). Upon closure, these facilities will be covered with an impermeable liner and will not require ongoing maintenance. See the conceptual closure plan in Section 8 for more details.

6.2.4.19 Adaptive Management

In addition to measures described above, an Adaptive Management Plan (AMP) will be prepared for the entire development. Alexco has recently updated the AMP for both

Care and Maintenance and Advanced Underground Exploration and will update the AMP again to include the scope of operations and mine production to ensure consistency with site wide AMP. This AMP would be a component of the site wide AMP. See also the Adaptive Management Overview in Section 7.6.

6.2.4.20 Reporting

Documentation of waste rock management activities including operational field screening and segregation and ongoing geochemical monitoring and analyses will be compiled and included in the annual mining land use and water use licence annual report.

6.2.4.21 Closure and Reclamation

Potentially-AML and non-AML waste rock facilities reclamation and closure are discussed in Section 8.

6.3 TAILINGS MANAGEMENT PLAN

6.3.1 Tailings Handling

Approximately 50% of final flotation tailings will be stored on surface by dry stacking (Figure 6-13) and 50% (together with all pyrite concentrate) will be stored underground, most likely as paste backfill. This measure will be taken in order to utilize pyrite concentrate and final flotation tailings in order to provide support for the excavated underground voids and to reduce surface environmental impact. Current closure planning studies (SRK, 2009) have concluded that historic Elsa tailings should remain geochemically stable. Nonetheless Alexco proposes to install a pyrite removal circuit in the mill to address any possible concerns with the long-term geochemical stability of the new dry stack tailings produced from the Bellekeno operation.

6.3.1.1 Dry Stack Tailings Disposal Procedure

The tailings will be placed in 300 mm lifts and compacted with a 10-tonne vibratory compactor, similar to the process used at the existing Minto Mine. The lift thickness can

be increased to a maximum of 600 mm if a 15-tonne vibratory compactor is used. Tailings will be compacted to at least 95% of the maximum dry density using standards effort (as per American Society for Testing and Materials [ASTM] D698). The pile will be a sidehill fill with a crest elevation of 919 m and a slope of 4H:1V. There will be a small bench of tailings near the toe that will have a crest elevation of 901 m and have a slope of 3H:1V. The organic soils will be left in place beneath the DSTF to provide some insulation and slow the rate of permafrost thaw.

Construction of the DSTF will occur over five years, as the tailings are generated by the mill. The north sump and east perimeter berms will be constructed prior to tailings placement. The south sump and perimeter berm will be constructed prior to beginning placement of tailings in Year 3 (see Appendix J, Volume 2 for EBA design details).

See Appendix J for EBA design details.

6.3.1.1.1 DSTF Designs

In addition to the DSTF location and design discussed above, other nearby DSTF designs and locations were considered during the project proposal development. One of these designs is included in Appendix E. This location to the northeast of the mill is also considered a future possibility contingent on further geotechnical testwork and fisheries studies; however, the location considered in Appendix E and other locations are not intended to be included within the scope of the current assessment.

6.3.1.2 Pyritic Tailings Fraction Disposal Procedure

Tailings are separated into two streams at the pyrite rougher section in the process plant, producing final tailings containing minimal pyrite for surface disposal, and pyrite concentrate. Final tailings and pyrite concentrate are pumped into the Final Tailings Thickener and the Pyrite Concentrate Thickener for dewatering to 58% and 58% solid respectively. Thickened tailings and effluent sludge will be pumped into stock tanks before being regulated into the filter.

Disk filter dewatering will bring final tailing and pyrite concentrate to approximately 85% solids for paste backfill preparation and discharges it into temporary chutes. The dewatered tailings are discharged from the temporary chutes on to 30 t truck for delivery underground.

While the final details of the physical delivery method to underground voids has not been decided conclusively, the most likely method is paste backfill.

See Figure 6-13 for the proposed final dry stack tailings configuration.

At the mobile underground paste plant, material is discharged into a live chute (5 t) before final discharging into the mixer. The live chute provides continuous supply of material to the plant during truck cycles.

Water and binder are metered into mixer with tailing for percentage solids and strength depending on its applications before being discharged into the paste pump hopper. The paste hopper feeds the piston pump where pastefill is delivered to underground openings. A gate valve is installed at the bottom of the hopper controlling feed into the pump or into an emergency discharge bin.

A sump located at the plant will decant pastefill and wash material during cleanout, spill or emergency shutdown. Material from the sump will be cleaned and disposed in accordance to spilled material procedure.

7.0 ENVIRONMENTAL MONITORING PROGRAM AND SURVEILLANCE NETWORK

7.1 INTRODUCTION

This section describes the environmental monitoring programs that will be carried out to ensure that the Bellekeno mine/mill development operations are conducted in a manner that provides human and environmental protection. These programs are designed to monitor:

- Potential effects to the receiving environment through scheduled sampling of water and aquatic resources, and inspection tours of the project components and receiving environment;
- Effluent discharge points and consequently operational treatment performance;
- Site facilities and incorporated design measures to ensure structural stability and prevent accidents and malfunctions;
- Mitigation success; and
- Adaptive management responses to improve procedure/process.

If monitoring indicates that physical structures, treatment systems or other mitigative measures are not performing, then maintenance measures or contingency plans can be implemented following an adaptive management approach as discussed in Section 7.6.

A number of monitoring programs and a surveillance network are already in place for care and maintenance activities and for advanced exploration and preliminary development activities at the Keno Hill Property. These programs include physical inspections, effluent treatment systems and flow monitoring, a water quality surveillance network, old mine workings monitoring, aquatic effects monitoring for benthic invertebrate populations, sediment monitoring, waste rock and mine wall sampling and/or the adaptive management plan. As discussed in Section 3.3.3, and Table 3-2, monitoring already occurs in the vicinity of Bellekeno, Onek and Christal Lake (previously old Mackeno mill). Existing and proposed monitoring stations near the potential mill and mine areas are discussed within the following sections.

7.2 WATER QUALITY SURVEILLANCE NETWORK

The existing water quality surveillance network at the Keno Hill Property includes surface receiving waters in the Bellekeno, Onek and Christal Lake area. Most of the monitoring stations have been sampled extensively in the past. Current water quality monitoring is required under Water Licence QZ06-074, Schedule A as well as under Water Licence QZ07-078, Schedule A (Flow Monitoring Plan).

Table 7-1 outlines existing sampling frequency and schedule for internal and external lab analysis in the area of Bellekeno, Onek and Christal Lake. Table 7-2 outlines the proposed and edited/continued monitoring stations to track receiving water quality from the Bellekeno mine/mill development and operations program. Figure 7-1 shows the existing and proposed monitoring station locations.

Water stations will be sampled weekly, monthly and quarterly. This will include the following sites upstream of Christal Creek and upstream of Lightning Creek:

- KV-6 – Christal Creek at the Keno Highway to monitor down stream of the old Mackeno Mill and tailings location;
- KV-7 – Christal Creek at Hanson Road to monitor effects from the old Mackeno Mill;
- KV-41 - Lightning Creek at Keno City Road Crossing to monitor impacts from adit drainages and waste rock seepage reporting to this creek;
- KV-43 – Bellekeno 625 Treatment pond decant to monitor the impacts from the mine edited to be ongoing weekly sampling;
- KV-78 – Onek Waste Rock Storage Facility;
- KV-52 or KV-80 – Potential mill water sources;
- KV-81 – Mill discharge (final discharge point) to monitor the mill impacts; and
- KV-2, KV-8, KV-38, KV-40, KV-42, KV-44, KV-45, KV-51, KV-65, KV-75, KV-76, KV-77 and KV-79 (refer to Table 7-2 for complete station descriptions) will also be included in the proposed water sampling stations.

Table 7-1 Current Monitoring Program Summary within the Area of the Mill and Mine

Monitoring Station	Description	Licence	Internal Lab							Total ICP Metals	Dissolved ICP Metals	Ammonia
			Inspect	Flow	pH	Temp.	Cond.	Total Zinc	Ammonia			
Required Monitoring under Current Water Licences												
	South McQuesten River @ Pumphouse	QZ06-074								Q	Q	
	Christal Creek at Keno Highway	QZ06-074								M	M	
	Christal Creek @ Hanson Road	QZ06-074								M	M	
	Christal Creek @ Mouth	QZ06-074								M	M	
	Christal Creek 600 m d/s Silver Trail	Closure								Q	Q	
	Silver Trail Culvert #4	QZ06-074								M	M	
	Christal Creek 825m d/s Silver Trail	Closure								Q	Q	
	Galkeno 900 Adit	QZ06-074		W	W	W	W	W		M	M	
	Galkeno 900 treatment Pond Decant	QZ06-074	D	W	D	D	D	D		M	M	
	Flame and Moth	QZ06-074								Q	Q	
	Lightning Creek u/s Hope Gulch	QZ06-074/QZ07-078		Q	Q	Q	Q	Q		Q	Q	
	Lightning Creek u/s Thunder Gulch	QZ06-074/QZ07-078		Q	Q	Q	Q	Q		Q (Q)	Q (Q)	
	Hope Gulch u/s Lightning Creek	QZ06-074		Q	Q	Q	Q	Q		Q	Q	
	Charity Gulch u/s Lightning Creek	Closure		Q	Q	Q	Q	Q		Q	Q	
	Lightning Creek u/s bridge at Keno City	QZ06-074/QZ07-078		Q	Q	Q	Q	Q		Q (Q)	Q (Q)	
	Bellekeno 625 Adit	QZ06-074/QZ07-078		C	D	D	D	D	D	M (W)	M (W)	M (W)
	Bellekeno 625 Treatment Pond Decant	QZ06-074/QZ07-078	D	D	D	D	D	D	D	M (W)	M (W)	M (W)
	Bellekeno 625 Seep	Closure/QZ07-078		Ms	Ms	Ms	Ms	Ms		Q A (A)	Q A (A)	
	Onek Adit	QZ06-074/QZ07-078		Q	Q	Q	Q	Q		Q (Q)	Q (Q)	
Hinton Creek u/s Christal Creek	QZ06-074								Q	Q		
Christal Creek u/s Hinton Creek	QZ06-074								Q	Q		
Christal Creek d/s Hinton Creek	QZ06-074								Q	Q		
Natural Spring to Christal Lake at Old Mackeno pump house												
Thunder Gulch Upstream of Bellekeno	QZ06-074		Q	Q	Q	Q	Q		Q	Q		
Bellekeno East – Decline	Closure/QZ07-078		Q	Q	Q	Q	Q		Q (M)	Q (M)	(M)	
Bellekeno East – Settling Pond Decant	Closure/QZ07-078		C	D	D	D	D	D	M (W)	M (W)	M (W)	
Thunder Gulch d/s of Bellekeno 625 adit	Closure/QZ07-078	D	D	D	D	D	D	D	M (W)	M (W)	M (W)	
Thunder Gulch upstream of Bellekeno East	Closure/QZ07-078		Q	Q	Q	Q	Q	Q	Q (M)	Q (M)	Q (M)	
Onek Waste Rock Storage Facility	Closure/QZ07-078		Q	Q	Q	Q	Q	Q	Q (Q)	Q (Q)		
Christal Creek d/s Mackeno Tailings	Closure		Ms	Ms	Ms	Ms	Ms	Ms	Q (Q)	Q (Q)		
Christal Lake u/s Mackeno Tailings	Closure								Q	Q		

Codes:

C = Continuous
D = Daily
W = Weekly
M = Monthly
Ms = Monthly (May - Oct)

Q = Quarterly
A = Annually
SA = Semi Annually
BA = Bi Annually - every 2 years
* = Background

red = not required under the Water Licence
v/- = monitorin
g

Licence: QZ06-074 type B care and maintenance, QZ07-078 type B advanced exploration, Closure - closure plan monitoring

ICP Metals include: Aluminum, Antimony, Arsenic, Barium, Bismuth, Boron, Cadmium, Calcium, Chromium
Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium
Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc and Zirconium

Table 7-2 Proposed Monitoring Program Summary within the Area of the Mill and Mine

Monitoring Station	Description	Internal Lab							External Lab					
		Inspect	Flow	pH	Temp.	Cond.	Total Zinc	Ammonia	Turbidity	Total ICP Metals	Dissolved ICP Metals	Ammonia	Hardness	pH
	Proposed Monitoring under Water Licence Application													
KV-2	South McQuesten River @ Pumphouse		Q	Q	Q	Q				Q	Q		Q	Q
KV-6	Christal Creek at Keno Highway			Q	Q	Q				M	M		M	M
KV-7	Christal Creek at Hanson Road		M	M	M	M				M	M		M	M
KV-8	Christal Creek @ Mouth		Q	Q	Q	Q				M	M		M	M
KV-38*	Lightning Creek u/s Thunder Gulch			Q	Q	Q				Q	Q		Q	Q
KV-41	Lightning Creek u/s bridge at Keno City		Q	Q	Q	Q				M	M		M	M
KV-42	Bellekeno 625 Adit		C	W	W	W	W	W	W	M	M	M	M	M
KV-43	Bellekeno 625 Treatment Pond Decant	D	D	D	D	D	D	D	D	W	W	W	W	W
KV-44	Bellekeno 625 Seep			Ms	Ms	Ms	Ms			Q	Q	Q	Q	Q
KV-45	Onek Adit		Q	Q	Q	Q				Q	Q		Q	Q
KV-51*	Christal Creek d/s Hinton Creek		Q	Q	Q	Q				Q	Q		Q	Q
	Natural Spring to Christal Lake at Old Mackeno pump house		M	M	M	M				M	M		M	M
KV-52														
KV-65	Thunder Gulch Upstream of Bellekeno		Q	Q	Q	Q				M	M	M	M	M
KV-76	Thunder Gulch d/s of Bellekeno 625 adit			Q	Q	Q	Q			M	M	M	M	M
KV-77	Thunder Gulch upstream of Bellekeno East		Q	Q	Q	Q				Q	Q	Q	Q	Q
KV-78	Onek Waste Rock Storage Facility			Ms	Ms	Ms				Q	Q	Q	Q	Q
KV-79	Christal Creek d/s Mackeno Tailings		Q	Q	Q	Q				Q	Q		Q	Q
KV-80	Christal Lake u/s Mackeno Tailings		Q	Q	Q	Q				Q	Q		Q	Q
KV-81	Mill Discharge Final Discharge Point	D	D	D	D	D	D	D	D	W	W	W	W	W

Codes:

C = Continuous

D = Daily

W = Weekly

M = Monthly

Ms = Monthly (May - Oct)

Q = Quarterly

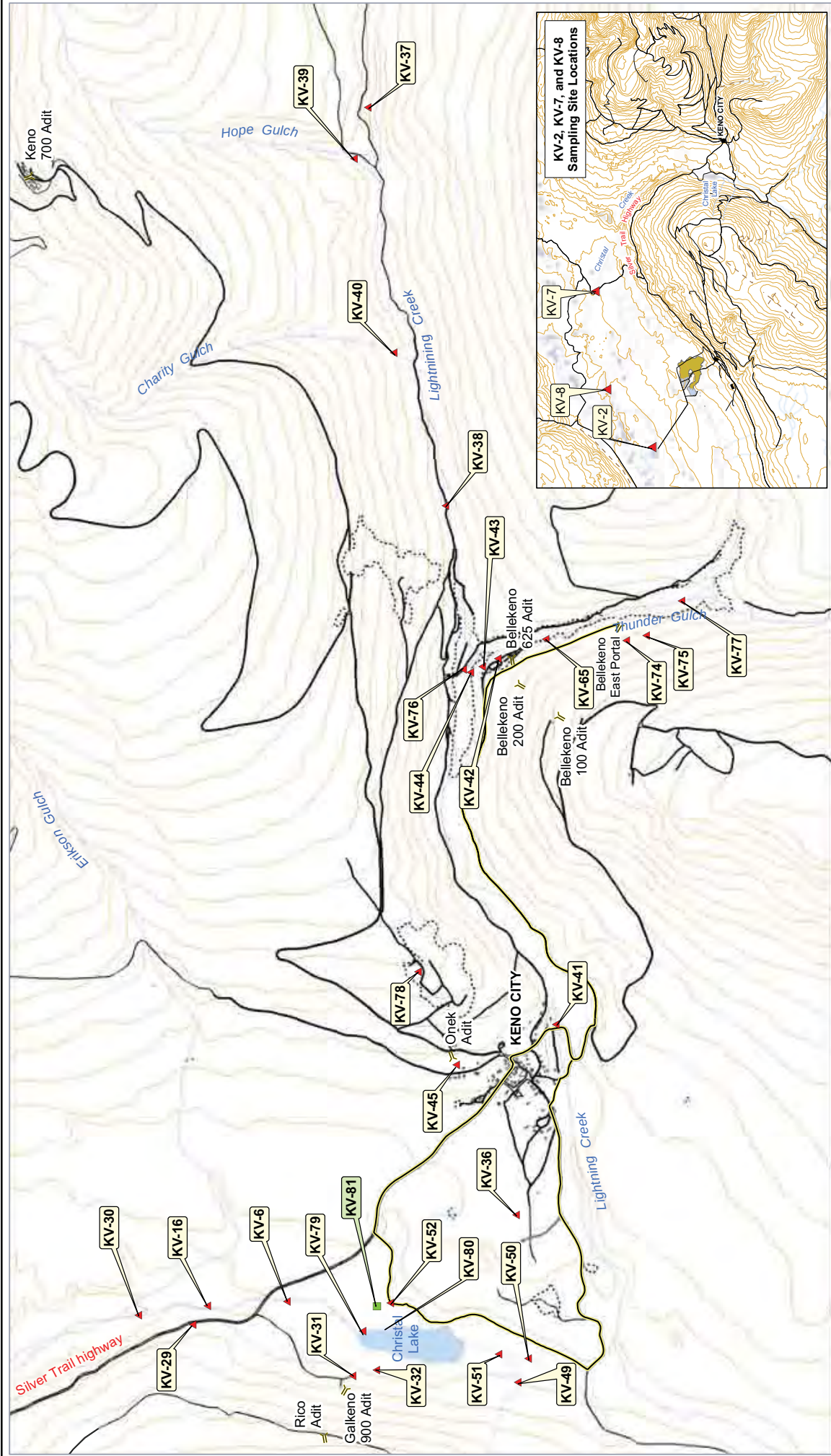
A = Annually

SA = Semi Annually

BA = Bi Annually - every 2 years

* = Background

ICP Metals include: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc and Zirconium



WATER USE LICENCE APPLICATION & MINING LAND USE
QUARTZ MINING LICENCE APPLICATION REQUEST
BELLEKENO MINE DEVELOPMENT
PROPOSED SURFACE WATER QUALITY
MONITORING LOCATIONS
Drawn By: HD
Date: December 2008
Checked by: KN



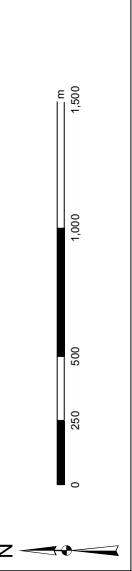
Note:
This map is for illustrative purposes only.
The map was prepared using data from the
National Topographic Data Bank (NTDB) compiled by Natural
Resources Canada at a scale of 1:50,000. Geospatial data
was obtained from the National Topographic Data Bank (NTDB) and
the Department of Natural Resources Canada. All rights reserved.
NTS Sheet 109M/14

Topography
Road
Contour
Watercourse
Waterbody

Mine Workings
Adit
Pit/Placer

Water Quality
Surface Water
Quality Station
Proposed Surface Water
Quality Station

Legend



Currently at Bellekeno 625, treated water (KV-43) is monitored daily through internal analysis for pH, flow, total zinc, ammonia and turbidity with monthly samples sent to an external lab. Similar monitoring is conducted for the Bellekeno East portal, with treated water (KV-75) sampled and analyzed at the same frequencies if it is discharged. The mill and mine discharge will be monitored through stations KV-43 and KV-81.

7.3 PHYSICAL INSPECTION PLAN

The purpose of the physical inspection is to observe and record sufficient information related to physical structures to permit development of a course of action; repair or rehabilitation if it is required. The current areas inspected under Water Licence QZ07-078 on a weekly basis near the Bellekeno mine/mill development and operation include the Bellekeno 625 settling ponds, the Bellekeno East decline settling ponds, the Onek waste rock storage facility, surface pipelines between and near Bellekeno East decline and Bellekeno 625. During dewatering of the Bellekeno mine, the condition of the channel of Thunder Gulch and Lightning Creek downstream of Bellekeno 625 treatment plant will be physically inspected.

The Water Licence to be issued for this proposed Bellekeno mine/mill development and operation will outline physical inspections required and will pertain to any new water retaining structures and water conveying structures. This may include but not limited to inspecting the waste rock storage area, the access road, dry stack tailings and the mill water and treatment ponds. The proposed physical inspections for mine production will be incorporated into the Water Licence QZ07-078 physical inspection plan and updated.

7.4 ENVIRONMENTAL EFFECTS MONITORING (UNDER MMER)

The MMER, governed under the Fisheries Act, was annexed on June 6, 2002. The Bellekeno mining operation will be subject to these regulations, if effluent discharge exceeds 50 m³/day, which will authorize the deposit of a deleterious substance (allow the deposit of an effluent) from the mining and milling operation according to the following categories and conditions (MMER 2002, Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring, June 2002):

7.4.1 Final Discharge Points

Bellekeno mine and mill operation will have two distinct discharge sites into two different receiving waters (mine operation effluent discharges to Lightning Creek; milling operation will discharge into Christal Creek and/or Christal Lake).

The final monitoring location selected will require a year-round accessible site where an accurate flow measuring device, according to Environment Canada specifications, can be constructed (Guidance Documents for the Sampling and Analysis of Metal Mining Effluents, Environment Canada, April 2001). This will also serve as the location where effluent sampling and monitoring will occur.

7.4.2 Effluent Monitoring

Monitoring at the above sites for discharge and water quality is required on a weekly basis and will be triggered at each respective location when mine and or mill construction commences. Acute lethal toxicity tests will be required monthly. Effluent must meet the following criteria (MMER 2004, Metal Mining Effluent Regulations, subsections 34(2), 36(5) and 38(9) of the *Fisheries Act*):

The concentration of the deleterious substance in the effluent does not exceed authorized limits as shown in Table 7-3:

Table 7-3 MMER Standards

Deleterious Substance	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized in a Grab Sample	Units
Arsenic	0.50	0.75	1.00	mg/l
Copper	0.30	0.45	0.60	mg/l
Cyanide	1.00	1.50	2.00	mg/l
Lead	0.20	0.30	0.40	mg/l
Nickel	0.50	0.75	1.00	mg/l
Zinc	0.50	0.75	1.00	mg/l
TSS	15.0	22.50	30.00	mg/l
Radium 226	0.37	0.74	1.11	Bq/l

*All concentrations are total values

The pH of the effluent is equal to or greater than 6.0 but is not greater than 9.5; and
The deleterious substance is not an acutely lethal effluent (trout and daphnia LT50)

7.4.3 Environmental Effects Monitoring (EEM) Program

Under MMER the Bellekeno operation will also be required to conduct an Environmental Effects Monitoring program. The sampling requirements under this program are as follows:

Part 1. Effluent and Water Quality Monitoring Studies

- a) Effluent Characterization: Quarterly sampling of extra parameters from final discharge point;
- b) Water Quality Monitoring: Quarterly sampling of sites within reference and exposure areas:
 - a. Reference Area: Water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as is practicable is most similar to the exposure area.
 - b. Exposure Area: All fish habitat and waters frequented by fish that are exposed to effluent; and

- c) Sublethal Toxicity Testing: Semi-annual sampling required at each final discharge point and analysis of effects on reproduction or growth of a fish species, a plant species, an invertebrate species and an algal species as acceptable to MMER.

Part 2: Biological Monitoring Studies

A number of study cycles that each include:

- A study design (first study design to be submitted within 12 months of triggering MMER and includes a site characterization);
- Environment Canada and stakeholder review;
- A Field Sampling Program; and
- Submission of an Interpretive Report that indicates whether or not an effect is observed.

Within each cycle, studies are conducted to determine if the effluent is having an effect on the following biological components including:

- a) Fish Population: Studies conducted in exposure and reference areas
- b) Fish Tissue Studies: Only required if concentrations in effluent exceed is equal to or greater than 0.1 ug/l or ppb – as determined by the effluent characterization program)
- c) Benthic Invertebrate Community: Studies conducted in exposure and reference areas.

The first study cycle is 30 months in duration. The subsequent cycles are 24-72 months in duration, depending on previous results (i.e. if an effect is indicated). A final cycle is required if notification of mine closure is issued. In order to avoid redundancy in sampling sites and monitoring programs, final discharge points for MMER will be considered final discharge points under the proposed water licence for the Bellekeno mine/mill development and operations and MMER EEM studies will be covered under the Water Use Licence.

7.5 SPILL CONTINGENCY PLAN

A Spill Contingency Plan is in place under the current Water Licence QZ07-078 for the purpose of advanced exploration and preliminary development activities at the Bellekeno Mine. The Spill Contingency Plan outlines that:

“The Licencee shall immediately contact the 24-hour Yukon Spill Report Centre, (867) 667-7244, and implement the Spill Contingency Plan 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 10 days after the occurrence”;

“All personnel shall be trained in procedures to be followed and the equipment to be used in the containment of a spill”; and

“The Spill Contingency Plan shall be posted on site for the term of the Licence”.

The current Spill Contingency Plan will be updated and followed during the proposed Bellekeno mine/mill development and operation program. An Emergency Response Plan which includes the Spill Contingency Plan is attached in Appendix G (Volume 2). Incident reports will be forwarded to NNDFN.

7.5.1 Spill Contingency Measures for Pyrite Tailings

In addition to spill hazards listed in the Spill Contingency Plan (Appendix G in Volume 2), pyritic tailings which are hauled by truck from the Christal Lake Mill to the Bellekeno Mine for underground backfill are also considered as a potential spill hazard. Proposed preventative and mitigation measures include:

- Reduced speed limits to lower risk of haul truck collision which might result in a spill;
- Mine haul traffic will be routed around Keno City (see Keno City Bypass, Figure 1-3) to lower risk of collisions;
- Mine haul roads traffic will be controlled except where public roads are used;
- Temporary stockpile area for pyrite tailings at the Christal Lake mill will be lined to prevent infiltration of potentially acidic material and runoff will be directed to the collection/treatment pond;
- Pyrite tailings will not be stockpiled at the mine site, they will go straight underground for backfilling; and

- Any pyrite tailings spill will be reported as per the Spill Contingency Plan and immediately picked up and taken to the Bellekeno Mine for underground backfill.

7.6 ADAPTIVE MANAGEMENT PLAN OVERVIEW

7.6.1 Adaptive Management Plan Objectives

An adaptive management plan (AMP) is a management tool designed to guide responses to unforeseen or contingency events respecting for example, water quality and quantity and physical conditions of site workings and infrastructure. The adaptive management approach will provide for assessment of mitigation measures and their effectiveness, and guide the orderly implementation of responses. Since it is difficult to predict the specific environmental condition that may arise which requires a response from management, the AMP does not necessarily provide specific detailed descriptions of responses to a situation. The AMP provides a range of possible responses to use as a guide to respond to specific environmental conditions encountered. Management should use the information provided in the AMP and adapt the appropriate response from this guide, which is the sole purpose of an AMP.

The AMP framework encompassing active Company management includes:

- routine inspection and environmental monitoring, maintenance and reclamation;
- routine assessment of monitoring and performance data;
- performance thresholds for implementation of appropriate levels of responses for planned contingency measures; and
- reporting of monitoring results and actions.

Results of the current monitoring programs will be assessed on an ongoing basis to determine if any negative trends in water quality, quantity or other parameters are occurring. If the results indicate that there are no negative environmental impacts, then the frequency and length of monitoring and maintenance would continue as usual. Adaptive management will be implemented to respond to negative trends observed through the monitoring programs.

7.6.2 AMP Events Summary

A number of “events” have been identified which represent potential environmental conditions that would require a management response, if they were to occur:

1. Change in Water Quality or Quantity

- a. Significant Change in Water Quality
 - i. Water Treatment Facilities/ Licensed Effluent Discharges
 - ii. Adit Discharges
 - iii. Bellekeno Mine Water Quality Significantly Altered After Dewatering
 - iv. Receiving Water Quality Significantly Altered During or Subsequent to Dewatering Bellekeno Mine
- b. Significant Increase or Decrease in Monitored Flow Occurs
 - i. Bellekeno Mine Water Quantity Significantly Altered After Dewatering
- c. Currently Monitored Water Flow Stops
- d. New Water Flow is Observed
- e. Water Flow Path Changes

2. Waste Rock Seepage Exhibits AML

- a. Waste Rock Seepage/Run-Off Trending to AML Conditions

3. Sludge Storage Area Effectiveness Compromised

- a. Seepage Observed Near Sludge Storage Area
- b. Sludge Storage Area Approaching Capacity

4. Physical Instabilities

- a. Area of Significant Subsidence is Observed
- b. Rock Fall or Landslide Occurs Within a Monitored Area
- c. Structure Failure or Portal Collapse

5. Site Security Compromised

- a. Gate, Fence or Sign Damaged

The AMPs for each of these events are described individually in the District Wide Adaptive Management Program (ACG, 2009) while Table 7-4 provides a summary of the approach to AMP events. This table describes a narrative trigger, indicators and response thresholds, monitoring locations and parameters.

7.6.3 AMP Approach

For each AMP event a methodical approach is provided:

1. Description of the event and possible environmental consequences - Addresses issues or information that trigger the AMP;
2. Location of possible event occurrence – Identifies specific working site locations if applicable to event;
3. Monitoring requirements – Identifies the parameters to be monitored, frequency and means for monitoring each parameter;
4. Specific indicators and thresholds - Defines the conditions when management actions should be taken. There may be a series of indicators and staged thresholds for an individual event; and
5. Approach to responses –Description of the approach to responses including a simplified flow chart to guide the implementation process if any specific thresholds have been crossed.

Table 7-4 Overall AMP Summary

EVENT	NARRATIVE TRIGGER	INDICATORS	THRESHOLDS	MONITORING LOCATIONS	MONITORING PARAMETERS
1. CHANGE IN WATER QUALITY OR QUANTITY					
a. Significant change in water quality	Water Treatment Facilities Decline in effluent pH noted or effluent quality trending towards possible exceedance of standards or exceeds licensed standards.	pH, Total zinc, ammonia	Treated effluent: pH <8.0; OR Total Zinc > 0.40 mg/L and pH <6.5 for two consecutive days; OR Ammonia > 4.0 mg/L and pH > 9.0 for two consecutive days; OR Effluent quality standards exceeded.	Water Treatment Facilities	Routine in-situ, on-site total zinc, external multi-element ICP, hardness, pH, conductivity, TSS, ammonia (Bellekeno), LT50
	Adit Discharges Routine site inspections indicate noticeable change in water clarity or declining pH or increasing conductivity. Contaminant concentrations display a statistically significant sustained increase over historical water quality database.	Visual observation of clarity, in-situ pH & conductivity, total cadmium, total zinc	Site inspection: pH < 6.5 or conductivity >2,000 S/cm; OR Increase of 2X or more in total Cd/Zn load or conductivity when compared to the average for the previous 24 months	Adit Discharges	Routine in-situ, external multi-element ICP, hardness, pH, conductivity, TSS
b. Adit discharge or treated effluent, quantity increases or decreases	Observed or measured flows display a sustained and statistically significant increase or decrease over historical flow database	Flow and water quality (total zinc, pH and conductivity) and stream type - fish bearing	Increase/decrease in flow of 2X or more when compared to the average for the previous 24 months AND threshold for Event 1 a) or b) as applicable also exceeded	Site-wide flow monitoring	same as indicators

EVENT	NARRATIVE TRIGGER	INDICATORS	THRESHOLDS	MONITORING LOCATIONS	MONITORING PARAMETERS
c. Flow stops from adit discharge	Water flowing from historical workings stops	Flow, ice plug formation	25% of adit opening filled with ice	Adit and treatment locations	same as indicators
d. New water flow is observed	Previously dry site exhibits flow and effects down gradient water quality and loadings	Flow and water quality (Total zinc, pH and conductivity)	Adit flows for 30 l/s for 7 day period	Site-wide mine workings	same as indicators
e. Water flow path changes	Flow path of mine working discharge changes path from historically known channel and enters a new watercourse	Flow and water quality (Total zinc, pH and conductivity)	Flow path changed and enters a new watercourse	Adit and treatment locations	same as indicators
2. WASTE ROCK SEEPAGE EXHIBITS AML					
a. Waste rock seepage or run-off trending to AML conditions	Seepages from waste rock storage areas or from works constructed or upgraded with non AML material show significant decline in pH and/or an increase in conductivity OR approaching licensed discharge standards (where appropriate i.e. Onek)	pH, conductivity	Significant decline in pH between measurements or pH <7.0 and/or conductivity showing a significant increasing trend or >2000 S/cm; OR indicators approaching licensed standards for Onek waste rock storage area	Waste rock storage areas and works or upgrades constructed from non-AML material	Routine multi-element ICP
3. SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED					
a. Seepage observed near sludge storage areas	Routine inspection of sludge storage area shows seepage	Total zinc, pH	pH >8.5 and total zinc > 1.0 mg/L	Sime Pit, Sime Waste Dump, Valley Tailings sludge storage cell	Same as indicator
c. Sludge storage area approaching capacity	Sludge storage area approaching minimum freeboard of 1.0 meter below the decant point	Visual observation of freeboard	Freeboard is at 1.5 meter below decant point	Sime Pit, Sime Waste Dump, Valley Tailings sludge storage cell	Same as indicator

EVENT	NARRATIVE TRIGGER	INDICATORS	THRESHOLDS	MONITORING LOCATIONS	MONITORING PARAMETERS
4. PHYSICAL INSTABILITIES					
a. Area of significant surface subsidence has occurred	An observed subsidence has exposed an opening to surface or resulting in slope failure	Visible slope failure, ground subsidence or opening on surface	Opening to underground workings or area of subsidence effects public safety or down gradient environment	Site-wide	same as indicators
b. Rock fall or landslide is observed that effects road right-of-way or intrudes into stream	An observed rock fall or landslide effects a road right-of-way, infrastructure or intrudes into stream	Mine source material movement	Source material effects road or stream	Site-wide	same as indicators
c. Structure failure or portal collapse	A building, engineered structure or portal is seen to be failing (settling, excessive erosion)	Visual observation	Structure near public access	Site-wide	same as indicators
5. SITE SECURITY COMPROMISED					
a. Security gate, fence, sign damaged	Public health and wildlife safety measure damaged or removed	Sign, fence, gates, locks	Security feature damaged, removed, or compromised	Site-wide	same as indicators

7.7 REPORTING

Reporting on water quality monitoring and management issues will be directed to the Yukon Water Board (YWB) and YG EMR in accordance with the requirements of the Water Licence. Monthly and annual reporting will be carried out during Bellekeno mine development activities and through the implementation of site decommissioning until it can be demonstrated through the monitoring results that the final closure reclamation objectives have been achieved.

Alexco also continues to liaise with the regulatory agencies, NNDFN, the Mayo RRC and the local community on environmental issues relating to the Bellekeno mine/mill development and operation program. For example all monthly and annual reports are provided to NNDFN.

8.0 DECOMMISSIONING AND RECLAMATION

8.1 PHILOSOPHY AND INTEGRATION WITH DISTRICT-WIDE CLOSURE PLANNING

Alexco recognizes the importance of developing a decommissioning and reclamation plan for the Bellekeno Mine that is synchronized with the district-wide Closure Plan that is currently being developed by the company in conjunction with the Governments of Canada, Yukon, and the NNDNFN. Closure objectives, issues, and options are being developed by these four parties in a thorough process that involves field investigations, pilot studies and test work to identify appropriate closure options, supplemented by public consultation, in order to ensure that closure measures with the best potential for success, as viewed by all stakeholders, are selected for implementation.

This understanding has guided Alexco in its preparation of the Conceptual Decommissioning and Reclamation Plan for the Bellekeno Mine. It is also important to note that some elements of this conceptual plan have already been developed, reviewed and approved under Mining Land Use Approval LQ00240 (such as closure measures for the portal reclamation, mine access road, waste rock storage area), and security has been provided to cover the anticipated costs. These measures are however repeated here in order to provide the reviewer the complete suite of the closure measures that will be implemented at the Bellekeno Mine. Further, it is assumed that certain components of the conceptual closure plan that was submitted with the advanced underground exploration permit application that continue to be pertinent to the project as it advances to commercial production, will be incorporated into the final Detailed Decommissioning and Reclamation Plan (DDRP) for the Bellekeno Mine.

During the mine licensing stage of the review and approval of the Bellekeno Mine, the closure measures presented in the Conceptual Decommissioning and Reclamation Plan will be individually costed so that security can be posted to cover the anticipated liability. These measures should be reviewed over the next couple of years to ensure conformity with site wide objectives, issues and closure measures that are developed during the district wide Closure Plan discussed above.

It is proposed that mine development will be sufficiently advanced so that the DDRP can be developed within two years of mine start up. Alexco understands that the requirement for submission of the DDRP will be a condition of the Quartz Mining Licence.

Upon cessation of mining activities at Bellekeno, closure measures identified herein will be implemented. Although the mill and related infrastructure may be retained as-is and where-is for use in mining other deposits after Bellekeno is depleted, costing for mill closure will be included in this conceptual plan because these plans are not complete. As the DDRP is updated in the future, site conditions and development activities will be refined based on detailed engineering that will be required to construct facilities. In keeping with its high standards for environmental and social responsibility, Alexco intends to implement environmentally sound and technically feasible decommissioning and reclamation measures.

To ensure that the overall closure philosophy can be achieved, the following objectives were emphasized during the development of this plan:

- protection of public health and safety;
- implementation of environmental protection measures that prevent adverse environmental impact;
- ensuring land use commensurate with surrounding lands;
- ensuring full consultation with the NNDFN, so that closure measures are appropriate and supported by the local peoples who are most affected; and
- progressive reclamation measures implemented during development and operations phases.

As mentioned above, the closure planning and implementation for the Bellekeno Mine will be incorporated into the overall closure implementation for the Keno Hill District. Although the work in developing the district wide Closure Plan is still in the early stages, preliminary objectives have been developed and are undergoing discussion and refinement concurrently with the design of the Bellekeno Mine.

Alexco has presented them in italics below so that reviewers of this document may appreciate the context in which this plan will also be developed:

Keno Hill Mines - Closure Planning
DRAFT Closure Plan Objectives

The following are draft objectives that are intended to guide the development of the Closure Plan for the Keno Hill Mines property. These objectives will be developed in conjunction with the local community and will assist with selection of preferred closure options and implementation of the final plan.

Public health and safety

- Ensure that the health and safety of people using the land and water are protected*
- Protect country and traditional food source*

Environment

- Protect wildlife health and safety*
- Identify and alleviate adverse environmental effects by protecting key resources such as the aquatic resources of the South McQuesten River*
- Mitigate significant adverse environmental effects to identified Valued Components (VC's) using a risk based approach*
- Minimize or prevent adverse environmental impact*

Community Land Use

- Consider the relevant expectations of stakeholders for post closure land use*
- Use traditional knowledge in the planning process to protect the culture and traditional pursuits of local First Nations.*
- Ensure the continued traditional use of aquatic and terrestrial resources*
- Provide a land use that allows the mine site to continue to be productive in a manner consistent with, although not necessarily identical to local and pre-mining land use.*

Socio-economic

- *Provide economic opportunities for the First Nation residents, local residents and Yukoners in general.*
- *Minimize negative socio-economic impacts in the area*

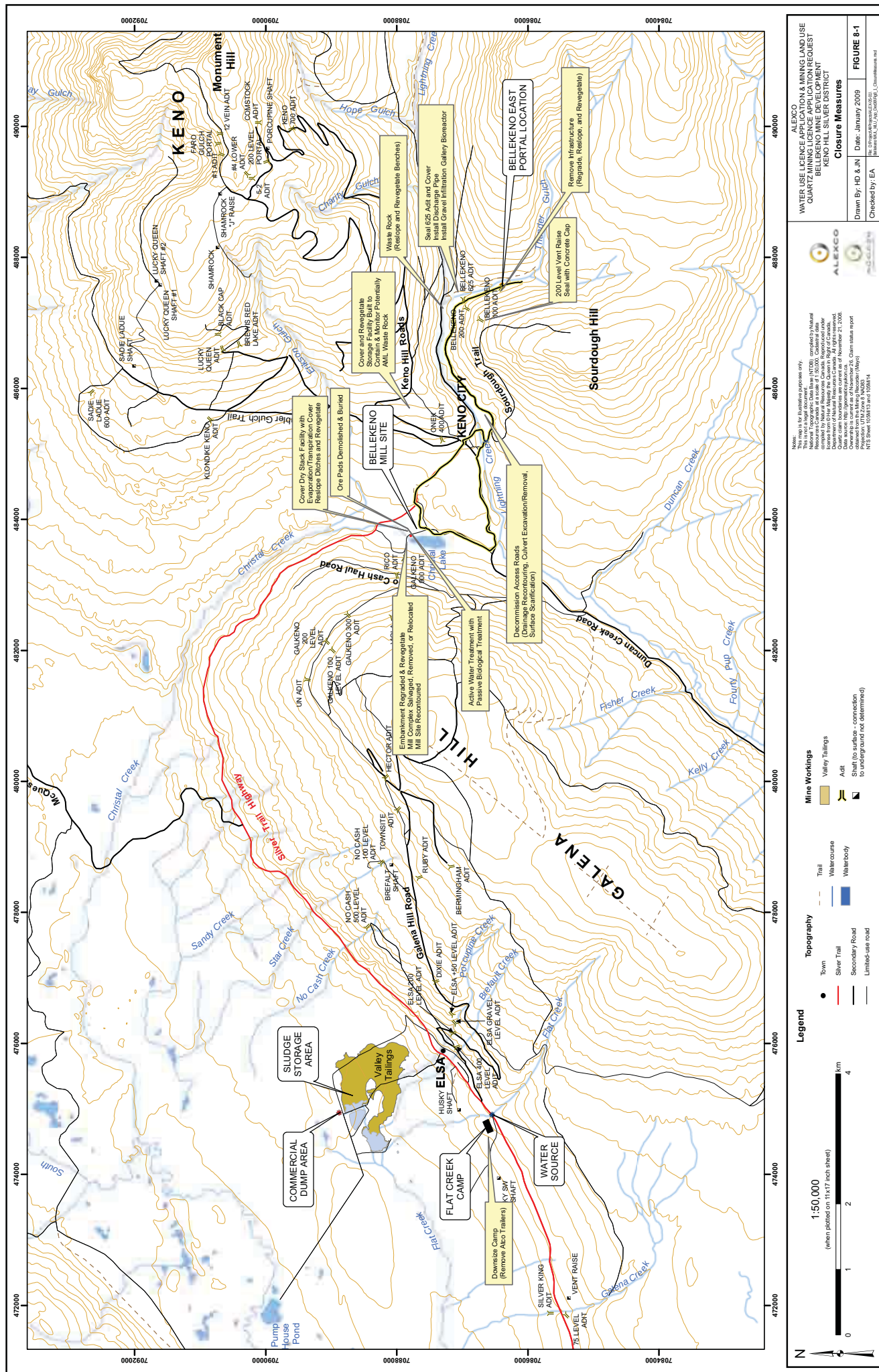
Cost Effective

- *Provide a closure plan that meets industry standards of best practice*
- *Minimize overall cost of remediation project*
- *Consider, and use where appropriate, technologies that reduce long-term liability and minimize requirements for long-term post-closure care and maintenance.*

Please refer to Figure 8-1 for an overview of the closure measures that will be undertaken at the various mine area components associated with the Bellekeno Mine. Alexco commits to developing a DDRP once the mine has been constructed, which will then be accurately designed for actual as-built features and structures. However, at a minimum, this plan will include the measures described in this document.

Upon cessation of mining at Bellekeno, Alexco will remain active on the property for many years undertaking the following activities:

- Closure and reclamation of the entire district as per our Subsidiary Agreement with Government of Canada and Government of Yukon;
- Continued exploration throughout the extensive claim block including potential production at other past producing mine sites. Thus, while 3rd party rates will be used for closure costing purposes, closure activities at Bellekeno would in all likelihood be undertaken by Alexco personnel using Alexco equipment; and
- Care and maintenance, including water treatment, throughout the Keno Hill Silver District.



8.1.1 Current Site Conditions

A certain amount of the footprint of this mine will take place on previously impacted terrain and watersheds. Closure measures involve reclamation of all new, additional impacts. The Bellekeno Mine site is currently undergoing an advanced underground exploration program, as described in Section 2, *Project Description*. Certain procedures and environmental mitigation measures developed for the advanced exploration project (eg the waste rock management plan) have provided information to support the development of technically sound assumptions for this conceptual closure plan.

8.1.2 Revegetation Measures

The closure measures that are expressed herein are based on the general approach used by the mining industry today, which has in recent years developed a great deal of experience in different climates and physical circumstances with revegetation. In general, revegetation measures can be grouped into two categories:

- Linear disturbances (roads, cut lines, power lines, etc.) that by their nature are within close proximity to natural seed sources are best prepared by decompacting the surface but allowing the surrounding flora to volunteer seed for the clearing. This has been shown to promote the most biologically authentic and hence natural performing and revegetated sites. The natural revegetation observed on the historic haul roads at Keno Hill probably took many years to become revegetated on a strictly volunteer basis because the road surfaces were compacted from truck traffic, and therefore water and seed had difficulty penetrating the surface. Therefore, simple surface preparation, known as scarification/decompacting, has been shown to produce excellent natural revegetation results and will normally suffice for revegetation. In certain circumstances, however, areas of access roads which may require drainage/erosion control will be assisted with reseeding.
- Areal disturbances (such as tailings areas, mill pad clearings, etc.) tend to require assisted revegetation to promote biologically authentic revegetation in a timely manner. Areas which have been compacted (mill pad and other areas subject to truck traffic) will be scarified/decompacted and reseeded. The DSTF

will be covered with 0.5m evapotranspiration soil cover and actively revegetated. Experience at other sites has shown that simple grass seeding may create large open areas of grass species that have the tendency to out-compete woody stemmed vegetation, thereby creating an unnatural 'pasture' in the boreal forest. Therefore, revegetation of these sites is focused on stabilizing the surface from erosion but allowing natural succession (willows, etc).

8.2 DECOMMISSIONING MEASURES

Conceptual closure measures have been developed to address the following components of the mine:

- Access and haul roads;
- Bellekeno East Portal Site;
- 200 level vent raise;
- Bellekeno 625 Adit site;
- Bellekeno 625 Water Treatment Facility;
- Potentially-AML WRSF and non-AML WRDA;
- Ore stockpile areas;
- Dry Stack Tailings Facility;
- Mill, mill site and related ancillary facilities;
- Camp expansion; and
- Post closure monitoring and maintenance.

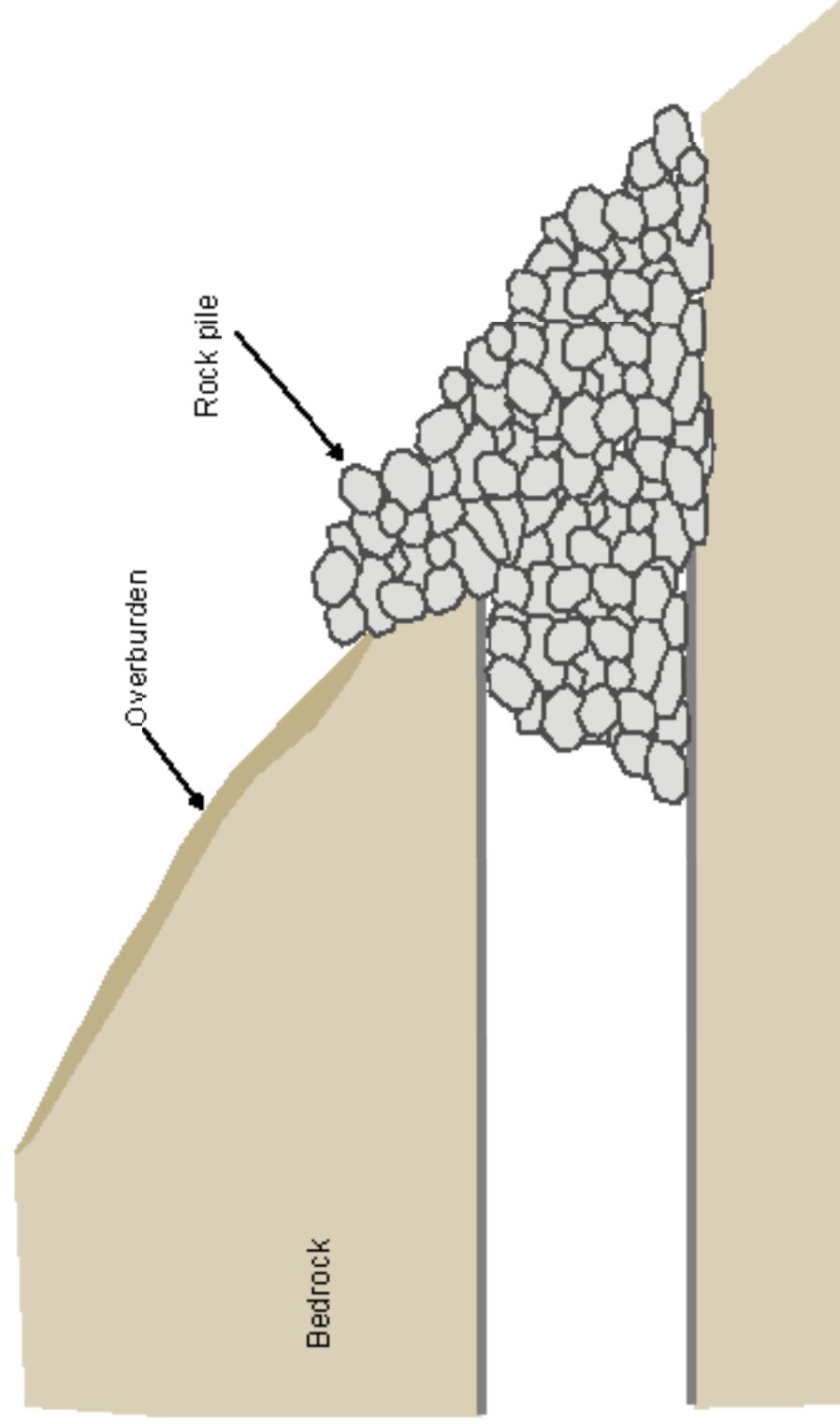
8.2.1 Access and Haul Roads

All roads either developed new or reconstructed/upgraded from existing roads (including the upgraded power line haul road, and the newly constructed haul road between BK East Portal and BK 625 Adit, and the reconstructed old access road from Silver Trail Highway to the mill site will be subject to standard road decommissioning and reclamation measures at closure, including culvert excavation/removal, drainage recontouring, and surface scarification. Regrading/contouring the roads will ensure that runoff sheds off the road surface.

8.2.2 Bellekeno East Portal Site

The following closure measures will be implemented at the Bellekeno East Portal site. The reclamation measures are predicated on the fact that the static water elevation of the Bellekeno Mine will not reach the elevation of the Bellekeno East portal and therefore this portal will not discharge water.

- Dismantling and removal of foreign materials from the portal location (buildings, tanks, signs, fencing, scrap metal, etc.) for re-use or proper disposal;
- Recontouring and surface scarification of the site surface and access roads constructed for this program to facilitate natural revegetation;
- Sampling and testing of any settling pond sludge material for contaminants;
- Recontouring of the site settling ponds, including removal of pond sludge to the valley tailings area (in accordance with the Sludge Management Plan developed under Water Licence QZ04-074), and liners and scarification of surface to facilitate natural revegetation;
- Removal of any in-adit hydraulic control structures;
- Filing of final plans to appropriate regulatory agencies with the locations of subsurface features;
- Reconstruction of adit decant channels;
- Blockage of adit opening to protect human health and safety and prevent wildlife access. See Figure 8-2 for a depiction of the proposed method of inserting rockfill for closure of the Bellekeno east portal. This method, in use at other northern Canadian mines, allows for movement of water and air through the opening, as well as allowing for any movement of rock walls, to prevent failure as would occur with, say, a concrete plug;
- Signage will be posted at the site indicating the presence of an adit and discharge channel;
- Remove any contaminated soils to the land treatment facility in Mayo or Elsa if one is developed there;
- Rehandle any temporary ore stockpile back underground to be deposited below rest water level; and
- Recontour and place impermeable synthetic barrier and compacted soil cover on potentially-AML WRSF at Onek Pit (as per Mining Land Use Approval LQ00240.



 ALEXCO Keno Hill Project	Conceptual Bellekeno East Portal Closure Rock Pile Drawn: Feb 2019 Approved: [Signature] Issue: 8-2

8.2.3 200 Vent Raise

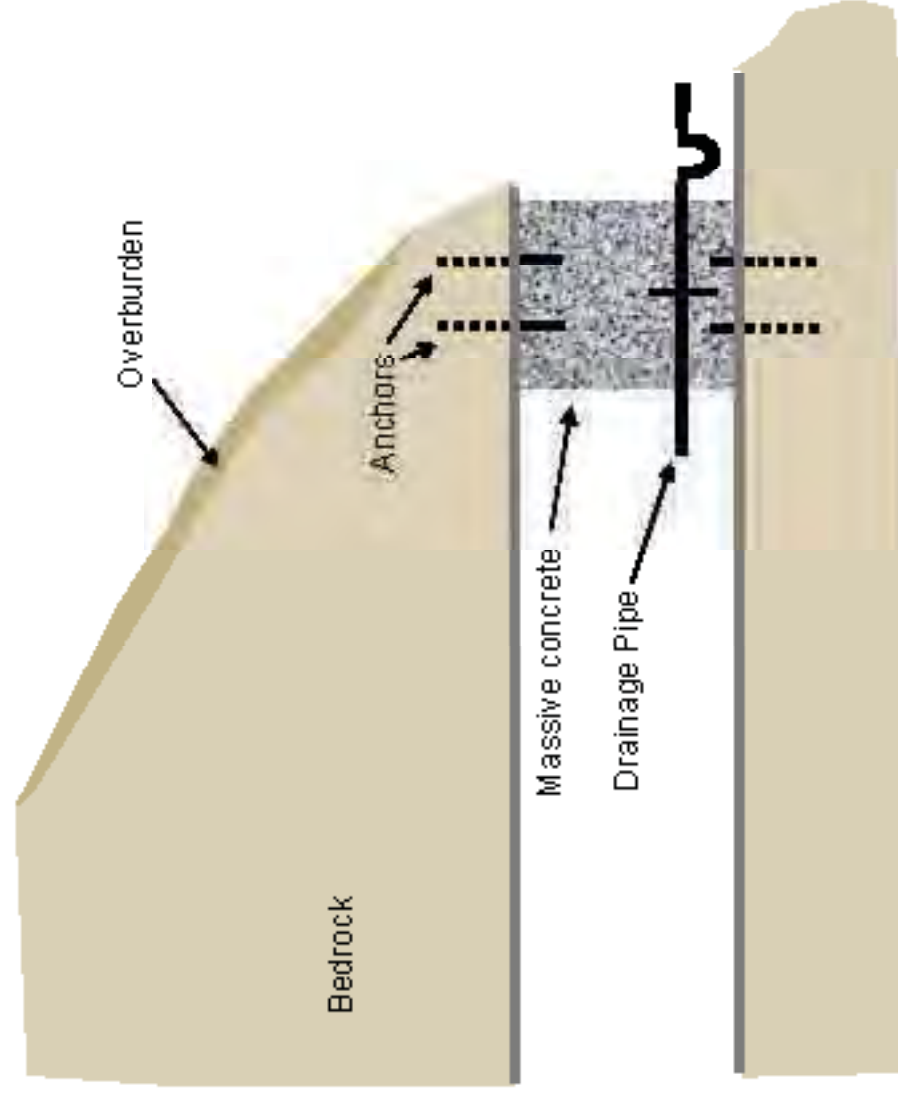
The 200 level vent raise will be capped with a pre-stressed concrete cap similar to what is used at mines elsewhere in Canada. This cement plug will prevent air movement and possible ice plug formation at the Bellekeno 625 adit.

8.2.4 Bellekeno 625 Adit

Without continued dewatering and pumping after closure, the static water elevation of the Bellekeno Mine will return to its existing location and flow out the Bellekeno 625 adit. Therefore the closure measures presented for the 625 adit are predicated on a hydraulic concrete plug to retain the mine pool while at the same time allow controlled discharge from the plug for additional treatment as necessary. A typical concrete plug design is shown in Figure 8-3. A detailed hydrologic study of the mined out Bellekeno Mine will be required to determine the final elevation of the static water once a plug has been constructed at the 625 elevation. The size of this opening is approximately 2.5 m x 2.5 m. In mine pool treatment using a carbon source such as molasses will be implemented within the flooded Bellekeno Mine to reduce soluble zinc loads. Additional polishing treatment if necessary will be conducted in the existing 625 treatment facilities.

8.2.5 Bellekeno 625 Water Treatment Facility

The existing water treatment facility will be decommissioned and a passive treatment system will be constructed. The ethanol-based, gravel infiltration gallery bioreactor currently in operation and demonstration at Galkeno 900 will be developed at the site. There will be a transition period from active chemical treatment to a passive biological treatment system.



	 ALEXCO	
Conceptual Bellekeno 625 Closure Plug	Keno Hill Project	
Date: Feb 2019	Approved:	Issue: 8-3

8.2.6 Potentially-AML Waste Rock Storage Facility

Potentially-AML waste rock from the mine development activities will be placed in the WRSF constructed at the Onek open pit (Figure 1-3). Final engineering design of this facility by EBA has been approved by YG, Energy Mines and Resources Branch, as per the requirements of Mining Land Use Approval LQ00240. Waste rock will be recontoured as necessary (although waste rock deposit protocols during use will be developed with closure measures in mind) and covered with a low permeable cover to prevent meteoric water from entering the cell and potentially becoming contaminated from the waste rock. The cover will be covered with growth medium and seeded to promote vegetative growth. If an additional equivalent facility is built during the course of the Bellekeno Mine development, it will be subject to the same closure measures as the Onek potentially-AML waste rock storage facility.

8.2.7 Non-AML Waste Rock Disposal Area

Preliminary engineering design by EBA of the linear benched WRDA to be developed adjacent to and to the east of the Bellekeno 625 adit has concluded that no additional contouring is required upon closure with regard to stability (see Appendix E in Volume 2). However, in order to further increase stability and improve aesthetics, Alexco will recontour the WRDA by pulling the crests back with an excavator followed by scarification and revegetation. The final overall (crest to crest) slope of the WRDA will be 3H:1V.

The condition of the permafrost beneath the WRDA will be monitored throughout operation and at least 10 years past closure. The requirement for ground temperature monitoring will be reviewed 10 years after closure. An annual geotechnical inspection should be conducted on the WRDA for at least 5 years after closure. The requirement for an annual geotechnical inspection will be reviewed 5 years after closure.

A toe buttress may be required along the alluvial terrace below the toe of the WRDA which was previously placer mined. This provision may be necessary to improve the

overall stability of the embankment in the event of an earthquake, or other seismic event. Adequate backfilling or re-contouring by the placer miner may alleviate this concern, but this should be re-examined at closure.

8.2.8 Ore Stockpile Pads

Ore produced during mining will be shipped to the Christal Lake mill site coarse ore stockpile, with a separate area for high grade ore that has been designated as direct shipping ore. Ore stockpile pads will be concrete or rolled concrete pad, with steel rails (mine tracks) embedded for ease of rehandling ore with loader bucket. It is expected that at closure the material beneath the ore stockpiles will be processed through the mill to remove any remaining economic values as well as eliminating any potential contaminant of concern from the material. The impermeable rehandling pads will be demolished and buried once cleaned of all metal contaminants.

8.2.9 Dry Stack Tailings Facility

Although the DSTF will be built in compacted 1 to 2 foot lifts to limit water penetration, closure measures will include covering the stack with an approximately 0.5 meter thick evapotranspiration cover. This cover will be fertilized and seeded to encourage revegetation. This cover will limit water migration through the stack.

Diversion (interceptor) ditches and collection ditches will be resloped and allowed to naturally revegetate.

If monitoring during operations indicates that treatment will be required for meteoric water after closure, a passive bioreactor treatment system will be constructed at the site immediately down slope from the DSTF. The area at the toe of the DSTF occupied by the runoff collection pond and polishing pond during operations can be reconstructed and used for the development of a gravel infiltration gallery, ethanol-based bioreactor cell (similar to the one currently in use at Galkeno 900 adit across Christal Lake). The operations-mode active lime water treatment plant will be removed for redeployment at future facilities once active treatment is no longer required.

8.2.10 Mill Pad Area Ancillary Facilities

The mill pad location will be built at the site of the former Mackeno Mill Site, which processed approximately 122,000 tonnes of ore from the Bellekeno and Galkeno Mines in the early 1950's. In addition to an unknown amount of tailings at the northeast shoreline of Christal Lake and in Christal Creek, there is a certain amount of trash and scrap metal at the site. Assuming the historic Mackeno tailings are not reprocessed, closure and remediation of this historic liability will be addressed in the district wide closure plan currently being developed.

The pad area will have its embankment shoulders re-graded to prevent water ponding, and the surface will be scarified and reseeded to promote vegetative cover.

The selection of mill site location has been made in consideration of the potential to use the mill for production from future producing mines. However, the closure concepts developed here assume that the site will no longer be used after the current Bellekeno mine life. The entire mill complex will be removed from the site through either salvaging or dismantling and burial in an approved landfill site. It is anticipated that the Keno City Solid Waste Management Facility (SWMF) is not large enough to accommodate this extra material; therefore it would be taken to the Elsa facility, or possibly to Mayo as appropriate. Concrete footings will be demolished and buried *in situ*.

8.2.11 Camp Expansion

The camp has been expanded (roughly doubled in size) to accommodate mine contractors and drilling crews required for the advanced exploration program, and this expansion is expected to increase once again another approximately 20% to house mine construction workforce.

This plan assumes the camp facilities are returned to their previous size (approximately 100 people). Work would involve the removal of some of the Atco trailers. The

expanded septic system, along with the increased freshwater supply will remain in place, to be utilized for the downsized camp.

8.2.12 Post Closure Monitoring and Maintenance

It is assumed that monitoring activity will be required to determine the ongoing and continued success of closure measures in meeting the closure objectives, for a period of 10 years. The adaptive management approach will be utilized to determine if criteria triggers for remedial action have been triggered, and then the success of the remedial measures will need to be incorporated into the monitoring and surveillance regimen.

At the time of closure, monitoring would continue to be undertaken by an Environmental Monitor. Monitoring will consist of the following areas of attention:

- Water quality sampling at monitoring stations identified in the Type A water licence ;
- Monitoring of road bank and drainage along access road;
- Physical inspection of tailings area;
- Physical inspection of the passive water treatment system;
- Physical stability of all waste rock storage areas;
- Success of revegetation measures where employed (principally portal area and mill pad area);
- Integrity of covers (geosynthetic cover on potentially-AML Waste Rock Storage Facility, and evapotranspiration cover on DSTF);
- Physical inspection of impacted earthen surfaces for evidence of erosion, gullyng, sediment transport to water courses;

The proposed program includes continued water sampling at the sites that will be provided for in the Type A Water Use Licence. At the time of closure, monitoring would continue to be undertaken by an Environmental Monitor.

8.2.13 Reclamation Security and Costing

GY currently holds a security bond to cover the potential liabilities arising from the ultimate advance of the advanced underground exploration project. Once final security has been assessed for the Bellekeno Mine, this bond will be augmented by such security as necessary to cover the cost of closure measures for additional mine related infrastructure such as the mill site, tailings facility and waste rock storage areas.

Reclamation costs for each of the components will be based on costs derived from experience in similar situations. Closure costs that were developed for the advanced underground exploration project have been incorporated in this conceptual plan. Closure costs for these sites involved discussions with mine contractors and management to come up with realistic third party costs to apply to unit costs and equipment hours. GY third party equipment costs were also used. At the above noted sites, detailed closure costs were audited by an independent engineer on behalf of Yukon Government and used to review closure security requirements.

9.0 ACKNOWLEDGEMENT AND CERTIFICATION

Alexco Keno Hill Mining Corp. has prepared this YESAA Project Proposal for Type A Water Use and Quartz Mining Licence Applications for our Bellekeno Mine Development Project, Keno Hill Silver District, Yukon.

The information within this document is submitted to the Yukon Water Board and YESAB for the purpose of conducting a screening under YESAA. It is acknowledged that pursuant to Section 119 of YESAA, a copy of this document will be placed on a public registry and will be available to any member of the public to review.

It is understood that misrepresenting or omitting information required for the evaluation may cause delays in the screening or render the recommendation invalid.

We trust this document fulfills your present requirements. If you have any questions or require further details, please contact the undersigned at Tel: (604) 633-4888 or in Whitehorse at Tel: (867) 668-6463.

I certify that the information provided is true and correct to the best of my knowledge and belief.

Brad A. Thrall, B.Sc., MBA
Chief Operating Officer
Alexco Keno Hill Mining Corp.

10.0 REFERENCES

- Access Consulting Group, 2009, February 2009. Keno Hill Silver District Adaptive Management Plan – 2009 Update. Submitted to Mining Land Use.
- Access Consulting Group, 2008a November 3, 2008. Waste Rock Facility Physical Inspection Plan. Submitted to Yukon Water Board.
- Access Consulting Group, 2008b November 3, 2008. Waste Rock Metals and Acid Base Accounting Testing Plan. Submitted to Yukon Water Board.
- Access Consulting Group, 2008c November 3, 2008. Mine Wall Testing Plan. Submitted to Yukon Water Board.
- Access Consulting Group, 2008d. Fisheries Reconnaissance Field Studies. Unpublished Data, 2008.
- Access Consulting Group, 2000. "Compilation of Non-Mining Land Use & Water Quality Hydrology Information." DIAND, 2000.
- Access Mining Consultants Ltd., June 6, 1996. *United Keno Hill Mines Limited, Report No. UKH/96/02 Closure Plan for Current Condition.*
- Access Mining Consultants Ltd., June 3, 1996. "United Keno Hill Mines Limited, Report No. UKH/96/01, Site Characterization Report" (Part of the environmental assessment and licensing process associated with the UKHM 1996 Water Licence application).
- Access Mining Consulting Ltd., 2000. "Compilation of Non-Mining Land Use & Water Quality Hydrology Information". (A recent discussion of site hydrology that was prepared for DIAND).
- Aho, E. A., 2006. *Hills of Silver: The Yukon's Mighty Keno Hill Mine.* Harbour Publishing Co. Ltd. Madeira Park, BC.
- Canadian Council of Ministers of the Environment (CCME), 1999 (Updated to 2007). *Canadian Environmental Quality Guidelines* (Plus Updates).
- Canadian Council of Ministers of the Environment (CCME), 1995. *Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life.* CCME EPC-98E. Prepared by Environment Canada, Guidelines Division, Technical Secretariat of the CCME Task Group on Water Quality Guidelines, Ottawa.
- Clearwater Consultants Ltd., 2008 United Keno Hill Mines -- Hydrological Update and Assessment Memorandum #CCL-UKHM to Access Consulting Group.
- Debicki, R.L., 1983. Yukon Mineral Industry 1941 to 1959. DIAND. Ottawa.

REFERENCES (cont'd)

Department of Fisheries and Oceans, 1995. *"Freshwater Intake End-of-Pipe Fish Screen Guidelines"*

Federal Environmental Assessment Review Office (FEARO), 1994. *"The Responsible Authority's Guide to the Canadian Environmental Assessment Act"*. Prepared by the Federal Environmental Assessment Review Office, September 1994.

Gamberg Consulting, 1999. Contaminants in Yukon Moose and Caribou. Whitehorse, YT. March 1999

Kwong et al., 1997. Post-mine metal transport and attenuation in the Keno Hill mining district, central Yukon, Canada. *Environmental Geology* V.30

Kwong et al., 1994. Lithogeochemistry and aqueous metal transport in the Keno Hill mining district, central Yukon Territory. In: *Current Research 1994-E; Geological Survey of Canada*.

Laberge Environmental Services, 1996. *Biological Monitoring Survey at United Keno Hill Mine Area, 1994*.

Laberge Environmental Services, 2005. *Keno Valley Receiving Water Monitoring Program, 2004/2005*.

Laberge Environmental Services, 2008. *Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007*.

MacGregor, D. M.Sc. Thesis: *"Natural Attenuation of Aqueous Zinc in Shallow Soils Over Permafrost Downslope of Galkeno 300 Mine Adit, United Keno Hill Mines, Central Yukon, 2002"*.

MMER 2004, Metal Mining Effluent Regulations, subsections 34(2), 36(5) and 38(9) of the *Fisheries Act*.

MMER 2002, Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring, June 2002.

Mining Land Use #LQ00240 Class 4 Approval for Advanced Underground Exploration and Development at Bellekeno Minesite, Issued to Alexco Resource Canada Corp., Effective June 17, 2008.

NNDFN (First Nation of Nä Cho Nyak Dun), 2008a. Cooperative Engagement Process for Economic Activities Proposed in the Traditional Territory of the First Nation of Nä Cho Nyak Dun. Mayo, YT.

NNDFN (First Nation of Nä Cho Nyak Dun), 2008b. Guiding Principles Towards Best Practices Codes for Mineral Interests within Nä Cho Nyak Dun First Nation Traditional Territory. Mayo, YT.

REFERENCES (cont'd)

- Process Research Associates (PRA), 2009. Metallurgical Testing of Samples Originating from the Bellekeno Project. Prepared for Alexco Resource Corp. January, 2009.
- SRK Consulting, June 2008. *“Bellekeno Preliminary Economic Assessment Technical Report, Keno Hill Mining District, Yukon”*, prepared for Alexco Resource Corp.
- SRK Consulting (Canada) Inc., February 2009. 2007/08 Geochemical Studies Keno Hill Silver District, YT,
- U.S. Environmental Protection Agency, Office of Solid Waste, December 1994. Technical Document Acid Mine Drainage Prediction. Prepared by the Office of Solid Waste, Washington, D.C.
- Wardrop, 2009. *“Bellekeno Project Backfill System”*, prepared for Alexco Resource Corp.
- White Mountain Environmental Consultants (WMEC), 2006. *Fisheries Assessments Conducted in the Keno Hill Mining Area, Including Metals Analysis of Fish Tissue Samples, 2006*.
- White Mountain Environmental Consultants (WMEC), 1996. *Fish and Fish Habitat Assessment Conducted Near Elsa, Yukon for United Keno Hill Mines August 1994 – September 1995*.
- Yukon Environmental and Socio-economic Assessment Board, 2005. “Proponents Guide to Project Proposal Submission to a Designated Office” (Guidance documents).
- Yukon Environmental and Socio-economic Assessment Board, 2006. “Assessor’s Guide to the Assessment of Environmental Effects” (Similar to FEARO’s “The Responsible Authority’s Guide to the Canadian Environmental Assessment Act”).
- Yukon Environmental and Socio-economic Assessment Act. Assessable Activities, Exceptions and Executive Committee Projects Regulations. November 28, 2005.
- YESAB, 2005. “The Proponents Guide to Project Proposal Submission to a Designated Office”.
- YESAB, 2006. “Assessor’s guide to the Assessment of Environmental Effects.”
- Yukon Community Profiles. Website Accessed March 11, 2005.
URL: <http://www.yukoncommunities.yk.ca>
- Yukon Quartz Mining Act, Quartz Mining Land Use Regulation, March 25, 2003. MLUA Class 3 LQ00186 (Schedule 1 Operating Conditions).

REFERENCES (cont'd)

Yukon Water Board, 2007. Water Licence QZ06-074 (Elsa Reclamation & Development Company's care and maintenance).

Yukon Water Board, 2008. Type B Water Use Licence #QZ07-078, for Bellekeno Advanced Underground Exploration Development Program, Issued to Alexco Resource Canada Corporation, Effective October 3, 2008.



ALEXCO

**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER
USE & QUARTZ MINING LICENCE APPLICATIONS
VOLUME 2 – APPENDICES**

*Bellekeno Mine Development
Keno Hill Silver District
Yukon*

February 2009

Prepared by:





**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX A
LISTING OF ALEXCO CLAIMS ON THE KENO HILL
PROPERTY**

As of December 18, 2007

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009												
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																										
12779	ROULETTE		3386	ERDC	August 27, 1919	January 26, 2009	20.6	51.65	105M14	17	16735	Mayo																										
13143	BLUE BELL		3387	ERDC	June 16, 1920	January 31, 2009	16.8	41.5	105M14	106	55064	Mayo																										
13787	MARY		3388	ERDC	June 21, 1921	January 31, 2009	2.9	7.44	105M14	112	55064	Mayo																										
12780	RICO		3380	ERDC	August 27, 1919	February 16, 2009	20.5	51.12	105M14	18	16735	Mayo																										
12816	SOLO	2	3383	ERDC	October 18, 1919	February 18, 2009	20.5	50.12	105M14	21	16735	Mayo																										
12784	KENO		3382	ERDC	September 10, 1919	February 23, 2009	20.6	50.46	105M14	19	16735	Mayo																										
12783	SCOTTY		3381	ERDC	September 10, 1919	February 24, 2009	20.5	50.44	105M14	20	16735	Mayo																										
83132	TECH		3384	ERDC	August 13, 1963	February 28, 2009	7	17.2	105M14	1126	52867	Mayo																										
83532	JENNY	3	3385	ERDC	July 17, 1964	February 28, 2009	22.1	11.26	105M14	1154	52868	Mayo																										
12909	ANTHONY		3389	ERDC	December 17, 1919	March 24, 2009	17.3	42.67	105M14	48	16982	Mayo																										
13452	RICO		3390	50% ERDC	October 2, 1920	March 28, 2009	20.2	49.57	105M14	151A	18945	Mayo																										
13622	TRAVICE		3391	ERDC	April 23, 1921	April 22, 2009	20.1	49.81	105M14	141	54104	Mayo																										
13225	LAKE	1	3392	ERDC	July 13, 1920	April 27, 2009	19.2	47.25	105M14	143	55056	Mayo																										
13276	LAKE	2	3393	ERDC	August 25, 1920	April 27, 2009	19.6	49.09	105M14	144	55056	Mayo																										
13277	LAKE	3	3394	ERDC	August 25, 1920	April 27, 2009	19.3	47.14	105M14	145	55056	Mayo																										
14288	SEXTANT		3425	ERDC	October 4, 1921	May 15, 2009	0.25	0.64	105M14	123	55064	Mayo																										
YC48258	Alex	127		ARCC	May 22, 2006	May 22, 2009	18		105M13			Mayo																										
YC48259	Alex	128		ARCC	May 22, 2006	May 22, 2009	18		105M13			Mayo																										
YC48260	Alex	129		ARCC	May 22, 2006	May 22, 2009	18		105M13			Mayo																										
YC48261	Alex	130		ARCC	May 22, 2006	May 22, 2009	18		105M13			Mayo																										
14336	GREENSTONE		3426	ERDC	October 19, 1921	May 28, 2009	3.2	7.86	105M14	124	55064	Mayo																										
YC48132	Alex	1		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48133	Alex	2		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48134	Alex	3		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48135	Alex	4		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48136	Alex	5		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48137	Alex	6		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48138	Alex	7		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48139	Alex	8		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48140	Alex	9		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48141	Alex	10		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48142	Alex	11		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48143	Alex	12		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48144	Alex	13		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48145	Alex	14		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48146	Alex	15		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48147	Alex	16		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48162	Alex	31		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48163	Alex	32		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48164	Alex	33		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48165	Alex	34		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48166	Alex	35		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48167	Alex	36		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																										
YC48168	Alex	37		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48169	Alex	38		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										
YC48170	Alex	39		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
YC48171	Alex	40		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48172	Alex	41		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48173	Alex	42		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48174	Alex	43		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48175	Alex	44		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48176	Alex	45		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48177	Alex	46		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48178	Alex	47		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48179	Alex	48		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48180	Alex	49		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48181	Alex	50		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48182	Alex	51		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48183	Alex	52		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48184	Alex	53		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48185	Alex	54		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48186	Alex	55		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48187	Alex	56		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48188	Alex	57		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48189	Alex	58		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48190	Alex	59		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48191	Alex	60		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48192	Alex	61		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48193	Alex	62		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48194	Alex	63		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48195	Alex	64		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48196	Alex	65		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48197	Alex	66		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48198	Alex	67		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48199	Alex	68		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48200	Alex	69		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48201	Alex	70		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48202	Alex	71		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48203	Alex	72		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48204	Alex	73		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48205	Alex	74		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48206	Alex	75		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48207	Alex	76		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48262	Alex	131		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48263	Alex	132		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48264	Alex	133		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48265	Alex	134		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48266	Alex	135		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48267	Alex	136		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48268	Alex	137		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48269	Alex	138		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48270	Alex	139		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES										UPDATED: JANUARY 16, 2009			
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District														
YC48271	Alex	140		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48272	Alex	141		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48273	Alex	142		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48274	Alex	143		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48275	Alex	144		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48276	Alex	145		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48277	Alex	146		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48278	Alex	147		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48279	Alex	148		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48280	Alex	149		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48281	Alex	150		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48282	Alex	151		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48283	Alex	152		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48284	Alex	153		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48285	Alex	154		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48286	Alex	155		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48287	Alex	156		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48288	Alex	157		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48289	Alex	158		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48290	Alex	159		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48291	Alex	160		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48292	Alex	161		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48293	Alex	162		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48294	Alex	163		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48295	Alex	164		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48296	Alex	165		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48297	Alex	166		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48298	Alex	167		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48299	Alex	168		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48300	Alex	169		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48301	Alex	170		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48302	Alex	171		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48303	Alex	172		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48304	Alex	173		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48305	Alex	174		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48306	Alex	175		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48307	Alex	176		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48308	Alex	177		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48309	Alex	178		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo														
YC48359	Alex	229		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48360	Alex	230		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48361	Alex	231		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48362	Alex	232		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48363	Alex	233		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48364	Alex	234		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														
YC48365	Alex	235		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo														

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
YC48366	Alex	236		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48367	Alex	237		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48368	Alex	238		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48369	Alex	239		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48370	Alex	240		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48371	Alex	241		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48372	Alex	242		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48373	Alex	243		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48374	Alex	244		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48375	Alex	245		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48376	Alex	246		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48377	Alex	247		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48378	Alex	248		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48379	Alex	249		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48380	Alex	250		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48381	Alex	251		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48382	Alex	252		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48383	Alex	253		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48384	Alex	254		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48385	Alex	255		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48386	Alex	256		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48387	Alex	257		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48388	Alex	258		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48389	Alex	259		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48390	Alex	260		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48391	Alex	261		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48392	Alex	262		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48393	Alex	263		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48394	Alex	265		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48396	Alex	267		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48398	Alex	269		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48400	Alex	271		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48402	Alex	273		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48404	Alex	275		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48406	Alex	277		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48456	Alex	333		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48457	Alex	334		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48458	Alex	335		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48459	Alex	336		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48460	Alex	337		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48461	Alex	338		ARCC	June 2, 2006	June 2, 2009	18		105M13			Mayo																		
YC48462	Alex	339		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48463	Alex	340		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48464	Alex	341		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48465	Alex	342		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		
YC48466	Alex	343		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District										
YC48467	Alex	344		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48468	Alex	345		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48469	Alex	346		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48470	Alex	347		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48471	Alex	348		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48472	Alex	349		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48473	Alex	350		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48474	Alex	351		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48475	Alex	352		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48476	Alex	353		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48477	Alex	354		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48478	Alex	355		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48479	Alex	356		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48480	Alex	357		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC48481	Alex	358		ARCC	June 2, 2006	June 2, 2009	18		105M14			Mayo										
YC56120	K	93 F		ARCC	June 13, 2007	June 13, 2009	18		105M14			Mayo										
YC56121	K	94 F		ARCC	June 13, 2007	June 13, 2009	18		105M14			Mayo										
YC56219	Alex	506		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56223	Alex	510		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56245	Alex	532		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56249	Alex	536		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56250	Alex	537		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56251	Alex	538		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56253	Alex	540		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56254	Alex	541		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56255	Alex	542		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56256	Alex	543		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56257	Alex	544		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56258	Alex	545		ARCC	June 22, 2007	June 22, 2009	18		106D03			Mayo										
YC56260	Alex	547		ARCC	June 22, 2007	June 22, 2009	18		105M14			Mayo										
YC56176	Alex	463		ARCC	June 12, 2007	December 12, 2009	18		105M14			Mayo										
YC56177	Alex	464		ARCC	June 12, 2007	December 12, 2009	18		105M14			Mayo										
YC56273	Alex	565		ARCC	June 13, 2007	December 13, 2009	18		106D03			Mayo										
YC56178	Alex	465		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56179	Alex	466		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56180	Alex	467		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56181	Alex	468		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56182	Alex	469		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56183	Alex	470		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56184	Alex	471		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56185	Alex	472		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56186	Alex	473		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56187	Alex	474		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56188	Alex	475		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56189	Alex	476		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56190	Alex	477		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District										
YC56191	Alex	478		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56192	Alex	479		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56193	Alex	480		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56194	Alex	481		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56195	Alex	482		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56196	Alex	483		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56197	Alex	484		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56198	Alex	485		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56199	Alex	486		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56200	Alex	487		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56201	Alex	488		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56202	Alex	489		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56203	Alex	490		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56204	Alex	491		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56205	Alex	492		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56206	Alex	493		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56207	Alex	494		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56208	Alex	495		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56209	Alex	496		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56210	Alex	497		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56211	Alex	498		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56212	Alex	499		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56213	Alex	500		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56214	Alex	501		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56215	Alex	502		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56216	Alex	503		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56217	Alex	504		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56218	Alex	505		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56220	Alex	507		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56221	Alex	508		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56222	Alex	509		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56224	Alex	511		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo										
YC56225	Alex	512		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56226	Alex	513		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56227	Alex	514		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56228	Alex	515		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56229	Alex	516		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56230	Alex	517		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56231	Alex	518		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56232	Alex	519		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56233	Alex	520		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56234	Alex	521		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56235	Alex	522		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56236	Alex	523		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56237	Alex	524		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										
YC56238	Alex	525		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo										

ALEXCO RESOURCE CORP.				KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009			
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District
YC56239	Alex	526		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56240	Alex	527		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56241	Alex	528		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56242	Alex	529		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56243	Alex	530		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56244	Alex	531		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56246	Alex	533		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56247	Alex	534		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56248	Alex	535		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56252	Alex	539		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56259	Alex	546		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56261	Alex	548		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56262	Alex	549		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56263	Alex	550		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56264	Alex	551		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56265	Alex	552		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56266	Alex	553		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
YC56267	Alex	554		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56268	Alex	556		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56269	Alex	558		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56270	Alex	560		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56271	Alex	562		ARCC	June 22, 2007	December 22, 2009	18		106D03			Mayo
YC56272	Alex	564		ARCC	June 22, 2007	December 22, 2009	18		105M14			Mayo
62977	LE BLANC		3439	ERDC	June 21, 1956	March 12, 2010	6	14.63	105M14	1173	53032	Mayo
81223	ANDY		3440	ERDC	June 26, 1962	March 12, 2010	7.5	18.45	105M14	1166	53055	Mayo
81225	SUSY Q.		3441	ERDC	June 26, 1962	March 12, 2010	14	33.76	105M14	1165	53055	Mayo
81226	CATHY		3442	ERDC	June 26, 1962	March 12, 2010	17.1	42.49	105M14	1163	53033	Mayo
81227	Mo		3443	ERDC	June 26, 1962	March 12, 2010	15.3	37.79	105M14	1162	53033	Mayo
82531	Joyce		3444	ERDC	March 12, 1963	March 12, 2010	3.8	9.2	105M14	1110	52067	Mayo
83133	Bunk		3446	ERDC	August 13, 1963	March 12, 2010	20	50.76	105M14	1144	52862	Mayo
83533	U.K. No.	17	3445	ERDC	July 17, 1964	March 12, 2010	6.6	15.91	105M14	1143	52865	Mayo
81721	R.J.		3447	ERDC	July 10, 1962	July 10, 2010	11.4	28	105M14	1108	52065	Mayo
14233	MAGGIE		3448	ERDC	September 24, 1921	September 24, 2010	2.4	6.24	105M14	109	55064	Mayo
12818	KING		3451	ERDC	October 20, 1919	September 27, 2010	21	51.65	105M14	156	54080	Mayo
12990	SILVER BELL		3449	ERDC	April 15, 1920	September 28, 2010	13.6	33.25	105M14	122	55064	Mayo
14833	TUNNEL		3450	ERDC	July 19, 1923	September 30, 2010	2.7	6.42	105M14	142	54104	Mayo
YC02673	Chiko	4		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02674	Chiko	5		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02675	Chiko	6		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02676	Chiko	7		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02677	Chiko	8		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02678	Chiko Fr.	9		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
YC02679	Chiko	10		ARCC	October 27, 2000	October 27, 2010			105M13			Mayo
62950	ORCHID	1		ERDC	May 30, 1956	October 31, 2010	27		105M13			Mayo
62951	ORCHID	2		ERDC	May 30, 1956	October 31, 2010	27.7		105M13			Mayo
62952	ORCHID	3		ERDC	May 30, 1956	October 31, 2010	20.9		105M13			Mayo

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
62953	ORCHID	4		ERDC	May 30, 1956	October 31, 2010	20.8		105M13			Mayo																		
62954	ORCHID	5		ERDC	May 30, 1956	October 31, 2010	20.7		105M13			Mayo																		
62955	ORCHID	6		ERDC	May 30, 1956	October 31, 2010	20.7		105M13			Mayo																		
62956	ORCHID	7		ERDC	May 30, 1956	October 31, 2010	19		105M13			Mayo																		
62957	ORCHID	8		ERDC	May 30, 1956	October 31, 2010	20.4		105M13			Mayo																		
62958	ORCHID	9		ERDC	May 30, 1956	October 31, 2010	21.3		105M13			Mayo																		
62959	ORCHID	10		ERDC	May 30, 1956	October 31, 2010	19.9		105M13			Mayo																		
62960	ORCHID	11		ERDC	May 30, 1956	October 31, 2010	12.7		105M13			Mayo																		
62961	ORCHID	12		ERDC	May 30, 1956	October 31, 2010	14.9		105M13			Mayo																		
62964	ORCHID	17		ERDC	May 30, 1956	October 31, 2010	12.3		105M13			Mayo																		
62965	ORCHID	18		ERDC	May 30, 1956	October 31, 2010	13.1		105M13			Mayo																		
62966	ORCHID	19		ERDC	May 30, 1956	October 31, 2010	20.2		105M14			Mayo																		
62967	ORCHID	20		ERDC	May 30, 1956	October 31, 2010	17.3		105M14			Mayo																		
YC48395	Alex	266		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48397	Alex	268		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48399	Alex	270		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48401	Alex	272		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48403	Alex	274		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48405	Alex	276		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48407	Alex	278		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48408	Alex	279		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48409	Alex	280		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48482	Alex	359		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48483	Alex	360		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48484	Alex	361		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48485	Alex	362		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48486	Alex	363		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48487	Alex	364		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48488	Alex	365		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48489	Alex	366		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48490	Alex	367		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48491	Alex	368		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48492	Alex	369		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48493	Alex	371		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48494	Alex	372		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48495	Alex	373		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48496	Alex	374		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48497	Alex	375		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48498	Alex	376		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48499	Alex	377		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48500	Alex	379		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48501	Alex	380		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48502	Alex	381		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48503	Alex	382		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48504	Alex	383		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		
YC48505	Alex	384		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District										
YC48506	Alex	386		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo										
YC48549	Alex	264		ARCC	June 2, 2006	December 31, 2010	18		105M14			Mayo										
YC42600	K	52		ARCC	December 3, 2005	December 3, 2011	18		105M14			Mayo										
YC42598	K	50		ARCC	December 15, 2005	December 15, 2011	18		105M14			Mayo										
59313	Paddy			ARCC	July 8, 1949	December 31, 2011	18		105M14			Mayo										
80239	Carol	1		ARCC	October 16, 1957	December 31, 2011	18		105M14			Mayo										
80240	Carol	2		ARCC	October 16, 1957	December 31, 2011	18		105M14			Mayo										
80241	Carol	3		ARCC	October 16, 1957	December 31, 2011	18		105M14			Mayo										
80242	Carol	4		ARCC	October 16, 1957	December 31, 2011	18		105M14			Mayo										
80348	Carol	5		ARCC	July 2, 1959	December 31, 2011	18		105M14			Mayo										
80453	Joe No.	1		ARCC	May 27, 1960	December 31, 2011	18		105M14			Mayo										
81152	Carol			ARCC	June 4, 1962	December 31, 2011	18		105M14			Mayo										
83253	Paddy	2		ARCC	October 16, 1963	December 31, 2011	18		105M14			Mayo										
83254	Paddy	3		ARCC	October 16, 1963	December 31, 2011	18		105M14			Mayo										
83721	Paddy	4		ARCC	October 26, 1964	December 31, 2011	18		105M14			Mayo										
83722	Paddy	5		ARCC	October 26, 1964	December 31, 2011	18		105M14			Mayo										
84489	Joe	2		ARCC	June 2, 1965	December 31, 2011	18		105M14			Mayo										
Y 31586	Toni	1		ARCC	December 2, 1968	December 31, 2011	18		105M14			Mayo										
Y 31587	Toni	2		ARCC	December 2, 1968	December 31, 2011	18		105M14			Mayo										
Y 33741	O.K.	1		ARCC	December 11, 1970	December 31, 2011	18		105M14			Mayo										
Y 33742	O.K.	2		ARCC	December 11, 1970	December 31, 2011	18		105M14			Mayo										
Y 56174	O.K.	3		ARCC	September 15, 1971	December 31, 2011	18		105M14			Mayo										
Y 56175	O.K.	4		ARCC	September 15, 1971	December 31, 2011	18		105M14			Mayo										
Y 85963	O.K.	5		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
Y 85964	O.K.	6		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
Y 85965	O.K.	7		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
Y 85966	O.K.	8		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
Y 85967	O.K.	9		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
Y 85968	O.K.	10		ARCC	October 10, 1973	December 31, 2011	18		105M14			Mayo										
YC42599	K	51		ARCC	December 15, 2005	December 31, 2011	18		105M14			Mayo										
YC56117	K	90 F		ARCC	June 13, 2007	December 31, 2011	18		105M14			Mayo										
YC56866	Alex	555		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56867	Alex	557		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56868	Alex	559		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56869	Alex	561		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56870	Alex	566		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56871	Alex	568		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56872	Alex	570		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56873	Alex	572		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56875	Alex	602		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56877	Alex	604		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56878	Alex	605		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YC56879	Alex	606		ARCC	July 24, 2007	December 31, 2011	18		105M14			Mayo										
YB64184	Lakehead	1		ARCC	June 28, 1995	March 4, 2012			105M13			Mayo										
YB64185	Lakehead	2		ARCC	June 28, 1995	March 4, 2012			105M13			Mayo										
16326	HECTOR		3519	ERDC	May 30, 1927	June 17, 2012	20	49.73	105M14	276	55080	Mayo										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES										UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District															
38715	JOCK		3517	ERDC	May 20, 1931	June 17, 2012	20.1	49.56	105M14	277	55080	Mayo															
38779	CHANCE		3518	ERDC	April 18, 1934	June 17, 2012	0.82	2.17	105M13	282	55080	Mayo															
13175	CAMOROTE		3527	ERDC	June 19, 1920	October 31, 2012	19.2	47.84	105M14	162	53800	Mayo															
YA17395	Lem	1		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17396	Lem	2		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17397	Lem	3		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17398	Lem	4		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17399	Lem	5		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17400	Lem	6		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17401	Lem	7		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17402	Lem	8		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17403	Lem	9		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17404	Lem	10		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
YA17405	Lem	11		ARCC	November 14, 1977	November 14, 2012	18		105M14			Mayo															
14989	RUBY		3525	ERDC	July 9, 1924	November 24, 2012	0.5	1.11	105M14	160	53801	Mayo															
16025	HAWKS NEST		3524	ERDC	August 31, 1925	November 24, 2012	15.1	37.4	105M14	222	55107	Mayo															
16497	DONNIE		3521	ERDC	August 28, 1924	November 24, 2012	20.2	48.63	105M14	218	55107	Mayo															
16511	NO CASH		3526	ERDC	September 9, 1924	November 24, 2012	18.3	45.26	105M14	223	55107	Mayo															
16512	LILL		3520	ERDC	September 9, 1924	November 24, 2012	18.4	45.6	105M14	224	55107	Mayo															
16568	MONOPLY		3522	ERDC	July 7, 1925	November 24, 2012	8.9	21.96	105M14	225	55107	Mayo															
16569	MONTE CARLO		3523	ERDC	July 7, 1925	November 24, 2012	21	51.15	105M13	228	FB20919	Mayo															
YC42549	K	1		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42550	K	2		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42551	K	3		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42552	K	4		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42553	K	5		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42554	K	6		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42555	K	7		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42556	K	8		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42557	K	9		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42558	K	10		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42559	K	11		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42560	K	12		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42561	K	13		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42562	K	14		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42563	K	15		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42564	K	16		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42565	K	17		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42566	K	18		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42567	K	19		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42568	K	20		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42569	K	21		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42570	K	22		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42571	K	23		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42572	K	24		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															
YC42573	K	25		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo															

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES							UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District												
YC42574	K	26		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42575	K	27		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42576	K	28		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42577	K	29		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42578	K	30		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42579	K	31		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42580	K	32		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42581	K	33		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42582	K	34		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42587	K	39		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42588	K	40		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42589	K	41		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42590	K	42		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42591	K	43		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42592	K	44		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42593	K	45		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42594	K	46		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42595	K	47		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42596	K	48		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42602	K	54		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42603	K	55		ARCC	December 15, 2005	December 15, 2012	18		105M13			Mayo												
YC42604	K	56		ARCC	December 15, 2005	December 15, 2012	18		105M13			Mayo												
YC42608	K	60		ARCC	December 15, 2005	December 15, 2012	18		105M13			Mayo												
YC42609	K	61		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42610	K	62		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42611	K	63		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42612	K	64		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42613	K	65		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42614	K	66		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42615	K	67		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42616	K	68		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42617	K	69		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42618	K	70		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42619	K	71		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42620	K	72		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42621	K	73		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42622	K	74		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42623	K	75		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42624	K	76		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42625	K	77		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42626	K	78		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42630	K	82		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42631	K	83		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42632	K	84		ARCC	December 15, 2005	December 15, 2012	18		105M14			Mayo												
YC42633	K	85		ARCC	December 15, 2005	December 15, 2012	18		105M13			Mayo												
13412	FOREST			ERDC	September 24, 1920	December 31, 2012	5.4		105M14			Mayo												

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District										
13799	IVAN			ERDC	June 23, 1921	December 31, 2012	7.4		105M14			Mayo										
14826	BELL YORK			ERDC	July 9, 1923	December 31, 2012	0.97		105M14			Mayo										
14858	ADA			ERDC	August 30, 1923	December 31, 2012	6.1		105M14			Mayo										
55392	YUKON			ERDC	January 30, 1946	December 31, 2012	14.6		105M14			Mayo										
55394	BOB			ERDC	March 5, 1946	December 31, 2012	17.1		105M14			Mayo										
59710	LEO	1		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	20.6		105M13			Mayo										
59711	LEO	2		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	19.7		105M13			Mayo										
59712	LEO	3		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	20.5		105M13			Mayo										
59714	LEO	4		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	18.4		105M13			Mayo										
59715	LEO	5		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	20.6		105M13			Mayo										
59716	LEO	6		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	18		105M13			Mayo										
59717	LEO	7		ERDC 65%-Cima 35%	September 26, 1950	December 31, 2012	20		105M13			Mayo										
59718	LEO	8		ERDC 70%-Cima 30%	September 26, 1950	December 31, 2012	15.8		105M13			Mayo										
59849	LEO	9		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	20.3		105M13			Mayo										
59850	LEO	10		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	16.6		105M13			Mayo										
59851	LEO	11		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	19.7		105M13			Mayo										
59852	LEO	12		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	16.3		105M13			Mayo										
59853	LEO	13		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	20.1		105M13			Mayo										
59854	LEO	14		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	18.3		105M13			Mayo										
59855	LEO	15		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	22.6		105M13			Mayo										
59856	LEO	16		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	14		105M13			Mayo										
59857	LEO	17		ERDC 70%-Cima 30%	October 2, 1950	December 31, 2012	12.6		105M13			Mayo										
59941	LEO	18		ERDC 70%-Cima 30%	October 12, 1950	December 31, 2012	16.1		105M13			Mayo										
59942	LEO	19		ERDC 70%-Cima 30%	October 12, 1950	December 31, 2012	20.2		105M13			Mayo										
61635	LEO			ERDC 70%-Cima 30%	June 11, 1951	December 31, 2012	15.4		105M13			Mayo										
62968	ORCHID	21		ERDC	May 30, 1956	December 31, 2012	22.7		105M14			Mayo										
62969	ORCHID	22		ERDC	May 30, 1956	December 31, 2012	18.8		105M14			Mayo										
62970	ORCHID	23		ERDC	May 30, 1956	December 31, 2012	22.2		105M14			Mayo										
62971	ORCHID	24		ERDC	May 30, 1956	December 31, 2012	17.5		105M14			Mayo										
80082	K.P.O.	1		ERDC 70%-Cima 30%	October 5, 1956	December 31, 2012	20.7		105M13			Mayo										
80083	K.P.O.	2		ERDC 70%-Cima 30%	October 5, 1956	December 31, 2012	13.1		105M13			Mayo										
80084	K.P.O.	3		ERDC 70%-Cima 30%	October 5, 1956	December 31, 2012	20.4		105M13			Mayo										
80085	K.P.O.	4		ERDC 70%-Cima 30%	October 5, 1956	December 31, 2012	16.3		105M13			Mayo										
80169	ORCHID	44		ERDC	April 3, 1957	December 31, 2012	6.8		105M14			Mayo										
80170	ORCHID	45		ERDC	April 3, 1957	December 31, 2012	10		105M14			Mayo										
80345	K.P.O.			ERDC 70%-Cima 30%	October 14, 1958	December 31, 2012	3.7		105M13			Mayo										
80362	K.P.O.	13		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	12.4		105M13			Mayo										
80364	K.P.O.	15		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20.8		105M13			Mayo										
80366	K.P.O.	17		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	21.4		105M13			Mayo										
80367	K.P.O.	18		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	21		105M13			Mayo										
80368	K.P.O.	19		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20.9		105M13			Mayo										
80369	K.P.O.	20		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20		105M13			Mayo										
80370	K.P.O.	21		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20.3		105M13			Mayo										
80372	K.P.O.	23		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	21.1		105M13			Mayo										
80374	K.P.O.	25		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20.8		105M13			Mayo										
80376	K.P.O.	27		ERDC 70%-Cima 30%	July 24, 1959	December 31, 2012	20.5		105M13			Mayo										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES							UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District												
80378	K.P.O.	29		ERDC 70%-Cima 30%	July 28, 1959	December 31, 2012	20.3		105M13			Mayo												
Y 68364	Orchid	46		ERDC	July 19, 1972	December 31, 2012	20.2		105M13			Mayo												
Y 68365	Orchid	47		ERDC	July 19, 1972	December 31, 2012	20.5		105M13			Mayo												
Y 68366	Orchid	48		ERDC	July 19, 1972	December 31, 2012	20		105M13			Mayo												
Y 68367	Orchid	49		ERDC	July 19, 1972	December 31, 2012	21.2		105M13			Mayo												
Y 68368	Orchid	50		ERDC	July 19, 1972	December 31, 2012	20.1		105M13			Mayo												
Y 68369	Orchid	51		ERDC	July 19, 1972	December 31, 2012	20.8		105M13			Mayo												
Y 68370	Orchid	52		ERDC	July 19, 1972	December 31, 2012	13.1		105M13			Mayo												
Y 68371	Orchid	53		ERDC	July 19, 1972	December 31, 2012	7.5		105M13			Mayo												
Y 68414	Case	1		ERDC	August 17, 1972	December 31, 2012	4.7		105M13			Mayo												
Y 68415	Case	2		ERDC	August 17, 1972	December 31, 2012	1.7		105M13			Mayo												
Y 68416	Case	3		ERDC	August 17, 1972	December 31, 2012	11		105M13			Mayo												
Y 87465	Snowdrift	4		ERDC	March 21, 1974	December 31, 2012	21		105M13			Mayo												
Y 87466	Snowdrift	5		ERDC	March 21, 1974	December 31, 2012	21.3		105M13			Mayo												
Y 87467	Snowdrift	6		ERDC	March 21, 1974	December 31, 2012	12		105M13			Mayo												
Y 87468	Snowdrift	7		ERDC	March 21, 1974	December 31, 2012	21.6		105M13			Mayo												
Y 87469	Snowdrift	8		ERDC	March 21, 1974	December 31, 2012	20.4		105M13			Mayo												
Y 97220	Snowdrift	13		ERDC	December 23, 1974	December 31, 2012	22.2		105M13			Mayo												
Y 97221	Snowdrift	14		ERDC	December 23, 1974	December 31, 2012	20.8		105M13			Mayo												
Y 97222	Snowdrift	15		ERDC	December 23, 1974	December 31, 2012	21		105M13			Mayo												
Y 97223	Snowdrift	16		ERDC	December 23, 1974	December 31, 2012	20.5		105M13			Mayo												
YA01413	Snowdrift	18		ERDC	October 8, 1975	December 31, 2012	12		105M13			Mayo												
YA01415	Snowdrift	20		ERDC	October 8, 1975	December 31, 2012	18		105M13			Mayo												
YB43712	Barb One			ERDC	October 12, 1994	December 31, 2012	8		105M14			Mayo												
YB43729	Raven			ERDC	October 18, 1994	December 31, 2012	20.8		105M13			Mayo												
YB65005	Webfoot			ERDC	September 29, 1995	December 31, 2012	16.2		105M13			Mayo												
YC02670	Chiko	1		ARCC	October 27, 2000	December 31, 2012			105M13			Mayo												
YC02671	Chiko	2		ARCC	October 27, 2000	December 31, 2012			105M13			Mayo												
YC02672	Chiko	3		ARCC	October 27, 2000	December 31, 2012			105M13			Mayo												
YC10897	North F.			ARCC	August 8, 2003	December 31, 2012			105M13			Mayo												
YC10946	Wedge	1		ARCC	September 9, 2003	December 31, 2012			105M13			Mayo												
YC10993	Wedge	2		ARCC	September 18, 2003	December 31, 2012			105M13			Mayo												
YC10994	Wedge	3		ARCC	September 18, 2003	December 31, 2012			105M13			Mayo												
YC10995	Mary A	0		ARCC	September 2, 2003	December 31, 2012			105M13			Mayo												
YC10996	Mary B	0		ARCC	September 2, 2003	December 31, 2012			105M13			Mayo												
YC42583	K	35		ARCC	December 1, 2005	December 31, 2012	18		105M14			Mayo												
YC42584	K	36		ARCC	December 1, 2005	December 31, 2012	18		105M14			Mayo												
YC42585	K	37		ARCC	December 1, 2005	December 31, 2012	18		105M14			Mayo												
YC42586	K	38		ARCC	December 1, 2005	December 31, 2012	18		105M14			Mayo												
YC42597	K	49		ARCC	December 3, 2005	December 31, 2012	18		105M14			Mayo												
YC42601	K	53		ARCC	December 5, 2005	December 31, 2012	18		105M14			Mayo												
YC48148	Alex	17		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo												
YC48149	Alex	18		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo												
YC48150	Alex	19		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo												
YC48151	Alex	20		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo												
YC48152	Alex	21		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo												

ALEXCO RESOURCE CORP.				KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009			
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District
YC48153	Alex	22		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48154	Alex	23		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48155	Alex	24		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48156	Alex	25		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48157	Alex	26		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48158	Alex	27		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48159	Alex	28		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48160	Alex	29		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48161	Alex	30		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo
YC48208	Alex	77		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48209	Alex	78		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48210	Alex	79		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48211	Alex	80		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48212	Alex	81		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48213	Alex	82		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48214	Alex	83		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48215	Alex	84		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48216	Alex	85		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48217	Alex	86		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48218	Alex	87		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48219	Alex	88		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48220	Alex	89		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48221	Alex	90		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48222	Alex	91		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48223	Alex	92		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48224	Alex	93		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48225	Alex	94		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48226	Alex	95		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48227	Alex	96		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48228	Alex	97		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48229	Alex	98		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48230	Alex	99		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48231	Alex	100		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48232	Alex	101		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48233	Alex	102		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48234	Alex	103		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48235	Alex	104		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48236	Alex	105		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48237	Alex	106		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48238	Alex	107		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48239	Alex	108		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48240	Alex	109		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48241	Alex	110		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48242	Alex	111		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48243	Alex	112		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo
YC48244	Alex	113		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo

ALEXCO RESOURCE CORP.					KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District		
YC48245	Alex	114		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48246	Alex	115		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48247	Alex	116		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48248	Alex	117		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48249	Alex	118		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48250	Alex	119		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48251	Alex	120		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48252	Alex	121		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48253	Alex	122		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48254	Alex	123		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48255	Alex	124		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48256	Alex	125		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48257	Alex	126		ARCC	May 22, 2006	December 31, 2012	18		105M13			Mayo		
YC48310	Alex	179		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48311	Alex	180		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48312	Alex	181		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48313	Alex	182		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48314	Alex	183		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48315	Alex	184		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48316	Alex	185		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48317	Alex	186		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48318	Alex	187		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48319	Alex	188		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48320	Alex	189		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48321	Alex	190		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48322	Alex	191		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48323	Alex	192		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48324	Alex	193		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48325	Alex	194		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48326	Alex	195		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48327	Alex	196		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48328	Alex	197		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48329	Alex	198		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48330	Alex	199		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48331	Alex	200		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48332	Alex	201		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48333	Alex	202		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48334	Alex	203		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48335	Alex	204		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48336	Alex	205		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48337	Alex	206		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48338	Alex	207		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48339	Alex	209		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48340	Alex	210		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48341	Alex	211		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		
YC48342	Alex	212		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District										
YC48343	Alex	213		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48344	Alex	214		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48345	Alex	215		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48346	Alex	216		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48347	Alex	217		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48348	Alex	218		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48349	Alex	219		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48350	Alex	220		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48351	Alex	221		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48352	Alex	222		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48353	Alex	223		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48354	Alex	224		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48355	Alex	225		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48356	Alex	226		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48357	Alex	227		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48358	Alex	228		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48410	Alex	287		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48411	Alex	288		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48412	Alex	289		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48413	Alex	290		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48414	Alex	291		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48415	Alex	292		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48416	Alex	293		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48417	Alex	294		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48418	Alex	295		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48419	Alex	296		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48420	Alex	297		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48421	Alex	298		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48422	Alex	299		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48423	Alex	300		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48424	Alex	301		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48425	Alex	302		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48426	Alex	303		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48427	Alex	304		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48428	Alex	305		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48429	Alex	306		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48430	Alex	307		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48431	Alex	308		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48432	Alex	309		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48433	Alex	310		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48434	Alex	311		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48435	Alex	312		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48436	Alex	313		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48437	Alex	314		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48438	Alex	315		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										
YC48439	Alex	316		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
YC48440	Alex	317		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48441	Alex	318		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48442	Alex	319		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48443	Alex	320		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48444	Alex	321		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48445	Alex	322		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48446	Alex	323		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48447	Alex	324		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48448	Alex	325		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48449	Alex	326		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48450	Alex	327		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48451	Alex	328		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48452	Alex	329		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48453	Alex	330		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48454	Alex	331		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48455	Alex	332		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48507	Alex	400		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48508	Alex	401		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48509	Alex	403		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48510	Alex	404		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48511	Alex	423		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48512	Alex	424		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48513	Alex	425		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48514	Alex	429		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48515	Alex	430		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48516	Alex	431		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48517	Alex	432		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48518	Alex	433		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48519	Alex	434		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48520	Alex	435		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48521	Alex	436		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48522	Alex	437		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48523	Alex	438		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48524	Alex	439		ARCC	June 2, 2006	December 31, 2012	18		105M14			Mayo																		
YC48525	Alex	440		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48526	Alex	441		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48527	Alex	442		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48528	Alex	443		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48529	Alex	444		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48530	Alex	445		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48531	Alex	446		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48532	Alex	447		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48533	Alex	448		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48534	Alex	449		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48535	Alex	450		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48536	Alex	451		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
YC48537	Alex	452		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48538	Alex	453		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48539	Alex	454		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48540	Alex	455		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48541	Alex	456		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48542	Alex	457		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48543	Alex	458		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48544	Alex	459		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48545	Alex	460		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48546	Alex	461		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48547	Alex	462		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC48548	Alex	208		ARCC	June 2, 2006	December 31, 2012	18		105M13			Mayo																		
YC55952	K	86		ARCC	May 29, 2007	December 31, 2012	18		105M14			Mayo																		
YC55953	K	87		ARCC	May 29, 2007	December 31, 2012	18		105M14			Mayo																		
YC56115	K	88 F		ARCC	June 13, 2007	December 31, 2012	18		105M14			Mayo																		
YC56116	K	89 F		ARCC	June 13, 2007	December 31, 2012	18		105M14			Mayo																		
YC56118	K	91 F		ARCC	June 13, 2007	December 31, 2012	18		105M13			Mayo																		
YC56119	K	92 F		ARCC	June 13, 2007	December 31, 2012	18		105M13			Mayo																		
YC56127	K	100		ARCC	June 15, 2007	December 31, 2012	18		105M14			Mayo																		
YC56128	K	101 F		ARCC	June 15, 2007	December 31, 2012	18		105M14			Mayo																		
YC56155	K	103 F		ARCC	June 22, 2007	December 31, 2012	18		105M14			Mayo																		
YC56156	K	104		ARCC	June 22, 2007	December 31, 2012	18		105M14			Mayo																		
YC56157	K	105 F		ARCC	June 22, 2007	December 31, 2012	18		105M14			Mayo																		
YC56158	K	106		ARCC	June 22, 2007	December 31, 2012	18		105M14			Mayo																		
YC56159	K	107 F		ARCC	June 22, 2007	December 31, 2012	18		105M14			Mayo																		
YC56874	Alex	601		ARCC	July 24, 2007	December 31, 2012	18		105M14			Mayo																		
YC56876	Alex	603		ARCC	July 24, 2007	December 31, 2012	18		105M14			Mayo																		
13158	PHOENIX		3537	ERDC	June 17, 1920	February 27, 2013	13.7	34.14	105M14	114	18257	Mayo																		
YC01212	South F			ARCC	July 6, 1998	March 4, 2013			105M13			Mayo																		
YC42605	K	57		ARCC	December 15, 2005	December 15, 2013	18		105M14			Mayo																		
YC42606	K	58		ARCC	December 15, 2005	December 15, 2013	18		105M13			Mayo																		
YC42607	K	59		ARCC	December 15, 2005	December 15, 2013	18		105M13			Mayo																		
YC42627	K	79		ARCC	December 15, 2005	December 15, 2013	18		105M14			Mayo																		
YC42628	K	80		ARCC	December 15, 2005	December 15, 2013	18		105M14			Mayo																		
YC42629	K	81		ARCC	December 15, 2005	December 15, 2013	18		105M14			Mayo																		
YC56124	K	97		ARCC	June 15, 2007	December 15, 2013	18		105M14			Mayo																		
YC56125	K	98		ARCC	June 15, 2007	December 15, 2013	18		105M14			Mayo																		
YC56126	K	99		ARCC	June 15, 2007	December 15, 2013	18		105M14			Mayo																		
YA40163	Dice	1		ERDC	June 29, 1979	December 29, 2013	2.1		105M14			Mayo																		
YA40164	Dice	2		ERDC	June 29, 1979	December 29, 2013	18.5		105M14			Mayo																		
YA40165	Dice	3		ERDC	June 29, 1979	December 29, 2013	17.1		105M14			Mayo																		
YA40166	Dice	4		ERDC	June 29, 1979	December 29, 2013	21.9		105M14			Mayo																		
YA40167	Dice	5		ERDC	June 29, 1979	December 29, 2013	14.5		105M14			Mayo																		
YA40168	Dice	6		ERDC	June 29, 1979	December 29, 2013	21.3		105M14			Mayo																		
YA40169	Dice	7		ERDC	June 29, 1979	December 29, 2013	21		105M14			Mayo																		
YA40170	Dice	8		ERDC	June 29, 1979	December 29, 2013	20.3		105M14			Mayo																		

ALEXCO RESOURCE CORP.					KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District		
YA40171	Dice	9		ERDC	June 29, 1979	December 29, 2013	21.1		105M14			Mayo		
YA40173	Dice	11		ERDC	June 29, 1979	December 29, 2013	20.9		105M14			Mayo		
YA40174	Dice	12		ERDC	June 29, 1979	December 29, 2013	20.5		105M14			Mayo		
YA40175	Dice	13		ERDC	June 29, 1979	December 29, 2013	19.7		105M14			Mayo		
YA40176	Dice	14		ERDC	June 29, 1979	December 29, 2013	21.9		105M14			Mayo		
YC02322	Twins	7		ARCC	December 29, 1999	December 29, 2013			105M13			Mayo		
Y 33308	Venus	3		ERDC	April 6, 1970	December 31, 2013	11.7		105M14			Mayo		
Y 69403	Galaxy			ERDC	June 5, 1973	December 31, 2013	9.3		105M14			Mayo		
Y 87462	Snowdrift	1		ERDC	March 21, 1974	December 31, 2013	21.3		105M13			Mayo		
Y 87463	Snowdrift	2		ERDC	March 21, 1974	December 31, 2013	14.6		105M13			Mayo		
Y 87464	Snowdrift	3		ERDC	March 21, 1974	December 31, 2013	20.1		105M13			Mayo		
Y 87470	Snowdrift	9		ERDC	March 21, 1974	December 31, 2013	14.3		105M13			Mayo		
Y 87471	Snowdrift	10		ERDC	March 21, 1974	December 31, 2013	16		105M13			Mayo		
Y 87472	Snowdrift	11		ERDC	March 21, 1974	December 31, 2013	15.7		105M13			Mayo		
Y 88686	Snowdrift			ERDC	June 5, 1974	December 31, 2013	1.3		105M13			Mayo		
Y 97219	Snowdrift	12		ERDC	December 23, 1974	December 31, 2013	8.7		105M13			Mayo		
Y 97333	Venus	4		ERDC	May 9, 1975	December 31, 2013	9		105M14			Mayo		
YA01412	Snowdrift	17		ERDC	October 8, 1975	December 31, 2013	10.9		105M13			Mayo		
YA01414	Snowdrift	19		ERDC	October 8, 1975	December 31, 2013	20.8		105M13			Mayo		
YA01416	Snowdrift	21		ERDC	October 8, 1975	December 31, 2013	19.5		105M13			Mayo		
YA39498	Bulldozer	1		ERDC	April 4, 1979	December 31, 2013	21		105M14			Mayo		
YA77506	Galena			ERDC	June 13, 1984	December 31, 2013	2		105M14			Mayo		
YB29727	ALLA	4		ERDC	March 19, 1993	December 31, 2013	12.9		105M13			Mayo		
YB29728	ALLA	5		ERDC	March 19, 1993	December 31, 2013	12		105M13			Mayo		
YB29729	ALLA	6		ERDC	March 19, 1993	December 31, 2013	6.3		105M13			Mayo		
YC01768	Jarret	2		ARCC	April 30, 1999	December 31, 2013			105M13			Mayo		
YC56122	K	95		ARCC	June 15, 2007	December 31, 2013	18		105M14			Mayo		
YC56123	K	96		ARCC	June 15, 2007	December 31, 2013	18		105M14			Mayo		
YC69940	K	108F		ARCC	September 10, 2008	December 31, 2013	0.344		105M14			Mayo		
12875	PORCUPINE		4065	ERDC	November 15, 1919	January 21, 2014	15.4	38.01	105M14	23	18252	Mayo		
13152	FRIENDSHIP		4066	ERDC	June 16, 1920	January 30, 2014	10	25.1	105M14	102	18256	Mayo		
13021	LUCKY QUEEN		4067	ERDC	May 4, 1920	February 17, 2014	20.1	48.29	105M14	181	36699	Mayo		
12923	UNCLE SAM		4068	ERDC	December 26, 1919	March 12, 2014	14.4	35.18	105M14	182	36699	Mayo		
13153	VIOLA		4069	ERDC	June 16, 1920	March 14, 2014	18.5	45.61	105M14	165	55110	Mayo		
14898	RIO		4070	ERDC	November 15, 1923	April 14, 2014	14	35.05	105M14	168	55110	Mayo		
16253	TIPPY		4074	ERDC	October 6, 1926	April 14, 2014	6.2	15.58	105M14	301	55112	Mayo		
38694	JESSIE		4075	ERDC	November 21, 1930	April 14, 2014	16.4	40.74	105M14	300	55112	Mayo		
38741	TOMTOM		4072	ERDC	June 20, 1932	April 14, 2014	10.3	25.19	105M14	298	55112	Mayo		
38744	JEWEL		4073	ERDC	July 21, 1932	April 14, 2014	9.1	22.58	105M14	299	55112	Mayo		
38812	GALENA HILL		4071	ERDC	November 12, 1934	April 14, 2014	17	41.57	105M14	297	55112	Mayo		
16079	TOO GOOD		4076	ERDC	November 29, 1925	June 11, 2014	4.6	10.61	105M14	183	36699	Mayo		
14846	DENVER		2092	ERDC	August 11, 1923	October 14, 2014	3.4	8.19	105M14	202	55109	Mayo		
12785	PINOCHLE		3749	ERDC	September 11, 1919	October 29, 2014	20.7	51.26	105M14	22	16735	Mayo		
12871	WOLVERINE		3750	ERDC	November 13, 1919	October 30, 2014	19.2	47.21	105M14	24	16735	Mayo		
14168	MASTIFF		4087	ERDC	September 14, 1921	November 14, 2014	13.9	34.3	105M14	158	53801	Mayo		
14089	ARCTIC		4088	ERDC	July 26, 1921	December 19, 2014	20.7	51.65	105M14	157	53801	Mayo		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
14169	ETTA		4089	ERDC	September 14, 1921	December 19, 2014	15.2	37.67	105M14	192	55109	Mayo																		
YC02323	Hoito	1		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02324	Hoito	2		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02325	Hoito	3		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02326	Hoito	4		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02327	Hoito	5		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02328	Hoito	6		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02329	Hoito	7		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
YC02330	Hoito	8		ARCC	December 29, 1999	December 29, 2014			105M13			Mayo																		
14088	MIDWAY		4090	ERDC	July 26, 1921	December 30, 2014	20.7	51.65	105M14	185	55109	Mayo																		
14085	FIG TREE		4098	ERDC	July 25, 1921	January 8, 2015	14.5	35.49	105M14	186	55109	Mayo																		
14084	BIRMINGHAM		4096	ERDC	July 25, 1921	January 15, 2015	17.3	41.91	105M14	179	55109	Mayo																		
14087	HUXLEY		4097	ERDC	July 26, 1921	January 20, 2015	10.3	25.59	105M14	176	55109	Mayo																		
14086	ORANGE		4092	ERDC	July 25, 1921	January 21, 2015	21.2	51.65	105M14	178	55109	Mayo																		
14893	SPENCER		4093	ERDC	November 14, 1923	January 27, 2015	0.2	0.46	105M14	189	55109	Mayo																		
14883	DARWIN		4091	ERDC	October 18, 1923	January 28, 2015	3.5	8.57	105M14	188	55109	Mayo																		
14998	ATLANTIC		4094	ERDC	July 14, 1924	January 29, 2015	7.1	17.27	105M14	191	55109	Mayo																		
14999	PACIFIC		4095	ERDC	July 14, 1924	January 29, 2015	12.9	31.4	105M14	190	55109	Mayo																		
13133	HOMESTAKE		2113	ERDC	June 15, 1920	February 27, 2015	20.8	51.65	105M14	241	FB20919	Mayo																		
13367	WARRIOR		2114	ERDC	October 12, 1920	February 27, 2015	13.7	33.75	105M14	372	41356	Mayo																		
12803	SHAMROCK		2116	ERDC	October 8, 1919	April 28, 2015	20.9	51.65	105M14	232	55071	Mayo																		
14903	DIXIE		4110	ERDC	November 21, 1923	October 7, 2015	17.1	41.81	105M14	217	55107	Mayo																		
12829	MAPLE LEAF		4111	ERDC	October 23, 1919	October 15, 2015	18.2	45.32	105M14	235	55071	Mayo																		
12800	RENO		4112	ERDC	October 1, 1919	October 19, 2015	19.9	48.5	105M14	233	55071	Mayo																		
12812	KID		4109	ERDC	October 16, 1919	October 19, 2015	20.6	51.1	105M14	234	55071	Mayo																		
12830	LION		4108	ERDC	October 23, 1919	October 24, 2015	17.8	44.19	105M14	236	55071	Mayo																		
12807	TIGER		4107	ERDC	October 10, 1919	October 27, 2015	20.7	51.21	105M14	237	55071	Mayo																		
12919	MAYO		4113	ERDC	December 22, 1919	December 21, 2015	20.7	51.63	105M14	180	36699	Mayo																		
16561	ARIZONA		2132	ERDC	June 30, 1925	January 27, 2016	10	24.99	105M14	257	53837	Mayo																		
YB29002	Mary	1		ARCC	September 25, 1992	March 4, 2016			105M13			Mayo																		
YB29003	Mary	2		ARCC	September 25, 1992	March 4, 2016			105M13			Mayo																		
YB29394	Mary	6		ARCC	November 18, 1992	March 4, 2016			105M13			Mayo																		
YB64186	Lakehead	5		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64187	Lakehead	6		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64188	Lakehead	7		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64189	Lakehead	8		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64190	Lakehead	9		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64191	Lakehead	10		ARCC	June 28, 1995	March 4, 2016			105M13			Mayo																		
YB64192	Lakehead	3		ARCC	June 30, 1995	March 4, 2016			105M13			Mayo																		
YB64193	Lakehead	4		ARCC	June 30, 1995	March 4, 2016			105M13			Mayo																		
YB64194	Lakehead	11		ARCC	June 30, 1995	March 4, 2016			105M13			Mayo																		
YB64195	Lakehead	12		ARCC	June 30, 1995	March 4, 2016			105M13			Mayo																		
YB64196	Lakehead	13		ARCC	June 30, 1995	March 4, 2016			105M13			Mayo																		
16557	WESTON		2133	ERDC	June 18, 1925	March 7, 2016	14.5	35.46	105M14	201	55047	Mayo																		
16571	MINERVA		2134	ERDC	July 7, 1925	March 22, 2016	19.1	46.94	105M14	197	55047	Mayo																		
16040	MINERVA JR.		2135	ERDC	September 23, 1925	April 14, 2016	9.3	22.99	105M14	199	55047	Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
15236	MOHAWK		2136	ERDC	June 13, 1928	April 20, 2016	15.8	38.98	105M14	200	55047	Mayo																		
56506	HILL		2179	ERDC	November 28, 1947	May 23, 2016	1.6	3.74	105M13	329	40951	Mayo																		
13480	BLACK MAGGIE		2181	ERDC	October 13, 1920	September 3, 2016	3.7	9.17	105M14	800	41543	Mayo																		
38748	MAY		2180	ERDC	August 15, 1932	September 3, 2016	17.9	44.59	105M14	777	41542	Mayo																		
12937	MATHOLE		2138	ERDC	January 3, 1920	September 7, 2016	20.5	50.6	105M14	269	21508	Mayo																		
38643	FLAME		2139	ERDC	November 13, 1929	November 29, 2016	13.7	33.77	105M14	249	21508	Mayo																		
38642	MOTH		2140	ERDC	November 13, 1929	December 8, 2016	16.4	39.91	105M14	250	21508	Mayo																		
YC56129	K	102 F		ARCC	June 15, 2007	December 31, 2016	18		105M14			Mayo																		
14228	Dolly Varden		2194	ERDC	September 24, 1921	February 15, 2017	4.3	10.15	105M14	289	41270	Mayo																		
YB28942	Doug	1		ARCC	September 4, 1992	March 4, 2017			105M13			Mayo																		
YB28943	Doug	2		ARCC	September 4, 1992	March 4, 2017			105M13			Mayo																		
YB28944	Doug	3		ARCC	September 4, 1992	March 4, 2017			105M13			Mayo																		
YB28945	Doug	4		ARCC	September 4, 1992	March 4, 2017			105M13			Mayo																		
YB28998	Doug	5		ARCC	September 25, 1992	March 4, 2017			105M13			Mayo																		
YB28999	Doug	6		ARCC	September 25, 1992	March 4, 2017			105M13			Mayo																		
YB29000	Doug	7		ARCC	September 25, 1992	March 4, 2017			105M13			Mayo																		
YB29001	Doug	8		ARCC	September 25, 1992	March 4, 2017			105M13			Mayo																		
YB29395	Doug	9		ARCC	November 18, 1992	March 4, 2017			105M13			Mayo																		
YB29440	Jarret	1		ARCC	December 18, 1992	March 4, 2017			105M13			Mayo																		
15329	LITTLE FRACTION		2197	ERDC	May 16, 1929	March 8, 2017	0.6	1	105M13	210	55102	Mayo																		
15304	GREEN BACK		2195	ERDC	November 27, 1928	March 13, 2017	18.4	44.65	105M13	208	55102	Mayo																		
16556	KENO		2200	ERDC	June 18, 1925	March 21, 2017	17.6	41.61	105M14	203	55047	Mayo																		
15364	LINK		2196	ERDC	July 16, 1929	March 22, 2017	8.2	19.06	105M13	213	55102	Mayo																		
15365	WASP		2201	ERDC	July 11, 1929	March 27, 2017	5.7	13.89	105M13	209	55102	Mayo																		
16585	LUCKY		2198	ERDC	June 11, 1925	March 29, 2017	2.2	5.02	105M14	258	53796	Mayo																		
13454	BULL FROG		2199	ERDC	October 2, 1920	March 30, 2017	20.8	51.65	105M13	261	21254	Mayo																		
16523	ELSA		2202	ERDC	October 11, 1924	May 12, 2017	15.4	38.2	105M14	193	55047	Mayo																		
16524	JEAN		2203	ERDC	October 11, 1924	May 19, 2017	16.9	41.23	105M14	194	55047	Mayo																		
16552	LUCKY STRIKE		2204	ERDC	June 15, 1925	June 14, 2017	5.6	13.64	105M14	196	55047	Mayo																		
16553	PORCUPINE		2205	ERDC	June 15, 1925	June 20, 2017	16.9	41.93	105M14	195	55047	Mayo																		
84580	SURPLOMB	2	2228	ERDC	July 14, 1965	October 8, 2017	1.9	4.83	105M14	1175	53032	Mayo																		
84581	SURPLOMB	3	2229	ERDC	July 14, 1965	October 8, 2017	1.7	4.08	105M14	1172	53032	Mayo																		
84616	GLORIA FRACTION		2232	ERDC	August 24, 1965	October 8, 2017	6.1	15.53	105M14	1168	53032	Mayo																		
84617	REVENGE FRACTIO		2231	ERDC	August 24, 1965	October 8, 2017	5.8	14.35	105M14	1169	53032	Mayo																		
84626	JEAN FRACTIONAL		2230	ERDC	August 26, 1965	October 8, 2017	10.4	25.91	105M14	1174	53032	Mayo																		
84628	TESS		2233	ERDC	September 9, 1965	October 8, 2017	0.38	0.88	105M14	1176	53032	Mayo																		
55364	HELEN		2211	ERDC	October 25, 1945	November 1, 2017	15.5	37	105M14	797	41545	Mayo																		
59274	JUNE		2212	ERDC	June 22, 1949	November 1, 2017	0.75	1	105M14	803	41540	Mayo																		
14081	WHIPSAW		OM00011	ERDC	July 23, 1921	December 15, 2017	8.6	20.67	105M14	163	55050	Mayo																		
14327	EUREKA		2227	ERDC	October 11, 1921	December 15, 2017	9	22.5	105M14	164	55050	Mayo																		
16087	EXTENSION		2226	ERDC	November 24, 1925	December 15, 2017	15.4	38.01	105M14	173	55050	Mayo																		
16170	NOD FR.		2225	ERDC	July 13, 1926	December 15, 2017	0.85	2	105M14	461	41801	Mayo																		
38730	SILVER FR.		2223	ERDC	September 16, 1931	December 15, 2017	2.5	6.32	105M14	463	41801	Mayo																		
55120	CHANCE		2222	ERDC	November 28, 1938	December 15, 2017	14.4	35.43	105M14	464	41801	Mayo																		
55327	SAM		2221	ERDC	October 16, 1945	December 15, 2017	16.6	41.3	105M14	465	41801	Mayo																		
55333	DOE		2220	ERDC	October 16, 1945	December 15, 2017	1.7	3.94	105M14	466	41801	Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
55473	ENDYMION		2219	ERDC	January 23, 1947	December 15, 2017	18.3	34.61	105M14	742	41555	Mayo																		
55474	ARETHUSA		2218	ERDC	January 23, 1947	December 15, 2017	6.3	15.81	105M14	743	41555	Mayo																		
55475	ARTEMIS		OM00017	ERDC	January 23, 1947	December 15, 2017	17.1	41.52	105M14	744	41555	Mayo																		
55476	APOLLO		2216	ERDC	January 23, 1947	December 15, 2017	13.6	33.4	105M14	745	41555	Mayo																		
55477	ADONAI		2215	ERDC	January 24, 1947	December 15, 2017	13.1	32.23	105M14	747	41552	Mayo																		
55478	HESPERIDES		2214	ERDC	January 24, 1947	December 15, 2017	16.7	41.19	105M14	748	41552	Mayo																		
56443	APEX FR.		OM00022	ERDC	July 15, 1947	December 15, 2017	8.1	2.09	105M14	462	41791	Mayo																		
12870	FORAKER FRACTION		2207	ERDC	November 13, 1919	December 27, 2017	6.1	14	105M14	266	21677	Mayo																		
12873	PERRY FRACTIONAL		2206	ERDC	November 14, 1919	December 28, 2017	6.3	15.19	105M14	267	21677	Mayo																		
13169	ELSIE FRACTIONAL		2209	ERDC	June 18, 1920	January 8, 2018	3.1	7.92	105M14	271	21667	Mayo																		
38619	MCCARTHY FRACTION		2208	ERDC	September 19, 1929	January 8, 2018	1.1	1.82	105M14	272	21677	Mayo																		
2201	MABEL		OM00028	ERDC	March 17, 1913	February 15, 2018	18.8	45.91	105M13	16	15165	Mayo																		
16564	PAL OF MINE		OM00031	ERDC	June 30, 1925	May 28, 2018	17.4	42.68	105M14	270	55064	Mayo																		
13110	WHITEHORSE		OM00032	ERDC	June 10, 1920	August 5, 2018	6.6	16	105M14	888	42093	Mayo																		
13088	CHIEF	2	OM00038	ERDC	June 8, 1920	August 18, 2018	19.2	47.88	105M14	415	41758	Mayo																		
13089	CHIEF		OM00039	ERDC	June 8, 1920	August 18, 2018	21.2	52	105M14	416	41758	Mayo																		
13156	VERNA		OM00034	ERDC	June 17, 1920	August 18, 2018	20.7	51	105M14	413	41761	Mayo																		
14466	AJAX		OM00033	ERDC	December 7, 1921	August 18, 2018	14.6	47.53	105M14	166	55110	Mayo																		
15303	SWISS		OM00037	ERDC	October 26, 1928	August 18, 2018	19.2	47	105M14	412	41759	Mayo																		
38687	AUGUST		OM00036	ERDC	September 16, 1930	August 18, 2018	1.7	3	105M14	410	41759	Mayo																		
55024	KENO		OM00035	ERDC	October 30, 1936	August 18, 2018	16.8	42	105M14	411	41759	Mayo																		
59125	FRONTIER		OM00041	ERDC	November 13, 1948	January 6, 2019	14	not kwrf	105M14	421	41762	Mayo																		
10269	HAPPY		NM00011	ERDC	July 22, 1936	July 27, 2019	7.3	17.7	105M14	664	42735	Mayo																		
13025	NABOB		NM00012	ERDC	May 5, 1920	July 27, 2019	14	34.23	105M14	673	42735	Mayo																		
13027	TIN CAN		NM00007	ERDC	May 5, 1920	July 27, 2019	21.1	51.7	105M14	661	42735	Mayo																		
13069	SILVER HOARD		NM00013	ERDC	May 31, 1920	July 27, 2019	17.1	42.81	105M14	662	42735	Mayo																		
15366	JIGGYWIG		NM00008	ERDC	July 18, 1929	July 27, 2019	15.2	37.83	105M14	670	42735	Mayo																		
55065	TIPTOP		NM00010	ERDC	March 28, 1938	July 27, 2019	1.4	3.32	105M14	665	42735	Mayo																		
55214	SANTIAGO		NM00009	ERDC	February 23, 1942	July 27, 2019	13.7	33.9	105M14	671	42735	Mayo																		
55569	BARKY		NM00014	ERDC	February 17, 1947	July 27, 2019	3.8	8.89	105M14	674	42735	Mayo																		
59160	BLUE BIRD		NM00015	ERDC	November 22, 1948	July 27, 2019	20.2	50.07	105M14	667	42735	Mayo																		
59161	TREASURE ISLAND		NM00016	ERDC	November 22, 1948	July 27, 2019	16.4	40.28	105M14	668	42735	Mayo																		
59336	KAYE		NM00017	ERDC	July 19, 1949	July 27, 2019	8.5	37.8	105M14	672	42735	Mayo																		
59341	NANCE		NM00019	ERDC	July 19, 1949	July 27, 2019	14.4	35.71	105M14	666	42735	Mayo																		
59342	BETS		NM00018	ERDC	July 19, 1949	July 27, 2019	13.4	32.99	105M14	669	42735	Mayo																		
59518	BEN		NM00005	ERDC	November 1, 1949	July 27, 2019	19.3	46.87	105M14	663	42735	Mayo																		
59754	EILEEN		NM00020	ERDC	September 26, 1950	July 27, 2019	8.8	21.58	105M14	648	41524	Mayo																		
62131	METEOR		NM00006	ERDC	June 16, 1952	July 27, 2019	3.9	9.28	105M14	675	42735	Mayo																		
55421	COMPLEX		NM00023	ERDC	August 16, 1946	August 28, 2019	20.8	51.65	105M14	537	41866	Mayo																		
12876	FISHER		NM00022	ERDC	November 26, 1919	September 14, 2019	17.5	43.66	105M14	68	55052	Mayo																		
12878	CARIBOU		NM00021	ERDC	November 26, 1919	September 14, 2019	18	46.6	105M14	66	18253	Mayo																		
55495	LORNE		NM00025	ERDC	February 1, 1947	October 12, 2019	10.6	26.25	105M14	486	41795	Mayo																		
55497	MAYO		NM00027	ERDC	February 1, 1947	October 12, 2019	12.1	29.87	105M13	322	40961	Mayo																		
55499	DUPLEX		NM00026	ERDC	February 1, 1947	October 12, 2019	16.5	40.97	105M13	323	40961	Mayo																		
13060	KIDDO		NM00024	50% ERDC	May 11, 1920	November 11, 2019	5.6	13.53	105M14	705	42747	Mayo																		
16558	PUNCH		OM00040	ERDC	June 18, 1925	December 29, 2019	9.9	24.26	105M14	205	55047	Mayo																		

ALEXCO RESOURCE CORP.												KENO HILL - MCQUESTEN PROPERTIES												UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																
YB29004	Mary	3		ARCC	September 25, 1992	December 31, 2019			105M13			Mayo																
YB29005	Mary	4		ARCC	September 25, 1992	December 31, 2019			105M13			Mayo																
12961	LAST CHANCE		NM00028	ERDC	February 26, 1920	February 5, 2020	20.3	50.09	105M14	246	54073	Mayo																
14002	UPTON		NM00029	ERDC	June 25, 1921	February 5, 2020	14.2	34.76	105M14	245	54073	Mayo																
55480	CORA		NM00031	ERDC	January 24, 1947	February 11, 2020	20.7	51.26	105M14	496	41798	Mayo																
12965	LONE STAR		NM00030	ERDC	March 1, 1920	February 20, 2020	16.2	39.93	105M14	244	54073	Mayo																
12998	WALSH		NM00032	ERDC	April 17, 1920	February 28, 2020	15.8	38.43	105M14	247	54073	Mayo																
12880	NAPOLEON		NM00033	ERDC	November 28, 1919	March 13, 2020	10.8	26.6	105M14	116	53816	Mayo																
13058	BUNNY		NM00035	ERDC	May 11, 1920	April 25, 2020	13.9	34.46	105M14	806	42747	Mayo																
13072	HIGHLANDER		NM00034	ERDC	June 4, 1920	April 25, 2020	14.8	36.21	105M14	807	42747	Mayo																
59335	TIP TOP		NM00010	ERDC	July 19, 1949	May 15, 2020	16.4	39.97	105M14	571	41529	Mayo																
12915	SIWASH		NM00040	ERDC	December 19, 1919	August 13, 2020	16.7	41.82	105M14	98	18256	Mayo																
12970	CANADIAN		NM00041	ERDC	March 4, 1920	August 14, 2020	2	4.66	105M14	37	16982	Mayo																
16350	RING		NM00036	ARCC	August 27, 1927	August 19, 2020	5.7	14.16	105M14	493	41799	Mayo																
12877	EUREKA		NM00038	ERDC	November 26, 1919	August 20, 2020	16.2	39.41	105M14	92	18254	Mayo																
12819	MOOSE		NM00037	ERDC	October 20, 1919	August 21, 2020	19.9	48.2	105M14	927	42112	Mayo																
12879	MIRAMICHI		NM00039	ERDC	September 26, 1919	September 16, 2020	19	46	105M14	195	53778	Mayo																
13073	RAM		NM00042	ERDC	June 4, 1920	October 17, 2020	20.8	51.65	105M14	170	55050	Mayo																
12838	TUNDRA		NM00043	ERDC	October 27, 1919	November 1, 2020	20.7	51.65	105M14	152A	18946	Mayo																
13122	BLUE ROCK		NM00044	ERDC	June 12, 1920	November 14, 2020	18.6	46	105M14	775	41556	Mayo																
55269	LITTLE GIRL		NM00045	ERDC	November 9, 1943	November 14, 2020	7.2	17.87	105M14	802	42220	Mayo																
55315	DELIA		NM00046	ERDC	February 19, 1945	November 14, 2020	19.3	48.19	105M14	782	41564	Mayo																
55330	JIMMIE		NM00047	ERDC	October 16, 1945	November 14, 2020	19	46.48	105M14	786	41564	Mayo																
55341	ROBIN		NM00048	ERDC	October 17, 1945	November 14, 2020	15.8	38.03	105M14	776	41556	Mayo																
55385	MARMOT		NM00049	ERDC	October 26, 1945	November 14, 2020	19.4	48	105M14	789	41564	Mayo																
55386	GOPHER		NM00050	ERDC	October 26, 1945	November 14, 2020	6	15.25	105M14	783	41564	Mayo																
55387	REX		NM00051	ERDC	October 26, 1945	November 14, 2020	1.9	3.96	105M14	784	42220	Mayo																
55389	PORKY		NM00052	ERDC	October 26, 1945	November 14, 2020	20.7	51.62	105M14	788	41564	Mayo																
55427	JAY		NM00053	ERDC	August 19, 1946	November 14, 2020	19.2	46.72	105M14	785	41564	Mayo																
55428	HAY		NM00054	ERDC	August 19, 1946	November 14, 2020	20.3	50.57	105M14	787	41564	Mayo																
12845	FOX		NM00056	ERDC	October 28, 1919	March 11, 2021	19.4	48.2	105M14	93	18254	Mayo																
59765	CORA Fr	2	NM00055	ERDC	September 27, 1950	June 17, 2021	2.4	5.89	105M14	893	42101	Mayo																
56522	QUEST		NM00111	ARCC	June 8, 1948	June 19, 2021	22.8	56.37	105M14	492	41817	Mayo																
59273	QUILL		NM00112	ARCC	June 21, 1949	June 19, 2021	10.7	26.55	105M14	541	41872	Mayo																
13108	ANEROID		NM00058	ERDC	June 10, 1920	July 18, 2021	12.1	29.82	105M14	542	42156	Mayo																
13109	WATCH		NM00130	ERDC	June 10, 1920	July 18, 2021	16.9	41.96	105M14	543	42156	Mayo																
14446	BARKER Jr		NM00061	ERDC	December 1, 1921	July 24, 2021	20.5	51.39	105M14	408	41747	Mayo																
14884	BUDDY		NM00065	ERDC	October 22, 1923	July 24, 2021	16.5	40.18	105M14	404	41747	Mayo																
14885	TILLY		NM00069	ERDC	October 22, 1923	July 24, 2021	19.6	47.8	105M14	403	41747	Mayo																
15250	BOYLE		NM00063	ERDC	August 6, 1928	July 24, 2021	17.4	43	105M14	405	41747	Mayo																
38737	ETHEL		NM00066	ERDC	April 11, 1932	July 24, 2021	21.6	53.86	105M14	402	41747	Mayo																
56501	83		NM00059	ERDC	September 24, 1947	July 24, 2021	6.9	20	105M14	394	41739	Mayo																
56502	A.A.		NM00060	ERDC	September 24, 1947	July 24, 2021	1.1	2.66	105M14	396	41747	Mayo																
56524	BETTY		NM00062	ERDC	June 11, 1948	July 24, 2021	20.9	51.61	105M14	518	41870	Mayo																
56577	HOBO		NM00067	ERDC	August 3, 1948	July 24, 2021	21.2	51.75	105M14	400	41747	Mayo																
59026	BOYLE		NM00064	ERDC	September 13, 1948	July 24, 2021	1	2.28	105M14	406	41747	Mayo																

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
59027	SISTER		NM000068	ERDC	September 13, 1948	July 24, 2021	10.8	25.85	105M14	395	41747	Mayo																		
14092	WALL EYE		NM000081	ERDC	July 26, 1921	August 8, 2021	21.8	53.96	105M14	347	40962	Mayo																		
14095	WIGWAM		NM000082	ERDC	July 26, 1921	August 8, 2021	18.5	45.66	105M14	345	40962	Mayo																		
14216	SILVER SPOON		NM000079	ERDC	September 24, 1921	August 8, 2021	18.8	43.33	105M14	338	40952	Mayo																		
14219	LOUISE		NM000078	ERDC	September 24, 1921	August 8, 2021	18.6	45.8	105M14	336	40952	Mayo																		
14220	FRANK		NM000076	ERDC	September 24, 1921	August 8, 2021	20.9	51.65	105M14	337	40952	Mayo																		
14223	DREADNAUGHT		NM000071	ERDC	September 24, 1921	August 8, 2021	20	48.72	105M14	339	40952	Mayo																		
14229	LITTLE CHARLIE		NM000077	ERDC	September 24, 1921	August 8, 2021	10.4	25.73	105M14	341	40962	Mayo																		
16083	WINFRED		NM000083	ERDC	November 20, 1925	August 8, 2021	4.3	10.93	105M14	346	40962	Mayo																		
59013	ALICE		NM000070	ERDC	September 1, 1948	August 8, 2021	16.1	39.35	105M14	353	40952	Mayo																		
59293	SYLDIX		NM000080	ERDC	June 30, 1949	August 8, 2021	0.18	0.31	105M14	380	41740	Mayo																		
59296	ELINOR	1	NM000072	ERDC	June 30, 1949	August 8, 2021	19.6	48.93	105M14	445	41746	Mayo																		
59297	ELINOR	3	NM000074	ERDC	June 30, 1949	August 8, 2021	22.9	57.08	105M14	447	41746	Mayo																		
59298	ELINOR	4	NM000075	ERDC	June 30, 1949	August 8, 2021	21.2	51.65	105M14	448	41746	Mayo																		
59302	ELINOR	2	NM000073	ERDC	June 30, 1949	August 8, 2021	20.3	50.61	105M14	446	41746	Mayo																		
14090	SAXON		NM000091	ERDC	July 26, 1921	August 20, 2021	20.7	51.65	105M14	349	40962	Mayo																		
14093	PAGODA		NM000089	ERDC	July 26, 1921	August 20, 2021	18.5	45.4	105M14	350	40962	Mayo																		
14227	READY CASH		NM000090	ERDC	September 24, 1921	August 20, 2021	20.2	49.58	105M14	355	40958	Mayo																		
14231	WETT		NM000094	ERDC	September 24, 1921	August 20, 2021	19.9	48.71	105M14	342	40962	Mayo																		
15305	GRUB STAKE		NM000086	ERDC	November 27, 1928	August 20, 2021	0.77	1.91	105M14	354	40962	Mayo																		
16166	BUNNY		NM000084	ERDC	July 12, 1926	August 20, 2021	7	17.21	105M14	383	41741	Mayo																		
16496	EFFIE		NM000085	ERDC	August 28, 1924	August 20, 2021	15.4	38.18	105M14	226	55107	Mayo																		
16498	WINSOME		NM000095	ERDC	August 28, 1924	August 20, 2021	20.8	51.65	105M14	219	55107	Mayo																		
56419	KIJO		NM000088	ERDC	June 10, 1947	August 20, 2021	20.5	50.75	105M14	852	41891	Mayo																		
59315	HARDIX		NM000087	ERDC	July 13, 1949	August 20, 2021	1.1	2.55	105M14	381	41740	Mayo																		
56504	TOPOLO		NM000093	ERDC	September 26, 1947	August 22, 2021	15.1	37.62	105M14	853	41891	Mayo																		
56505	TOM BOY		NM000092	ERDC	October 10, 1947	August 22, 2021	20.6	51.63	105M14	854	41891	Mayo																		
56515	YUKON		NM000096	ERDC	April 19, 1948	August 22, 2021	12.1	28.95	105M14	851	41891	Mayo																		
13092	CHIEF	3	NM00103	ERDC	June 8, 1920	August 26, 2021	20.4	50.56	105M14	414	41758	Mayo																		
13721	STAURT		NM00108	ERDC	June 7, 1921	August 26, 2021	5.8	14.04	105M14	417	41737	Mayo																		
14445	BUSH		NM000099	ERDC	December 1, 1921	August 26, 2021	21.3	51.93	105M14	398	41767	Mayo																		
14816	GIBALTAR		NM00106	ERDC	April 13, 1923	August 26, 2021	8.2	20.29	105M14	439	41735	Mayo																		
14880	JUMBO		NM00107	ERDC	October 17, 1923	August 26, 2021	6	14.71	105M14	438	41735	Mayo																		
15306	BEAR		NM000097	ERDC	November 29, 1928	August 26, 2021	10.2	24.84	105M14	437	41768	Mayo																		
59120	CLIMBER		NM00105	ERDC	November 10, 1948	August 26, 2021	18.4	45.19	105M14	423	41893	Mayo																		
59420	CACHI	1	NM00100	ERDC	August 10, 1949	August 26, 2021	1.4	3.31	105M14	418	41766	Mayo																		
59421	CACHI	2	NM00101	ERDC	August 10, 1949	August 26, 2021	4.1	10.15	105M14	419	41766	Mayo																		
59422	CACHI	3	NM00102	ERDC	August 10, 1949	August 26, 2021	4.2	10.06	105M14	420	41766	Mayo																		
59474	BERRHOME		NM000098	ERDC	September 3, 1949	August 26, 2021	2.6	6.37	105M14	443	41757	Mayo																		
59475	CLIMBEAGLE		NM00104	ERDC	September 3, 1949	August 26, 2021	9.2	22.57	105M14	442	41893	Mayo																		
55048	BEE		NM00109	ERDC	October 29, 1937	August 28, 2021	2.8	6.92	105M14	387	41763	Mayo																		
59295	TIPTOE		NM00110	ERDC	June 30, 1949	August 29, 2021	13.9	34.78	105M14	440	41743	Mayo																		
55317	FROG		NM00132	ERDC	February 19, 1945	February 3, 2022	21.8	53.79	105M14	485	41783	Mayo																		
55496	WARREN		NM00131	ERDC	February 1, 1947	February 3, 2022	10.8	26.06	105M14	498	41803	Mayo																		
55581	JENBET		NM00133	ERDC	March 20, 1947	February 3, 2022	20.3	49.94	105M14	798	42217	Mayo																		
14225	ARNOLD		NM00134	ERDC	September 24, 1921	May 7, 2022	15.4	38.25	105M14	343	40962	Mayo																		

ALEXCO RESOURCE CORP.												KENO HILL - MCQUESTEN PROPERTIES												UPDATED: JANUARY 16, 2009					
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																	
55484	CANADA		NM00135	ERDC	January 24, 1947	May 7, 2022	14.1	34.75	105M14	340	40952	Mayo																	
59014	MARY L.		NM00136	ERDC	September 1, 1948	May 7, 2022	5.1	12.78	105M14	352	40952	Mayo																	
59030	HAVLOCK		NM00137	ERDC	September 17, 1948	May 7, 2022	21.6	53.72	105M14	401	41747	Mayo																	
59121	BERRMAC	1	NM00138	ERDC	November 10, 1948	May 7, 2022	1.8	4.4	105M14	433	41750	Mayo																	
59122	BERRMAC	2	NM00139	ERDC	November 10, 1948	May 7, 2022	14.7	36.47	105M14	434	41750	Mayo																	
59123	BERRMAC	3	NM00140	ERDC	November 10, 1948	May 7, 2022	5.6	13.82	105M14	435	41750	Mayo																	
59124	BERRMAC	4	NM00141	ERDC	November 10, 1948	May 7, 2022	22	54.28	105M14	436	41750	Mayo																	
59338	VALLEY		NM00142	ERDC	July 19, 1949	May 7, 2022	23.6	57.76	105M14	568	41529	Mayo																	
59476	BERNAT		NM00143	ERDC	September 3, 1949	May 7, 2022	6.1	14.83	105M14	444	41757	Mayo																	
38813	SPOT		NM00160	ERDC	November 12, 1934	June 2, 2022	19.6	48.69	105M14	923	42089	Mayo																	
55361	WANDERER		NM00161	ERDC	October 25, 1945	June 2, 2022	20.7	51.65	105M14	820	42700	Mayo																	
56574	CORA	2	NM00162	ERDC	July 21, 1948	June 2, 2022	0.28	0.76	105M14	497	42101	Mayo																	
38819	ASTORIA		NM00163	ERDC	November 19, 1934	June 12, 2022	12.4	30.38	105M14	315	40964	Mayo																	
38831	BILLYS		NM00164	ERDC	May 15, 1935	June 12, 2022	0.39	0.55	105M14	536	41873	Mayo																	
55312	MONTY		NM00165	ERDC	February 13, 1945	June 12, 2022	7.1	16.5	105M14	316	40955	Mayo																	
55561	PIRATE		NM00166	ERDC	February 17, 1947	June 12, 2022	3.4	8.06	105M13	318	40963	Mayo																	
55562	PIRATE	1	NM00167	ERDC	February 17, 1947	June 12, 2022	21.2	51.65	105M13	319	40963	Mayo																	
56566	OHIO		NM00168	ERDC	June 28, 1948	June 12, 2022	20.4	51.65	105M13	333	40960	Mayo																	
56567	INDIANA		NM00169	ERDC	June 28, 1948	June 12, 2022	19.9	49.17	105M13	334	40960	Mayo																	
56575	ACRE FRACTION		NM00170	ERDC	July 21, 1948	June 12, 2022	0.45	1.05	105M13	500	41878	Mayo																	
59041	BUCKEYE		NM00171	ERDC	September 21, 1948	June 12, 2022	7	17.41	105M13	499	41860	Mayo																	
59299	PIRATE EAST		NM00172	ERDC	June 30, 1949	June 12, 2022	3.8	9.63	105M13	362	41745	Mayo																	
13415	NORTH STAR		NM00173	ERDC	September 25, 1920	November 13, 2022	15.5	39.37	105M14	147	55056	Mayo																	
16393	ARGENTUM		NM00174	50% ERDC	February 25, 1928	November 16, 2022	16.4	40.88	105M14	819	55107	Mayo																	
12869	BLACK CAP		NM00175	ERDC	November 12, 1919	November 19, 2022	16	38.79	105M14	45	16982	Mayo																	
12931	SHEPHERD		NM00177	ERDC	December 31, 1919	November 19, 2022	17.3	42.95	105M14	46	16982	Mayo																	
59367	DE CHUCK		NM00176	ERDC	July 25, 1949	November 19, 2022	13.6	33.48	105M14	873	41863	Mayo																	
59294	PACSAX		NM00178	ERDC	June 30, 1949	December 29, 2022	2.4	5.95	105M14	441	41738	Mayo																	
12852	ORPHAN		NM00179	ERDC	October 31, 1919	January 18, 2023	10.2	25.37	105M14	35	16982	Mayo																	
15294	JEFFREY SPECIAL		NM00180	ERDC	September 28, 1928	February 2, 2023	2.5	6.14	105M14	532	41873	Mayo																	
15323	KLONDIKE		NM00181	ERDC	April 25, 1929	February 2, 2023	13.2	32.9	105M14	227	55107	Mayo																	
16313	THELMA		NM00182	ERDC	April 7, 1927	February 2, 2023	12.7	31.14	105M13	521	41859	Mayo																	
55029	PREMIER		NM00183	ERDC	February 15, 1937	February 2, 2023	15.9	38.87	105M13	335	40957	Mayo																	
55307	STANWIX		NM00184	ERDC	February 12, 1945	February 2, 2023	18.2	44.95	105M13	317	40956	Mayo																	
56500	WILD CAT		NM00185	ERDC	September 22, 1947	February 2, 2023	10.3	25.03	105M13	332	40959	Mayo																	
56581	OVERTIME	1	NM00187	ERDC	August 13, 1948	February 9, 2023	14.6	35.3	105M14	469	41804	Mayo																	
56582	OVERTIME	2	NM00188	ERDC	August 13, 1948	February 9, 2023	13.7	33.69	105M14	470	41804	Mayo																	
59542	BUNT		NM00186	ERDC	May 1, 1950	February 9, 2023	4.7	11.7	105M14	481	41786	Mayo																	
59543	BOB		NM00189	ERDC	May 1, 1950	February 9, 2023	6.9	17.39	105M14	482	41786	Mayo																	
59491	BOBBIE	7	NM00190	ERDC	September 6, 1949	February 12, 2023	6.4	17.32	105M14	740	42102	Mayo																	
59493	BOBBIE	9	NM00191	ERDC	September 6, 1949	February 12, 2023	7.6	18.84	105M14	741	42102	Mayo																	
59494	BOBBIE	10	NM00192	ERDC	September 6, 1949	February 12, 2023	10.6	25.93	105M14	921	42102	Mayo																	
16271	VAN KEUREN		NM00194	ERDC	October 23, 1926	February 22, 2023	12.6	30.5	105M14	487	41784	Mayo																	
13032	GALENA FARM		NM00193	ERDC	May 6, 1920	March 22, 2023	18.3	45.4	105M14	69	18253	Mayo																	
59373	BANKER		NM00195	ERDC	July 29, 1949	June 16, 2023	15.4	37.8	105M14	808	42674	Mayo																	
59374	BANKER	1	NM00196	ERDC	July 29, 1949	June 16, 2023	14.1	34.52	105M14	809	42674	Mayo																	

ALEXCO RESOURCE CORP.					KENO HILL - MCQUESTEN PROPERTIES					UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District		
59375	BANKER	2	NM00197	ERDC	July 29, 1949	June 16, 2023	14.5	35.67	105M14	810	42674	Mayo		
59376	BANKER	3	NM00198	ERDC	July 29, 1949	June 16, 2023	14.9	36.92	105M14	811	42674	Mayo		
59360	BLUE FOX	4	NM00203	ERDC	July 19, 1949	July 20, 2023	15.8	38.75	105M14	581	42665	Mayo		
59361	BLUE FOX	5	NM00204	ERDC	July 19, 1949	July 20, 2023	10.3	25.26	105M14	582	42665	Mayo		
59362	BLUE FOX	6	NM00205	ERDC	July 19, 1949	July 20, 2023	19.2	46.67	105M14	583	42665	Mayo		
59363	BLUE FOX	7	NM00206	ERDC	July 19, 1949	July 20, 2023	19.2	47.24	105M14	584	42665	Mayo		
59364	BLUE FOX	8	NM00207	ERDC	July 19, 1949	July 20, 2023	15	37.08	105M14	585	42665	Mayo		
59365	BLUE FOX	9	NM00208	ERDC	July 19, 1949	July 20, 2023	12.2	29.85	105M14	586	42665	Mayo		
59366	BLUE FOX	10	NM00209	ERDC	July 19, 1949	July 20, 2023	17.1	41.81	105M14	587	42665	Mayo		
59343	BLUE FOX	2	NM00202	ERDC	July 19, 1949	July 27, 2023	12.7	31.43	105M14	579	42665	Mayo		
59351	BLUE-FOX	1	NM00210	ERDC	July 19, 1949	July 27, 2023	1.5	3.49	105M14	578	42665	Mayo		
59359	BLUE FOX	3	NM00201	ERDC	July 19, 1949	July 27, 2023	7.6	18.6	105M14	580	42665	Mayo		
13009	SMILES			ARCC	April 28, 1920	July 29, 2023	20.2	49.46	105M14	491	41792	Mayo		
59692	DORA			ARCC	September 19, 1950	July 29, 2023	9.4	22.96	105M14	897	42094	Mayo		
55536	HUSKY			ERDC	February 12, 1947	August 10, 2023	6.5	16.06	105M13	302	40963	Mayo		
55537	HUSKY	1	NM00213	ERDC	February 12, 1947	August 10, 2023	21.2	51.13	105M13	303	40963	Mayo		
55538	HUSKY	2	NM00214	ERDC	February 12, 1947	August 10, 2023	20.4	48.32	105M13	305	40963	Mayo		
55539	HUSKY	3	NM00215	ERDC	October 22, 1946	August 10, 2023	20.5	50.74	105M13	306	40963	Mayo		
55540	HUSKY	4	NM00216	ERDC	October 22, 1946	August 10, 2023	12.3	30.28	105M13	307	40964	Mayo		
55541	HUSKY	5	NM00217	ERDC	October 22, 1946	August 10, 2023	20.4	50.81	105M13	308	40964	Mayo		
55542	HUSKY	6	NM00218	ERDC	October 22, 1946	August 10, 2023	4.2	10.23	105M13	309	40964	Mayo		
55543	HUSKY	7	NM00219	ERDC	October 22, 1946	August 10, 2023	20.9	51.49	105M13	310	40964	Mayo		
55544	HUSKY	8	NM00220	ERDC	February 12, 1947	August 10, 2023	2.7	6.25	105M14	311	40964	Mayo		
55545	HUSKY	9	NM00221	ERDC	October 22, 1946	August 10, 2023	15.4	38.16	105M13	312	40964	Mayo		
55546	HUSKY	10	NM00222	ERDC	February 13, 1947	August 10, 2023	3.6	9.13	105M14	313	40964	Mayo		
55547	HUSKY	11	NM00223	ERDC	October 22, 1946	August 10, 2023	12.9	30.9	105M13	314	40964	Mayo		
56576	HUSKY	12	NM00224	ERDC	July 21, 1948	August 10, 2023	15.3	38.01	105M13	320	40963	Mayo		
56592	HOLIDAY	1	NM00225	ERDC	August 23, 1948	August 22, 2023	4.9	12.01	105M13	358	41751	Mayo		
56593	HOLIDAY	2	NM00226	ERDC	August 23, 1948	August 22, 2023	4.9	12.37	105M13	359	41751	Mayo		
56594	HOLIDAY	3	NM00227	ERDC	August 23, 1948	August 22, 2023	3.7	9.08	105M13	360	41751	Mayo		
56595	HOLIDAY	4	NM00228	ERDC	August 23, 1948	August 22, 2023	6.2	14.75	105M13	361	41751	Mayo		
56597	HOLIDAY	7	NM00229	ERDC	August 23, 1948	August 22, 2023	19.6	47.98	105M13	363	41745	Mayo		
56598	HOLIDAY	8	NM00230	ERDC	August 23, 1948	August 22, 2023	10	24.63	105M13	364	41745	Mayo		
56599	HOLIDAY	9	NM00231	ERDC	August 23, 1948	August 22, 2023	2.3	5.14	105M13	365	41745	Mayo		
56600	HOLIDAY	10	NM00232	ERDC	August 23, 1948	August 22, 2023	7.8	19.16	105M13	366	41745	Mayo		
59001	HOLIDAY	11	NM00233	ERDC	August 23, 1948	August 22, 2023	14.3	35.28	105M13	367	41745	Mayo		
59002	HOLIDAY	12	NM00234	ERDC	August 23, 1948	August 22, 2023	16	39.19	105M13	368	41745	Mayo		
59003	HOLIDAY	13	NM00235	ERDC	August 23, 1948	August 22, 2023	18	44.1	105M13	369	41745	Mayo		
59004	HOLIDAY	14	NM00236	ERDC	August 23, 1948	August 22, 2023	20.7	51.1	105M13	370	41745	Mayo		
56559	POO FRACTION			ERDC	June 25, 1948	August 29, 2023	1.7	3.64	105M13	304	40963	Mayo		
59178	JESSIE	1	NM00237	ERDC	January 25, 1949	August 29, 2023	20.4	49.94	105M13	374	41754	Mayo		
59180	JESSIE	3	NM00238	ERDC	January 25, 1949	August 29, 2023	4.5	9.83	105M13	373	41754	Mayo		
55334	TAKU			ERDC	October 16, 1945	September 7, 2023	20	50.05	105M13	331	41026	Mayo		
13258	VANGUARD FRAC.			ARCC	July 28, 1920	September 13, 2023	14.6	36.34	105M14	184	FB20607	Mayo		
59436	SLOPE	2	NM00249	ERDC	August 19, 1949	December 19, 2023	8.4	20.64	105M14	750	41562	Mayo		
59457	SUDDO	1	NM00250	ERDC	August 19, 1949	December 19, 2023	21.4	53.43	105M14	751	41562	Mayo		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009					
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																			
59458	SUDDO	2	NM00251	ERDC	August 18, 1949	December 19, 2023	21.2	53.15	105M14	752	41562	Mayo																			
59459	SUDDO	3	NM00252	ERDC	August 19, 1949	December 19, 2023	22.7	55.95	105M14	753	41562	Mayo																			
59460	SUDDO	4	NM00253	ERDC	August 19, 1949	December 19, 2023	21.1	52.33	105M14	754	41562	Mayo																			
59461	SUDDO	5	NM00254	ERDC	August 19, 1949	December 19, 2023	24	59.48	105M14	755	41558	Mayo																			
59462	SUDDO	6	NM00255	ERDC	August 19, 1949	December 19, 2023	13.5	32.74	105M14	756	41558	Mayo																			
59463	SUDDO	7	NM00256	ERDC	August 19, 1949	December 19, 2023	21.8	54.08	105M14	757	41558	Mayo																			
59464	SUDDO	8	NM00257	ERDC	August 19, 1949	December 19, 2023	8.3	20.4	105M14	758	41558	Mayo																			
59465	SUDDO	9	NM00258	ERDC	August 19, 1949	December 19, 2023	23.7	58.16	105M14	759	42679	Mayo																			
59466	SUDDO	10	NM00259	ERDC	August 19, 1949	December 19, 2023	19.1	46.88	105M14	760	42679	Mayo																			
59467	SUDDO	11	NM00260	ERDC	August 19, 1949	December 19, 2023	21.5	53.48	105M14	761	41562	Mayo																			
55599	FRANCES	3	NM00261	ERDC	April 18, 1947	January 9, 2024	11.3	27.26	105M14	471	41778	Mayo																			
55600	FRANCES	4	NM00262	ERDC	April 18, 1947	January 9, 2024	20	49.81	105M14	472	41778	Mayo																			
56401	FRANCES	5	NM00263	ERDC	April 18, 1947	January 9, 2024	13.2	32.75	105M14	473	41778	Mayo																			
56402	FRANCES	6	NM00264	ERDC	April 18, 1947	January 9, 2024	4.4	10.65	105M14	474	41778	Mayo																			
56403	FRANCES	7	NM00265	ERDC	April 18, 1947	January 9, 2024	19.5	47.61	105M14	475	41778	Mayo																			
56404	FRANCES	8	NM00266	ERDC	April 18, 1947	January 9, 2024	4	10.03	105M14	476	41778	Mayo																			
59248	CAMEO		NM00267	ERDC	May 31, 1949	January 18, 2024	9.1	22.13	105M14	552	41529	Mayo																			
59249	CAMARRILA		NM00268	ERDC	May 31, 1949	January 18, 2024	10.3	25.34	105M14	553	41529	Mayo																			
59250	CAPSTAN		NM00269	ERDC	May 31, 1949	January 18, 2024	20.1	49.98	105M14	556	41529	Mayo																			
59253	DENTON		NM00270	ERDC	June 3, 1949	January 18, 2024	17.2	42.4	105M14	558	41522	Mayo																			
59255	MATTAGAMI		NM00271	ERDC	June 3, 1949	January 18, 2024	16.9	41.37	105M14	559	41529	Mayo																			
59385	INCA		NM00272	ERDC	July 29, 1949	January 18, 2024	5	12.25	105M14	577	41523	Mayo																			
14307	SYLVIA		NM00241	ERDC	October 6, 1921	February 28, 2024	20	50.33	105M14	294	55053	Mayo																			
15249	BRIDGETTE		NM00242	ERDC	August 6, 1928	February 28, 2024	20.9	51.28	105M14	278	55080	Mayo																			
15319	CALUMET	2	NM00243	ERDC	March 27, 1929	February 28, 2024	8.3	20	105M14	279	55080	Mayo																			
15331	"X"		NM00244	ERDC	May 30, 1929	February 28, 2024	0.62	1.53	105M14	285	55080	Mayo																			
16093	MAY G		NM00245	ERDC	December 7, 1925	February 28, 2024	18.6	46.64	105M14	291	55053	Mayo																			
16105	BETTY		NM00246	ERDC	January 20, 1926	February 28, 2024	16.5	40.53	105M14	292	55053	Mayo																			
16554	IKWOGGY		NM00247	ERDC	June 15, 1925	February 28, 2024	19.7	48.29	105M14	290	55053	Mayo																			
38720	HOBO		NM00248	ERDC	July 24, 1931	February 28, 2024	8.9	21.38	105M14	280	55080	Mayo																			
12817	GROUND HOG		NM00273	ERDC	October 20, 1919	April 18, 2024	21	51.65	105M14	794	42217	Mayo																			
12988	BRITANNIA		NM00274	ERDC	April 9, 1920	April 18, 2024	17.6	44.04	105M14	74	55113	Mayo																			
55365	BOKA		NM00275	ERDC	October 25, 1945	April 18, 2024	19.9	48.74	105M14	795	42104	Mayo																			
55573	ALICE		NM00276	ERDC	February 17, 1947	April 18, 2024	15.1	37.8	105M14	930	42099	Mayo																			
55577	DEVON		NM00277	ERDC	March 20, 1947	April 18, 2024	21.4	51.62	105M14	931	42107	Mayo																			
55579	KENO		NM00278	ERDC	March 20, 1947	April 18, 2024	13.9	34.76	105M14	545	41876	Mayo																			
59171	HONEYMOON	1	NM00279	ERDC	January 25, 1949	April 18, 2024	15.1	37.11	105M14	546	42104	Mayo																			
62282	CALF		NM00280	ERDC	October 2, 1952	April 18, 2024	0.87	1.86	105M14	932	42099	Mayo																			
15207	TICK		NM00281	ERDC	April 28, 1928	June 27, 2024	20.3	50.64	105M13	259	53387	Mayo																			
16375	VENTURE		NM00282	ERDC	October 18, 1927	June 27, 2024	20.7	51.67	105M13	356	40954	Mayo																			
55436	RAND		NM00283	ERDC	June 24, 1946	June 27, 2024	17.3	42.29	105M14	855	41920	Mayo																			
55442	LIME		NM00284	ERDC	July 30, 1946	June 27, 2024	13.1	32.38	105M14	856	41920	Mayo																			
59040	OXO		NM00285	ERDC	September 21, 1948	June 27, 2024	13.7	33.61	105M13	522	41879	Mayo																			
59177	KAY R.		NM00286	ERDC	January 25, 1949	June 27, 2024	10	24.86	105M13	371	41745	Mayo																			
59316	BRISTOL		NM00287	ERDC	July 19, 1949	June 27, 2024	1.5	3.53	105M14	560	41522	Mayo																			
62341	CAKE		NM00288	ERDC	November 20, 1953	June 27, 2024	14.5	35.83	105M14	989	50280	Mayo																			

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
62826	FILTER FRACTION		NM00289	ERDC	June 23, 1955	June 27, 2024	3.6	9.12	105M14	965	50268	Mayo																		
62339	ROCKET FRACTION		NM00291	ERDC	October 2, 1953	July 13, 2024	8.1	19.63	105M13	964	50268	Mayo																		
13114	CALUMET	1	NM00290	ERDC	June 11, 1920	August 15, 2024	20.9	51.65	105M14	240	FB20919	Mayo																		
55273	HUB		NM00298	ERDC	May 27, 1944	January 30, 2025	3.4	8.19	105M14	799	41539	Mayo																		
55500	PIL		NM00299	ERDC	February 1, 1947	January 30, 2025	3.3	7.89	105M14	1006	50420	Mayo																		
55501	LOVIE		NM00300	ERDC	February 1, 1947	January 30, 2025	13.2	32.6	105M14	489	41793	Mayo																		
55503	BUCONJO FRACTIO		NM00301	ERDC	February 1, 1947	January 31, 2025	1.3	3.22	105M13	328	40951	Mayo																		
55504	BUCONJO	1	NM00302	ERDC	February 1, 1947	January 31, 2025	20.8	51.65	105M13	327	40951	Mayo																		
55505	BUCONJO	2	NM00303	ERDC	February 1, 1947	January 31, 2025	20.8	50.24	105M13	326	40951	Mayo																		
55506	BUCONJO	3	NM00304	ERDC	February 1, 1947	January 31, 2025	21.2	51.51	105M13	501	41926	Mayo																		
55507	BUCONJO	4	NM00305	ERDC	February 1, 1947	January 31, 2025	1.2	2.57	105M13	330	40951	Mayo																		
55508	BUCONJO	5	NM00306	ERDC	February 1, 1947	January 31, 2025	13	31.77	105M13	502	41842	Mayo																		
55509	BUCONJO	6	NM00307	ERDC	February 1, 1947	January 31, 2025	20.9	51.66	105M13	503	41926	Mayo																		
55510	BUCONJO	7	NM00308	ERDC	February 1, 1947	January 31, 2025	21	52.03	105M13	504	41926	Mayo																		
55511	BUCONJO	8	NM00309	ERDC	February 3, 1947	January 31, 2025	20.5	49.67	105M13	505	41926	Mayo																		
55512	BUCONJO	9	NM00310	ERDC	February 3, 1947	January 31, 2025	19.2	47.34	105M13	325	40951	Mayo																		
55513	BUCONJO	10	NM00311	ERDC	February 3, 1947	January 31, 2025	5.4	13.41	105M13	324	40951	Mayo																		
55514	BUCONJO	11	NM00312	ERDC	February 3, 1947	January 31, 2025	19.4	48.48	105M13	321	40951	Mayo																		
55515	BUCONJO	12	NM00313	ERDC	February 3, 1947	January 31, 2025	18.7	45.55	105M13	506	41926	Mayo																		
55516	BUCONJO	13	NM00314	ERDC	February 3, 1947	January 31, 2025	20.1	49.18	105M13	507	41926	Mayo																		
55517	BUCONJO	14	NM00315	ERDC	February 3, 1947	January 31, 2025	20.9	51.66	105M13	508	41926	Mayo																		
55518	BUCONJO	15	NM00316	ERDC	February 3, 1947	January 31, 2025	11.2	27.37	105M13	509	41926	Mayo																		
62154	BUCONJO	16	NM00317	ERDC	July 2, 1952	January 31, 2025	3.1	7.84	105M13	531	41842	Mayo																		
2203	PATRICIA		NM00318	ERDC	April 8, 1913	February 1, 2025	20.1	50.34	105M13	286	22098	Mayo																		
62152	BUCK		NM00319	ERDC	July 2, 1952	February 1, 2025	1.7	3.64	105M13	510	41926	Mayo																		
62153	CON		NM00320	ERDC	July 2, 1952	February 1, 2025	1.1	2.39	105M13	511	41926	Mayo																		
56516	LOOS		NM00321	ERDC	April 21, 1948	February 2, 2025	6	14.71	105M14	490	50420	Mayo																		
55548	ACE-HI		NM00322	ERDC	February 13, 1947	February 8, 2025	0.1	0.22	105M14	835	41921	Mayo																		
55549	ACE-HI	1	NM00323	ERDC	February 13, 1947	February 8, 2025	20.1	49.89	105M14	836	41921	Mayo																		
55550	ACE-HI	2	NM00324	ERDC	February 13, 1947	February 8, 2025	20.2	50.27	105M14	837	41921	Mayo																		
55552	ACE-HI	4	NM00325	ERDC	February 14, 1947	February 8, 2025	20.8	51.63	105M14	839	41921	Mayo																		
55553	ACE-HI	5	NM00326	ERDC	February 14, 1947	February 8, 2025	6.6	16.05	105M14	840	41921	Mayo																		
55555	ACE-HI	6	NM00327	ERDC	February 14, 1947	February 8, 2025	20.4	51.4	105M14	841	41921	Mayo																		
55556	ACE-HI	7	NM00328	ERDC	February 14, 1947	February 8, 2025	3.7	8.54	105M14	842	41922	Mayo																		
55557	ACE-HI	8	NM00329	ERDC	February 14, 1947	February 8, 2025	19.9	49.61	105M14	843	41922	Mayo																		
55558	ACE-HI	9	NM00330	ERDC	February 14, 1947	February 8, 2025	2	4.44	105M14	844	41922	Mayo																		
55559	ACE-HI	10	NM00331	ERDC	February 14, 1947	February 8, 2025	20.4	50.85	105M14	845	41922	Mayo																		
55560	ACE-HI	11	NM00332	ERDC	February 14, 1947	February 8, 2025	2.6	6.17	105M14	846	41922	Mayo																		
55563	PIRATE	2	NM00333	ERDC	February 17, 1947	February 8, 2025	16.4	40.46	105M14	876	41921	Mayo																		
55564	PIRATE	3	NM00334	ERDC	February 17, 1947	February 15, 2025	17.4	43.22	105M14	877	41921	Mayo																		
55565	PIRATE	4	NM00335	ERDC	February 17, 1947	February 15, 2025	16.9	41.51	105M14	878	41921	Mayo																		
55566	PIRATE	5	NM00336	ERDC	February 17, 1947	February 15, 2025	15.7	38.46	105M14	879	41922	Mayo																		
55567	PIRATE	6	NM00337	ERDC	February 17, 1947	February 15, 2025	17.3	43.09	105M14	880	41922	Mayo																		
55568	PIRATE	7	NM00338	ERDC	February 17, 1947	February 15, 2025	16	38.58	105M14	881	41922	Mayo																		
62267	MORGAN		NM00339	ERDC	September 17, 1952	February 15, 2025	1.5	2.97	105M14	868	41922	Mayo																		
62268	DRAKE		NM00340	ERDC	September 17, 1952	February 15, 2025	5.2	12.59	105M14	867	41922	Mayo																		

ALEXCO RESOURCE CORP.												KENO HILL - MCQUESTEN PROPERTIES												UPDATED: JANUARY 16, 2009					
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																	
62269	QUEEN		NM00341	ERDC	September 17, 1952	February 15, 2025	4.1	10.25	105M14	848	41922	Mayo																	
62270	KING		NM00342	ERDC	September 17, 1952	February 15, 2025	1.9	4.6	105M14	869	41921	Mayo																	
62271	DUCE		NM00343	ERDC	September 17, 1952	February 15, 2025	3.6	8.3	105M14	890	41921	Mayo																	
62272	BLOOD		NM00344	ERDC	September 17, 1952	February 15, 2025	1.2	2.94	105M14	870	41921	Mayo																	
62281	TREY		NM00345	ERDC	October 2, 1952	February 15, 2025	0.84	1.67	105M14	838	41921	Mayo																	
55586	REX		NM00293	ARCC	March 28, 1947	February 23, 2025	16.4	40.59	105M14	1060	50901	Mayo																	
55587	CAIN		NM00294	ARCC	March 28, 1947	February 23, 2025	13.9	34.28	105M14	1057	50901	Mayo																	
55588	PRO		NM00295	ARCC	March 28, 1947	February 23, 2025	13.8	34.08	105M14	1058	50901	Mayo																	
55589	HORSESHOE		NM00296	ARCC	March 28, 1947	February 23, 2025	16.7	40.59	105M14	1061	50901	Mayo																	
55590	ABEL		NM00297	ARCC	March 28, 1947	February 23, 2025	16.2	39.43	105M14	1059	50901	Mayo																	
15264	KIM		NM00346	ERDC	August 10, 1928	March 30, 2025	7.2	17.44	105M14	384	41763	Mayo																	
16012	NORTH STAR		NM00347	ERDC	August 14, 1925	March 30, 2025	21.1	52.16	105M14	390	41755	Mayo																	
16026	EXTENSION		NM00348	ERDC	August 31, 1925	March 30, 2025	3.5	8.43	105M14	386	41756	Mayo																	
16499	PLATA		NM00349	ERDC	August 28, 1924	March 30, 2025	14.4	35.31	105M14	392	41755	Mayo																	
16588	EAGLE		NM00350	ERDC	July 23, 1925	March 30, 2025	12.7	42.82	105M14	221	55107	Mayo																	
16589	ARDELLE		NM00351	ERDC	July 23, 1925	March 30, 2025	19	46.39	105M14	220	55107	Mayo																	
56503	V.O.		NM00352	ERDC	September 24, 1947	March 30, 2025	7.9	19.13	105M14	393	41739	Mayo																	
56525	HARRIETT		NM00353	ERDC	June 14, 1948	March 30, 2025	21.1	51.58	105M14	399	41747	Mayo																	
56578	REX (F)		NM00354	ERDC	August 3, 1948	March 30, 2025	0.66	1.32	105M14	391	41756	Mayo																	
56591	EILEEN		NM00355	ERDC	August 20, 1948	March 30, 2025	17.1	42.46	105M14	385	41744	Mayo																	
62314	ZELMA	3	NM00356	ERDC	July 31, 1953	March 30, 2025	15.5	38.32	105M14	969	50270	Mayo																	
62315	ZELMA	4	NM00357	ERDC	July 31, 1953	March 30, 2025	11.7	28.78	105M14	970	50270	Mayo																	
62366	MOSSBACK		NM00358	ERDC	June 8, 1954	March 30, 2025	22.7	56.77	105M14	968	50270	Mayo																	
14990	NAETHING		NM00359	ERDC	July 9, 1924	April 12, 2025	21	51.74	105M14	388	41756	Mayo																	
12820	PEACH		NM00360	ERDC	October 20, 1919	April 30, 2025	20	48.89	105M14	889	42104	Mayo																	
12840	AJAX		NM00361	ERDC	October 28, 1919	April 30, 2025	19.2	47.53	105M14	793	42217	Mayo																	
14091	PASCO		NM00362	ERDC	July 26, 1921	April 30, 2025	21.9	53.99	105M14	348	40962	Mayo																	
14094	CORAL		NM00363	ERDC	July 26, 1921	April 30, 2025	18.7	46.12	105M14	344	40962	Mayo																	
55177	HARDWICK		NM00364	ERDC	December 19, 1940	April 30, 2025	18.3	45.48	105M14	382	41741	Mayo																	
55371	BINGO		NM00365	ERDC	October 25, 1945	April 30, 2025	19.7	48.96	105M14	796	42217	Mayo																	
55377	HOPE		NM00366	ERDC	October 26, 1945	April 30, 2025	15.5	38.63	105M14	887	42104	Mayo																	
59468	DUNCAN	1	NM00367	ERDC	August 19, 1949	April 30, 2025	14.3	34.8	105M14	710	41559	Mayo																	
59469	DUNCAN	2	NM00368	ERDC	August 19, 1949	April 30, 2025	13.2	32.96	105M14	711	41561	Mayo																	
59470	DUNCAN	3	NM00369	ERDC	August 19, 1949	April 30, 2025	16.8	40.94	105M14	712	41561	Mayo																	
62200	B & H		NM00370	ERDC	August 4, 1952	April 30, 2025	12.3	30.72	105M14	550	42104	Mayo																	
62316	ZELMA	5	NM00371	ERDC	July 31, 1953	April 30, 2025	8.6	20.86	105M14	971	50270	Mayo																	
13418	CUB		NM00372	ERDC	September 25, 1920	May 10, 2025	10	24.67	105M14	821	42700	Mayo																	
55326	IRENE		NM00373	ERDC	October 16, 1945	May 22, 2025	19.7	47.95	105M14	972	50274	Mayo																	
55332	MOSS		NM00374	ERDC	October 16, 1945	May 22, 2025	13.6	34.23	105M14	973	50274	Mayo																	
55525	U. N.		NM00375	ERDC	February 4, 1947	May 22, 2025	9.4	22.64	105M14	974	50274	Mayo																	
55526	ROSE		NM00376	ERDC	February 4, 1947	May 22, 2025	17	41.32	105M14	975	50274	Mayo																	
55527	FLY FRACTION		NM00377	ERDC	February 4, 1947	May 22, 2025	1.2	3.03	105M14	976	50274	Mayo																	
56417	WILD MAN		NM00378	ERDC	June 10, 1947	May 22, 2025	13.4	32.79	105M14	744	42216	Mayo																	
59172	HONEYMOON	2	NM00379	ERDC	January 25, 1949	May 22, 2025	11.7	28.56	105M14	935	42095	Mayo																	
59173	HONEYMOON	3	NM00380	ERDC	January 25, 1949	May 22, 2025	0.62	2.75	105M14	547	42097	Mayo																	
59174	HONEYMOON	4	NM00381	ERDC	January 25, 1949	May 22, 2025	14.2	34.75	105M14	548	42097	Mayo																	

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009												
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																										
59175	HONEYMOON	5	NM00382	ERDC	January 25, 1949	May 22, 2025	4.9	12.2	105M14	549	42097	Mayo																										
59176	HONEYMOON	6	NM00383	ERDC	January 25, 1949	May 22, 2025	10.9	26.09	105M14	929	42097	Mayo																										
59452	FALLS	16	NM00384	ERDC	August 19, 1949	May 22, 2025	4.5	10.95	105M14	728	42677	Mayo																										
59520	MARG		NM00385	ERDC	December 14, 1949	May 22, 2025	15.1	37.16	105M14	980	50270	Mayo																										
59670	EDITH-CAVELL	9	NM00386	ERDC	August 16, 1950	May 22, 2025	1.8	4.42	105M14	860	41895	Mayo																										
61209	HOBO	3	NM00387	ERDC	December 18, 1950	May 22, 2025	2.4	5.62	105M14	978	50274	Mayo																										
62297	MUD		NM00388	ERDC	November 5, 1952	May 22, 2025	20.9	51.65	105M13	1009	50346	Mayo																										
62298	MUD FR.		NM00389	ERDC	November 5, 1952	May 22, 2025	18.9	46.14	105M14	1010	50346	Mayo																										
62299	MUD	2	NM00390	ERDC	November 5, 1952	May 22, 2025	20.9	51.65	105M13	1008	50346	Mayo																										
62312	ZELMA	1	NM00391	ERDC	July 31, 1953	May 22, 2025	13	32.13	105M14	966	50272	Mayo																										
62313	ZELMA	2	NM00392	ERDC	July 31, 1953	May 22, 2025	11.9	29.11	105M14	967	50272	Mayo																										
12809	JEAN		NM00393	ERDC	October 10, 1919	June 12, 2025	21.4	51.6	105M14	539	41864	Mayo																										
12810	IVY		NM00394	ERDC	October 14, 1919	June 12, 2025	20.2	50.26	105M14	847	41896	Mayo																										
59528	RUTH		NM00395	ERDC	January 7, 1950	June 12, 2025	13.9	34.6	105M14	1020	50962	Mayo																										
59673	LOON		NM00396	ERDC	September 8, 1950	June 12, 2025	18.3	45.16	105M14	991	50282	Mayo																										
61733	DON FRACTION		NM00397	ERDC	July 19, 1951	June 12, 2025	0.16	0.4	105M14	992	50282	Mayo																										
61744	JACK		NM00398	ERDC	July 20, 1951	June 12, 2025	0.47	1.12	105M14	900	42092	Mayo																										
61919	JOY FRACTION		NM00399	ERDC	August 31, 1951	June 12, 2025	0.81	1.91	105M14	990	50282	Mayo																										
62051	LAMB FRACTION		NM00400	ERDC	November 7, 1951	June 12, 2025	2.9	7.09	105M14	993	50296	Mayo																										
62198	KARL		NM00401	ERDC	August 4, 1952	June 12, 2025	22.2	55	105M14	997	50288	Mayo																										
62199	RUBE		NM00402	ERDC	August 4, 1952	June 12, 2025	20.9	50.74	105M14	998	50288	Mayo																										
62236	CAT		NM00403	ERDC	August 27, 1952	June 12, 2025	9	22.76	105M14	891	41919	Mayo																										
62294	DOUBT		NM00404	ERDC	October 11, 1952	June 12, 2025	4.6	10.08	105M14	995	50288	Mayo																										
62309	RENO		NM00405	ERDC	July 15, 1952	June 12, 2025	2.2	5.33	105M14	983	50276	Mayo																										
62837	MINK FRACTION		NM00406	ERDC	August 3, 1955	June 12, 2025	19.5	48.58	105M14	999	50288	Mayo																										
59327	TALISMAN		NM00407	ERDC	July 19, 1949	June 19, 2025	10	24.93	105M14	604	41528	Mayo																										
12821	LIZZIE		NM00423	ERDC	October 20, 1919	November 26, 2025	20.7	51.64	105M14	54	55085	Mayo																										
12920	MINTO	2	NM00424	ERDC	December 22, 1919	November 26, 2025	4.7	11.76	105M14	238	55071	Mayo																										
14908	HELEN		NM00425	ERDC	November 27, 1923	November 26, 2025	3.5	8.71	105M14	407	41734	Mayo																										
15346	VIMY		NM00426	ERDC	June 21, 1929	November 26, 2025	6.2	15.21	105M14	1002	50292	Mayo																										
15374	NANCY		NM00427	ERDC	July 24, 1929	November 26, 2025	1.5	3.91	105M13	535	41873	Mayo																										
55309	SHAMROCK		NM00428	ERDC	February 12, 1945	November 26, 2025	5.1	12.59	105M14	928	42111	Mayo																										
55318	HENRY		NM00429	ERDC	February 19, 1945	November 26, 2025	20.7	51.04	105M14	484	41794	Mayo																										
55362	DIVIDE		NM00430	ERDC	October 25, 1945	November 26, 2025	15	36.94	105M14	544	42097	Mayo																										
55440	DOUGLAS		NM00431	ERDC	July 6, 1946	November 26, 2025	19	47.41	105M14	1018	50968	Mayo																										
55443	MONARCH		NM00432	ERDC	August 26, 1946	November 26, 2025	17.7	44.12	105M14	805	41548	Mayo																										
56405	LOUIS	1	NM00433	ERDC	April 18, 1947	November 26, 2025	21.5	53.62	105M14	477	41778	Mayo																										
56407	LOUIS	3	NM00434	ERDC	April 18, 1947	November 26, 2025	21.8	54.68	105M14	479	41778	Mayo																										
56408	LOUIS	4	NM00435	ERDC	April 18, 1947	November 26, 2025	21.8	54.7	105M14	480	41778	Mayo																										
56533	BES		NM00436	ERDC	June 23, 1948	November 26, 2025	17.4	42.8	105M14	858	56533	Mayo																										
56534	SEGLE		NM00437	ERDC	June 23, 1948	November 26, 2025	17.4	43.14	105M14	859	56534	Mayo																										
56573	MAYO		NM00438	ERDC	July 12, 1948	November 26, 2025	19.8	48.17	105M14	1019	50966	Mayo																										

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
56583	OVERTIME	13	NM00439	ERDC	August 13, 1948	November 26, 2025	21.4	52.59	105M14	449	41787	Mayo																		
56584	OVERTIME	14	NM00440	ERDC	August 13, 1948	November 26, 2025	21.5	52.52	105M14	450	41787	Mayo																		
56585	OVERTIME	15	NM00441	ERDC	August 13, 1948	November 26, 2025	21	51.62	105M14	451	41787	Mayo																		
56586	OVERTIME	16	NM00442	ERDC	August 13, 1948	November 26, 2025	20.7	51.49	105M14	452	41787	Mayo																		
59169	NEWLYWED	1	NM00443	ERDC	January 25, 1949	November 26, 2025	14.3	35.28	105M14	933	42678	Mayo																		
59170	NEWLYWED	2	NM00444	ERDC	January 25, 1949	November 26, 2025	15.1	36.68	105M14	934	42109	Mayo																		
59453	OVERTIME	17	NM00445	ERDC	August 19, 1949	November 26, 2025	20.5	51.1	105M14	707	41561	Mayo																		
59454	OVERTIME	18	NM00446	ERDC	August 19, 1949	November 26, 2025	20.8	51.23	105M14	706	41561	Mayo																		
59455	OVERTIME	19	NM00447	ERDC	August 19, 1949	November 26, 2025	17.6	43.53	105M14	708	41561	Mayo																		
59456	OVERTIME	20	NM00448	ERDC	August 19, 1949	November 26, 2025	17.9	43.48	105M14	709	41561	Mayo																		
59478	EDITH-CAVELL	1	NM00449	ERDC	September 6, 1949	November 26, 2025	15.2	38.33	105M14	729	41559	Mayo																		
59479	EDITH-CAVELL	2	NM00450	ERDC	September 6, 1949	November 26, 2025	10.7	26.03	105M14	730	41559	Mayo																		
59480	EDITH-CAVELL	3	NM00451	ERDC	September 6, 1949	November 26, 2025	18.2	44.27	105M14	731	41559	Mayo																		
59481	EDITH-CAVELL	4	NM00452	ERDC	September 6, 1949	November 26, 2025	18.9	46.6	105M14	732	41559	Mayo																		
59482	EDITH-CAVELL	5	NM00453	ERDC	September 6, 1949	November 26, 2025	15.1	36.78	105M14	733	41559	Mayo																		
59483	EDITH-CAVELL	6	NM00454	ERDC	September 6, 1949	November 26, 2025	14.2	35.46	105M14	734	41559	Mayo																		
59484	EDITH-CAVELL	7	NM00455	ERDC	September 6, 1949	November 26, 2025	19.4	48.26	105M14	735	41559	Mayo																		
59486	BOBBIE	2	NM00456	ERDC	September 6, 1949	November 26, 2025	14.4	35.2	105M14	737	41550	Mayo																		
59487	BOBBIE	3	NM00457	ERDC	September 6, 1949	November 26, 2025	2	5.02	105M14	738	41550	Mayo																		
59488	BOBBIE	4	NM00458	ERDC	September 6, 1949	November 26, 2025	16	39.93	105M14	739	41550	Mayo																		
59630	SOLO FRACTION		NM00459	ERDC	July 21, 1950	November 26, 2025	12.1	29.97	105M14	1001	50292	Mayo																		
59821	GRACE		NM00460	ERDC	October 2, 1950	November 26, 2025	1.7	3.94	105M14	1021	50968	Mayo																		
61596	ONEK		NM00461	ERDC	May 21, 1951	November 26, 2025	5.3	12.19	105M14	857	43000	Mayo																		
61908	EDBO		NM00462	ERDC	August 22, 1951	November 26, 2025	5.1	12.14	105M14	790	41550	Mayo																		
61909	EDBO	2	NM00463	ERDC	August 22, 1951	November 26, 2025	3.9	9.87	105M14	791	41550	Mayo																		
62202	MAGGIE		NM00464	ERDC	August 5, 1952	November 26, 2025	14.9	36.87	105M14	1022	50968	Mayo																		
62247	ERICA		NM00465	ERDC	September 5, 1952	November 26, 2025	15.5	38.77	105M14	885	41848	Mayo																		
62283	DIVORCE		NM00466	ERDC	October 2, 1952	November 26, 2025	8.3	19.84	105M14	994	50286	Mayo																		
62284	CITY		NM00467	ERDC	October 2, 1952	November 26, 2025	2.1	5.34	105M14	988	50278	Mayo																		
62295	KENT		NM00468	ERDC	October 11, 1952	November 26, 2025	1.8	4.4	105M14	996	50288	Mayo																		
62310	KID		NM00469	ERDC	July 15, 1953	November 26, 2025	0.99	2.49	105M14	981	50276	Mayo																		
62317	ALICE	1	NM00470	ERDC	August 5, 1953	November 26, 2025	11.6	25.25	105M14	986	50284	Mayo																		
62318	ALICE	2	NM00471	ERDC	August 5, 1953	November 26, 2025	11.8	29.06	105M14	987	50284	Mayo																		
62367	DAWSON		NM00472	ERDC	June 21, 1954	November 26, 2025	15.6	37.76	105M14	1023	50966	Mayo																		
62558	PRINCESS FRACTION		NM00473	ERDC	October 27, 1954	November 26, 2025	15	36.76	105M14	985	50276	Mayo																		
62944	FAIR FRACTION		NM00474	ERDC	January 6, 1956	November 26, 2025	7.4	18.22	105M14	1003	50294	Mayo																		
62945	WEATHER FRACTION		NM00475	ERDC	January 6, 1956	November 26, 2025	7.9	19.35	105M14	1004	50294	Mayo																		
62946	SNOW		NM00476	ERDC	February 10, 1956	November 26, 2025	5.1	12.44	105M14	1000	50290	Mayo																		
62962	ORCHID	15	NM00477	ERDC	May 30, 1956	November 26, 2025	21.1	51.6	105M13	1024	50958	Mayo																		
62963	ORCHID	16	NM00478	ERDC	May 30, 1956	November 26, 2025	21	51.65	105M13	1025	50958	Mayo																		
62972	ORCHID	25	NM00479	ERDC	May 30, 1956	November 26, 2025	15.4	38.09	105M13	1026	50958	Mayo																		
62973	ORCHID	26	NM00480	ERDC	May 30, 1956	November 26, 2025	20.5	51.64	105M14	1027	50962	Mayo																		
62974	ORCHID	27	NM00481	ERDC	May 30, 1956	November 26, 2025	20.7	51.59	105M14	1028	50962	Mayo																		

ALEXCO RESOURCE CORP.													KENO HILL - MCQUESTEN PROPERTIES													UPDATED: JANUARY 16, 2009				
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																		
62975	ORCHID	28	NM00482	ERDC	May 30, 1956	November 26, 2025	20.7	51.56	105M14	1029	50964	Mayo																		
62976	ORCHID	29	NM00483	ERDC	May 30, 1956	November 26, 2025	20.9	51.28	105M14	1030	50964	Mayo																		
80117	ORCHID	31	NM00484	ERDC	December 13, 1956	November 26, 2025	14.4	55.49	105M13	1031	50958	Mayo																		
80118	ORCHID	32	NM00485	ERDC	December 13, 1956	November 26, 2025	18.8	46.43	105M13	1032	50958	Mayo																		
80119	ORCHID	33	NM00486	ERDC	December 13, 1956	November 26, 2025	21.8	54.33	105M13	1033	50958	Mayo																		
80120	ORCHID	34	NM00487	ERDC	December 13, 1956	November 26, 2025	24	59.52	105M13	1034	50960	Mayo																		
80121	ORCHID	35	NM00488	ERDC	December 13, 1956	November 26, 2025	19.8	48.5	105M13	1035	50960	Mayo																		
80122	ORCHID	36	NM00489	ERDC	December 13, 1956	November 26, 2025	17.2	42.35	105M13	1036	50960	Mayo																		
80123	ORCHID	13	NM00490	ERDC	December 13, 1956	November 26, 2025	16.8	40.37	105M13	1037	50960	Mayo																		
80124	ORCHID	14	NM00491	ERDC	December 13, 1956	November 26, 2025	17.9	44.03	105M13	1038	50960	Mayo																		
80162	ORCHID	37	NM00492	ERDC	April 3, 1957	November 26, 2025	23.9	59.32	105M14	1039	50962	Mayo																		
80163	ORCHID	38	NM00493	ERDC	April 3, 1957	November 26, 2025	21	51.59	105M14	1040	50962	Mayo																		
80164	ORCHID	39	NM00494	ERDC	April 3, 1957	November 26, 2025	20.5	51.66	105M14	1041	50964	Mayo																		
80165	ORCHID	40	NM00495	ERDC	April 3, 1957	November 26, 2025	14.7	36.2	105M14	1042	50964	Mayo																		
80166	ORCHID	41	NM00496	ERDC	April 3, 1957	November 26, 2025	10.3	25.43	105M14	1043	50962	Mayo																		
80167	ORCHID	42	NM00497	ERDC	April 3, 1957	November 26, 2025	14.3	35.24	105M14	1044	50962	Mayo																		
80168	ORCHID	43	NM00498	ERDC	April 3, 1957	November 26, 2025	8.9	22.01	105M14	1045	50964	Mayo																		
80178	ALBERTA L		NM00499	ERDC	December 13, 1956	November 26, 2025	11.6	28.89	105M14	984	50276	Mayo																		
80179	ORCHID	30	NM00500	ERDC	May 10, 1957	November 26, 2025	23.1	57.05	105M13	1046	50960	Mayo																		
56529	MALCOM		NM00502	ARCC	June 14, 1948	November 28, 2025	7.6	18.76	105M14	540	41872	Mayo																		
14222	LILY		NM00501	ERDC	September 24, 1921	March 31, 2026	15.6	37.91	105M14	159	53801	Mayo																		
13035	STONE		NM00503	ERDC	May 6, 1920	November 1, 2026	20.2	49.65	105M14	146	55056	Mayo																		
38658	NOIDER		NM00504	ERDC	January 27, 1930	November 1, 2026	5.5	13.35	105M14	871	41865	Mayo																		
55270	V.D.		NM00505	ERDC	November 9, 1943	November 1, 2026	2.2	5.55	105M14	778	42220	Mayo																		
55308	PRINCE		NM00506	ERDC	February 12, 1945	November 1, 2026	18.4	45.35	105M14	982	50276	Mayo																		
55384	ROAD		NM00507	ERDC	October 26, 1945	November 1, 2026	5	12.26	105M14	779	42220	Mayo																		
56530	MARIE ELENA		NM00508	ERDC	June 17, 1948	November 1, 2026	10.8	26.87	105M14	850	41868	Mayo																		
59005	D.C.		NM00509	ERDC	August 26, 1948	November 1, 2026	0.14	0.3	105M14	780	42220	Mayo																		
59437	FALLS	1	NM00510	ERDC	August 19, 1949	November 1, 2026	19.6	48.32	105M14	713	41566	Mayo																		
59438	FALLS	2	NM00511	ERDC	August 19, 1949	November 1, 2026	21.1	51.66	105M14	714	41566	Mayo																		
59439	FALLS	3	NM00512	ERDC	August 19, 1949	November 1, 2026	17.7	43.01	105M14	715	41560	Mayo																		
59440	FALLS	4	NM00513	ERDC	August 19, 1949	November 1, 2026	21	51.59	105M14	716	41560	Mayo																		
59441	FALLS	5	NM00514	ERDC	August 19, 1949	November 1, 2026	15.1	37.59	105M14	717	41560	Mayo																		
59442	FALLS	6	NM00515	ERDC	August 19, 1949	November 1, 2026	21	51.31	105M14	718	41560	Mayo																		
59443	FALLS	7	NM00516	ERDC	August 19, 1949	November 1, 2026	0.53	1.24	105M14	719	41560	Mayo																		
59444	FALLS	8	NM00517	ERDC	August 19, 1949	November 1, 2026	14.9	36.46	105M14	720	41560	Mayo																		
59445	FALLS	9	NM00518	ERDC	August 19, 1949	November 1, 2026	21.4	52.86	105M14	721	41566	Mayo																		
59446	FALLS	10	NM00519	ERDC	August 19, 1949	November 1, 2026	20.8	50.74	105M14	722	41566	Mayo																		
59447	FALLS	11	NM00520	ERDC	August 19, 1949	November 1, 2026	21.2	52.16	105M14	723	41566	Mayo																		
59448	FALLS	12	NM00521	ERDC	August 19, 1949	November 1, 2026	20.6	50.68	105M14	724	41566	Mayo																		
59449	FALLS	13	NM00522	ERDC	August 19, 1949	November 1, 2026	21.9	52.68	105M14	725	41566	Mayo																		
59450	FALLS	14	NM00523	ERDC	August 19, 1949	November 1, 2026	19.8	49.01	105M14	726	41566	Mayo																		
59451	FALLS	15	NM00524	ERDC	August 19, 1949	November 1, 2026	20.7	50.79	105M14	727	41566	Mayo																		

ALEXCO RESOURCE CORP.												KENO HILL - MCQUESTEN PROPERTIES												UPDATED: JANUARY 16, 2009					
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																	
61725	FALLOT		NM00525	ERDC	July 16, 1951	November 1, 2026	19	47.21	105M14	746	41566	Mayo																	
62248	KARIN		NM00526	ERDC	September 5, 1952	November 1, 2026	8.9	21.68	105M14	886	41862	Mayo																	
80227	VENUS FRACTION	1	NM00527	ERDC	July 3, 1957	November 7, 2026	8.2	20.35	105M14	1052	51000	Mayo																	
80228	VENUS FRACTION	2	NM00528	ERDC	July 3, 1957	November 7, 2026	10.6	25.66	105M14	1053	51000	Mayo																	
55271	ROSEMARY		NM00529	ERDC	November 9, 1943	November 9, 2026	19.6	47.83	105M14	538	41861	Mayo																	
13542	OUTCAST FRACTION		NM00530	ERDC	October 25, 1920	November 18, 2026	3.5	8.59	105M14	483	41913	Mayo																	
13094	OK FRACTION		NM00556	ERDC	June 9, 1920	November 2, 2027	3.3	7.76	105M14	1120	52069	Mayo																	
13591	SCOT		NM00557	ERDC	February 18, 1921	November 2, 2027	12	29.72	105M14	1112	52068	Mayo																	
13709	ROY		NM00558	ERDC	May 28, 1921	November 2, 2027	9.4	23	105M14	1111	52068	Mayo																	
15393	DONNIE		NM00559	ERDC	August 26, 1929	November 2, 2027	1.7	4.03	105M14	1101	52061	Mayo																	
16097	DAVID		NM00531	ARCC	December 8, 1925	November 2, 2027	11.1	27.66	105M14	455	41797	Mayo																	
38723	VIOLA		NM00560	ERDC	August 14, 1931	November 2, 2027	2.9	7.05	105M14	1113	52068	Mayo																	
55022	RANDO		NM00561	ERDC	October 28, 1936	November 2, 2027	5.7	14.12	105M14	457	54073	Mayo																	
55206	PEARL		NM00562	ERDC	October 30, 1941	November 2, 2027	18.7	46.45	105M14	1119	52069	Mayo																	
55319	ELI		NM00563	ERDC	February 19, 1945	November 2, 2027	5.9	15.1	105M14	458	41796	Mayo																	
55420	GROESUS		NM00564	ERDC	May 27, 1946	November 2, 2027	12.9	31.69	105M14	849	41919	Mayo																	
55426	WILDCAT		NM00532	ARCC	June 3, 1946	November 2, 2027	5.4	13.12	105M14	762	41565	Mayo																	
55429	BALTO		NM00533	ARCC	June 6, 1946	November 2, 2027	21	51.61	105M14	763	41565	Mayo																	
55433	SUNRISE		NM00534	ARCC	June 20, 1946	November 2, 2027	12.9	31.84	105M14	764	41565	Mayo																	
55445	SOLOMAN		NM00535	ARCC	August 16, 1946	November 2, 2027	16	39.23	105M14	456	41797	Mayo																	
55446	SOL		NM00536	ARCC	August 21, 1946	November 2, 2027	18.7	45.97	105M14	467	41802	Mayo																	
55519	WILLOW		NM00537	ARCC	February 4, 1947	November 2, 2027	13.6	33.74	105M14	765	41565	Mayo																	
55520	THUNDER BIRD		NM00538	ARCC	February 4, 1947	November 2, 2027	14.5	35.66	105M14	766	41565	Mayo																	
55582	HECLA		NM00565	ERDC	March 20, 1947	November 2, 2027	10.3	25.18	105M14	894	42101	Mayo																	
55583	NIKKA		NM00566	ERDC	March 20, 1947	November 2, 2027	5	12.37	105M14	874	41874	Mayo																	
55585	DIXIE		NM00567	ERDC	March 20, 1947	November 2, 2027	5.9	14.46	105M14	875	41874	Mayo																	
55592	FOX		NM00539	ARCC	March 28, 1947	November 2, 2027	4.5	10.98	105M14	768	41565	Mayo																	
55593	GRETA		NM00540	ARCC	March 28, 1947	November 2, 2027	16.8	41.12	105M14	769	41565	Mayo																	
56590	MIKE		NM00568	ERDC	August 18, 1948	November 2, 2027	8.3	20.48	105M14	1116	52069	Mayo																	
59275	QUAIL		NM00541	ARCC	June 22, 1949	November 2, 2027	12.1	29.67	105M14	770	41565	Mayo																	
59387	PUEBLO		NM00569	ERDC	July 29, 1949	November 2, 2027	19.2	46.99	105M14	1102	52062	Mayo																	
59419	ELI	2	NM00570	ERDC	August 8, 1949	November 2, 2027	14.2	34.86	105M14	459	41800	Mayo																	
59519	EVY		NM00542	ARCC	November 30, 1949	November 2, 2027	12.2	30.22	105M14	767	41565	Mayo																	
59534	BUNKER		NM00543	ARCC	April 1, 1950	November 2, 2027	12.9	31.98	105M14	915	42086	Mayo																	
59535	BUNKER NO.	1	NM00544	ARCC	April 1, 1950	November 2, 2027	10.2	25.1	105M14	916	42086	Mayo																	
59645	DAISY FRACTION		NM00545	ARCC	July 22, 1950	November 2, 2027	6.8	16.57	105M14	468	41797	Mayo																	
59683	ROCK		NM00546	ARCC	September 19, 1950	November 2, 2027	20.9	51.59	105M14	896	42101	Mayo																	
59764	MIKE		NM00571	ERDC	September 26, 1950	November 2, 2027	15.1	37.68	105M14	892	42101	Mayo																	
59795	BUCKO		NM00572	ERDC	October 2, 1950	November 2, 2027	12.8	31.35	105M14	895	42101	Mayo																	
59796	CHARITY		NM00573	ERDC	October 2, 1950	November 2, 2027	5.5	12.26	105M14	898	42101	Mayo																	
59824	QUAIL FRACTION		NM00547	ARCC	October 2, 1950	November 2, 2027	4.4	10.38	105M14	771	41565	Mayo																	
59932	DUDE		NM00548	ARCC	October 11, 1950	November 2, 2027	4.7	11.31	105M14	772	41565	Mayo																	
61021	DOT		NM00574	ERDC	October 27, 1950	November 2, 2027	0.1	0.17	105M14	1118	52069	Mayo																	
61598	JIB NO.	2	NM00549	ARCC	May 25, 1951	November 2, 2027	3	7.06	105M14	773	41565	Mayo																	
61599	DON FRACTION		NM00550	ARCC	May 25, 1951	November 2, 2027	1.9	4.21	105M14	863	41877	Mayo																	
61600	GROUSE		NM00551	ARCC	May 25, 1951	November 2, 2027	1.8	4.2	105M14	864	41877	Mayo																	

ALEXCO RESOURCE CORP.												KENO HILL - MCQUESTEN PROPERTIES												UPDATED: JANUARY 16, 2009					
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District																	
61601	TARM		NM00552	ARCC	May 25, 1951	November 2, 2027	1.8	4.26	105M14	781	41547	Mayo																	
61877	FOX		NM00553	ARCC	August 15, 1951	November 2, 2027	3.6	8.52	105M14	749	41565	Mayo																	
61916	EVY		NM00554	ARCC	August 29, 1951	November 2, 2027	1.2	2.89	105M14	899	42101	Mayo																	
61976	ROZ FRACTION		NM00575	ERDC	September 19, 1951	November 2, 2027	5.1	12.5	105M14	804	42220	Mayo																	
62132	AGRAM		NM00555	ARCC	June 17, 1952	November 2, 2027	2.7	6.71	105M14	866	41854	Mayo																	
62235	NM		NM00576	ERDC	August 27, 1952	November 2, 2027	2.9	7.39	105M14	1117	52069	Mayo																	
80346	INCA FRACTION		NM00577	ERDC	April 30, 1959	November 2, 2027	15.5	38.88	105M14	1007	50298	Mayo																	
80347	FILL		NM00578	ERDC	June 10, 1959	November 2, 2027	20.4	50.63	105M14	1047	50966	Mayo																	
80357	HAP		NM00579	ERDC	July 21, 1959	November 2, 2027	3.4	8.34	105M14	1048	50966	Mayo																	
80358	CLOSURE		NM00580	ERDC	July 21, 1959	November 2, 2027	9.8	23.04	105M14	1049	50966	Mayo																	
80359	FINAL		NM00581	ERDC	July 21, 1959	November 2, 2027	10.9	26.62	105M14	1050	50966	Mayo																	
80360	OBOE		NM00582	ERDC	July 22, 1959	November 2, 2027	2.7	6.8	105M14	979	50274	Mayo																	
80361	GNAT		NM00583	ERDC	July 22, 1959	November 2, 2027	0.392	0.9	105M14	977	50274	Mayo																	
80517	GAIL FRACTION		NM00584	ERDC	August 4, 1960	November 2, 2027	5.4	13.09	105M14	1106	52064	Mayo																	
80518	WREN FRACTION		NM00585	ERDC	August 4, 1960	November 2, 2027	2.7	6.61	105M14	1107	52064	Mayo																	
80561	KANGAROO FRACTION		NM00586	ERDC	October 25, 1960	November 2, 2027	15.6	38.19	105M14	1109	52066	Mayo																	
81139	JEFFY FRACTION		NM00587	ERDC	May 31, 1962	November 2, 2027	3.5	8.93	105M14	1125	52072	Mayo																	
81228	JENNY FRACTION		NM00588	ERDC	June 28, 1962	November 2, 2027	1.5	3.67	105M14	1123	52071	Mayo																	
82289	LITE FRACTION		NM00589	ERDC	August 7, 1962	November 2, 2027	2.1	5.08	105M14	1105	52063	Mayo																	
83003	JENNY TOO FRACT		NM00590	ERDC	June 12, 1963	November 2, 2027	18.7	46.04	105M14	1124	52071	Mayo																	
83004	NIP FRACTION		NM00591	ERDC	June 12, 1963	November 2, 2027	6.3	14.83	105M14	1121	52070	Mayo																	
83010	NORTH FRACTION		NM00592	ERDC	June 25, 1963	November 2, 2027	6.4	3.67	105M14	1122	52070	Mayo																	
83011	ADAM FRACTION		NM00593	ERDC	July 9, 1963	November 2, 2027	0.85	2.09	105M14	1103	52062	Mayo																	
83012	CATHY FRACTION		NM00594	ERDC	July 9, 1963	November 2, 2027	3	7.07	105M14	1104	52062	Mayo																	
83023	STONE FRACTION		NM00595	ERDC	July 16, 1963	November 2, 2027	3	7.38	105M14	1114	52068	Mayo																	
56406	LOUIS	2	NM00596	ERDC	April 18, 1947	November 26, 2027	10.4	25.84	105M14	478	41778	Mayo																	
59485	EDITH-CAVELL	8	NM00597	ERDC	September 6, 1949	November 26, 2027	6.6	16.4	105M14	736	41559	Mayo																	
56473	CORA		NM00601	ERDC	August 25, 1947	July 22, 2028	1.2	2	105M14	872	41877	Mayo																	
62723	UK	1	NM00606	ERDC	March 29, 1955	April 30, 2029	20.9	51.55	105M14	1127	52865	Mayo																	
62724	UK	2	NM00607	ERDC	March 29, 1955	April 30, 2029	19.5	48.35	105M14	1128	52865	Mayo																	
62729	UK	7	NM00608	ERDC	March 29, 1955	April 30, 2029	20.9	51.65	105M14	1133	52865	Mayo																	
62730	UK	8	NM00609	ERDC	March 29, 1955	April 30, 2029	15.1	37.97	105M14	1134	52865	Mayo																	
62735	UK	13	NM00610	ERDC	March 29, 1955	April 30, 2029	12	29.43	105M14	1139	52865	Mayo																	
62736	UK	14	NM00611	ERDC	March 29, 1955	April 30, 2029	19.6	47.75	105M14	1140	52865	Mayo																	
62835	UK	15	NM00612	ERDC	July 8, 1955	April 30, 2029	20.2	49.76	105M14	1141	52865	Mayo																	
62836	UK	16	NM00613	ERDC	July 8, 1955	April 30, 2029	23.1	56.47	105M14	1142	52865	Mayo																	
13558	LADUE		NM00603	ERDC	November 5, 1920	July 7, 2029	7.6	18.13	105M14	108	55064	Mayo																	
14332	TRIANGLE		NM00604	ERDC	October 18, 1921	July 11, 2029	0.3	0.09	105M14	100	55064	Mayo																	
14404	WILLIAM FOURTH		NM00605	ERDC	November 5, 1921	July 11, 2029	0.11	0.26	105M14	125	55064	Mayo																	
55479	IDOL		NM00602	ERDC	January 24, 1947	July 22, 2029	19.1	47.02	105M14	495	41798	Mayo																	
62992	JUNE		NM00614	ERDC	July 11, 1956	August 21, 2029	5.8	14.29	105M14	1170	53032	Mayo																	
13182	POCA PLATA		NM00615	ERDC	June 21, 1920	September 30, 2029	14.8	36.81	105M14	107	55064	Mayo																	
13019	LOTUS		3360	ERDC	May 4, 1920	November 25, 2029	17.8	43.63	105M14	104	55064	Mayo																	
16204	THISTLE		3354	ERDC	August 12, 1926	December 3, 2029	18.3	45.83	105M14	177	55096	Mayo																	
13093	CHIEF	4	3365	ERDC	June 9, 1920	December 6, 2029	18.6	46.09	105M14	295	55080	Mayo																	
38857	M.T.		3361	ERDC	October 1, 1935	December 6, 2029	3.4	8.2	105M13	281	55080	Mayo																	

ALEXCO RESOURCE CORP.				KENO HILL - MCQUESTEN PROPERTIES						UPDATED: JANUARY 16, 2009			
Grant	Claim Name	Nbr	Lease	Owner	Record Date	Expiry Date	Hectares	Acres	NTS	Lot	Survey No.	District	
38873	NEIN		3366	ERDC	December 4, 1935	December 6, 2029	1.4	2.89	105M14	284	55080	Mayo	
38882	SLIVER		3363	ERDC	March 31, 1936	December 6, 2029	1.7	5.9	105M14	283	55080	Mayo	
55039	SIS		3362	ERDC	September 3, 1937	December 6, 2029	4.3	10.27	105M14	296	41801	Mayo	
55091	IKE		3364	ERDC	August 12, 1938	December 6, 2029	3.4	8.76	105M14	293	55053	Mayo	
12814	MINTO		3355	ERDC	August 17, 1919	December 16, 2029	18.7	46.44	105M14	49	18252	Mayo	
13038	SADIE		3358	ERDC	May 6, 1920	December 17, 2029	17.6	43.68	105M14	101	18256	Mayo	
13222	LAKOTA		3356	ERDC	July 9, 1920	December 29, 2029	3.3	8.27	105M14	110	55064	Mayo	
13151	BLUE STONE		3357	ERDC	June 16, 1920	December 31, 2029	11.9	29.35	105M14	105	55064	Mayo	
13586	LUNA		3359	ERDC	November 12, 1920	December 31, 2029	4.1	10.05	105M14	111	55064	Mayo	



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX B
REVIEW OF HISTORIC KENO STATIC TEST DATA TO
DEFINE ARD/ML - CONTROLLING AND CORRELATING FACTORS**

January 2008

Prepared by: Altura Environmental Consultants



To: Dan Cornett, Rob McIntyre, Access Consulting Group
From: Diane Lister
Date: January 4, 2008
RE: **Review of Historic Keno Static Test Data to Define ARD/ML – Controlling and Correlating Factors**

1. Scope

Review static test data of 1996 Keno Hill site-wide waste rock characterization sampling that were analysed in 2006 for standard ICP multi-elements, acid base accounting, and leachate extraction. Objective is to identify any geochemical parameters that are controlling or are strongly correlated with generation of net acidity and/or Zn or Pb leaching. This purpose of this review is to provide a tool to assist in prediction of ARD/ML in any future development in the Keno Hill area, and to provide a basis for field classification of potentially reactive material during excavation.

2. Background

This study examines analyses carried out on 47 samples of dump and pit material from various sites at the Keno Hill Mine site in central Yukon. Sampling was conducted in 1996 using a backhoe to collect approximately 60 kg of rock per site, and duplicated locations sampled in 1995 and reported in the Keno Hill Mines Site Characterization Study (Access Mining Consultants, 1996).

Samples were labelled and sealed in plastic pails, and stored until 2006, when they were retrieved, their condition verified, and submitted to ALS Chemex Labs in North Vancouver for analysis.

Samples were analysed via 27-element ICP-AES with aqua regia digestion (including sulphur), modified acid-base accounting including sulphate via both sodium carbonate leach and HCl digestion, total inorganic carbon via coulometer, and paste pH at a 1:1 solids to water ratio. Twenty-four hour shake flask extractions were performed using a 3:1 water to solids ratio, and the filtrate analysed for pH and 33-element dissolved metals.

Data were compiled and for statistical analysis purposes, results above or below limits of detection were assigned a value equal to the respective detection limit. Metal loading in mg/kg was calculated by multiplying leachate concentration by the dilution factor of 3:1, and percent extraction by dividing the metal loading by its respective solids concentration in ppm. The zone and lithology of each sample was added to the database, based on the sample description information.

3. *Details of Analysis*

This review consisted of four phases:

- i) conduct general review of data and generate of statistical summaries;
- ii) identify reactive samples in dataset;
- iii) analyse data for trends and database criteria that appear to control or correlate strongly with sample reactivity, and that can be used to isolate reactive samples; and
- iv) check of criteria against the database to determine over or under-filtering.

3.1. *Summary of Data*

All analytical data is given in Appendix A1, and comprehensive summary statistics in Appendix A2. Statistics for acid base accounting and selected trace element parameters are given in Tables 1 and 2.

Samples show a range of geochemical characteristics, with paste pH ranging from 3.2 to 8.7, and a median value of 7.2. Total sulphur concentrations in solids is low to moderately elevated, ranging from detection-limit levels of 0.01% to 1.93%, with a median of 0.17%. Carbonate tends to be somewhat low with a median of 0.5%, with samples typically ranging up to 4 percent. Two outliers of 6.7% and 13.4%CO₂ occur in samples of quartzite and vein respectively. Neutralization potential (NP) tends to be low (median of 7 kg CaCO₃/t), with samples of more than 0.5% CO₂ tending to have NP's in 10 to 70 kg CaCO₃/t range.

An average of 40% of sulphur is in the soluble form of sulphate. Other elements with elevated soluble fraction are Ca, Co, Cd, Mn, and Zn (averaging 11%, 11%, 9%, 6% and 5% respectively).

Appendix A6 shows statistical box and whisker plots of key ABA and ICP parameters by lithology. The various lithologies show similar tendencies, however schist lithology samples tend to show the lowest paste pH in the dataset, while quartzite samples show the broadest range of sulphur (<0.01 to 2 percent).

Table 1. Summary Statistics of of Acid Base Accounting Parameters

Statistic	Paste pH	Fizz Rating	Total S (%)	Sulphate via Carbonate Leach (%)		Sulphate via HCl Leach (%)	Sulphide, Calculated (%)	Maximum Potential Acidity (kgCaCO ₃ /t)	Neutralization Potential (kgCaCO ₃ /t)	Net Neutralization Potential : Maximum Potential Acidity	Inorganic Carbon (%)	CO ₂ , Calculated (%)
No. of observations	47	47	47	47	47	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	3.2	1	0.01	0.01	0.01	0.01	0.01	0.3	-5.0	-0.26	0.05	0.20
Maximum	8.7	3	1.93	0.45	0.46	0.46	1.48	60.3	308.0	54.40	3.64	13.40
Median	7.2	1	0.17	0.02	0.03	0.03	0.06	5.3	7.0	2.29	0.06	0.20
Mean	6.9	1.6	0.35	0.11	0.11	0.11	0.24	10.9	23.9	4.93	0.33	1.23
Standard deviation	1.2	0.8	0.46	0.14	0.13	0.13	0.36	14.3	48.1	8.51	0.60	2.22
Geometric mean	6.8	1.5	0.12	0.04	0.05	0.05	0.08	3.7			0.13	0.52
Geometric standard deviation	1.2	1.6	5.16	4.29	4.31	4.31	5.04	5.2			3.42	3.31

Table 2. Summary Statistics of Selected Trace Element Parameters

Trace Element Composition via ICP-AES							
Statistic	Ag (ppm)	As (ppm)	Ca (%)	Fe (%)	Pb (ppm)	S (%)	Zn (ppm)
No. of observations	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0
Minimum	1	5	0.02	0.45	18	0.01	57
Maximum	100	944	8.32	14.05	10000	2.00	10000
Median	20	85	0.15	2.81	896	0.17	489
Mean	37	219	0.64	3.37	2653	0.36	1731
Standard deviation (n)	39	248	1.36	2.66	3500	0.48	2655
Geometric mean	13	107	0.17	2.62	753	0.12	642
Geometric standard deviation	6	4	5.05	2.06	7	5.27	4

Soluble Loading (mg product in leachate per kilogram of solid)							
Statistic	Ag	As	Ca	Fe	Pb	S ¹	Zn
No. of observations	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0
Minimum	0.00003	0.0004	2.2	0.090	0.001	0.01	0.012
Maximum	0.014	4.2	1644	1854	48.9	0.45	867
Median	0.0005	0.003	96.9	0.09	0.11	0.02	0.32
Mean	0.0017	0.117	380.3	60.9	1.99	0.11	70.6
Standard deviation (n)	0.003	0.609	521.8	280.7	7.17	0.14	209.0
Geometric mean	0.001	0.006	77.2	0.29	0.12	0.04	0.9
Geometric standard deviation	4.923	6.272	8.6	12.5	13.73	4.29	26.2

Soluble Fraction (mass ratio of product product in leachate : product in solid, as percent)							
Statistic	Ag	As	Ca	Fe	Pb	S ¹	Zn
No. of observations	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0
Minimum	0.0%	0.0%	0.0%	0.0%	0.0%	3%	0.0%
Maximum	0.8%	5.1%	50.6%	10.1%	1.5%	100%	87.7%
Median	0.0%	0.0%	4.5%	0.0%	0.0%	33%	0.0%
Mean	0.0%	0.1%	11.2%	0.4%	0.1%	44%	5.2%
Standard deviation (n)	0.1%	0.7%	13.7%	1.6%	0.2%	29%	14.6%
Geometric mean	0.0%	0.0%	4.5%	0.0%	0.0%	34%	0.1%
Geometric standard deviation	5.44	8.92	4.85	15.02	7.01	226	18.05

¹ Calculated based on total sulphur via Leco furnace and sulphate via carbonate leach extraction.

3.2. Identifying Reactive Samples in Dataset

The leachate extraction dataset was examined to determine levels of leachate pH, Zn loading and Pb loading that serve to divide the “reactive” (those generating net acidity and/or Pb or Zn leaching) from non-reactive samples. Frequency distribution curves (histograms and cumulative distributions) were utilized.

Net Acidity. A leachate pH criteria ≤ 5.5 is selected to differentiate those samples generating net acidity. Histogram and cumulative distribution plots for leachate pH are shown in Figure 1. As seen, two very distinct populations are present: i) 5 acidic samples ranging in pH from 2.61 to 3.78; and ii) 41 weakly acidic to weakly alkaline samples ranging in pH from 5.74 to 7.87. Only one sample, at pH 4.99, lies between the two groups. A pH value of 5.5 isolates the larger, essentially non-reactive group, and conservatively assigns any between-population pH results to the acidic category.

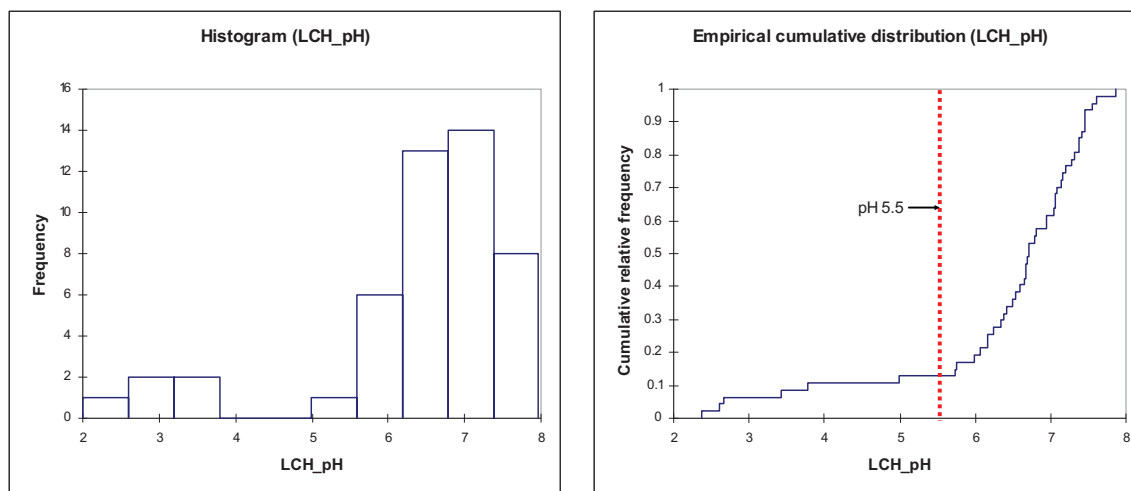


Figure 1. Frequency Distribution of Leachate pH and Selected Criteria

Metal Leaching. Criteria of 10 mg/kg Zn and 3 mg/kg Pb were selected based on the logarithmic distribution plots shown in Figures 2 and 3. For Pb, a horizontal inflection between $10^{0.087}$ and $10^{0.511}$ (1 to 3 mg/kg Pb) indicates a division between populations. Hence a 3 mg/kg Pb value would better serve to differentiate the lesser from the elevated loadings. In the case of Zn, the cumulative distribution curve demonstrates more uniform population than that of Pb, but nonetheless with a plateau in the cumulative curve between $10^{0.498}$ and $10^{1.044}$ (3 and 11 mg/kg Zn). Thus a value of 10 mg/kg Zn is selected distinguishes the elevated loadings in the dataset.

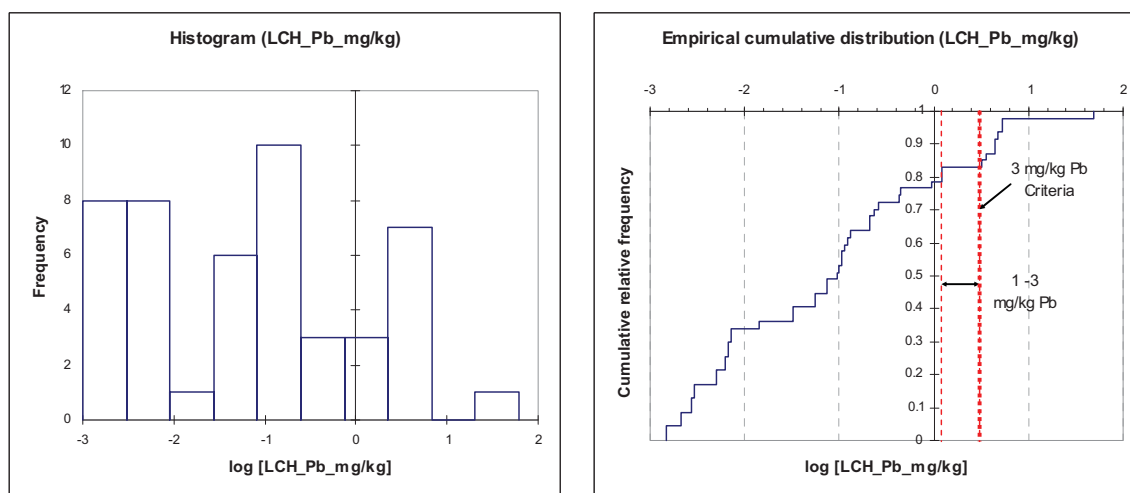


Figure 2. Frequency Distribution of Pb Loading and Selected Criteria

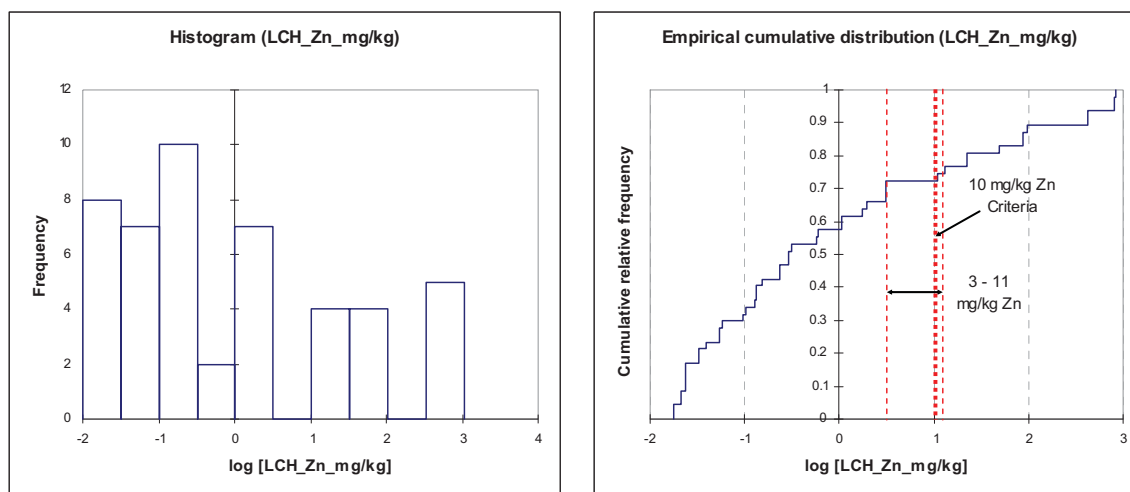


Figure 3. Frequency Distribution of Zn Loading and Selected Criteria

Tables 3 and 4 summarize the breakdown of reactive samples by rock type, and by zones sampled.

Of the 47 samples, 17 (36%) meet one or more of the “reactive” criteria, with 6 of the 17 being net acidic, 13 zinc-leaching, and 8 lead-leaching. The quartzite units sampled showed the highest proportion of reactive samples (46%), followed by mixed quartzite and schist (40%), and vein (25%). Pit wall samples appear to store less soluble products, (none of the pit wall samples were reactive), likely a function of the more exposed environment relative to a waste rock dump with limited infiltration and transport of solutes.

Table 3. Summary of 2006 Leachate Extraction Results by Major Rock Type

Zone	Database Code	Total # of Samples	# Non-Reactive	# Reactive	% of Samples Reactive	Leachate Extraction Characteristics (# of Samples)		
						Leachate pH ≤ 5.5	Zn load ≥ 10 mg/kg	Pb Load ≥ 3 mg/kg
All		47	30	17	36%	6	13	8
Mixed Quartzite & Schist	02	5	3	2	40%	1	2	1
Schist	10	10	8	2	20%	1	2	0
Quartzite	20	26	14	12	46%	4	8	6
Greenstone	30	1	1	0	0%	0	0	0
Vein	40	4	3	1	25%	0	1	1
Unspecified	01	1	1	0	0%	0	0	0

Table 4. Summary of 2006 Leachate Extraction Results by Zone

Zone	Sample Type	Total # of Samples	# Non-Reactive	# Reactive	% of Samples Reactive	Leachate Extraction Characteristics (# of Samples)		
						Leachate pH ≤ 5.5	Zn load ≥ 10 mg/kg	Pb Load ≥ 3 mg/kg
All		47	30	17	36%	6	13	8
Bellekeno Adit	Dump	1	1	0	0%	0	0	0
Birmingham Pit	Pit Wall	6	6	0	0%	0	0	0
Birmingham Pit	Dump	6	5	1	17%	0	1	1
Calumet 1-15 Pit	Pit Wall	2	2	0	0%	0	0	0
Calumet 1-15 Pit	Dump	3	0	3	100%	0	0	3
Dixie Adit	Dump	3	0	3	100%	3	3	0
Galkeno 900	Unspecified	1	0	1	100%	1	1	0
Hector Adit	Dump	3	0	3	100%	0	3	1
Hector Pit	Dump	1	0	1	100%	0	0	1
Husky SW	Dump	1	0	1	100%	1	1	0
Keno 700 Adit	Dump	2	2	0	0%	0	0	0
Miller Pit	Dump	1	1	0	0%	0	0	0
ONEK pit	Pit Wall	1	1	0	0%	0	0	0
ONEK pit	Dump	4	4	0	0%	0	0	0
Ruby Adit	Dump	3	3	1	33%	0	1	1
SIME 35 pit	Pit Wall	2	2	0	0%	0	0	0
SIME 4&6 pit	Dump	1	1	0	0%	0	0	0
SIME 4 pit	Pit Wall	1	1	0	0%	0	0	0
SIME 6 pit	Pit Wall	2	2	0	0%	0	0	0
Silver King Pit	Dump	1	0	1	100%	1	1	0
Townsite Adit	Dump	2	0	2	100%	0	2	1
UN Adit	Dump	1	1	0	0%	0	0	0

3.3. Key Controlling and Correlating Factors for Sample Reactivity

Parameters which are either readily available in an exploration database, or are easily measured in the field were examined to identify any factors potentially controlling net acidity and/or metal dissolution. Based on the information provided with the 47 samples for this review, these ‘eligible’ parameters include multi-element analyses via ICP, and the sample’s ‘fizz’ rating (effervescence reaction of sample to dilute hydrochloric acid). Of this suite, the examination then focussed on those parameters which either demonstrate high mobility in the leachate extraction tests (specifically Ca, Cd, Co, Mg, and Zn) or are obviously anomalously elevated in the rock (Pb and Zn).

Key findings are summarized in the following text and illustrated by graphs.

As shown in Table 2, Ca showed the highest water soluble fraction during the leachate extraction tests relative to its ICP value in the rock, with a median calculated percent extraction of 4.5% (average of 11%). Values ranged from less than 1 to just over 50%. Other elements demonstrating a lesser, but notable water-soluble fraction were Cd, Co, Mg, and Zn (see Table 2 for Zn, and Appendix A4 for remaining elements).

The six samples yielding acidic leachate demonstrate a relatively wide range of sulphur values (0.28% to 1.25%), indicating a relatively low sulphur “cutoff” value under certain conditions. As is commonly observed in other deposits, calcium appears to influence the manifestation of net acidity – in the case of the Keno Hill samples the extraction data indicates that samples with leachate pH less than 3 show between 44 to 50% of total Ca in soluble form. Samples with leachate pH between 3.4 and 6.6 show intermediate values. Thus, it is likely that dissolution of Ca is occurring in response to localized acid generating reactions.

When Ca and S geochemistry of the 47 samples is plotted on a simple x-y graph, all samples with leachate pH less than 5.5 fall within a quadrant defined by $S > 0.25\%$ and $Ca < 0.51\%$ (see Figure 4), demonstrating that for this dataset, this criteria pair serves as a ‘net acidity’ threshold.

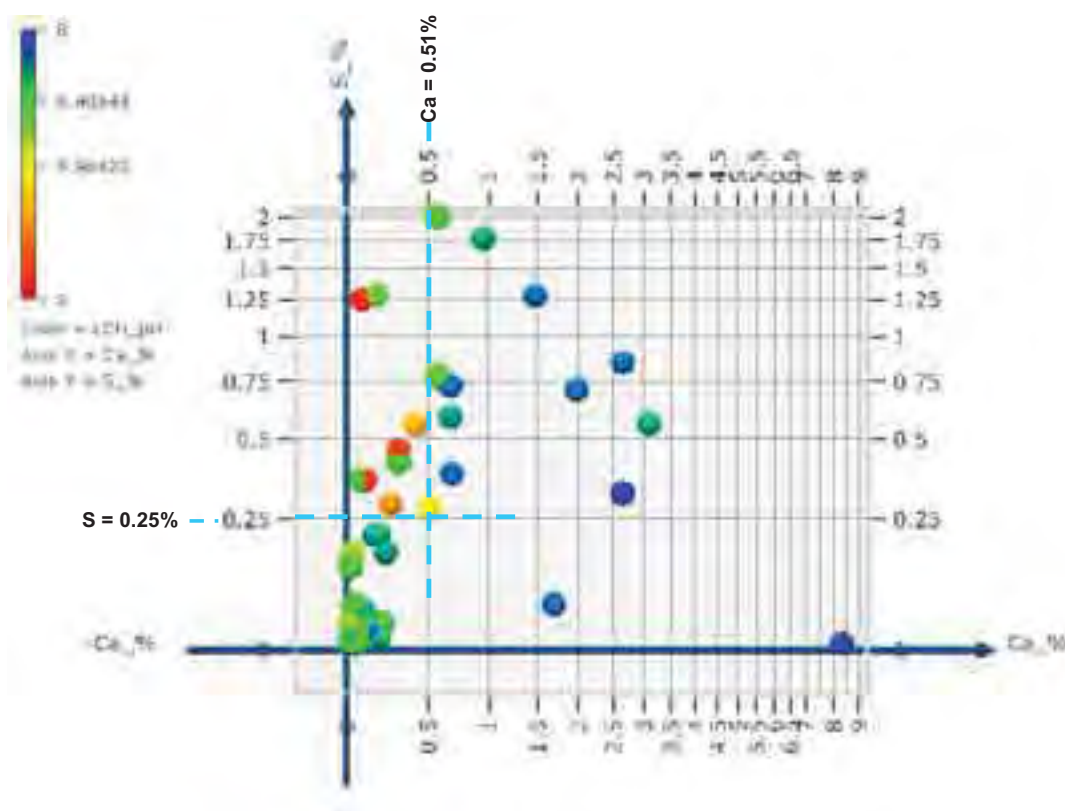


Figure 4. Ca vs. S in rock analyses. Note that low pH leachate samples (shown as yellow, orange and red data points) are clustered in a quadrant defined by $S > 0.25\%$ and $Ca < 0.51\%$.

The mobility of Zn appears to be controlled by two mechanisms, as shown in Figures 5 and 6:

- i) due to the increased mobility of Zn with decreasing pH, many of the samples with elevated Zn loading also fall within the 'net acidity' quadrant defined by $S > 0.25\%$ and $Ca < 0.51\%$. Thus, most samples with net acidity also demonstrate elevated Zn dissolution;
- ii) samples with anomalous Zn in the rock geochemistry (eg. > 5000 ppm Zn) tend to show elevated dissolution of Zn.

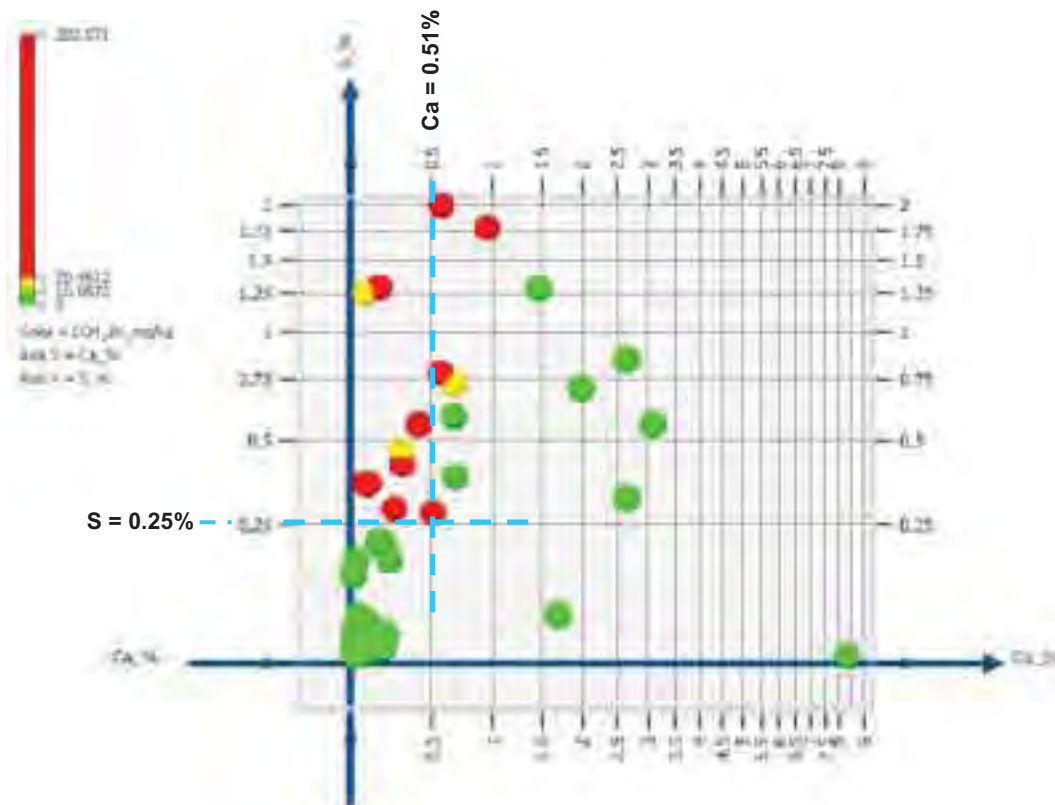


Figure 5. Ca vs. S in rock analyses. Note that many of the 13 elevated Zn loading samples (shown as yellow and red data points) are within the same quadrant occupied by the low leachate pH samples; see also Figure 4.

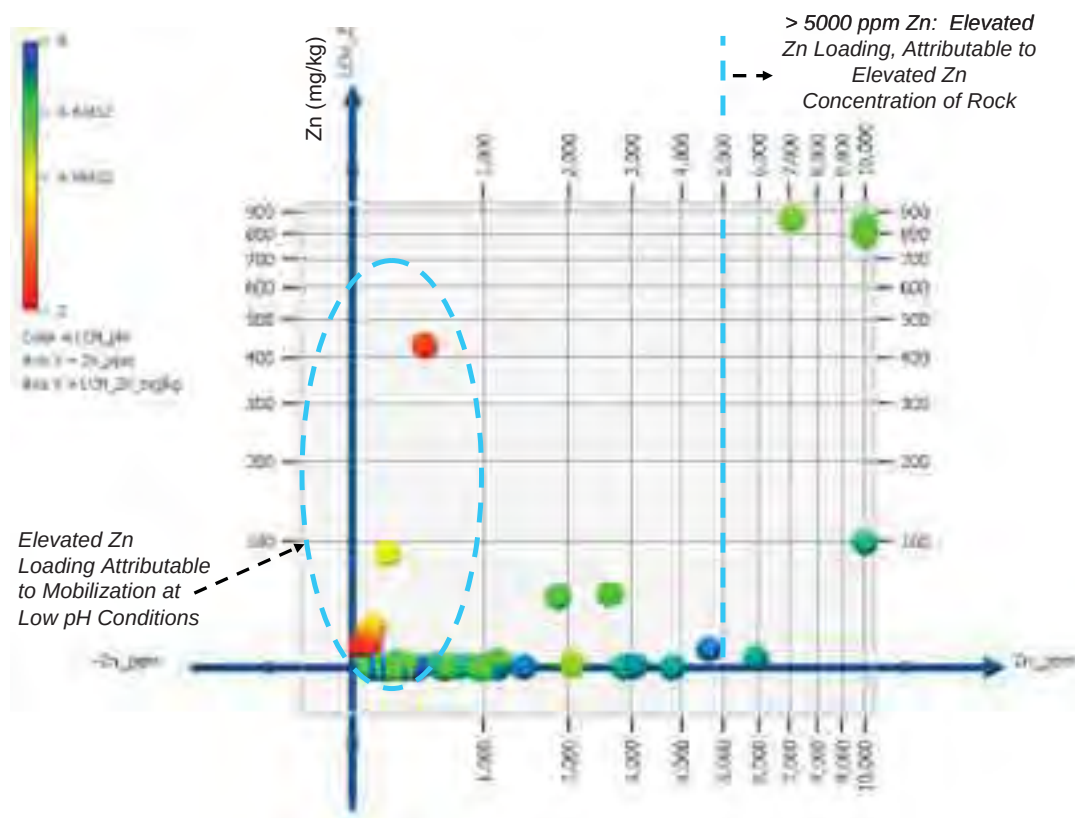


Figure 6. Zn in rock vs. Zn dissolution. Note the two apparent mechanisms for Zn dissolution:
 1) low pH conditions (as shown by the red, yellow and orange data points), and 2) elevated Zn in rock.

Occurrences of elevated Pb dissolution is less frequent in the dataset than that of Zn (8 of the 47 samples showing ≥ 3 mg/kg) and appears to be purely a function of concentration of Pb in the rock, as shown in Figure 7. A threshold of 5000 ppm appears to segregate the samples with dissolution ≥ 3 mg/kg. Due to solubility constraints Pb dissolution occurs only at neutral to alkaline pH conditions.

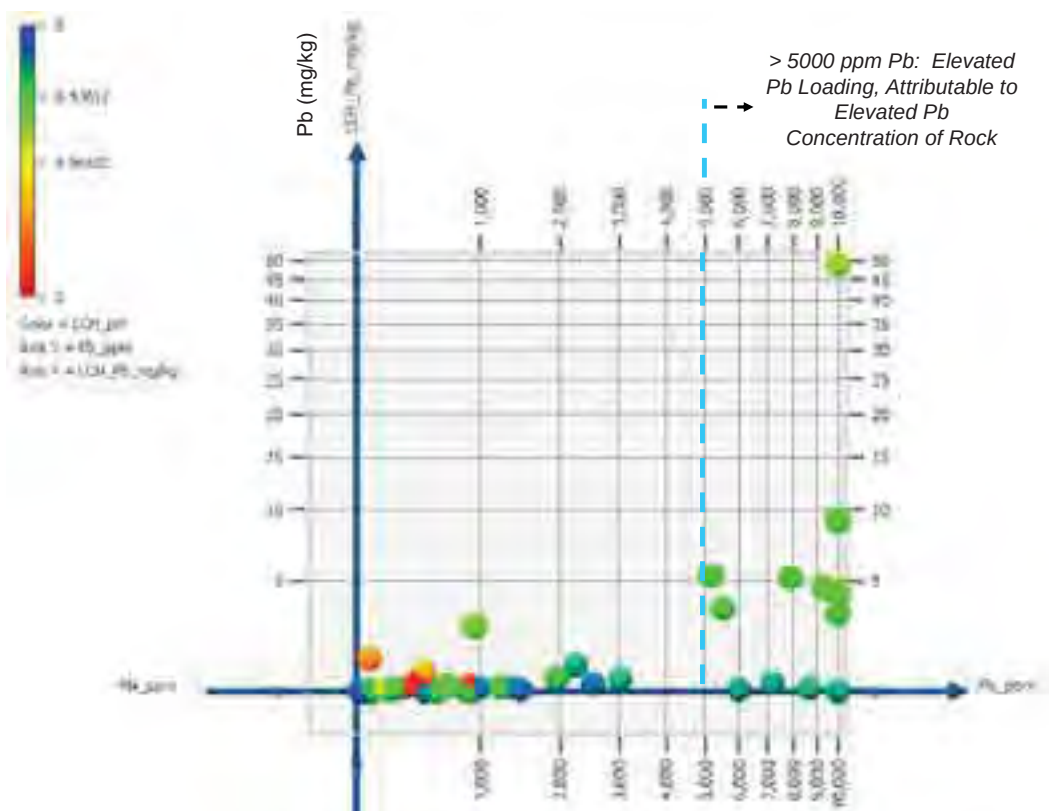


Figure 7. Pb in rock vs. Pb dissolution. Note that elevated Pb dissolution (≥ 3 mg/kg) appears to be largely a function of Pb concentration in rock. Also note the very low Pb dissolution under acidic conditions..

Based on the above graphics, the criteria of $S_{\text{via ICP}} \geq 0.25\%$ and $\text{Ca} \leq 0.51\%$ was selected for identifying samples with net acidity $\pm$ metal leaching. Criteria of $\text{Pb} \geq 5000$ ppm and $\text{Zn} \geq 5000$ ppm were selected for segregation of samples showing elevated Pb and Zn solubility.

The above screening criteria were applied singly and then in combination to the 47-sample dataset to assess the degree of success in: i) isolating the reactive samples, and ii) minimizing “dilution” by non-reactive samples (in other words, minimizing the inclusion of any non-reactive samples in the samples isolated).

Results of the filtering are summarized in Table 5. When all three of the above criteria are applied to the 47-sample database, 20 samples are isolated, including 16 of the 17 reactive samples and 4 non-reactive samples. Only one marginally reactive sample showing 11 mg/kg Zn dissolution, 4640 ppm Zn, 0.73 %S, and leachate pH of 7.4 reports to the non-reactive category. In a waste rock segregation scenario, the occasional inclusion of a rock demonstrating marginally elevated Zn loading with no net acidity is acceptable as it is unlikely to have a significant effect on overall drainage water quality from a waste rock pile. Conversely, this filtering also shows that 13% of the non-reactive samples in the dataset are grouped by this filtering.

Similar results are obtained when substituting a Fizz Rating of <3 in place of ICP Calcium $\leq 0.51\%$ – the reactive samples are filtered identically, however ‘dilution’ by non-reactive samples increases to 20%. Nonetheless, these results indicate Fizz Rating to be a potential screening parameter, which is of interest as a field screening tool for segregating rock during active mining.

Table 5. Summary of Results of Filter Criteria Trials, 2006 Leachate Extraction Analyses (selected criteria in bold)

Criteria for Reactive Sample	# Samples	S% $\geq$ 0.25% and Ca $\leq$ 0.51%	S% $\geq$ 0.25% and Fizz Rating < 3	Pb $\geq$ 5000 ppm	Zn $\geq$ 5000 ppm	S% $\geq$ 0.25% and Ca% $\leq$ 0.51% or Pb $\geq$ 5000 ppm or Zn $\geq$ 5000 ppm	S% $\geq$ 0.25% and Fizz Rating < 3 or Pb $\geq$ 5000 ppm or Zn $\geq$ 5000 ppm
Total # Samples	47	9	12	12	17	20	22
Leachate pH	6	6	6	0	0	6	6
Zn Loading (mg/kg)	13	9	10	4	7	12	12
Pb Loading (mg/kg)	8	2	3	8	7	8	8
# of Samples Meeting any one Criteria	17	9	10	8	10	16	16
# of Samples Not Meeting any of Above Criteria	30	0	2	4	7	4	6
% of Low Leachate pH samples isolated		100%	100%	0%	0%	100%	100%
% of anomalous Zn load samples isolated		69%	77%	31%	54%	92%	92%
% of anomalous Pb samples isolated		25%	38%	100%	88%	100%	100%
% of Reactive Samples Isolated		53%	59%	47%	59%	94%	94%
% of Non-Reactive Samples Included		0%	7%	13%	23%	13%	20%

4. Key Conclusions

- In the 47-sample leachate extraction database examined, net acidic samples are defined as those yielding a leachate pH ≤ 5.5 . Metal leaching samples are defined as those with Zn loading ≥ 10 mg/kg, and/or Pb loading ≥ 3 mg/kg. Any sample meeting at least one of these three conditions is defined as “reactive”.
- As observed in section 7 of the 1996 Characterization Study, it is important to note that most samples were taken from adit dump waste rock pile samples, and thus tend to be comprised of material in close proximity to mineralization. Samples from open pit waste piles, comprised of a greater amount of rock further from the vein systems, are less sulphidic and show less evidence of acidity and metal solubilization.
- Of the 47 samples, 17 (36%) meet one or more of the “reactive” criteria, with 6 of the 17 being net acidic, 13 zinc-leaching, and 8 lead-leaching. The quartzite units sampled showed the highest proportion of reactive samples (46%), followed by mixed quartzite and schist (40%), and vein (25%). Pit wall samples appear to store less soluble products, (none of the pit wall samples were reactive), likely a function of the more exposed environment relative to a waste rock dump with limited infiltration and transport of solutes.
- An average of 40% of sulphur is in the soluble form of sulphate, as indicated by an average SO₄:Total S ratio of 0.4 for the 47 samples. Other elements with elevated soluble fraction are Ca, Co, Cd, Mn, and Zn (averaging 11%, 11%, 9%, 6% and 5% respectively).
- The following controls are noted for acidity and metal leaching:
 - Net Acidity: The two key aspects of samples demonstrating leachate pH ≤ 5.5 , are either a calcium level in the rock of $\leq 0.51\%$ or a CO₂ level of $\leq 0.6\%$, coupled with a sulphur level of $\geq 0.25\%$. Production of net acidity thus appears to be directly related to insufficient levels of available calcium (as calcium carbonate) to compensate for ongoing oxidation of sulphide minerals.
 - Zinc Leaching: leaching of zinc to levels ≥ 10 mg/kg appears to occur under two differing conditions: i) solubilization of zinc under net acidic conditions – independent of zinc concentration in rock, and ii) solubilization of zinc under overall neutral to alkaline conditions where Zn concentrations in rock exceed 5000 ppm.
 - Lead Leaching: leaching of lead to levels ≥ 3 mg/kg occurs only under neutral pH conditions, where Pb concentrations in rock exceed 5000 ppm.

- Various geochemical parameters were evaluated to identify a simple filter to best isolate the reactive samples from the non-reactive samples, using information normally available in an exploration database (eg. lithology, ICP analyses, simple field tests). While priority was given to ensuring complete isolation of the net acidic samples, it was considered that minor under-filtering of metal-leaching would not be detrimental to overall drainage quality of a waste rock storage area. After several trials, the following filter criteria were identified to discriminate reactive samples in the 47-sample database:
 1. $S_{via\ ICP} \geq 0.25\%$ and $Ca \leq 0.51\%$; or
 2. $Pb \geq 5000\text{ ppm}$; or
 3. $Zn \geq 5000\text{ ppm}$.
- When these criteria are applied to the 47-sample database, 16 of the 17 reactive samples are isolated, along with 4 non-reactive samples. 100% of the net acidic samples, 92% of the zinc-leaching samples, and 100% of the lead-leaching samples are isolated. On the other hand, 13% of the samples isolated using these criteria were actually non-reactive in the leachate extraction test, indicating that some potential 'dilution' by non- ARD/ML waste rock is possible if using this filter for waste rock classification.
- Similar results are obtained when substituting a Fizz Rating of <3 in place of $ICP\ Calcium \leq 0.51\%$ – the reactive samples are filtered identically, however 'dilution' by non-reactive samples increases to 20%. Nonetheless, these results indicate Fizz Rating to be a potential screening parameter, which is of interest as a field screening tool for segregating rock during active mining.

Prepared By:

ALTURA ENVIRONMENTAL CONSULTING



Diane Lister, P.Eng.

Attachments:

Appendices A1 through A6

APPENDIX A1-1

Rock Codes

00	Miscellaneous
01	Unspecified
02	Mixed Quartzite and Schist
OVB	Overburden
10 SCH	Schists, undifferentiated
11 CHSCH	Chloritic Schist
12 GSCH	Graphitic Schist
13 SSCH	Sericitic Schist
14 CSCH	Calcareous Schist
20	Quartzite, Undifferentiated
21 CQTZT	Calcareous Quartzite
22 QTZT	Quartzite
30 GNST	Greenstone, Undifferentiated
40 VN	Vein, undifferentiated
50 PHY	Phyllite

Zones:

Unspecified	0
Dixie	10
DixieAdit	11
Birmingham	20
BermhamPit	21
Ruby	30
RubyAdit	31
Calumet	40
Calu_1_15_pit	41
Husky	50
HuskySW	51
Hector	60
HectorPit	61
HectorAdit	62
Millier	70
MillerPit	71
SIME	80
SIME6pit	81
SIME4pit	82
SIME35pit	83
SIME4&6pit	84
ONEK	90
ONEKpit	91
Keno	100
Keno700_Adit	101
UN	110
UNAdit	111
Townsite	120
TownsiteAdit	121
Bellekeno	130
BelleKenoAdit	131
Silver King	140
SlvrKing_Pit	141
Galkeno	150
Galkeno900	151

Waste Rock Dump Sample Descriptions - May 2007			
Mine/dump location	No. of 20 L Pails	Sample ID	Sample Description
DIXIE Adit dump			
	1	95UKHDD01	grey fine gr. mat'l, minor >3", 3" rusty bands every 12"
	1	95UKHDD02	brownish & grey fine gr. mat'l (broken schist, some fragments, grey qtzite)
	1	95UKHDD03	grey fine gr. mat'l, rusty bands (6") every 14", sample from 8" depth
BERMINGHAM pit wall			
	1	95UKHBP01	thin bedded qtzite, rusty weathering; North wall of pit
	2	95UKHBP02	thick bedded blocky, rusty weathering qtzite; manganese staining (?); above old brim. Shaft; N. wall pit
	2	95UKHBP03	thick bedded, blocky qtzite, buff weathering, some minor graphitic schist talus; N. wall pit
	2	95UKHBP04	rusty weathering, blocky qtzite, minor schist; 70%>4", 10%>8"
	2	95UKHBP06	graphitic schist, platy talus on South pit wall, 1/2" x 8" pieces
	2	95UKHBP07	sericitic schist, platy to blocky talus on S. pit bench
BERMINGHAM pit dump			
	2	95UKHBD01	fine grained ore stockpile (1/2">x<3"), rusty weathering, 70% "soil" fraction mat'l
	2	95UKHBD02	fine grained ore stockpile (1/2">x<3"), rusty weathering, 70% "soil" fraction mat'l
	1	95UKHBD03	ore and colluvium (?) scraped from floor of ore stockpile area
	1	95UKHBD04	graphitic schist
	1	95UKHBD05	ore and colluvium (?) scraped from floor of ore stockpile area
	1	95UKHBD06	buff weathering, blocky qyzite
RUBY adit dump			
	2	95UKHRD01	grey - black fine grained qtzite rubble, iron stain banding (on only, 6" thick, dipping 45')
	2	95UKHRD02	grey - black fine grained qtzite rubble, weak iron stain banding (on only, 6" thick, dipping 45')
	2	95UKHRD03	grey - black fine grained qtzite rubble, iron stain banding (on only, 6" thick, dipping 45')
HUSKY SW			
	1	95UKHWD01	very pyritic grey qtzite
CALUMET 1-15 pit dump			
	2	95UKHCD01	buff weathering, altered (?) qtzite, rusty fractures
	2	95UKHCD02	buff weathering, blocky qtzite, rusty fracturing, possible some vein mat'l (15%)
	2	95UKHCD03	ore stockpile scrapings mixed and some colluvium, minor buff weathering qtzite w/ rusty fractures
CALUMET 1-15 pit wall			
	1	95UKHCP01	graphitic schist, platy talus (1/2" thick x 6-10" long)
	2	95UKHCP02	grey blocky qtzite, maroon fractures, >60%+4"
HECTOR pit dump			
	2	95UKHCD04	grey blocky qtzite, maroon weathering on fractures
MILLER pit dump			
	2	95UKHMD01	greenish-grey fine grained qtzite, rusty weathering on fracture surfaces, some pyrite casts
HECTOR adit dump			
	1	95UKHHD01	grey qtzite rubble, mixed with debris; top of dump
	2	95UKHHD02	grey qtzite rubble, mixed with debris; top of dump
	1	95UKHHD03	green sercite schist rubble, woody debris & fines; toe of dump
SIME 6 pit wall			
	2	95UKHSP01	grey, platy graphitic schist; 1/4" thick x 4-10" long
	2	95UKHSP02	buff weathering, blocky qtzite, some rusty fracture surfaces
SIME 4 pit wall			
	1	95UKHSP03	thick bedded, grey massive qtzite, some pyrite casts, all surfaces iron stained
SIME 35 pit wall			
	2	95UKHSP04	very fine grained schist, some Fe stain
	2	95UKHSP05	
SIME 4 & 6 pits wall			
	1	95UKHSD01	clean buff qtzite, 4" blocks, minor oxidation on 50% of fracture surfaces
ONEK pit			
	2	95UKHOP01	grey, clean qtzite mixed with schist - Fe staining laminar in schist
ONEK pit dump			
	1	95UKHOD01	greenstone, blocky 3" x 7" pieces and chips
	1	95UKHOD02	buff weathered qtzite, rusty fractures
	2	95UKHOD03	grey platy graphitic schist, 1/2" x 7"
KENO 700 adit dump			
	1	95UKHKD01	grey qtzite, qtz bands
	1	95UKHKD02	green sericitic schist
UN adit dump			
	2	95UKHUD01	mixture grey graphitic schist and buff weath. qtzite, 30" + 3" 70" <3"
TOWNSITE adit dump			
	2	95UKHTD01	buff weathering qtzite, 10% >3", mostly fine fraction, some oxidation
	2	95UKHTD02	grey qtzite with sercite schist, 10% > 3", mostly fine fraction
BELLEKENO adit dump			
	2	95UKHLD01	dark grey pyritic qtzite, qtz stringers abundant
SILVER KING pit dump			
	1	95UKHVD01	mixed grey and buff qtzite, minor schist, some sandsize particles
GALKENO 900			
	1	95UKGK901	grey, fine gr. Schist
TOTAL # of SAMPLE SITES:	47		
TOTAL # of 20 L PAILS	74		

ALS Environmental
11-May-07

RESULTS OF ANALYSIS

Mine/Dump Location

Sample ID
Date of Analysis
ALS Sample ID
Matrix

11-May-07

Leachable Anions & Nutrients

Units
pH

Leachable Metals

Aluminum (Al)-Leachable
Antimony (Sb)-Leachable
Arsenic (As)-Leachable
Barium (Ba)-Leachable
Beryllium (Be)-Leachable
Bismuth (Bi)-Leachable
Boron (B)-Leachable
Cadmium (Cd)-Leachable
Calcium (Ca)-Leachable
Chromium (Cr)-Leachable
Cobalt (Co)-Leachable
Copper (Cu)-Leachable
Iron (Fe)-Leachable
Lead (Pb)-Leachable
Lithium (Li)-Leachable
Magnesium (Mg)-Leachable
Manganese (Mn)-Leachable
Mercury (Hg)-Leachable
Molybdenum (Mo)-Leachable
Nickel (Ni)-Leachable
Phosphorus (P)-Leachable
Potassium (K)-Leachable
Selenium (Se)-Leachable
Silicon (Si)-Leachable
Silver (Ag)-Leachable
Sodium (Na)-Leachable
Strontium (Sr)-Leachable
Thallium (Tl)-Leachable
Tin (Sn)-Leachable
Titanium (Ti)-Leachable
Uranium (U)-Leachable
Vanadium (V)-Leachable
Zinc (Zn)-Leachable

APPENDIX A2-2
Shakeflask Extraction Results

Dixie Adit Dump				Birmingham Pit Wall				Birmingham Pit Dump				95UKHBD06				
95UKHDD01	95UKHDD02	95UKHDD03		95UKHBP01	95UKHBP02	95UKHBP03	95UKHBP04	95UKHBP05	95UKHBP06	95UKHBP07	95UKHBD01	95UKHBD02	95UKHBD03	95UKHBD04	95UKHBD05	95UKHBD06
L481965-1	L481965-2	L481965-3	Soil	L481965-4	L481965-5	L481965-6	L481965-7	L481965-8	L481965-9	L481965-10	L481965-11	L481965-12	L481965-13	L481965-14	L481965-15	Soil
3.43	2.61	4.99		6.17	6.94	6.67	6.69	7.45	7.56	7.14	7.07	6.07	7.20	7.27	6.95	7.38
38.6	98.2	2.68		0.0111	0.0197	0.0204	0.0263	0.0198	0.840	<0.0030	0.203	<0.10	0.0054	<0.0030	0.0146	0.295
<0.0020	0.011	<0.0010		0.00289	0.00420	0.00205	0.00359	0.00558	0.00561	0.00051	0.00118	<0.010	0.00072	0.00208	0.00530	0.0031
0.0049	0.130	<0.0010		0.00102	0.00729	0.00177	0.00082	0.00051	0.00101	0.00029	0.00681	<0.010	0.00023	0.00036	0.00081	0.0068
0.109	<0.0050	0.0439		0.00935	0.00244	0.00683	0.00151	0.0232	0.00853	0.00224	0.0114	0.0569	0.00649	0.00267	0.00586	0.0263
<0.010	<0.050	<0.0050		<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.00050	<0.050	<0.0010	<0.00050	<0.00050	<0.0050
<0.010	<0.050	<0.0050		<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	<0.00050	<0.00050	<0.050	<0.0010	<0.00050	<0.00050	<0.0050
<0.20	<1.0	<0.10		0.013	<0.010	0.013	<0.010	<0.020	0.011	<0.010	<0.010	<1.0	<0.020	0.011	<0.010	<0.10
0.173	2.41	0.500		0.00604	0.000448	0.000716	0.000264	0.00111	0.000218	0.0120	0.0122	35.7	0.0446	0.00194	0.137	0.0156
268	148	511		5.22	11.3	3.31	1.87	142	5.01	47.0	86.5	136	45.8	4.52	6.15	548
0.023	0.210	<0.0050		0.00094	0.00156	0.00084	0.00240	<0.0010	<0.00050	<0.00050	0.00081	<0.050	<0.0010	<0.00050	<0.00050	<0.0050
0.0478	0.210	0.108		0.00013	<0.00010	<0.00010	<0.00010	0.00178	0.00022	<0.00010	0.00066	0.064	<0.00020	0.00012	0.00025	0.0044
0.125	1.14	0.0732		0.00168	<0.00060	<0.00050	0.00170	0.00515	0.00434	<0.00050	0.00323	0.016	<0.0011	<0.0010	0.00091	0.0028
15.2	188	2.03		<0.030	0.036	<0.030	<0.030	<0.030	0.409	<0.030	0.215	<0.030	<0.030	<0.030	<0.030	0.316
0.407	0.0697	0.0251		0.00168	<0.00050	<0.00090	0.000973	0.00238	0.00204	0.00226	0.0353	1.45	0.0187	<0.00070	0.0108	0.0383
<0.10	<0.50	0.066		0.0067	0.0097	0.0088	<0.0050	0.016	0.0085	0.0125	0.0111	<0.50	0.019	<0.0050	<0.0050	<0.050
48.1	30.4	62.1		1.10	2.13	0.92	0.47	30.4	1.59	26.1	28.2	51.0	19.9	1.24	1.66	205
90.6	207	15.9		0.142	0.00428	0.0237	0.0162	1.26	0.0443	0.0311	0.282	122	0.276	1.94	0.461	3.48
<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
<0.0010	<0.0050	<0.00050		<0.00050	0.000216	0.000062	0.000068	0.00625	0.00495	<0.000050	0.00066	<0.0050	<0.00010	0.000189	0.000083	<0.00050
0.234	0.981	0.417		0.00317	<0.00050	0.00067	0.00051	0.00039	0.00075	0.00072	0.00183	0.166	0.0014	0.00068	0.00088	0.0238
<0.30	1.59	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
3.4	<2.0	4.5		4.2	<2.0	2.7	<2.0	6.3	3.5	2.6	3.5	6.4	3.4	<2.0	<2.0	6.0
<0.020	<0.10	<0.010		<0.0010	<0.0010	<0.0010	<0.0010	0.00079	0.0013	0.0049	0.0075	<0.10	0.0073	0.0015	<0.0010	<0.010
5.84	4.35	3.77		3.99	3.04	3.85	2.48	2.41	5.79	2.00	2.29	1.85	1.81	2.44	2.54	1.30
0.00452	0.0011	<0.00010		0.000077	0.000208	0.000375	0.000045	0.000065	0.000080	0.000216	0.00105	<0.0010	0.000080	0.000026	0.000141	0.00099
<2.0	<2.0	<2.0		<2.0	4.2	<2.0	<2.0	<2.0	2.6	4.8	6.2	5.9	<2.0	<2.0	<2.0	<2.0
0.168	0.097	0.175		0.0243	0.0255	0.0173	0.0802	0.378	0.0110	0.0686	0.100	0.221	0.0561	0.0234	0.0296	0.784
0.0026	<0.010	0.0013		<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.010	<0.00020	<0.00010	<0.00010	<0.0010
<0.0020	<0.010	<0.0010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.010	<0.00020	<0.00010	<0.00010	<0.0010
<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	<0.010	<0.010
0.00947	0.0503	0.00043		<0.000010	0.000013	<0.000010	<0.00010	0.00155	0.000079	<0.000010	0.000075	<0.00010	<0.000020	<0.000010	<0.000010	0.00059
<0.020	<0.10	<0.010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.00010	<0.00010	<0.0010	<0.10	<0.0020	<0.00010	<0.00010	<0.010
7.42	143	29.0		0.0790	<0.0060	0.0107	<0.0080	0.0080	<0.0070	0.0437	0.0988	266	0.351	0.0178	1.05	0.105

APPENDIX A2-2
Shakeflask Extraction Results

ALS Environmental
11-May-07

RESULTS OF ANALYSIS

Mine/Dump Location

Sample ID
Date of Analysis
ALS Sample ID
Matrix

11-May-07

Leachable Anions & Nutrients

Units
pH

Leachable Metals

Aluminum (Al)-Leachable
Antimony (Sb)-Leachable
Arsenic (As)-Leachable
Barium (Ba)-Leachable
Beryllium (Be)-Leachable
Bismuth (Bi)-Leachable
Boron (B)-Leachable
Cadmium (Cd)-Leachable
Calcium (Ca)-Leachable
Chromium (Cr)-Leachable
Cobalt (Co)-Leachable
Copper (Cu)-Leachable
Iron (Fe)-Leachable
Lead (Pb)-Leachable
Lithium (Li)-Leachable
Magnesium (Mg)-Leachable
Manganese (Mn)-Leachable
Mercury (Hg)-Leachable
Molybdenum (Mo)-Leachable
Nickel (Ni)-Leachable
Phosphorus (P)-Leachable
Potassium (K)-Leachable
Selenium (Se)-Leachable
Silicon (Si)-Leachable
Silver (Ag)-Leachable
Sodium (Na)-Leachable
Strontium (Sr)-Leachable
Thallium (Tl)-Leachable
Tin (Sn)-Leachable
Titanium (Ti)-Leachable
Uranium (U)-Leachable
Vanadium (V)-Leachable
Zinc (Zn)-Leachable

Ruby Adit Dump 95UKHRD02		Calumet 1-15 Pit Dump 95UKHCD01		Calumet 1-15 Pit Wall 95UKHCP01		Husky SW 95UKHWD01		Hector Pit Dump 95UKHCD04		Miller Pit Dump 95UKHMD01		Hector Adit Dump 95UKHHD01		Hector Adit Dump 95UKHHD02		SIME 6 Pit Wall 95UKHSP01											
Soil	L481965-17	Soil	L481962-1	Soil	L481962-2	Soil	L481962-7	Soil	L481962-4	Soil	L481962-5	Soil	L481962-3	Soil	L481962-6	Soil	L481962-8	Soil	L481962-9	Soil	L481962-10	Soil	L481962-11	Soil	L481962-12	Soil	L481962-13
6.59	7.07	6.25	5.74	6.49	5.76	6.17	2.38	6.34	6.71	6.42	7.04	7.41	7.08	6.53													
<0.0050	0.0468	<0.0030	0.0217	<0.0010	0.142	0.0041	0.0037	0.0245	<0.80	<0.080	0.0221	0.0286	0.0055														
0.00136	0.00277	0.00077	<0.00050	0.00170	0.00134	0.00299	0.0090	0.00069	0.00175	<0.010	0.0045	0.00098	0.00101														
<0.00050	0.00051	0.00014	0.00070	0.00031	0.00055	0.00080	1.40	0.00022	0.00083	0.012	0.0048	0.00127	0.00028														
0.0422	0.0392	0.0213	0.306	0.0418	0.00609	0.00765	0.0133	0.259	0.0255	0.0202	0.0860	0.0620	0.0226														
<0.0025	<0.0025	<0.0050	<0.0025	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.050	<0.0050	<0.0025	<0.00050														
<0.0025	<0.0025	<0.0050	<0.0025	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.050	<0.0050	<0.0025	<0.00050														
<0.050	<0.050	0.013	<0.050	0.012	0.021	0.012	<0.20	<0.010	0.012	<1.0	<0.10	<0.050	<0.020														
1.25	0.0610	0.00208	0.0771	0.0107	0.000993	0.0169	0.0648	0.190	0.000435	5.03	1.10	0.350	0.0169														
351	439	1.22	32.3	2.75	0.723	3.73	129	6.86	3.39	418	483	1.12	1.12														
<0.0025	<0.0025	<0.0050	<0.0025	<0.0050	<0.0050	<0.0050	0.450	<0.0050	0.00271	<0.050	<0.0050	<0.0050	<0.00050														
0.0237	0.0403	0.00024	0.00124	0.00014	0.00012	0.00138	0.356	0.00357	<0.00010	0.315	0.0218	0.00522	0.00038														
0.0460	0.00157	0.00052	0.0106	0.00130	0.00391	0.00486	1.04	0.00500	0.00283	0.017	0.0113	0.00756	0.00232														
<0.030	0.054	<0.030	<0.030	<0.030	<0.030	<0.030	618	<0.030	0.036	<0.090	<0.030	<0.030	<0.030														
1.17	0.00482	1.56	16.3	1.08	0.0410	0.0786	0.144	1.75	0.0317	1.78	0.148	0.0878	0.319														
<0.025	0.036	<0.0050	<0.025	<0.0050	<0.0050	0.0054	0.27	<0.0050	<0.0050	<0.50	<0.050	<0.025	0.0050														
49.3	46.2	0.17	3.70	0.51	0.16	0.54	95.3	1.63	0.25	75.9	85.0	48.3	0.20														
14.2	16.6	0.0303	0.345	0.0462	0.0434	0.615	19.7	0.448	0.0251	515	17.1	5.41	0.230														
<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010														
<0.00025	<0.00025	<0.000050	<0.00025	<0.00050	<0.000050	<0.000050	0.0024	0.000547	<0.000050	0.0052	0.00053	0.00041	0.000230														
0.144	0.136	0.00176	0.0067	0.00090	<0.00050	0.00441	0.907	0.00863	<0.00050	0.663	0.0735	0.0260	0.00176														
<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	2.29	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30														
4.6	4.8	2.3	12.1	3.1	6.2	3.5	<2.0	2.4	<2.0	5.6	5.0	6.8	6.4														
0.0050	<0.0050	<0.0010	<0.0050	<0.0010	0.0022	0.0015	<0.020	<0.0010	<0.0010	<0.10	<0.010	<0.0050	<0.0010														
2.45	2.19	2.06	3.52	2.87	3.17	2.65	6.77	3.45	2.72	2.32	2.06	2.03	3.99														
0.000187	<0.000050	0.00156	0.00465	0.000618	0.000213	0.000061	0.00132	0.000023	0.000047	<0.0010	0.00016	0.000160	0.000883														
<2.0	<2.0	<2.0	6.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0														
0.232	0.324	0.00670	0.156	0.0208	0.00563	0.0168	0.263	0.0582	0.00645	0.432	0.764	0.463	0.00678														
<0.00050	<0.00050	0.00017	<0.00050	<0.0010	0.00014	<0.0010	<0.0020	<0.0010	<0.0010	<0.010	<0.0010	<0.00050	<0.0010														
<0.00050	<0.00050	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.010	<0.0010	<0.00050	<0.0010														
<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010														
<0.000050	0.000276	<0.000010	<0.000050	<0.000010	<0.000010	<0.000010	0.0109	0.000046	<0.000010	<0.0010	0.00022	0.000435	0.000011														
<0.0050	<0.0050	<0.0010	<0.0050	<0.0010	<0.0010	<0.0010	0.235	<0.0010	<0.0010	<0.10	<0.010	<0.0050	<0.0010														
16.2	0.590	0.0318	0.660	0.0518	0.0194	0.192	4.36	1.03	0.0418	277	32.9	3.69	0.199														

APPENDIX A2-2
Shakeflask Extraction Results

ALS Environmental
11-May-07

RESULTS OF ANALYSIS

Mine/Dump Location

11-May-07

Sample ID

Date of Analysis

ALS Sample ID

Matrix

Leachable Anions & Nutrients

Units
pH

Leachable Metals

Aluminum (Al)-Leachable

Antimony (Sb)-Leachable

Arsenic (As)-Leachable

Barium (Ba)-Leachable

Beryllium (Be)-Leachable

Bismuth (Bi)-Leachable

Boron (B)-Leachable

Cadmium (Cd)-Leachable

Calcium (Ca)-Leachable

Chromium (Cr)-Leachable

Cobalt (Co)-Leachable

Copper (Cu)-Leachable

Iron (Fe)-Leachable

Lead (Pb)-Leachable

Lithium (Li)-Leachable

Magnesium (Mg)-Leachable

Manganese (Mn)-Leachable

Mercury (Hg)-Leachable

Molybdenum (Mo)-Leachable

Nickel (Ni)-Leachable

Phosphorus (P)-Leachable

Potassium (K)-Leachable

Selenium (Se)-Leachable

Silicon (Si)-Leachable

Silver (Ag)-Leachable

Sodium (Na)-Leachable

Strontium (Sr)-Leachable

Thallium (Tl)-Leachable

Tin (Sn)-Leachable

Titanium (Ti)-Leachable

Uranium (U)-Leachable

Vanadium (V)-Leachable

Zinc (Zn)-Leachable

SIME 4 Pit Wall 95UKHSP03	SIME 35 Pit Wall 95UKHSP04	SIME 4 & 6 Pit Walls 95UKHSD01	Onek Pit 95UKHOP01	Onke Pit Dump 95UKHOD01	Onke Pit Dump 95UKHOD02	Onke Pit Dump 95UKHOD03	Keno 700 Adit Dump 95UKHKD01	UN Adit Dump 95UKHUD01	Townsite Adit Dump 95UKHTD01	Bellekeno Adit Dump 95UKHLD01
L481962-14 Soil	L481962-15 Soil	L481962-17 Soil	L481962-18 Soil	L481962-19 Soil	L481962-20 Soil	L481962-21 Soil	L481962-22 Soil	L481962-24 Soil	L481962-25 Soil	L481962-26 Soil
6.81	6.66	7.32	7.87	7.61	6.67	7.45	7.15	6.78	5.99	7.37
0.0084	0.0120	0.0408	0.156	0.270	0.0857	0.0486	0.0099	0.0444	0.48	0.0289
0.0156	0.00148	0.00291	0.00232	0.0125	0.00337	0.00100	0.00938	0.00558	<0.020	0.00628
0.00508	0.00073	0.00274	0.00091	0.0118	0.00463	0.00124	0.00121	0.00063	<0.020	0.00106
0.00275	0.00327	0.00424	0.00260	0.00118	0.00852	0.0133	0.0396	0.0411	0.027	0.0359
<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	<0.10	<0.0025
<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.00050	<0.10	<0.0025
<0.010	<0.010	<0.010	0.011	<0.010	0.027	0.012	<0.020	0.014	<2.0	<0.050
0.00247	0.00137	0.00298	0.000071	<0.000050	0.00196	0.000301	0.174	0.0132	5.58	0.00930
2.33	5.42	9.57	18.7	9.93	1.80	39.6	134	3.76	91.7	214
<0.00050	<0.00050	0.00133	<0.00050	<0.00050	0.00118	0.00075	<0.0010	<0.00050	<0.10	<0.0025
0.00014	0.00010	<0.00010	<0.00010	0.00015	<0.00010	<0.00010	0.00198	0.00043	0.361	<0.00050
0.00144	0.00168	0.00047	<0.0012	0.00272	0.00383	0.00348	0.00842	0.00427	0.038	0.00893
<0.030	<0.030	<0.030	<0.030	0.098	0.081	<0.030	<0.030	<0.030	<0.030	<0.030
0.0331	0.00965	0.00161	0.00155	<0.00040	0.0175	0.00895	0.105	0.156	0.881	0.0464
<0.0050	0.0126	<0.0050	0.0057	<0.0050	<0.0050	0.0067	<0.010	0.0066	<1.0	<0.025
0.26	0.56	0.17	1.74	0.65	0.31	4.40	6.09	0.70	47.3	13.0
0.0577	0.0642	0.0874	0.00686	0.00381	0.0847	0.00540	0.701	0.170	455	0.319
<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
0.000104	0.000570	0.000265	0.00201	0.00197	0.000269	0.00143	0.00086	<0.00050	<0.010	0.00971
<0.00050	0.00079	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0054	0.00148	0.62	<0.0025
<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
<2.0	<2.0	<2.0	4.2	<2.0	<2.0	4.1	3.2	3.1	5.0	6.7
<0.0010	0.0030	<0.0010	0.0029	<0.0010	<0.0010	0.0068	<0.0020	<0.0010	<0.20	<0.0050
1.69	3.71	1.67	1.79	4.03	2.52	2.04	2.24	3.59	2.24	2.16
0.000078	0.000012	0.000018	<0.000010	<0.000010	0.000229	0.000016	0.000171	0.000172	<0.00020	0.000096
<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.5	<2.0	<2.0	<2.0	9.0
0.0101	0.0140	0.00937	0.00557	0.0204	0.0126	0.103	0.205	0.0154	0.140	0.332
<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	<0.00010	<0.0020	<0.00050
<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00016	<0.00010	<0.00020	<0.00010	<0.020	<0.00050
<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
<0.000010	<0.000010	0.000021	0.000223	0.000033	0.000015	0.000240	0.000076	<0.000010	<0.00050	0.00237
<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.20	<0.0050
0.0131	0.0317	0.0473	<0.0040	<0.0050	0.0278	<0.0050	1.76	0.118	289	0.0829

Keno Hill Waste Rock Chemistry Data			DXIE Adit dump				BERMINGHAM pit wall				BERMINGHAM pit dump					
	Method	Units	95UKHDD01	95UKHDD02	95UKHDD03	95UKHBP01	95UKHBP02	95UKHBP03	95UKHBP04	95UKHBP06	95UKHBP07	95UKHBD01	95UKHBD02	95UKHBD03	95UKHBD05	95UKHBD06
MPA	OA-VOL08 Basic Acid Base Accounting	ICaCO3/1000t ore	10	11.6	9.1	0.9	0.6	0.9	0.3	21.6	0.6	5.3	6.3	23.4	6.6	0.9
FLZZ RATING	OA-VOL08 Basic Acid Base Accounting	ICaCO3/1000t ore	1	1	2	1	1	1	1	3	1	1	1	2	3	1
NIP	OA-VOL08 Basic Acid Base Accounting	ICaCO3/1000t ore	-6	-15	2	4	4	6	5	46	6	15	11	285	24	6
NP	OA-VOL08 Basic Acid Base Accounting	ICaCO3/1000t ore	4	-3	11	5	5	7	5	68	7	20	17	308	31	7
pH	OA-ELE07 Paste pH	Unity	4.3	3.5	5.2	6.6	7	7.1	7.4	7.7	8.2	7.4	7.4	7	7.5	7.6
Ratio (NP:MPA)	OA-VOL08 Basic Acid Base Accounting	Unity	0.4	-0.26	1.21	5.33	8	7.47	16	3.15	11.2	3.76	2.72	13.14	4.72	7.47
S	S-IR08 Total Sulphur (Leco)	%	0.32	0.37	0.29	0.03	0.02	0.03	0.01	0.69	0.02	0.17	0.2	0.75	0.21	0.03
S	S-GRA06 Sulfate Sulphur-carbonate leach	%	0.22	0.3	0.23	0.01	0.01	<0.01	<0.01	0.05	0.01	0.03	0.05	0.18	0.02	0.01
S	S-GRA06a Sulfate Sulphur (HCl leachable)	%	0.21	0.3	0.22	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.16	0.17	0.21	0.08	0.01
S	S-GAL06 Sulfate Sulphur (calculated)	%	0.1	0.07	0.06	0.02	0.01	0.03	0.01	0.64	0.01	0.14	0.15	0.57	0.19	0.02
C	C-GAS05 Inorganic Carbon (CO2)	%	0.08	<0.05	0.15	<0.05	<0.05	<0.05	<0.05	0.8	<0.05	0.18	0.15	3.64	0.37	0.11
CO2	C-GAS05 Inorganic Carbon (CO2)	%	0.3	<0.2	0.8	<0.2	<0.2	<0.2	<0.2	2.9	<0.2	0.7	0.6	13.4	1.4	0.4
Au	AU-CP21 Au 30g FA/ICP-AES Finish	ppm	0.013	0.015	0.003	0.005	0.008	0.019	0.004	0.001	<0.01	0.056	0.046	0.085	0.009	0.016
Ag (Silver)	ME-ICP61 27 element four acid ICP-AES	ppm	1.7	14.7	1.6	11.5	6.1	15.1	3.4	0.5	<0.5	>100	>100	>100	95.4	5.3
Al (Aluminum)	ME-ICP61 27 element four acid ICP-AES	ppm	2.08	1.3	3.42	1.87	4.16	5.69	1.02	4.49	8.68	2.39	2.94	1.72	3.19	0.46
As (Arsenic)	ME-ICP61 27 element four acid ICP-AES	ppm	66	49	22	69	304	331	43	38	<5	620	433	944	424	39
Ba (Barium)	ME-ICP61 27 element four acid ICP-AES	ppm	300	210	430	350	600	1110	130	770	860	530	880	330	630	140
Be (Beryllium)	ME-ICP61 27 element four acid ICP-AES	ppm	0.6	<0.5	1	0.5	1.3	1.4	<0.5	1.1	2.3	0.7	0.8	0.6	0.8	<0.5
Bi (Bismuth)	ME-ICP61 27 element four acid ICP-AES	ppm	0.25	<2	<2	2	<2	3	<2	<2	3	5	7	7	3	<2
Ca (Calcium)	ME-ICP61 27 element four acid ICP-AES	ppm	<0.5	5.9	3.7	15.8	24.6	15.8	5.2	1.2	1	211	151	691	110	12.9
Cd (Cadmium)	ME-ICP61 27 element four acid ICP-AES	ppm	<1	<1	2	3	2	6	1	8	14	5	3	<1	3	<1
Co (Cobalt)	ME-ICP61 27 element four acid ICP-AES	ppm	46	34	60	38	77	78	45	47	61	36	42	32	56	32
Cr (Chromium)	ME-ICP61 27 element four acid ICP-AES	ppm	9	15	11	39	25	39	14	24	22	119	86	137	76	10
Cu (Copper)	ME-ICP61 27 element four acid ICP-AES	ppm	2.1	1.2	1.81	1.45	2.95	4.14	1.15	2.24	3.95	10.9	8.54	14.05	6.01	1.21
Ga (Gallium)	ME-ICP61 27 element four acid ICP-AES	ppm	10	<10	10	10	10	10	<10	10	20	<10	<10	<10	<10	<10
K (Potassium)	ME-ICP61 27 element four acid ICP-AES	ppm	0.36	0.36	0.66	0.5	0.88	1.69	0.21	1.27	2.56	0.62	0.87	0.49	0.85	0.13
La (Lanthanum)	ME-ICP61 27 element four acid ICP-AES	ppm	10	10	20	10	20	10	<10	20	40	10	10	10	20	<10
Mg (Magnesium)	ME-ICP61 27 element four acid ICP-AES	ppm	0.16	0.06	0.24	0.14	0.54	0.34	0.12	0.95	0.93	0.24	0.24	0.38	0.25	0.02
Mn (Manganese)	ME-ICP61 27 element four acid ICP-AES	ppm	1040	691	179	1690	1985	4430	1615	707	441	46400	29300	82800	18700	3420
Mo (Molybdenum)	ME-ICP61 27 element four acid ICP-AES	ppm	1	<1	1	<1	1	1	<1	4	<1	1	2	<1	<1	<1
Na (Sodium)	ME-ICP61 27 element four acid ICP-AES	ppm	0.08	0.02	0.14	---	0.15	0.17	0.04	0.39	0.97	0.08	0.08	0.04	0.1	0.01
Ni (Nickel)	ME-ICP61 27 element four acid ICP-AES	ppm	8	6	15	15	26	25	10	24	34	19	17	11	17	3
P (Phosphorous)	ME-ICP61 27 element four acid ICP-AES	ppm	280	390	470	440	600	560	150	1320	340	630	650	750	540	190
Pb (Lead)	ME-ICP61 27 element four acid ICP-AES	ppm	81	896	122	897	75	576	101	38	18	>10000	8660	>10000	6010	489
S (Sulphur)	ME-ICP61 27 element four acid ICP-AES	ppm	0.29	0.36	0.26	0.02	0.02	0.03	0.01	0.71	0.03	0.17	0.21	0.78	0.21	0.02
Sb (Antimony)	ME-ICP61 27 element four acid ICP-AES	ppm	21	35	9	18	27	24	12	5	9	222	153	247	131	11
Sc (Scandium)	ME-ICP61 27 element four acid ICP-AES	ppm	3	3	5	4	10	12	7	7	13	7	7	7	7	2
Sr (Strontium)	ME-ICP61 27 element four acid ICP-AES	ppm	35	20	59	28	71	91	24	126	92	86	82	37	76	10
Ti (Titanium)	ME-ICP61 27 element four acid ICP-AES	ppm	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Tl (Thallium)	ME-ICP61 27 element four acid ICP-AES	ppm	0.13	0.12	0.18	0.11	0.25	0.23	0.11	0.22	0.24	0.1	0.1	0.08	0.18	0.05
Tl (Thallium)#	ME-ICP61 27 element four acid ICP-AES	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
U (Uranium)	ME-ICP61 27 element four acid ICP-AES	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
V (Vanadium)	ME-ICP61 27 element four acid ICP-AES	ppm	41	30	63	37	92	130	31	66	77	52	63	36	66	10
W (Tungsten)	ME-ICP61 27 element four acid ICP-AES	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Zn (Zinc)	ME-ICP61 27 element four acid ICP-AES	ppm	93	489	214	646	621	659	276	120	112	3800	2860	>10000	3070	337
Fire Assay Results for samples triggered due to concentration indicated during ICP testing																
Ag (Silver)	Ag-OS62 One Grade Ag - Four Acid	ppm										230	191		190	
Ag (Silver)	Calculated	oz. (troy) / Tonne										7.39	6.14		6.11	
Pb (Lead)	Pb-OS62 One Grade Pb - Four Acid	%										1.17			1.14	
Zn (Zinc)	Zn-OS62 One Grade Zn - Four Acid	%													1.18	

Red = fire assay testing triggered

Keno Hill Waste Rock Chemistry Data		RUBY adit dump		HUSKY SW	CALUMET 1-14 pit wall	95UKHCD01	95UKHCD02	HUSKY SW	CALUMET 1-15 pit wall	95UKHCP01	95UKHCP02	CALUMET 1-15 pit dump	MILLER pit dump
MPA	Units	Method	Units	98UKHRD01	95UKHRD02	95UKHRD03	98UKHRD01	95UKHRD01	95UKHCD01	95UKHCD01	95UKHCD02	95UKHCD03	95UKHMD01
MPA		Basic Acid Base Accounting	ICaCO3/1000t ore	38.1	12.8	15.6	37.5	0.6	0.9	0.9	2.2	4.4	0.3
FLZZ RATING		Basic Acid Base Accounting	ICaCO3/1000t ore	2	2	2	1	1	1	1	1	1	1
NIP		Basic Acid Base Accounting	ICaCO3/1000t ore	14	5	2	-43	0	-1	-1	3	-4	4
NP		Basic Acid Base Accounting	ICaCO3/1000t ore	52	18	18	-5	2	0	2	5	0	4
pH		Paste pH	Unltd	7.5	7.1	7.6	3.2	6.6	6.1	6.9	7.1	6.7	7.3
Ratio (NP:MPA)		Basic Acid Base Accounting	Unltd	1.36	1.4	1.15	-0.13	0.38	0	2.13	2.29	0	12.8
S	%	Total Sulphur (Leco)	%	1.22	0.41	0.5	1.2	0.02	0.17	0.03	0.03	0.07	0.14
S	%	Sulfate Sulphur (leach)	%	0.44	0.12	0.26	0.42	0.01	0.13	0.02	0.02	0.02	0.11
S	%	Sulfate Sulphur (HCl leachable)	%	0.46	0.14	0.25	0.37	<0.01	0.13	0.02	0.02	0.04	<0.01
S	%	Sulfide Sulphur (calculated)	%	0.78	0.29	0.24	0.78	0.01	0.1	0.78	0.02	0.05	0.03
C	%	Inorganic Carbon (CO2)	%	0.78	0.34	0.12	<0.03	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
CO2		Inorganic Carbon (CO2)	%	0.78	0.34	0.12	<0.03	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Au	ppm	Au 30g ICP-AES Finish	ppm	0.024	0.177	0.011	0.029	0.018	0.018	0.011	0.001	0.066	0.005
Ag (Silver)		27 element four acid ICP-AES	ppm	19	>100	23	8.2	>100	>100	21.5	34.3	>100	>100
Al (Aluminum)	%	27 element four acid ICP-AES	%	4.73	3.02	4.85	2.62	1.15	1.15	6.8	2.21	2.14	1.87
As (Arsenic)	ppm	27 element four acid ICP-AES	ppm	172	178	53	82	117	800	56	70	295	829
As (Barium)	ppm	27 element four acid ICP-AES	ppm	610	420	310	420	100	480	1180	410	150	230
Ba (Barium)	ppm	27 element four acid ICP-AES	ppm	1.2	0.8	0.8	0.5	0.6	0.5	1.5	0.7	<0.5	<0.5
Bi (Bismuth)	ppm	27 element four acid ICP-AES	ppm	<2	<2	<2	<2	<2	<2	2	<2	3	<2
Br (Bromine)	%	27 element four acid ICP-AES	%	1.47	0.3	3.09	0.08	0.02	0.03	0.08	0.02	0.04	0.02
Ca (Calcium)	ppm	27 element four acid ICP-AES	ppm	17.4	47.3	7.9	0.5	1	22.9	2	3.4	27.8	16.6
Co (Cobalt)	ppm	27 element four acid ICP-AES	ppm	6	1	21	<1	<1	<1	1	<1	5	<1
Cr (Chromium)	ppm	27 element four acid ICP-AES	ppm	71	53	42	52	25	53	110	56	51	46
Cu (Copper)	ppm	27 element four acid ICP-AES	ppm	21	128	100	14	73	242	27	11	295	211
Fe (Iron)	ppm	27 element four acid ICP-AES	ppm	3.71	3.06	5.41	1.83	1.28	6.51	2.51	1.71	3.17	3.67
Ga (Gallium)	ppm	27 element four acid ICP-AES	ppm	10	10	10							1.21
K (Potassium)	%	27 element four acid ICP-AES	%	1.16	0.73	0.46	0.51	0.27	0.81	2.12	0.62	0.27	0.52
La (Lanthanum)	ppm	27 element four acid ICP-AES	ppm	20	20	10							0.19
Mg (Magnesium)	%	27 element four acid ICP-AES	%	0.42	0.22	1.52	0.17	0.04	0.07	0.14	0.11	0.44	0.02
Mn (Manganese)	ppm	27 element four acid ICP-AES	ppm	8880	5920	1865	176	182	6630	94	155	2950	3590
Mo (Molybdenum)	ppm	27 element four acid ICP-AES	ppm	2	1	<1	<1	<1	<1	1	<1	<1	<1
Na (Sodium)	%	27 element four acid ICP-AES	%	0.15	0.09	0.49	0.09	0.02	0.06	0.14	0.05	0.19	0.04
Ni (Nickel)	ppm	27 element four acid ICP-AES	ppm	40	14	41	10	6	5	9	8	20	5
P (Phosphorous)	ppm	27 element four acid ICP-AES	ppm	650	430	730	70	80	440	370	500	270	320
Pb (Lead)	ppm	27 element four acid ICP-AES	ppm	992	5520	915	447	9330	>1000	668	691	7890	>1000
S (Sulphur)	%	27 element four acid ICP-AES	%	126	0.42	0.56	1.25	0.02	0.17	0.04	0.03	0.07	0.14
Sr (Strontium)	ppm	27 element four acid ICP-AES	ppm	24	161	27	22	54	282	17	20	136	256
Sc (Scandium)	ppm	27 element four acid ICP-AES	ppm	8	6	16							15
Sr (Strontium)	ppm	27 element four acid ICP-AES	ppm	99	47	128	27	8	29	94	30	41	18
Ti (Titanium)	ppm	27 element four acid ICP-AES	ppm	<20	<20	<20							12
Ti (Titanium)#	%	27 element four acid ICP-AES	%	0.24	0.15	0.69	0.24	0.08	0.11	0.36	0.14	0.23	0.1
U (Uranium)	ppm	27 element four acid ICP-AES	ppm	<10	<10	<10							0.06
V (Vanadium)	ppm	27 element four acid ICP-AES	ppm	<10	<10	<10							
W (Tungsten)	ppm	27 element four acid ICP-AES	ppm	77	57	197	65	16	48	108	42	72	32
Zn (Zinc)	ppm	27 element four acid ICP-AES	ppm	<10	<10	<10	10	<10	<10	<10	<10	<10	<10
Zn (Zinc)	ppm	27 element four acid ICP-AES	ppm	1430	1860	578	57	276	2050	306	357	1155	1040
Fire Assay Results for samples triggered due to concentration indicated during ICP testing													
Ag (Silver)	ppm	One Grade Ag - Four Acid	ppm	241				126	200			265	219
Ag (Silver)	oz. (troy) / Tonne	Calculated	ppm	7.75				4.05	9.22			8.52	7.04
Pb (Lead)	%	One Grade Pb - Four Acid	%										1.46
Zn (Zinc)	%	One Grade Zn - Four Acid	%										

Red = fire assay testing triggered

Keno Hill Waste Rock Chemistry Data			HECTOR adit dump		SIME 6 pit wall		SIME 4 pit wall		SIME 35 pit wall		SIME 4 & 6 pits wall		ONEK pit		ONEK pit dump		KENO 700	
MPA	Units	Method	95UKHH001	95UKHH002	95UKHH003	95UKHSP01	95UKHSP02	95UKHSP03	95UKHSP04	95UKHSP05	95UKHSD01	95UKHSP01	95UKHSD01	95UKHSD01	95UKHSD02	95UKHSD03	95UKHSD01	95UKHSD01
MPA		Basic Acid Base Accounting	60.3	53.8	0.3	1.9	1.3	0.3	1.3	0.9	0.6	0.6	0.3	0.3	0.3	1.9	0.3	17.8
FLZZ RATING	OA-VOL08	Basic Acid Base Accounting	2	3	1	3	1	1	1	1	1	1	1	1	1	1	1	3
NIP	OA-VOL08	Basic Acid Base Accounting	1	49	1	2	1	1	3	2	3	55	17	1	1	36	17	35
NIP	OA-VOL08	Basic Acid Base Accounting	61	103	41	4	4	2	4	4	64	17	1	1	1	38	17	35
pH	OA-EL07	Paste pH	6	7.2	7.4	7.1	7.1	7.5	7.4	7.6	8	8.4	8.7	8.1	7.8	7.7	7.8	1.96
Ratio (NP:MPA)	OA-EL08	Basic Acid Base Accounting	1.01	1.92	1.87	2.13	1.6	3.2	3.2	3.2	6.4	6.83	54.4	3.2	20.27	20.27	1.96	0.57
S	S-IR08	Total Sulphur (Leco)	1.93	1.72	0.7	0.7	0.06	0.04	0.01	0.04	0.03	0.02	0.3	0.01	0.01	0.06	0.06	0.04
S	S-GR06	Sulfate Sulphur (HCl leachable)	0.45	0.26	0.18	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04
S	S-GR06a	Sulfate Sulphur (HCl leachable)	0.43	0.24	0.16	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04
S	S-GR06b	Sulfate Sulphur (calculated)	1.48	1.46	0.52	0.04	0.03	0.01	0.04	0.03	0.02	0.3	0.01	0.01	0.01	0.06	0.53	0.53
C	C-GR05	Inorganic Carbon (CO2)	0.91	1.82	0.63	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.88	0.11	<0.05	0.51	0.47	0.47	0.47
CO2	C-GR05	Inorganic Carbon (CO2)	3.3	6.7	2.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	3.3	0.4	<0.2	1.9	1.7	1.7	1.7
Au	ME-ICP21	Au 30g FA/ICP-AES Finish	0.058	0.039	0.022	0.179	0.069	0.011	0.066	0.003	0.004	<0.01	<0.01	<0.01	0.004	0.001	0.116	0.116
Ag (Silver)	ME-ICP61	27 element four acid ICP-AES	>100	60.1	94.8	57.4	8.9	2.9	0.71	1.3	1.2	<0.5	<0.5	<0.5	4.9	<0.5	90.5	90.5
Al (Aluminum)	ME-ICP61	27 element four acid ICP-AES	3.44	3.48	7.04	2.97	7.04	0.43	5.52	3.59	0.58	3.92	8.55	0.58	9.26	1.72	1.72	1.72
As (Arsenic)	ME-ICP61	27 element four acid ICP-AES	352	733	188	59	36	84	18	37	29	9	7	85	25	423	423	423
Ba (Barium)	ME-ICP61	27 element four acid ICP-AES	500	510	680	1070	480	70	940	440	80	500	20	50	1160	310	310	310
Be (Beryllium)	ME-ICP61	27 element four acid ICP-AES	0.8	0.6	0.8	1.9	0.7	<0.5	1.4	0.9	<0.5	1	0.7	<0.5	2.3	<0.5	<0.5	<0.5
Bi (Bismuth)	ME-ICP61	27 element four acid ICP-AES	2	2	2	2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ca (Calcium)	ME-ICP61	27 element four acid ICP-AES	0.57	0.95	0.67	0.09	0.02	0.02	0.2	0.1	0.05	2.65	8.32	0.05	1.69	0.67	0.67	0.67
Cd (Cadmium)	ME-ICP61	27 element four acid ICP-AES	203	211	614	9.6	2.1	4.5	2.3	10.3	7.8	2.9	0.9	6.2	1.4	85.2	85.2	85.2
Co (Cobalt)	ME-ICP61	27 element four acid ICP-AES	1	5	4	1	1	<1	<1	<1	2	6	41	<1	12	3	3	3
Cr (Chromium)	ME-ICP61	27 element four acid ICP-AES	50	48	63	87	60	27	95	79	34	58	109	42	112	48	48	48
Cu (Copper)	ME-ICP61	27 element four acid ICP-AES	109	58	51	59	16	7	28	7	2	11	144	55	28	68	68	68
Fe (Iron)	ME-ICP61	27 element four acid ICP-AES	4.8	5.35	2.91	2.84	1.59	0.46	3.12	2.09	0.45	2.17	8.5	1	4.52	2.19	2.19	2.19
Ga (Gallium)	ME-ICP61	27 element four acid ICP-AES																
K (Potassium)	ME-ICP61	27 element four acid ICP-AES	0.92	0.74	1.05	2.36	0.93	0.12	1.16	0.79	0.16	0.76	0.02	0.17	1.78	0.49	0.49	0.49
La (Lanthanum)	ME-ICP61	27 element four acid ICP-AES																
Mg (Magnesium)	ME-ICP61	27 element four acid ICP-AES	0.27	0.46	0.3	0.16	0.1	0.02	0.37	0.12	0.02	0.26	4.15	0.04	0.36	0.18	0.18	0.18
Mn (Manganese)	ME-ICP61	27 element four acid ICP-AES	13550	23900	8300	952	174	73	229	752	732	275	1440	163	277	3870	3870	3870
Mo (Molybdenum)	ME-ICP61	27 element four acid ICP-AES	<1	<1	1	1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Na (Sodium)	ME-ICP61	27 element four acid ICP-AES	0.08	0.06	0.1	0.17	0.05	0.01	0.26	0.1	0.02	0.16	1.08	0.02	0.31	0.07	0.07	0.07
Ni (Nickel)	ME-ICP61	27 element four acid ICP-AES	16	21	15	10	5	2	21	16	4	21	93	2	54	13	13	13
P (Phosphorous)	ME-ICP61	27 element four acid ICP-AES	440	350	390	740	440	120	1210	450	110	450	610	170	1030	260	260	260
Pb (Lead)	ME-ICP61	27 element four acid ICP-AES	5170	3020	2530	2250	1230	262	48	103	68	43	19	224	79	7170	7170	7170
S (Sulphur)	ME-ICP61	27 element four acid ICP-AES	2	1.78	0.73	0.06	0.04	0.01	0.04	0.03	0.02	0.32	0.01	0.01	0.01	0.07	0.59	0.59
Sr (Strontium)	ME-ICP61	27 element four acid ICP-AES	130	78	39	46	17	19	<5	9	<5	5	11	6	<5	96	96	96
Sc (Scandium)	ME-ICP61	27 element four acid ICP-AES																
Sr (Strontium)	ME-ICP61	27 element four acid ICP-AES	37	42	55	103	30	8	108	43	10	207	253	6	226	42	42	42
Th (Thorium)	ME-ICP61	27 element four acid ICP-AES																
Ti (Titanium)	ME-ICP61	27 element four acid ICP-AES	0.16	0.13	0.17	0.38	0.19	0.05	0.27	0.2	0.06	0.2	0.97	0.07	0.27	0.13	0.13	0.13
Tl (Thallium)#	ME-ICP61	27 element four acid ICP-AES																
U (Uranium)	ME-ICP61	27 element four acid ICP-AES	54	47	58	117	49	8	108	60	9	59	341	12	145	31	31	31
V (Vanadium)	ME-ICP61	27 element four acid ICP-AES	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
W (Tungsten)	ME-ICP61	27 element four acid ICP-AES	>10000	>10000	4640	778	224	108	161	414	309	421	181	172	168	5920	5920	5920
Zn (Zinc)	ME-ICP61	27 element four acid ICP-AES																
Fire Assay Results for samples triggered due to concentration indicated during ICP testing																		
Ag (Silver)	Ag-OG62	One Grade Ag - Four Acid	123															
Ag (Silver)	Ag (Silver)	Calculated	3.95															
Pb (Lead)	Pb-OG62	One Grade Pb - Four Acid																
Zn (Zinc)	Zn-OG62	One Grade Zn - Four Acid	1.62	1.66														

Red = fire assay testing triggered

Red = fire assay testing triggered

APPENDIX A3-1

Samp_ID	LCH_Al_mg/kg	LCH_Sb_mg/	LCH_As_mg/	LCH_Ba_mg/	LCH_Be_mg/	LCH_Bi_mg/kg	LCH_B_mg/kg	LCH_Cd_mg/	LCH_Ca_mg/	LCH_Cr_mg/kg	LCH_Co_mg/	LCH_Cu_mg/	LCH_Fe_mg/	LCH_Pb_mg/	LCH_Li_mg/kg	LCH_Mg_mg/	LCH_Mn_mg/
	g	kg	kg	kg	kg	g	g	kg	kg	g	kg	kg	kg	kg	g	kg	kg
95UKHDD01	115.800	0.006	0.015	0.327	0.030	0.030	0.600	0.519	804.000	0.069	0.143	0.375	45.600	1.221	0.300	144.300	271.800
95UKHDD02	294.600	0.033	0.390	0.015	0.150	0.150	3.000	7.230	444.000	0.630	0.630	3.420	564.000	0.209	1.500	91.200	621.000
95UKHDD03	8.040	0.003	0.003	0.132	0.015	0.015	0.300	1.500	1533.000	0.015	0.324	0.220	6.090	0.075	0.198	186.300	47.700
95UKHBP01	0.033	0.009	0.003	0.028	0.002	0.002	0.039	0.001	15.660	0.003	0.000	0.005	0.090	0.005	0.020	3.300	0.426
95UKHBP02	0.059	0.013	0.022	0.007	0.002	0.002	0.030	0.001	33.900	0.005	0.000	0.002	0.108	0.002	0.029	6.390	0.013
95UKHBP03	0.061	0.006	0.005	0.020	0.002	0.002	0.039	0.002	9.930	0.003	0.000	0.002	0.090	0.003	0.026	2.760	0.071
95UKHBP04	0.079	0.011	0.002	0.005	0.002	0.002	0.030	0.001	5.610	0.007	0.000	0.005	0.090	0.003	0.015	1.410	0.049
95UKHBP06	0.059	0.017	0.002	0.070	0.003	0.003	0.060	0.003	426.000	0.003	0.005	0.015	0.090	0.007	0.048	91.200	3.780
95UKHBP07	2.520	0.017	0.003	0.026	0.002	0.002	0.033	0.001	15.030	0.002	0.001	0.013	1.227	0.006	0.026	4.770	0.133
95UKHBD01	0.009	0.002	0.001	0.007	0.002	0.002	0.030	0.036	141.000	0.002	0.000	0.002	0.090	0.007	0.038	78.300	0.093
95UKHBD02	0.609	0.004	0.020	0.034	0.002	0.002	0.030	0.037	259.500	0.002	0.002	0.010	0.645	0.106	0.033	84.600	0.846
95UKHBD03	0.300	0.030	0.030	0.171	0.150	0.150	3.000	107.100	408.000	0.150	0.192	0.048	0.090	4.350	1.500	153.000	366.000
95UKHBD04	0.016	0.002	0.001	0.019	0.003	0.003	0.060	0.134	137.400	0.003	0.001	0.003	0.090	0.056	0.057	59.700	0.828
95UKHBD05	0.009	0.006	0.001	0.008	0.002	0.002	0.033	0.006	13.560	0.002	0.000	0.003	0.090	0.002	0.015	3.720	5.820
95UKHBD06	0.044	0.016	0.002	0.018	0.002	0.002	0.030	0.411	18.450	0.002	0.001	0.003	0.090	0.032	0.015	4.980	1.383
95UKHRD01	0.885	0.009	0.020	0.079	0.015	0.015	0.300	0.047	1644.000	0.015	0.013	0.008	0.948	0.115	0.150	615.000	10.440
95UKHRD02	0.015	0.004	0.002	0.127	0.008	0.008	0.150	3.750	1053.000	0.008	0.071	0.138	0.090	3.510	0.075	147.900	42.600
95UKHRD03	0.140	0.008	0.002	0.118	0.008	0.008	0.150	0.183	1317.000	0.008	0.121	0.005	0.162	0.014	0.108	138.600	49.800
95UKHCD01	0.009	0.002	0.000	0.064	0.002	0.002	0.039	0.006	3.660	0.002	0.001	0.002	0.090	4.680	0.015	0.510	0.091
95UKHCD02	0.065	0.002	0.002	0.918	0.008	0.008	0.150	0.231	96.900	0.008	0.004	0.032	0.090	48.900	0.075	11.100	1.035
95UKHCD03	0.003	0.005	0.001	0.125	0.002	0.002	0.036	0.032	8.250	0.002	0.000	0.004	0.090	0.095	0.015	0.750	0.075
95UKHCP01	0.426	0.004	0.002	0.018	0.002	0.002	0.063	0.003	2.169	0.002	0.000	0.012	0.090	0.123	0.015	0.480	0.130
95UKHCP02	0.012	0.009	0.002	0.023	0.002	0.002	0.036	0.051	11.190	0.002	0.004	0.015	0.090	0.236	0.016	1.620	1.845
95UKHWD01	474.000	0.027	4.200	0.040	0.030	0.030	0.600	0.194	387.000	1.350	0.068	3.120	1854.000	0.432	0.810	285.900	59.100
95UKHSD04	0.011	0.002	0.001	0.777	0.002	0.002	0.030	0.570	20.580	0.002	0.011	0.015	0.090	5.250	0.015	4.890	1.344
95UKHMD01	0.074	0.005	0.002	0.077	0.002	0.002	0.036	0.001	10.170	0.008	0.000	0.008	0.108	0.095	0.015	0.750	0.075
95UKHHD01	2.400	0.030	0.036	0.061	0.150	0.150	3.000	15.090	1254.000	0.150	0.945	0.051	0.270	5.340	1.500	227.700	1545.000
95UKHHD02	0.240	0.014	0.014	0.258	0.015	0.015	0.300	3.300	1449.000	0.015	0.065	0.034	0.090	0.444	0.150	255.000	51.300
95UKHHD03	0.066	0.014	0.004	0.186	0.008	0.008	0.150	1.050	1374.000	0.008	0.016	0.023	0.090	0.263	0.075	144.900	16.230
95UKHSP01	0.086	0.003	0.001	0.068	0.002	0.002	0.066	0.051	3.360	0.002	0.001	0.007	0.090	0.957	0.015	0.600	0.690
95UKHSP02	0.017	0.003	0.002	0.013	0.002	0.002	0.060	0.007	3.480	0.002	0.001	0.012	0.090	0.132	0.018	0.870	0.546
95UKHSP03	0.025	0.047	0.015	0.008	0.002	0.002	0.030	0.007	6.990	0.002	0.000	0.004	0.090	0.099	0.015	0.780	0.173
95UKHSP04	0.036	0.004	0.002	0.010	0.002	0.002	0.030	0.004	16.260	0.002	0.000	0.005	0.090	0.029	0.038	1.680	0.193
95UKHSP05	0.357	0.011	0.008	0.013	0.002	0.002	0.030	0.009	5.730	0.002	0.000	0.005	0.243	0.080	0.018	0.510	0.262
95UKHSD01	0.122	0.009	0.007	0.001	0.002	0.002	0.030	0.004	28.710	0.004	0.000	0.001	0.090	0.005	0.015	1.680	0.218
95UKHOP01	0.468	0.007	0.003	0.008	0.002	0.002	0.033	0.000	56.100	0.002	0.000	0.004	0.090	0.005	0.017	5.220	0.021
95UKHOD01	0.810	0.038	0.035	0.004	0.002	0.002	0.030	0.000	29.790	0.002	0.000	0.008	0.294	0.001	0.015	1.950	0.011
95UKHOD02	0.257	0.010	0.014	0.026	0.002	0.002	0.081	0.006	5.400	0.004	0.000	0.010	0.243	0.053	0.015	0.930	0.254
95UKHOD03	0.146	0.003	0.004	0.040	0.002	0.002	0.036	0.000	118.800	0.002	0.000	0.010	0.090	0.027	0.020	13.200	0.016
95UKHKD01	0.030	0.028	0.004	0.119	0.003	0.003	0.060	0.522	402.000	0.002	0.006	0.025	0.090	0.315	0.030	18.270	2.103
95UKHKD02	0.030	0.024	0.018	0.116	0.003	0.003	0.060	0.061	465.000	0.003	0.001	0.016	0.090	0.060	0.030	57.900	0.603
95UKHJD01	0.133	0.017	0.002	0.123	0.002	0.002	0.042	0.040	11.280	0.002	0.001	0.013	0.090	0.488	0.020	2.100	0.510
95UKHTD01	1.440	0.060	0.060	0.081	0.300	0.300	6.000	16.740	275.100	0.300	1.083	0.114	0.090	2.643	3.000	141.900	1365.000
95UKHTD02	0.134	0.019	0.003	0.108	0.008	0.008	0.150	3.870	185.400	0.008	0.022	0.027	0.090	9.090	0.075	193.800	15.180
95UKHLD01	0.087	0.026	0.016	0.124	0.008	0.008	0.150	0.028	642.000	0.008	0.002	0.014	0.090	0.139	0.075	39.000	0.957
95UKHVD01	263.100	0.003	0.525	0.024	0.018	0.015	0.300	0.345	1518.000	0.702	0.921	3.390	342.000	0.134	0.465	219.900	63.000
95UKGK901	135.600	0.015	0.015	0.151	0.075	0.075	1.500	0.299	1206.000	0.075	1.107	1.146	43.800	0.687	0.750	375.000	292.500

APPENDIX A3-1

Samp_ID	LCH_Hg_mg/ kg	LCH_Mo_mg/ kg	LCH_Ni_mg/kg	LCH_P_mg/kg	LCH_K_mg/kg	LCH_Se_mg/kg	LCH_Si_mg/kg	LCH_Ag_mg/ kg	LCH_Na_mg/ kg	LCH_Sr_mg/kg	LCH_Ti_mg/kg	LCH_Sn_mg/kg	LCH_U_mg/kg	LCH_V_mg/kg	LCH_Zn_mg/ kg
95UKHDD01	0.003	0.003	0.702	0.900	10.200	0.060	17.520	0.014	6.000	0.504	0.008	0.006	0.028	0.060	22.260
95UKHDD02	0.003	0.015	2.943	4.770	6.000	0.300	13.050	0.003	6.000	0.291	0.030	0.030	0.151	0.300	429.000
95UKHDD03	0.003	0.002	1.251	0.900	13.500	0.030	11.310	0.000	6.000	0.525	0.004	0.003	0.001	0.030	87.000
95UKHBP01	0.003	0.000	0.010	0.900	12.600	0.003	11.970	0.000	6.000	0.073	0.000	0.000	0.000	0.030	0.237
95UKHBP02	0.003	0.001	0.002	0.900	6.000	0.003	9.120	0.001	12.600	0.077	0.000	0.000	0.000	0.003	0.018
95UKHBP03	0.003	0.000	0.002	0.900	8.100	0.003	11.550	0.001	6.000	0.052	0.000	0.000	0.000	0.003	0.032
95UKHBP04	0.003	0.000	0.002	0.900	6.000	0.003	7.440	0.000	6.000	0.024	0.000	0.000	0.000	0.003	0.024
95UKHBP06	0.003	0.019	0.012	0.900	18.900	0.024	7.230	0.000	6.000	1.134	0.001	0.001	0.005	0.006	0.024
95UKHBP07	0.003	0.015	0.002	0.900	10.500	0.004	17.370	0.000	7.800	0.033	0.000	0.000	0.000	0.003	0.021
95UKHBD01	0.003	0.000	0.002	0.900	7.800	0.015	6.000	0.001	14.400	0.209	0.000	0.000	0.000	0.003	0.131
95UKHBD02	0.003	0.000	0.005	0.900	10.500	0.023	6.870	0.003	18.600	0.300	0.000	0.000	0.000	0.003	0.296
95UKHBD03	0.003	0.015	0.498	0.900	19.200	0.300	5.550	0.003	17.700	0.663	0.030	0.030	0.003	0.300	798.000
95UKHBD04	0.003	0.000	0.004	0.900	10.200	0.022	5.430	0.000	6.000	0.168	0.001	0.001	0.000	0.006	1.053
95UKHBD05	0.003	0.001	0.002	0.900	6.000	0.005	7.320	0.000	6.000	0.070	0.000	0.000	0.000	0.003	0.053
95UKHBD06	0.003	0.000	0.003	0.900	6.000	0.003	7.620	0.000	6.000	0.089	0.000	0.000	0.000	0.003	3.150
95UKHRD01	0.003	0.002	0.071	0.900	18.000	0.030	3.900	0.003	6.000	2.352	0.003	0.003	0.002	0.030	0.315
95UKHRD02	0.003	0.001	0.432	0.900	13.800	0.015	7.350	0.001	6.000	0.896	0.002	0.002	0.000	0.015	48.600
95UKHRD03	0.003	0.001	0.408	0.900	14.400	0.015	6.570	0.000	6.000	0.972	0.002	0.002	0.001	0.015	1.770
95UKHCD01	0.003	0.000	0.005	0.900	6.900	0.003	6.180	0.005	6.000	0.020	0.001	0.000	0.000	0.003	0.095
95UKHCD02	0.003	0.001	0.020	0.900	36.300	0.015	10.560	0.014	18.600	0.468	0.002	0.002	0.000	0.015	1.980
95UKHCD03	0.003	0.000	0.003	0.900	9.300	0.003	8.610	0.002	6.000	0.062	0.000	0.000	0.000	0.003	0.155
95UKHCP01	0.003	0.000	0.002	0.900	18.600	0.007	9.510	0.001	6.000	0.017	0.000	0.000	0.000	0.003	0.058
95UKHCP02	0.003	0.000	0.013	0.900	10.500	0.005	7.950	0.000	6.000	0.050	0.000	0.000	0.000	0.003	0.576
95UKHWD01	0.003	0.007	2.727	6.810	6.000	0.060	20.310	0.004	6.000	0.789	0.006	0.006	0.033	0.705	13.080
95UKHCD04	0.003	0.002	0.026	0.900	7.200	0.003	10.350	0.000	6.000	0.175	0.000	0.000	0.000	0.003	3.090
95UKHMD01	0.003	0.000	0.002	0.900	6.000	0.003	8.160	0.000	6.000	0.019	0.000	0.000	0.000	0.003	0.125
95UKHHD01	0.003	0.016	1.989	0.900	16.800	0.300	6.960	0.003	6.000	1.296	0.030	0.030	0.003	0.300	831.000
95UKHHD02	0.003	0.002	0.221	0.900	15.000	0.030	6.180	0.000	6.000	2.292	0.003	0.003	0.001	0.030	98.700
95UKHHD03	0.003	0.001	0.078	0.900	20.400	0.015	6.090	0.000	6.000	1.389	0.002	0.002	0.001	0.015	11.070
95UKHSP01	0.003	0.001	0.005	0.900	19.200	0.003	11.970	0.003	6.000	0.020	0.000	0.000	0.000	0.003	0.597
95UKHSP02	0.003	0.000	0.004	0.900	12.300	0.003	10.740	0.000	6.000	0.019	0.000	0.000	0.000	0.003	0.103
95UKHSP03	0.003	0.000	0.002	0.900	6.000	0.003	5.070	0.000	6.000	0.030	0.000	0.000	0.000	0.003	0.039
95UKHSP04	0.003	0.002	0.002	0.900	6.000	0.009	11.130	0.000	6.000	0.042	0.000	0.000	0.000	0.003	0.095
95UKHSP05	0.003	0.001	0.003	0.900	6.900	0.003	6.330	0.001	6.000	0.019	0.000	0.000	0.000	0.003	0.263
95UKHSD01	0.003	0.001	0.002	0.900	6.000	0.003	5.010	0.000	6.000	0.028	0.000	0.000	0.000	0.003	0.142
95UKHOP01	0.003	0.006	0.002	0.900	12.600	0.009	5.370	0.000	6.000	0.167	0.000	0.000	0.001	0.003	0.012
95UKHOD01	0.003	0.006	0.002	0.900	6.000	0.003	12.090	0.000	6.000	0.061	0.000	0.000	0.000	0.014	0.015
95UKHOD02	0.003	0.001	0.002	0.900	6.000	0.003	7.560	0.001	6.000	0.038	0.000	0.000	0.000	0.003	0.083
95UKHOD03	0.003	0.004	0.002	0.900	12.300	0.020	6.120	0.000	13.500	0.309	0.000	0.000	0.001	0.003	0.015
95UKHKD01	0.003	0.003	0.016	0.900	9.600	0.006	6.720	0.001	6.000	0.615	0.001	0.001	0.000	0.006	5.280
95UKHKD02	0.003	0.056	0.003	0.900	14.100	0.006	6.270	0.000	6.000	1.005	0.001	0.001	0.002	0.006	0.663
95UKHJD01	0.003	0.000	0.004	0.900	9.300	0.003	10.770	0.001	6.000	0.046	0.000	0.000	0.000	0.003	0.354
95UKHTD01	0.003	0.030	1.860	0.900	15.000	0.600	6.720	0.006	6.000	0.420	0.060	0.060	0.006	0.600	867.000
95UKHTD02	0.003	0.001	0.088	0.900	12.300	0.015	12.060	0.000	6.000	0.068	0.002	0.002	0.000	0.015	51.000
95UKHLD01	0.003	0.029	0.008	0.900	20.100	0.015	6.480	0.000	27.000	0.996	0.002	0.002	0.007	0.015	0.249
95UKHVD01	0.003	0.002	1.335	1.980	6.000	0.030	23.580	0.003	6.000	1.158	0.003	0.003	0.093	0.030	13.680
95UKGK901	0.003	0.008	3.780	0.900	13.500	0.150	17.460	0.002	6.000	1.329	0.015	0.015	0.022	0.150	25.290

APPENDIX A3-1

Samp_ID	%Extr_Ag	%Extr_AI	%Extr_As	%Extr_Ba	%Extr_Be	%Extr_Bi	%Extr_Ca	%Extr_Cd	%Extr_Co	%Extr_Cr	%Extr_Cu	%Extr_Fe	%Extr_K	%Extr_Mg	%Extr_Mn	%Extr_Na	%Extr_Ni
95UKHDD01	0.8%	0.6%	0.02%	0.1%	5.0%	1.5%	32.2%	104%	14.3%	0.2%	4.2%	0.2%	0.3%	9.0%	26.1%	0.8%	8.8%
95UKHDD02	0.0%	2.3%	0.80%	0.0%	30.0%	7.5%	44.4%	123%	63.0%	1.9%	22.8%	4.7%	0.2%	15.2%	89.9%	3.0%	49.1%
95UKHDD03	0.0%	0.0%	0.01%	0.0%	1.5%	0.8%	30.1%	41%	16.2%	0.0%	2.0%	0.0%	0.2%	7.8%	26.6%	0.4%	8.3%
95UKHBP01	0.0%	0.0%	0.00%	0.0%	0.3%	0.1%	2.6%	0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.2%	0.0%	0.1%	0.0%
95UKHBP02	0.0%	0.0%	0.01%	0.0%	0.1%	0.1%	1.9%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.8%	0.0%
95UKHBP03	0.0%	0.0%	0.00%	0.0%	0.1%	0.1%	1.2%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.4%	0.0%
95UKHBP04	0.0%	0.0%	0.01%	0.0%	0.3%	0.1%	2.8%	0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.1%	0.0%	1.5%	0.0%
95UKHBP06	0.0%	0.0%	0.00%	0.0%	0.3%	0.2%	2.2%	0%	0.1%	0.0%	0.1%	0.0%	0.1%	1.0%	0.5%	0.2%	0.0%
95UKHBP07	0.0%	0.0%	0.06%	0.0%	0.1%	0.1%	1.0%	0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%
95UKHBD01	0.0%	0.0%	0.00%	0.0%	0.2%	0.0%	6.4%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	3.3%	0.0%	1.8%	0.0%
95UKHBD02	0.0%	0.0%	0.00%	0.0%	0.2%	0.0%	14.4%	0%	0.1%	0.0%	0.0%	0.0%	0.1%	3.5%	0.0%	2.3%	0.0%
95UKHBD03	0.0%	0.0%	0.00%	0.1%	25.0%	2.1%	7.2%	15%	19.2%	0.5%	0.0%	0.0%	0.4%	4.0%	0.4%	4.4%	4.5%
95UKHBD04	0.0%	0.0%	0.00%	0.0%	0.4%	0.1%	9.2%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	2.4%	0.0%	0.6%	0.0%
95UKHBD05	0.0%	0.0%	0.00%	0.0%	0.3%	0.1%	4.5%	0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.9%	0.2%	6.0%	0.1%
95UKHBD06	0.0%	0.0%	0.00%	0.0%	0.3%	0.1%	9.2%	5%	0.1%	0.0%	0.0%	0.0%	0.2%	1.0%	0.1%	2.0%	0.1%
95UKHRD01	0.0%	0.0%	0.01%	0.0%	1.3%	0.8%	11.2%	0%	0.2%	0.0%	0.0%	0.0%	0.2%	14.6%	0.1%	0.4%	0.2%
95UKHRD02	0.0%	0.0%	0.00%	0.0%	0.9%	0.4%	35.1%	8%	7.1%	0.0%	0.1%	0.0%	0.2%	6.7%	0.7%	0.7%	3.1%
95UKHRD03	0.0%	0.0%	0.00%	0.0%	0.9%	0.4%	4.3%	2%	0.6%	0.0%	0.0%	0.0%	0.3%	0.9%	2.7%	0.1%	1.0%
95UKHCD01	0.0%	0.0%	0.00%	0.1%	0.3%	0.1%	1.8%	1%	0.1%	0.0%	0.0%	0.0%	0.3%	0.1%	0.0%	3.0%	0.1%
95UKHCD02	0.0%	0.0%	0.00%	0.2%	1.3%	0.4%	32.3%	1%	0.4%	0.0%	0.0%	0.0%	0.4%	1.6%	0.0%	3.1%	0.4%
95UKHCD03	0.0%	0.0%	0.00%	0.1%	0.3%	0.1%	4.1%	0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.0%	1.5%	0.1%
95UKHCP01	0.0%	0.0%	0.00%	0.0%	0.1%	0.1%	1.1%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.4%	0.0%
95UKHCP02	0.0%	0.0%	0.00%	0.0%	0.2%	0.1%	2.2%	1%	0.4%	0.0%	0.1%	0.0%	0.2%	0.1%	1.2%	1.2%	0.2%
95UKHWD01	0.0%	1.8%	5.12%	0.0%	6.0%	1.5%	48.4%	39%	106.8%	2.6%	22.3%	10.1%	0.1%	16.8%	33.6%	0.7%	27.3%
95UKHCD04	0.0%	0.0%	0.00%	0.5%	0.3%	0.1%	5.1%	2%	0.2%	0.0%	0.0%	0.0%	0.3%	0.1%	0.0%	0.3%	0.1%
95UKHMD01	0.0%	0.0%	0.00%	0.1%	0.3%	0.1%	3.4%	0%	0.0%	0.0%	0.1%	0.0%	0.3%	0.4%	0.0%	3.0%	0.1%
95UKHHD01	0.0%	0.0%	0.01%	0.0%	18.8%	7.5%	22.0%	7%	94.5%	0.3%	0.0%	0.0%	0.2%	8.4%	11.4%	0.8%	12.4%
95UKHHD02	0.0%	0.0%	0.00%	0.1%	2.5%	0.8%	15.3%	2%	1.3%	0.0%	0.1%	0.0%	0.2%	5.5%	0.2%	1.0%	1.1%
95UKHHD03	0.0%	0.0%	0.00%	0.0%	0.9%	0.4%	20.5%	2%	0.4%	0.0%	0.0%	0.0%	0.2%	4.8%	0.2%	0.6%	0.5%
95UKHSP01	0.0%	0.0%	0.00%	0.0%	0.1%	0.1%	0.4%	1%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.4%	0.1%
95UKHSP02	0.0%	0.0%	0.00%	0.0%	0.2%	0.1%	1.7%	0%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%	0.3%	1.2%	0.1%
95UKHSP03	0.0%	0.0%	0.02%	0.0%	0.3%	0.1%	3.5%	0%	0.0%	0.0%	0.1%	0.0%	0.5%	0.4%	0.2%	6.0%	0.1%
95UKHSP04	0.0%	0.0%	0.01%	0.0%	0.1%	0.1%	0.8%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.2%	0.0%
95UKHSP05	0.1%	0.0%	0.02%	0.0%	0.2%	0.1%	0.6%	0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.6%	0.0%
95UKHSD01	0.0%	0.0%	0.02%	0.0%	0.3%	0.1%	5.7%	0%	0.0%	0.0%	0.1%	0.0%	0.4%	0.8%	0.0%	3.0%	0.0%
95UKHOP01	0.0%	0.0%	0.03%	0.0%	0.2%	0.1%	0.2%	0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.0%	0.4%	0.0%
95UKHOD01	0.0%	0.0%	0.51%	0.0%	0.2%	0.1%	0.0%	0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.1%	0.0%
95UKHOD02	0.0%	0.0%	0.02%	0.1%	0.3%	0.1%	1.1%	0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%	0.2%	3.0%	0.1%
95UKHOD03	0.0%	0.0%	0.01%	0.0%	0.1%	0.1%	0.7%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	0.0%	0.4%	0.0%
95UKHKD01	0.0%	0.0%	0.00%	0.0%	0.6%	0.1%	6.0%	1%	0.2%	0.0%	0.0%	0.0%	0.2%	1.0%	0.1%	0.9%	0.1%
95UKHKD02	0.0%	0.0%	0.00%	0.0%	0.3%	0.1%	6.8%	0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.7%	0.0%	0.3%	0.0%
95UKHUD01	0.0%	0.0%	0.00%	0.0%	0.1%	0.1%	1.0%	1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.3%	0.0%
95UKHTD01	0.0%	0.0%	0.05%	0.0%	60.0%	15.0%	17.2%	18%	27.1%	0.5%	0.3%	0.0%	0.3%	10.9%	18.7%	1.5%	20.7%
95UKHTD02	0.0%	0.0%	0.00%	0.0%	1.1%	0.4%	23.2%	7%	2.2%	0.0%	0.0%	0.0%	0.3%	19.4%	0.4%	1.2%	0.7%
95UKHLD01	0.0%	0.0%	0.00%	0.0%	1.3%	0.4%	2.4%	0%	0.1%	0.0%	0.1%	0.0%	0.4%	1.5%	0.0%	4.5%	0.0%
95UKHVD01	0.0%	0.6%	0.18%	0.0%	2.0%	0.8%	50.6%	25%	92.1%	1.3%	13.6%	1.5%	0.0%	8.8%	26.8%	0.4%	12.1%
95UKGK901	0.0%	0.4%	0.01%	0.0%	8.3%	3.8%	29.4%	27%	55.4%	0.1%	6.0%	0.2%	0.1%	13.9%	49.3%	0.5%	21.0%

Samp_ID	%Extr_P	%Extr_Pb	%Extr_Sb	%Extr_Sr	%Extr_V	%Extr_Zn	%Extr_Ag_or_e	%Extr_Pb_or_e	%Extr_Zn_ore
95UKHDD01	0.3%	1.5%	0.0%	1.4%	0.1%	23.9%			
95UKHDD02	1.2%	0.0%	0.1%	1.5%	1.0%	87.7%			
95UKHDD03	0.2%	0.1%	0.0%	0.9%	0.0%	40.7%			
95UKHBP01	0.2%	0.0%	0.0%	0.3%	0.0%	0.0%			
95UKHBP02	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%			
95UKHBP03	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%			
95UKHBP04	0.6%	0.0%	0.1%	0.1%	0.0%	0.0%			
95UKHBP06	0.1%	0.0%	0.3%	0.9%	0.0%	0.0%			
95UKHBP07	0.3%	0.0%	0.2%	0.0%	0.0%	0.0%			
95UKHBD01	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	
95UKHBD02	0.1%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	
95UKHBD03	0.1%	0.0%	0.0%	1.8%	0.8%	8.0%	0.0%	0.0%	6.8%
95UKHBD04	0.2%	0.0%	0.0%	0.2%	0.0%	0.0%			
95UKHBD05	0.5%	0.0%	0.1%	0.7%	0.0%	0.0%			
95UKHBD06	0.6%	0.0%	0.1%	0.3%	0.0%	1.1%			
95UKHRD01	0.1%	0.0%	0.0%	2.4%	0.0%	0.0%			
95UKHRD02	0.2%	0.1%	0.0%	1.5%	0.0%	2.6%	0.0%		
95UKHRD03	0.1%	0.0%	0.0%	0.8%	0.0%	0.3%			
95UKHCD01	1.1%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	
95UKHCD02	0.2%	0.5%	0.0%	1.6%	0.0%	0.1%	0.0%	0.3%	
95UKHCD03	0.3%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	
95UKHCP01	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%			
95UKHCP02	0.2%	0.0%	0.0%	0.2%	0.0%	0.2%			
95UKHWD01	9.7%	0.1%	0.1%	2.9%	1.1%	22.9%			
95UKHCD04	0.3%	0.1%	0.0%	0.4%	0.0%	0.3%	0.0%	0.0%	
95UKHMD01	0.4%	0.0%	0.0%	0.2%	0.0%	0.0%			
95UKHHD01	0.2%	0.1%	0.0%	3.5%	0.6%	8.3%	0.0%	0.0%	5.1%
95UKHHD02	0.3%	0.0%	0.0%	5.5%	0.1%	1.0%			0.6%
95UKHHD03	0.2%	0.0%	0.0%	2.5%	0.0%	0.2%			
95UKHSP01	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%			
95UKHSP02	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%			
95UKHSP03	0.8%	0.0%	0.2%	0.4%	0.0%	0.0%			
95UKHSP04	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%			
95UKHSP05	0.2%	0.0%	0.1%	0.0%	0.0%	0.1%			
95UKHSD01	0.8%	0.0%	0.2%	0.3%	0.0%	0.0%			
95UKHOP01	0.2%	0.0%	0.1%	0.1%	0.0%	0.0%			
95UKHOD01	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%			
95UKHOD02	0.5%	0.0%	0.2%	0.6%	0.0%	0.0%			
95UKHOD03	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%			
95UKHKD01	0.3%	0.0%	0.0%	1.5%	0.0%	0.1%			
95UKHKD02	0.3%	0.0%	0.1%	1.0%	0.0%	0.0%			
95UKHUD01	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%			
95UKHTD01	0.3%	0.3%	0.2%	2.0%	1.7%	12.3%			
95UKHTD02	0.2%	0.1%	0.0%	0.3%	0.1%	1.9%	0.0%	0.0%	
95UKHLD01	0.2%	0.0%	0.1%	0.9%	0.0%	0.0%			
95UKHVD01	0.6%	0.0%	0.1%	1.5%	0.0%	13.0%			
95UKGK901	0.2%	0.1%	0.1%	1.7%	0.2%	19.9%			

Review of Historic Keno Static Test Data

APPENDIX A4-1 Statistical Summary

Acid Base Accounting Parameters

Statistic	paste pH		FIZZ RATING	SL %		SO4 ChLth %		SO4 HCl% S2-%		MPA IgGCaC NP IgGCaC 3it		NPMPA O3it		Cinong %		CO2 %	
	47	47		47	47	47	47	47	47	47	47	47	47	47	47	47	
No. of observations																	
No. of missing values	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	3.200	1.000		0.010	0.010	0.010	0.010	0.010	0.010	0.300	-5.000	-43.000	-0.260	0.050	0.200	0.000	0.200
Maximum	8.700	3.000		1.930	0.450	0.460	1.480	0.460	1.480	60.300	308.000	285.000	54.400	3.640	13.400	13.400	13.400
1st Quartile	6.700	1.000		0.030	0.010	0.010	0.020	0.010	0.020	0.900	2.500	1.000	1.180	0.200	0.200	0.200	0.200
Median	7.200	1.000		0.170	0.020	0.030	0.060	0.030	0.060	5.300	7.000	3.000	2.290	0.060	0.200	0.200	0.200
3rd Quartile	7.600	2.000		0.485	0.200	0.210	0.295	0.200	0.210	15.150	25.500	14.500	5.025	0.365	1.350	1.350	1.350
Mean	6.904	1.617		0.348	0.108	0.113	0.242	0.108	0.113	10.877	23.851	12.957	4.931	0.330	1.228	1.228	1.228
Standard deviation (n)	1.213	0.787		0.458	0.138	0.132	0.363	0.138	0.132	14.308	48.104	43.931	8.512	0.804	2.217	2.217	2.217
Variation coefficient	0.176	0.487		1.315	1.273	1.164	1.498	1.164	1.164	1.498	2.017	3.390	1.726	1.829	3.876	3.876	3.876
Skewness (Pearson)	-1.520	0.789		1.801	1.262	1.119	1.989	1.262	1.119	1.989	1.801	4.497	5.026	4.339	3.862	3.862	3.862
Kurtosis (Pearson)	1.799	-0.943		2.799	0.267	0.089	3.454	0.267	0.089	3.454	2.797	23.142	28.411	21.629	17.138	17.253	17.253
Geometric mean	6.767	1.452		0.121	0.041	0.046	0.076	0.041	0.046	0.076	3.742	5.229	3.418	3.418	0.135	0.520	0.135
Geometric standard deviation	1.242	1.580		5.155	4.312	4.312	5.044	4.312	4.312	5.044	5.229	5.044	5.229	5.044	3.418	3.418	3.418

Leachate Extraction Parameters

[illegible]

Elemental Composition of Solids

Statistic	As ppm		Ba ppm		Bi ppm		Ca %		Cd ppm		Co ppm		Cr ppm		Cu ppm		Fe ppm		Ga ppm		K %		La ppm		Mg %		Mn ppm		Mo ppm		Na %		Ni ppm		P ppm		Pb ppm		47						
	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47				
No. of observations																																													
No. of missing values																																													
Minimum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Maximum	5	20	1	1	2	10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	10	0	0	0	10	0	0	73	1	0	1	0	1	93	2	70	16	10000							
1st Quartile	944	2870	2	7	8	691	41	112	295	14	20	3	40	4	82800	4	1	93	1320	173	324	1	0	0	324	1	0	8	290	1	0	15	430	896											
Median	46	260	1	2	0	3	1	42	16	2	10	0	10	0	1615	1	0	15	430	896	1615	1	0	0	1615	1	0	8	290	1	0	15	430	896											
2nd Quartile	85	430	1	2	0	10	2	53	28	3	10	0	16	0	4935	1	0	21	580	4095	4935	1	0	21	580	1	0	17	455	2653															
3rd Quartile	340	725	1	2	1	31	5	61	4	10	21	0	20	0	14168	1	0	16	283	3500	14168	1	0	16	283	1	0	16	283	3500															
Mean	219	545	1	2	1	47	4	56	62	3	11	1	20	0	6485	1	0	17	455	2653	6485	1	0	17	455	1	0	16	283	3500															
Standard deviation (n)	248	475	0	1	1	110	7	21	3	2	8	1	8	1	14168	1	0	16	283	3500	14168	1	0	16	283	1	0	16	283	3500															
Variation coefficient	1	1	1	1	0	2	2	0	1	0	2	2	0	2	2	0	1	1	1	1	2	0	2	2	0	2	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Skewness (Pearson)	1	3	2	3	4	4	1	2	2	3	4	1	2	3	4	4	3	1	1	1	2	0	2	2	0	2	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Kurtosis (Pearson)	1	10	2	9	19	22	17	3	5	13	2	3	26	16	19	10	2	10	2	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14
Geometric mean	107	379	1	2	0	10	2	53	35	3	10	1	14	0	1549	1	0	12	381	753	1549	1	0	12	381	1	0	12	381	753															
Geometric standard deviation	4	3	2	2	1	5	3	2	3	2	3	2	3	6	2	3	2	2	2	2	3	1	3	2	3	1	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

Acid Base Accounting Parameters

Statistic	
No. of observations	
No. of missing values	
Minimum	
Maximum	
1st Quartile	
Median	
3rd Quartile	
Mean	
Standard deviation (n)	
Variation coefficient	
Skewness (Pearson)	
Kurtosis (Pearson)	
Geometric mean	
Geometric standard deviation	

Leachate Extraction Parameters

Statistic	LCH_Ni_mg/L	LCH_P_mg/L	LCH_K_mg/L	LCH_Se_mg/L	LCH_Si_mg/L	LCH_Ag_mg/L	LCH_Na_mg/L	LCH_Str_mg/L	LCH_Ti_mg/L	LCH_Sn_mg/L	LCH_Tl_mg/L	LCH_U_mg/L	LCH_V_mg/L	LCH_Zn_mg/L
No. of observations	47	47	47	47	47	47	47	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.001	0.300	2.000	0.001	1.300	0.000	2.000	0.006	0.000	0.000	0.010	0.000	0.001	0.004
Maximum	1.260	2.270	12.100	0.200	7.860	0.006	9.000	0.784	0.020	0.020	0.019	0.050	0.235	289.000
1st Quartile	0.001	0.300	2.000	0.001	2.100	0.000	2.000	0.015	0.000	0.000	0.010	0.000	0.001	0.030
Median	0.002	0.300	3.500	0.003	2.520	0.000	2.000	0.056	0.000	0.000	0.010	0.000	0.001	0.105
3rd Quartile	0.051	0.300	4.750	0.008	3.740	0.001	2.000	0.227	0.001	0.001	0.010	0.000	0.005	4.025
Mean	0.132	0.377	3.857	0.015	3.089	0.001	2.593	0.150	0.001	0.001	0.010	0.003	0.019	23.523
Standard deviation (n)	0.288	0.339	1.956	0.037	1.402	0.001	1.479	0.191	0.004	0.004	0.001	0.009	0.049	69.666
Variation coefficient	2.166	0.899	0.507	2.362	0.454	1.759	0.573	1.274	2.457	2.490	0.137	3.342	2.503	2.962
Skewness (Pearson)	2.475	4.688	1.679	3.501	1.509	3.086	2.695	1.670	3.470	3.491	5.347	4.449	3.207	3.178
Kurtosis (Pearson)	5.302	21.236	4.439	12.630	2.028	9.792	6.819	2.450	12.424	12.531	28.620	19.939	9.792	8.532
Geometric mean	0.006	0.330	3.458	0.004	2.837	0.000	2.348	0.056	0.000	0.000	0.010	0.000	0.003	0.301
Geometric standard deviation	14.457	1.480	1.588	4.381	1.494	4.923	1.470	4.758	4.671	4.636	1.111	12.175	5.139	26.160

Elemental Composition of Solids

Statistic	S_%	Sh_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Ti_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm	Ag_ore_ppm	As_ore	Co/Ti_Pb_ore_%	Zn_ore_%
No. of observations	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
No. of missing values	0	0	0	29	0	29	0	29	29	0	0	37	37	37	44
Minimum	0	5	1	6	6	20	0	10	10	8	10	123	4	4	1
Maximum	2	707	18	253	20	20	1	10	10	341	10	10000	679	22	4
1st Quartile	0	13	4	27	43	20	0	10	10	34	10	219	190	6	1
Median	0	27	7	43	20	20	0	10	10	57	10	489	225	7	1
3rd Quartile	1	68	8	92	20	20	0	10	10	77	10	1955	259	8	2
Mean	0	72	7	65	20	0	0	10	10	67	10	1731	255	8	2
Standard deviation (n)	0	118	4	55	0	0	0	0	0	57	0	2655	150	5	1
Variation coefficient	1	2	1	1	1	0	1	0	0	1	0	2	1	1	0
Skewness (Pearson)	2	4	1	2	3	0	3	0	0	3	0	2	2	2	1
Kurtosis (Pearson)	3	15	1	3	10	10	10	10	10	4	4	3	3	3	0
Geometric mean	0	31	6	45	20	20	0	10	10	50	10	642	227	7	2
Geometric standard deviation	5	3	2	2	2	1	2	1	1	2	1	2	2	2	1

APPENDIX A4-1

Statistical Summary

[illegible][illegible]

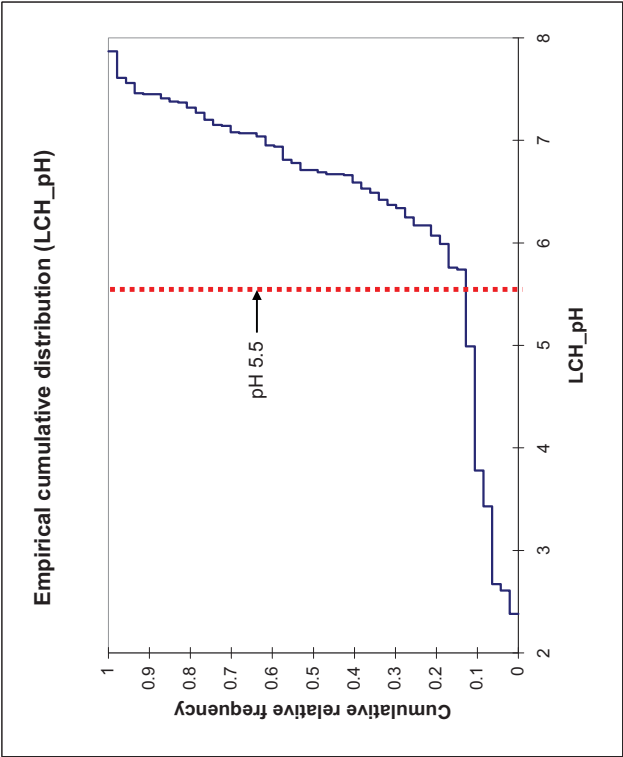
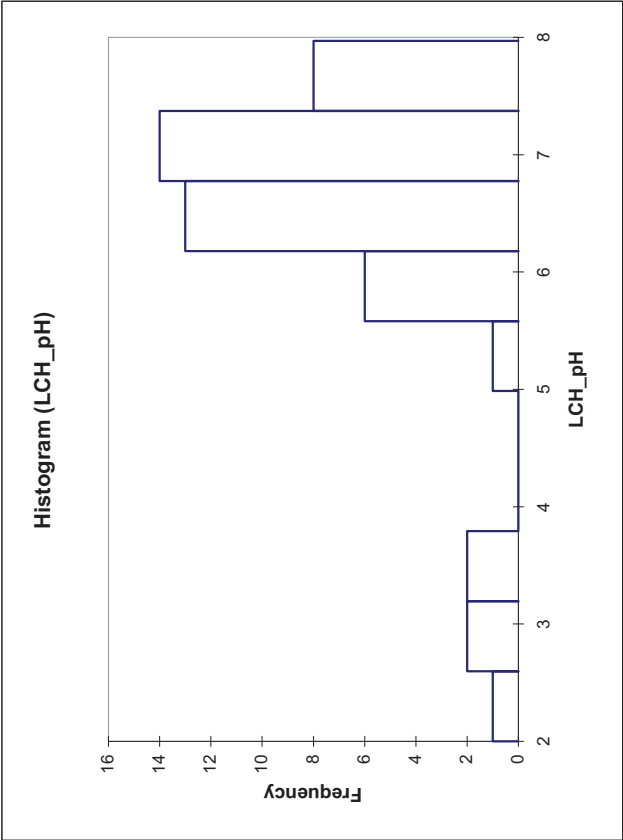
Soluble Product Loading

Statistic	LCH_P_mg/k	LCH_K_mg/k	LCH_Se_mg	LCH_Si_mg	LCH_Ag_mg	LCH_Na_mg	LCH_Sr_mg	LCH_Tl_mg	LCH_Sn_mg	LCH_Tl_mg	LCH_U_mg	LCH_V_mg/k	LCH_Zn_mg
	g	g	/kg	kg	/kg	/kg	kg	kg	/kg	kg	kg	g	kg
No. of observations	47	47	47	47	47	47	47	47	47	47	47	47	47
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.900	6.000	0.003	3.900	0.000	6.000	0.017	0.000	0.000	0.030	0.000	0.003	0.012
Maximum	6.810	36.300	0.600	23.560	0.014	27.000	2.352	0.060	0.060	0.057	0.151	0.705	887.000
1st Quartile	0.900	6.000	0.003	6.300	0.000	6.000	0.044	0.000	0.000	0.030	0.000	0.003	0.089
Median	0.900	10.500	0.009	7.560	0.000	6.000	0.168	0.000	0.000	0.030	0.000	0.003	0.315
3rd Quartile	0.900	14.250	0.023	11.220	0.002	6.000	0.560	0.002	0.002	0.030	0.001	0.015	12.075
Mean	1.131	11.572	0.046	9.266	0.002	7.749	0.451	0.004	0.004	0.031	0.006	0.056	70.570
Standard deviation (n)	1.016	5.868	0.110	4.206	0.003	4.437	0.574	0.011	0.011	0.004	0.026	0.146	208.998
Variation coefficient	0.899	0.507	2.362	0.454	1.759	0.573	1.274	2.457	2.490	0.137	3.342	2.503	2.962
Skewness (Pearson)	4.668	1.679	3.501	1.509	3.086	2.695	1.670	3.470	3.491	5.347	4.449	3.207	3.178
Kurtosis (Pearson)	21.236	4.439	12.630	2.028	9.792	6.819	2.450	12.424	12.531	28.620	19.939	9.792	8.532
Geometric mean	0.990	10.373	0.011	8.512	0.001	7.044	0.167	0.001	0.001	0.031	0.000	0.010	0.903
Geometric standard deviation	1.480	1.588	4.381	1.494	4.923	1.470	4.758	4.671	4.636	1.111	12.175	5.139	26.160

% Solubilized (or % Extraction)

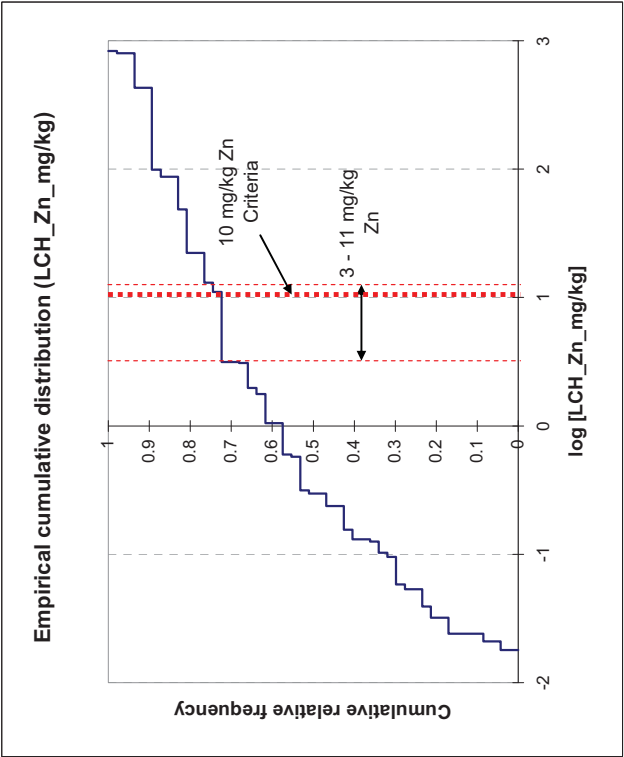
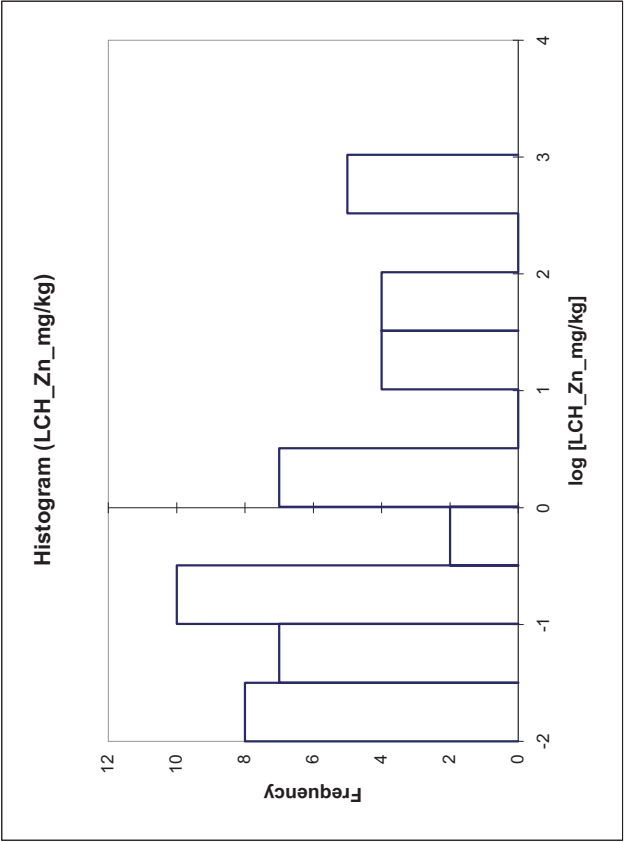
Statistic	%Extr_Sr	%Extr_V	%Extr_Zn
	47	47	47
No. of observations	0	0	0
No. of missing values	0	0	0
Minimum	0.000	0.000	0.000
Maximum	0.055	0.017	0.877
1st Quartile	0.001	0.000	0.000
Median	0.004	0.000	0.000
3rd Quartile	0.015	0.000	0.011
Mean	0.009	0.001	0.052
Standard deviation (n)	0.011	0.003	0.146
Variation coefficient	1.228	2.560	2.797
Skewness (Pearson)	2.051	3.201	4.214
Kurtosis (Pearson)	5.023	9.864	19.529
Geometric mean	0.004	0.000	0.001
Geometric standard deviation	4.597	5.763	18.050

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
LCH_pH	47	0	47	2.380	7.870	6.388	1.328
LCH_Zn_mg/kg	47	0	47	-1.745	2.920	-0.038	1.478
LCH_Pb_mg/kg	47	0	47	-2.824	1.689	-1.109	1.189



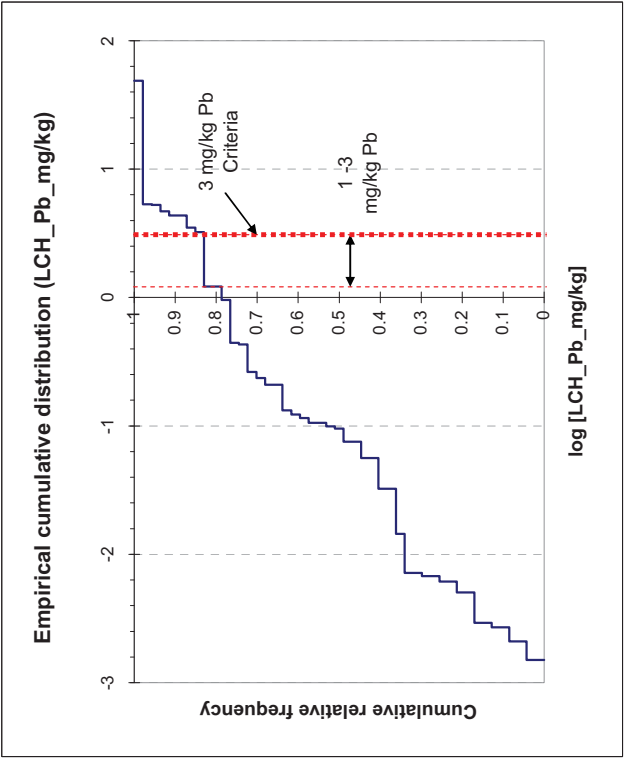
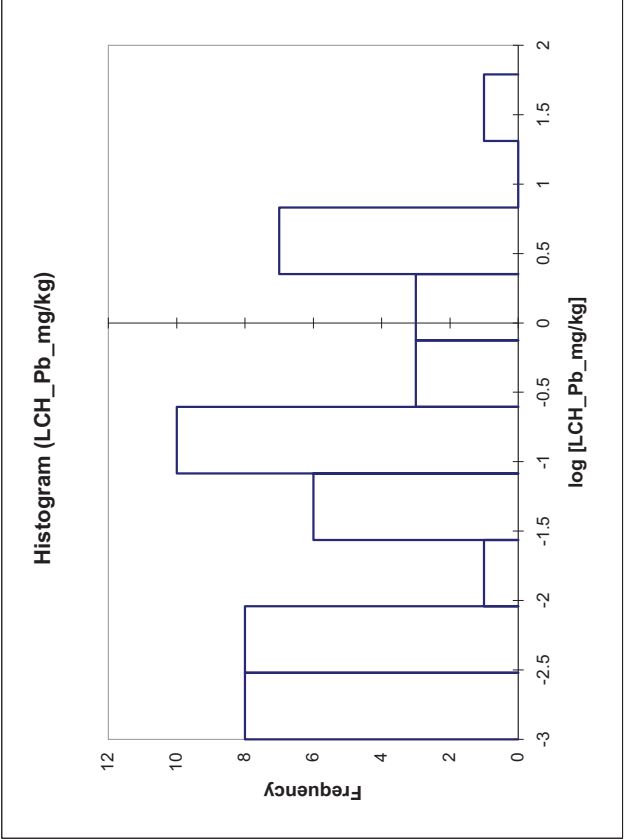
Descriptive statistics for the intervals (LCH_pH):

Lower bound [	Upper bound [	Frequency	Relative frequency	Density
2	2.597	1	0.021	0.036
2.597	3.194	2	0.043	0.071
3.194	3.791	2	0.043	0.071
3.791	4.388	0	0.000	0.000
4.388	4.985	0	0.000	0.000
4.985	5.582	1	0.021	0.036
5.582	6.179	6	0.128	0.214
6.179	6.776	13	0.277	0.463
6.776	7.373	14	0.298	0.499
7.373	7.97	8	0.170	0.285



Descriptive statistics for the intervals (LCH_Zn_mg/kg):

Lower bound [	Upper bound [	Frequency	Relative frequency	Density
-2	-1.498039898	8	0.170	0.339
-1.498039898	-0.996079795	7	0.149	0.297
-0.996079795	-0.494119693	10	0.213	0.424
-0.494119693	0.00784041	2	0.043	0.085
0.00784041	0.509800512	7	0.149	0.297
0.509800512	1.011760614	0	0.000	0.000
1.011760614	1.513720717	4	0.085	0.170
1.513720717	2.015680819	4	0.085	0.170
2.015680819	2.517640921	0	0.000	0.000
2.517640921	3.019601024	5	0.106	0.212



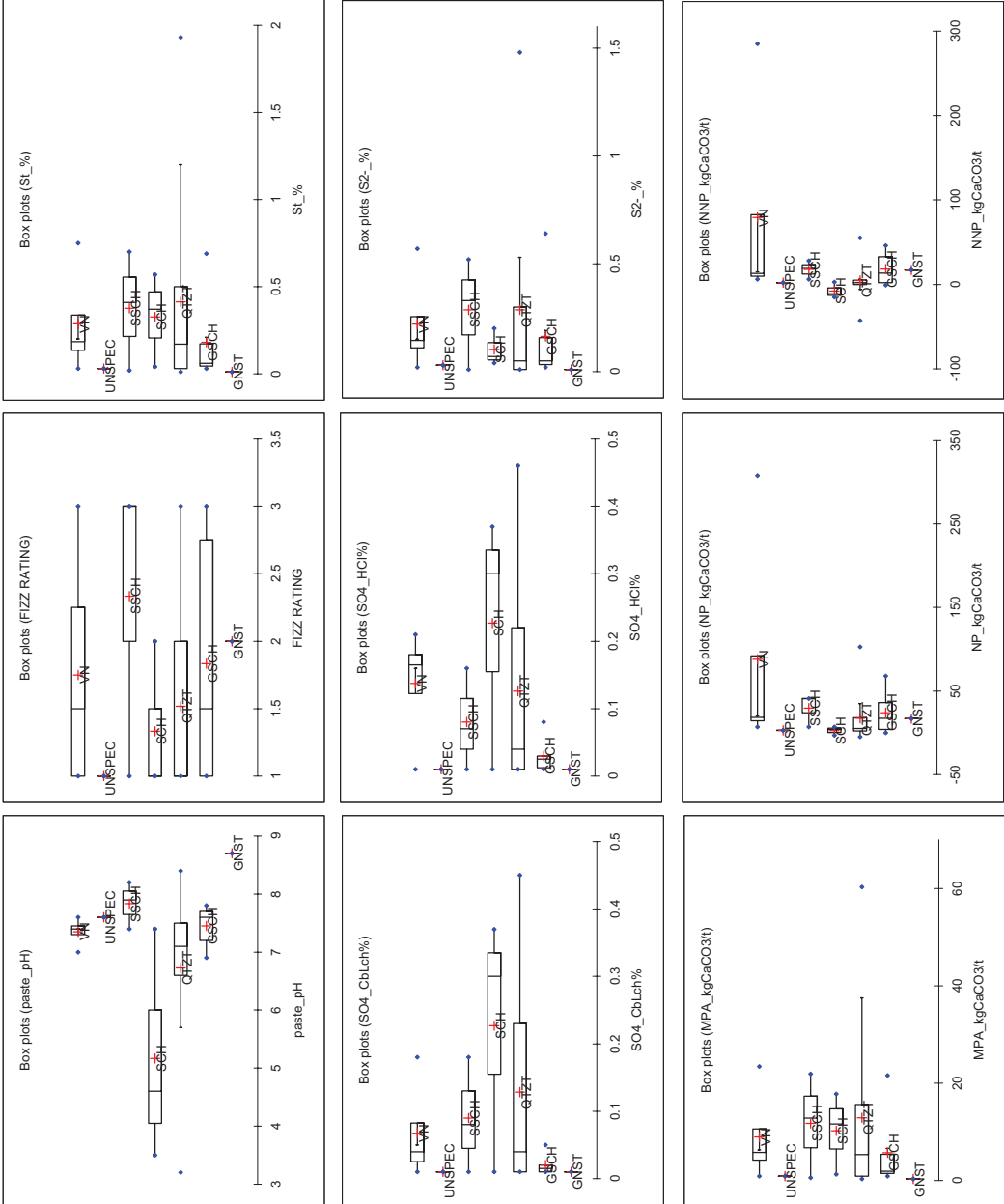
Descriptive statistics for the intervals (LCH_Pb_mg/kg):

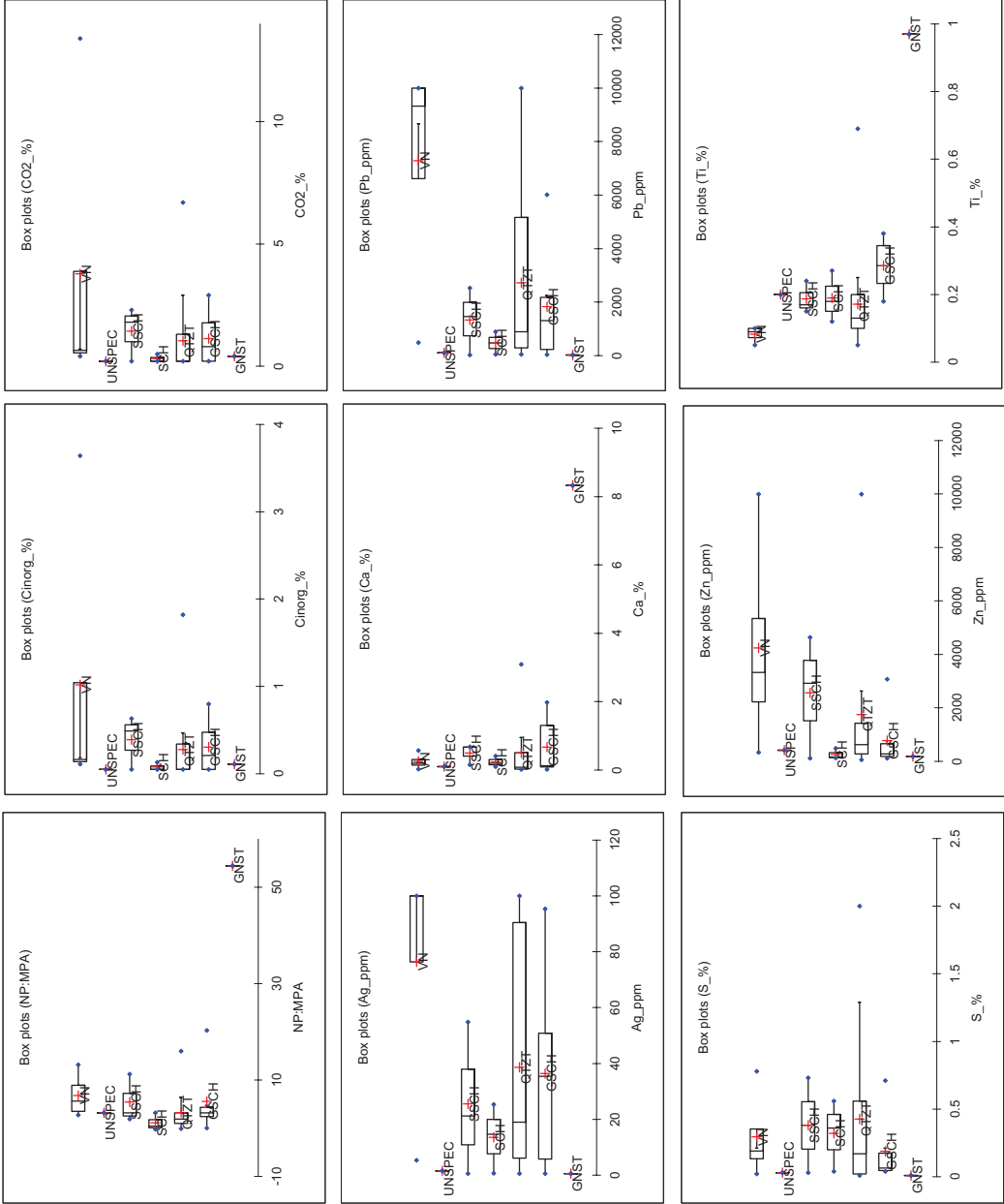
Lower bound [	Upper bound [	Frequency	Relative frequency	Density
-3	-2.521069114	8	0.170	0.355
-2.521069114	-2.042138228	8	0.170	0.355
-2.042138228	-1.563207342	1	0.021	0.044
-1.563207342	-1.084276456	6	0.128	0.267
-1.084276456	-0.60534557	10	0.213	0.444
-0.60534557	-0.126414685	3	0.064	0.133
-0.126414685	0.352516201	3	0.064	0.133
0.352516201	0.831447087	7	0.149	0.311
0.831447087	1.310377973	0	0.000	0.000
1.310377973	1.789308859	1	0.021	0.044

XLSTAT 2007.8.03 - Univariate plots - on 1/8/2008 at 7:22:49 PM
Quantitative data: Workbook = Compilation 1995 and 2007 ABAs.xls / Sheet = '1995 Rock Char'!\$E\$1:\$V\$48 / 47 rows and 18 columns
Subsamples: Workbook = Compilation 1995 and 2007 ABAs.xls / Sheet = '1995 Rock Char'!\$C\$1:\$C\$48 / 47 rows and 1 column

Box plots

Box plots:







**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX C
GEOENVIRONMENTAL ROCK CHARACTERIZATION
BELLEKENO ZONE**

January 2008

Prepared by: Altura Environmental Consultants



To: Dan Cornett, Rob McIntyre, Access Consulting Group
From: Diane Lister
Date: January 8, 2008
RE: **Geoenvironmental Rock Characterization, Bellekeno Zone**

1.0 Purpose and Scope

This report summarizes results of geoenvironmental rock characterization focussed on the Bellekeno zone at Keno Hill, Yukon.

The purpose of this evaluation is to review general characteristics of Bellekeno rock with respect to its potential for generation of net acidity and/or metal leaching (“AML”). The objective is to provide a technical basis to support management for rock to be excavated in the zone, by deriving: 1) AML geochemical screening criteria, 2) estimated proportions AML and Non-AML material by rock type for Bellekeno, and 3) potential field criteria for differentiating AML and Non-AML rock during excavation activities.

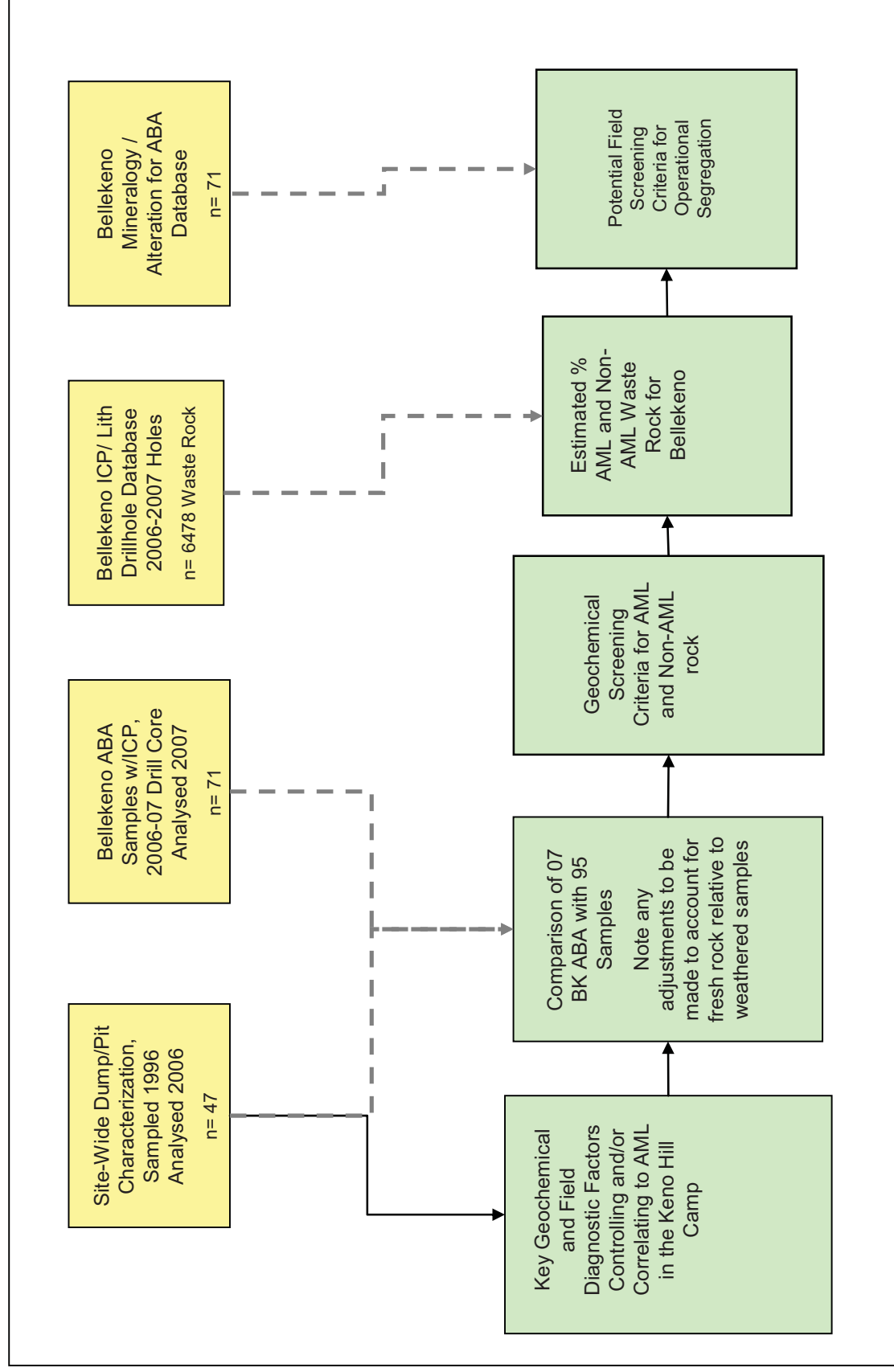
1.1 Study Approach

This geoenvironmental evaluation consisted of data analysis and integration of four specific data components: 1) site-wide studies on weathered rock (47 samples), 2) acid base accounting of 2006-2007 Bellekeno drill core (71 samples), 3) Bellekeno drillhole multi-element and lithology database (6478 samples), and 4) mineralogy and alteration logging data on acid base accounting samples.

An overall flowchart of data review and synthesis is presented in Figure 1.

The evaluation utilized a previous review of site-wide geoenvironmental sampling conducted during 1995 to 1996 on weathered rock dump and pit samples; this study identified key geochemical and field diagnostic factors that appear to either control or correlate to the generation of net acidity and/or metal leaching in the Keno Hill rock suite (Altura, 2008a). These factors were then integrated into the review of the recent acid base accounting characterization analyses on the unweathered Bellekeno drill core samples, in order to determine any adjustments to be made to account for fresh rock relative to weathered samples. The adjusted factors served as geochemical screening criteria and were applied to the 6400-sample waste rock geochemical database for estimation of proportions of potential AML rock and Non-AML rock for each of the major Bellekeno rock types. Lastly, the acid base accounting and mineralogical/alteration information were reviewed to identify any potential correlations; potential field screening criteria were then identified for further development by site geologists.

Figure 1. Bellekeno Rock Characterization Study – Components and Study Synthesis



2.0 Methodology

All data were provided to the consultant by Alexco Resource Corp. Data were compiled and for statistical analysis purposes, results beyond minimum or maximum limits of detection were assigned a value equal to the respective detection limit. Analysis was carried out using Excel™ and XLStat™ software.

Samples in the 6478-sample waste rock drillhole database were analysed via 27-element ICP-AES with aqua regia digestion (including sulphur). The 71 acid base accounting samples were tested via the modified acid-base accounting methods including sulphate via both sodium carbonate leach and HCl digestion, total inorganic carbon via coulometer, and paste pH at a 1:1 solids to water ratio. All samples were analysed at ALS Chemex Labs in North Vancouver.

The sample's lithological, mineralogical and alteration information was determined by Alexco geologists at the time of logging and sampling. Of importance to note is the difference in lithological designation in the waste rock drillhole database versus the acid base accounting database. Due to the nature of the local geology, a specific lithology is typically intercalated with secondary lithologies over the scale of a few metres. Thus, when logging the core for deposit model purposes, over a given interval in the 10's of metres, the primary lithology is noted along with its percent proportion. Secondary lithologies are also designated along with their percent proportion. Thus, in the waste rock drillhole database a given lithology designation, for example quartzite (QTZT), should be interpreted as "predominantly quartzite". In contrast, the lithology designations in the acid base accounting database are specific to the given interval sampled.

3.0 Characterization Overview of Bellekeno Rock

3.1 Geology and Major rock types

The Keno Silver District is underlain by Yukon Group metasedimentary rocks, described in detail in the United Keno Hill Mines Limited Site Characterization Study (Access Mining Consultants, 1996).

The metasedimentary rocks have been divided locally into three formations; Upper Schist, Central Quartzite and Lower Schist. The Upper Schist (Hyland Group, pre-Cambrian to Cambrian age) consists of quartz-mica schist, quartzite, graphitic schist and minor limestone. The Central Quartzite (Keno Hill Quartzite, Mississippian age) contains thick-and thin-bedded quartzite, massive quartzite, graphitic phyllite, graphitic schist and calcareous schist. This unit is approximately 700 m (2300 ft) thick and hosts most of the major silver deposits in the area. The Lower Schist includes graphitic schist, argillite, thin-bedded quartzite, calcareous schist, phyllite, slate, sericite schist and minor thick-bedded quartzite. Conformable greenstone (altered diorite/gabbro) lenses and sills occur in places and narrow lamprophyre and quartz-feldspar porphyry dykes occur locally. Granite bodies have intruded the metasedimentary – greenstone package at several places to the north and south of the Keno Hill – Galena Hill area.

The Bellekeno zone is located approximately 1.5 km west of Keno City at Sourdough Hill, an area predominantly underlain by the Upper Schist above, and the mineralization-bearing Central Quartzite beneath. Near the schist-quartzite contact greenstone sills have been emplaced.

Principal rock units in approximate order of predominance at Bellekeno thus include quartzite, schist, and greenstone. Key aspects of these units and their respective sub-units are described in further detail below, as extracted from descriptions by Boyle (1962) in the 1996 Site Characterization Study.

Quartzite (QTZT): by far the most predominant unit at Bellekeno, quartzite may occur as either thinly bedded (inches to one foot or more thick) or thickly bedded (3 to 25 feet thick) sequences interbedded with assemblages of schist, argillite, and phyllite. Thin sections show that the quartzites consist essentially of quartz, with minor amounts of white mica (sericite) and, locally, carbonate minerals. Calcareous varieties contain up to 30 percent carbonate minerals (unit CQTZT). The black quartzites contain much carbonaceous material. Accessory minerals in all varieties include irregular patches and specks of leucoxene, tourmaline, zircon, apatite, and pyrite. The pyrite occurs mainly as cubes, distorted cubes, and crystal groups.

Schist (SCH): The predominant varieties of schist found in the area include graphitic schists (GSCH), quartz sericite schist (SSCH), and chlorite schist (CHSCH).

The graphitic schists are black or greyish black, weather easily to a crumbly mass of small black schistose fragments, and occur in beds ranging from a fraction of an inch to a few feet in thickness and are everywhere intercalated with phyllites, slates, or thin- and thick-bedded quartzites. Under the microscope the principal mineral constituents are dense opaque carbonaceous matter (graphite), quartz, sericite, carbonate minerals, feldspar, chlorite, isotropic colloidal material, and numerous metacrysts of pyrite. In some sections microcrystalline pyrite is strung out along the graphitic laminae.

The quartz-sericite and chlorite schists are greenish or mottled greenish yellow, and like the graphitic schist, weather easily and form few prominent outcrops. In thin sections the quartz-sericite schists are seen to consist essentially of quartz and sericite with subordinate amounts of carbonate minerals and leucoxene. The main accessories are apatite, zircon, and tourmaline, and a few pyrite metacrysts are also present in most sections.

Greenstone (GNST): The greenstones are schistose, greyish green to dark green rocks that occur in conformable elongated lenses and sills, principally in the schistose formations and to a lesser extent in the quartzite formations. The greenstones weather differentially compared with the schists and quartzites and form prominent precipices and knobs. In most occurrences they are jointed and present a slabby appearance. In some bodies narrow shear zones, joints, and irregular fractures contain small lenses and masses of quartz, epidote, and calcite. In thin sections the greenstones present considerable variety both in mineral composition and texture. All are highly altered, and it is rare to find bodies with any original minerals. The principal minerals now present in the greenstones are hornblende, actinolite, saussurite (zoisite, epidote, albite, sericite, carbonate), plagioclase (oligoclase to andesine), chlorite, stilpnomelane, biotite, white mica (sericite), leucoxene, and carbonate minerals. Quartz, potash feldspar, illuminite, magnetite, limonite, and apatite are common minor constituents, and pyrite is present in some bodies. All these minerals are not necessarily found in any one greenstone mass. Chlorite is generally present, commonly in considerable amounts, and biotite, sericite, quartz, and carbonate minerals are found in some bodies.

Vein (VN): Although strictly not a lithological unit, the economic mineralization in the Keno Silver District occurs in irregular shoots within vein systems developed along the vein faults, typically within the more brittle quartzite or greenstone units. Where the fault passes into soft phyllites or schists, the vein becomes less well defined and eventually dissipates. Two stages of vein mineralization are distinguished in the area. The first stage deposited quartz, pyrite, some arsenopyrite, trace gold and some sulphosalts in the vein faults. Following movement on the vein faults, a second stage of mineralization deposited siderite, galena, sphalerite, pyrite, freibergite, and pyrargyrite. Most of the economically mineable ore deposits to date have been stage two types. Supergene enrichment has occurred but is not believed to have been an important ore forming process. The oxidation zone extends from a few meters to 150 meters (10 - 500 feet) below surface. Within this zone, minerals such as limonite, pyrolusite, cerussite, and anglesite are common. Native silver, argentite and jarosite may occur locally. The principal gangue mineral is siderite.

3.2 Elemental characterization

Elemental characteristics of the Bellekeno waste rock were determined through analysis of an extensive multi-element exploration drillhole database and associated sample lithology. Table 1 shows the distribution of samples in the Bellekeno waste rock drillhole database.

Table 1. Distribution of Samples in the Bellekeno Waste Rock Drillhole Database

Lithology		Number of Samples
Description	Code	
Chloritic Schist	CHSCH	222
Calcareous Quartzite	CQTZT	505
Calcareous Schist	CSCH	36
Greenstone	GNST	567
Graphitic Schist	GSCH	870
Phyllite	PHY	5
Quartzite	QTZT	3293
Schist, Undifferentiated	SCH	775
Sericitic Schist	SSCH	205
Total		6478

3.2.1 Results

Key statistical measures of the geochemistry are tabulated in Appendix C1, in accordance with major lithology.

Analysis of the results delineated certain elements of interest in the Bellekeno waste rock, and highlights are presented in the following text. Appendix C2 shows box plots of these selected elements in waste rock lithologies.

Aluminum (Al)

The more siliceous quartzite units show a tendency for relatively low aluminum values relative to the schist and greenstone units.

Arsenic (As)

A database-wide median value for arsenic of 9 ppm versus a mean of 45 ppm demonstrates the potential for significantly elevated values in a small subset of samples. As shown in the box plot for As in Appendix C2, elevated As in the several hundred to thousands ppm levels occur in most lithologies, however the quartzite units tend to show the most anomalous As occurrences.

Calcium (Ca)

Calcium content is relatively consistent across most units, tending to be below the 5 percent level. Greenstone is the exception, demonstrating a Ca tendency in the 5 to 10 percent range, likely due to the predominance of hornblende and actinolite.

Copper (Cu)

Median copper levels for most units are in the order of 50 ppm, with the exception of greenstone which shows a distinct tendency for slightly elevated copper in the 100 to 200 ppm range. Anomalous values above 400 ppm only occur within the greenstone and quartzite units.

Iron (Fe)

Most units show low iron content (less than 5%), with chloritic schist and greenstone slightly elevated, likely due to the presence of iron-bearing silicates such as chlorite and biotite.

Manganese (Mn)

Manganese occurs in a wide range of concentrations across all units, from a few hundred up to the hundreds of thousand ppm level. Greenstone units show a tendency for slightly higher manganese relative to other units.

Lead (Pb)

The median lead value for most units is relatively low in the 30 ppm range, however anomalously high values to the thousands ppm level also occur across all units. The quartzite unit demonstrates the greatest variation and most anomalous values. Greenstone shows the lowest median value for lead (5 ppm), however some anomalous outliers of several thousand ppm do occur even in this unit.

Sulphur (S)

Overall median sulphur value for the 6478 sample dataset is 0.32%, with a mean of 0.45%. Schist units tended to have medians above this value, including calcareous schist (0.46%), graphitic schist (0.72%), and undifferentiated schist (0.53%). Greenstone and phyllite units show a distinct tendency for low sulphur (medians of 0.03%), however it should be noted that the phyllite, with only 5 samples, is not sufficiently represented in the dataset, nor is this unit abundant in the Bellekeno zone.

Antimony (Sb)

Waste rock samples show an overall very low tendency for antimony, with the majority of median values at or close to the 5 ppm detection limit. Greenstone demonstrates the occurrence of some slightly elevated samples (albeit in the 10 ppm range). Rare anomalous values in the order of 100 to 200 ppm occur in the quartzite and calcareous quartzite units only.

Zinc (Zn)

Median zinc levels tend to slightly elevated, in the order 80 to 100 ppm for all units. Quartzite and calcareous quartzite show a wide range between upper and lower limits, potentially indicating sub-populations of distinctly lower and higher zinc contents. Most units have occasional occurrences of highly anomalous values over 5000 ppm.

3.2.2 Discussion of Results

Analysis of data from the 6,478 waste rock samples of the major Bellekeno units of quartzite, schist, and greenstone show that these units tend have overall low sulphur (less than 0.5%). The schist units demonstrate slightly higher values relative to the quartzite units, with the greenstone significantly lower in sulphur.

Most rock units, despite having overall low metals and sulphur, nonetheless demonstrate potential for occasional anomalous levels. All units demonstrate a weak zinc overprint in the order of 80 to 100 ppm.

3.3 Acid base accounting

A total of 71 Bellekeno waste rock and mineralized samples of varying lithology were submitted for acid base accounting analysis. The primary objective of this testing is to provide a quantitative determination of the balance between acid-producing (sulphide) and acid consuming minerals (namely carbonates) of materials in the Bellekeno zone. Samples were selected by Alexco geologists to provide both spatial and lithological representation of the entire Bellekeno zone. Table 2 shows the distribution of samples by lithology.

Table 2. Distribution of Acid Base Accounting Samples for Bellekeno

Lithology		Number of Samples		
Description	Code	Waste Rock	Mineralized Rock	Total
Calcareous Quartzite	CQTZT	12	0	12
Greenstone	GNST	12	0	12
Graphitic Schist	GSCH	13	0	13
Quartzite	QTZT	12	0	12
Sericitic Schist	SSCH	12	0	12
Vein	VN	4	6	10
	Total	65	6	71

3.3.1 Results

Acid base accounting results are tabulated in Appendix B1, and summary statistics in Appendix B3. Various relationships of the database with respect to lithology, zone, mineralized and non-mineralized samples are given in Appendix B4.

Paste pH

The 65 waste rock samples ranged in paste pH from 6.4 to 8.9 with a median of 8.3, and the majority in the range of 7.5 to 8.9, indicating that no samples were producing net acidity at the time of analysis. The six mineralized samples were distinctly lower slightly lower in pH (see Appendix B4-1c for box plot), ranging from 5.8 to 7.6.

Sulphur Species

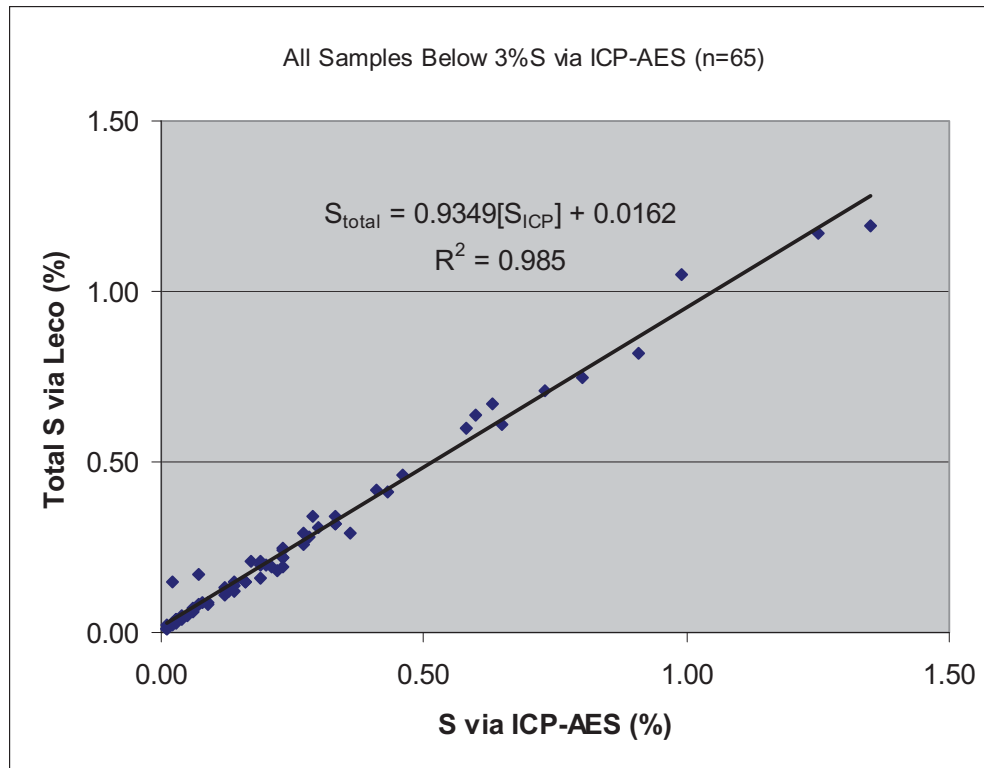
Total sulphur content of waste rock samples ranged from the 0.01 minimum detection limit to 1.19%, with a median value of 0.18%. As expected, the mineralized samples were significantly higher, ranging from 5.66 to 18.75%.

Sulphate were analysed using both carbonate leach and hydrochloric acid leach; aggregate results were very similar between the two methods, however upon reviewing sample-by sample results, there appears to be a greater sensitivity of the carbonate leach at near detection limit levels of sulphate. For future campaigns, Alexco may wish to consider deleting the hydrochloric acid leach method from the ABA suite.

Carbonate leach sulphate levels were low in the waste rock samples, ranging from the 0.01 minimum detection limit to 0.14%, indicating that on average 12% of the total sulphur is in the form of sulphate. While the mineralized samples show sulphate values up to 0.77%, sulphate accounts on average for just over 1% of the total contained sulphur. The relatively low proportion of sulphate may in part be due to the sulphides in the mineralized samples being mainly comprised of less-oxidizable galena and sphalerite.

Of interest for future analyses is the very good correlation between total sulphur via Leco and sulphur via ICP-AES, particularly at sulphur levels below 3% (eg. for typical waste rock). This indicates that sulphur values obtained as part of a multi-element ICP-AES scan, for example in the Bellekeno drillhole database, can be considered a reasonable estimate of total sulphur in a waste rock sample.

Figure 2. Correlation of Sulphur via ICP-AES and Sulphur via Leco, for samples below 3%S



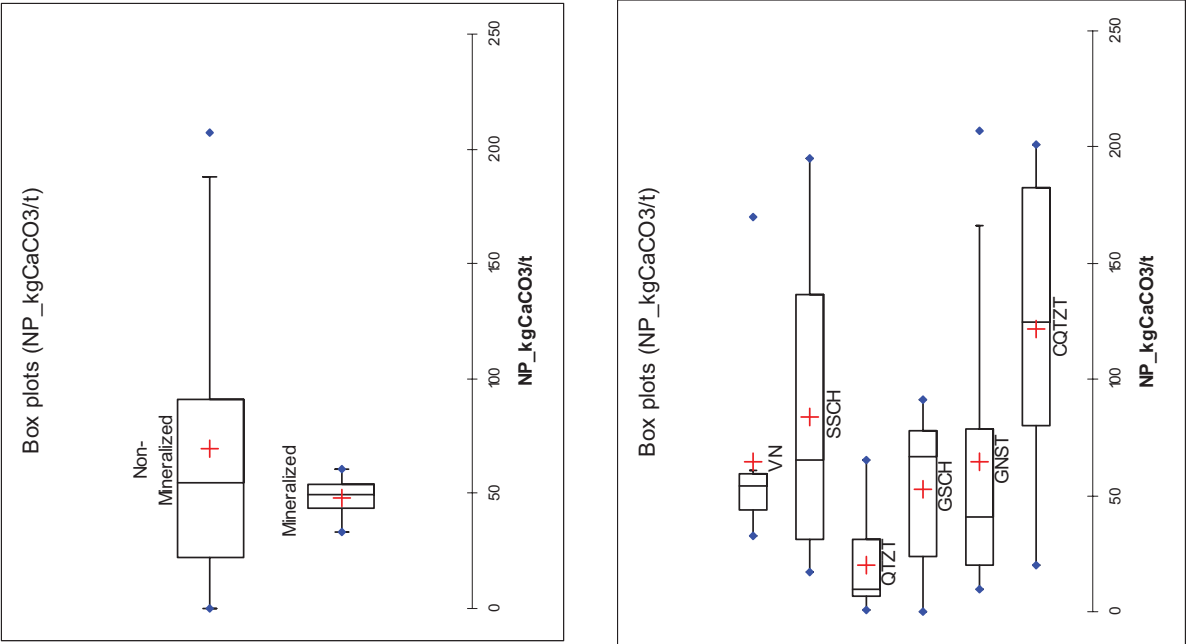
In order to assess ratios of sulphide to neutralizing potential, in acid base accounting analyses the sulphide value (calculated as the difference between total sulphur and sulphate) is multiplied by a factor of 31.25 for conversion to units of kg CaCO_3/t . This value is typically termed “maximum potential acidity”, or MPA. Use of the MPA value allows direct comparison to the samples neutralizing potential, expressed in these same units, and also allows for calculation of the ratio of neutralizing potential to maximum potential acidity. MPA values for the Bellekeno samples are included in Appendix B1.

Neutralizing Potential

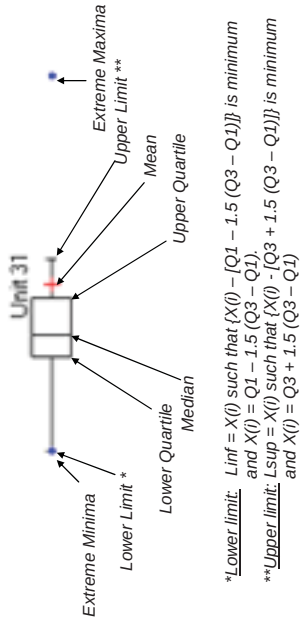
The 65 sample waste rock dataset returned a median NP of 55 kg CaCO_3/t , only slightly above the 49.5 kg CaCO_3/t median for mineralized samples. While mineralized samples show a very tight distribution around its respective median (Figure 3), waste rock samples show a much greater range of NP values, from 0 to 207 kg CaCO_3/t (the minimum value was from a sample of GSCH, the maximum from a calcareous GNST sample).

The similarity in median NP in the mineralized samples is attributed to the significant quantities of siderite (FeCO_3) in the veins. Siderite is capable of buffering net acidity only up to a slightly acidic pH range of 5 to 6, therefore would be measured in a neutralization potential analysis, but is a less efficient neutralizer than calcite (CaCO_3).

Figure 3. Box Plots for Neutralizing Potential and NP : MPA

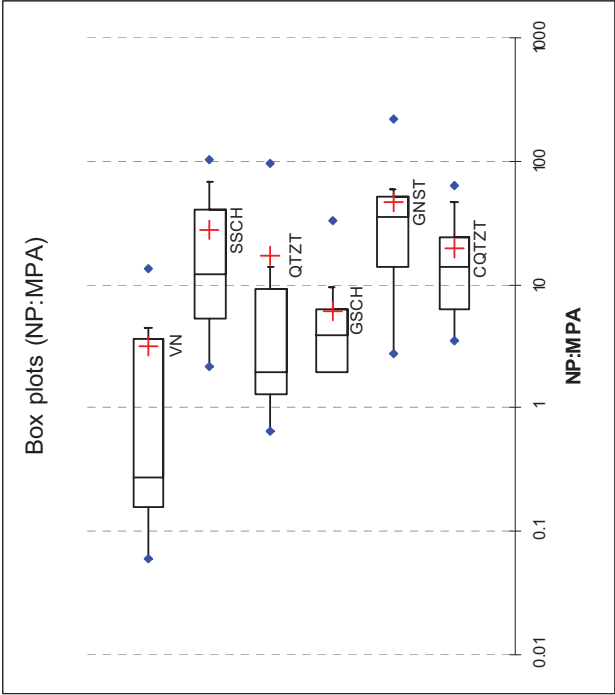


LEGEND FOR BOX PLOTS:



*Lower limit: $\text{Lin}f = X(i)$ such that $\{X(i) - [Q1 - 1.5 (Q3 - Q1)]\}$ is minimum and $X(i) = Q1 - 1.5 (Q3 - Q1)$.

**Upper limit: $\text{Lsup} = X(i)$ such that $\{X(i) - [Q3 + 1.5 (Q3 - Q1)]\}$ is minimum and $X(i) = Q3 + 1.5 (Q3 - Q1)$



By lithology, the calcareous quartzite unit has the tendency for the highest NP, with a median in the order of 125 kg CaCO₃/t (Figure 3). Quartzite, one of the more predominant units at Bellekeno, tends to have a relatively low NP, and appears to have a sub-population of very marginal NP samples in the 1 to 11 kg CaCO₃/t range, with the remaining samples between 20 and 65 kg CaCO₃/t.

The relationships between neutralizing potential and other geochemical parameters are important in: i) determining potential controls to buffering of net acidity, ii) evaluating the potential for correlation of the smaller acid base accounting database with the larger exploration drillhole database, and iii) determining potential correlations of NP to simple field screening parameters. Some key relationships are discussed in the following paragraphs, and shown in Figure 4.

Neutralizing potential of the Bellekeno ABA sample suite demonstrates a direct proportional relationship with both carbonate (as CO₂) and calcium (Figure 4). Of note in the left graphs of Figure 4 is that the VN and GNST units tend to be outliers in an otherwise linear trend. When samples of these units are filtered from the dataset, a very good correlation is derived ($r^2 > 0.9$), as shown in the right hand graphs. Moreover, the slopes of the NP:CO₂% and NP:Ca% trendlines correspond closely with the stoichiometric ratio of CaCO₃ to each of these constituents (22.7 and 25 respectively). These close relationships indicate that for the various quartzite and schist units at Bellekeno, that carbonate as calcite is the primary source of available neutralization. The vein units, on the other hand, have elevated carbonate attributable to its siderite gangue, and demonstrate the less effective neutralization by this mineral. Many of the greenstone units occur as a discrete group of outliers in the Ca versus NP graph, likely attributable to the occurrence of Ca in a non-neutralizing form such as hornblende, actinolite, and other amphibole minerals.

NP:MPA

As previously mentioned, the neutralizing to maximum potential acidity ratio, or NP:MPA is calculated by dividing the sample's neutralizing potential by its acid production potential expressed in kg CaCO₃/t (% sulfide content x 31.25).

A common industry practice is to infer that samples with NP:MPA of greater than 3:1 are unlikely to produce net acidity, with no further testwork or study. British Columbia guidelines (BC Ministry of Energy and Mines, 1997) consider a 4:1 NP:MPA ratio. For samples with lower ratios, additional information (such as data from field and lab weathering studies) are indicated, in order to confirm any site-specific controls on net acid generation.

Distribution of the Bellekeno results across the NP:MPA ratio range are given in Table 3, and shown in the lower right-hand graph of Figure 3. A total of 49 of the 71 samples have NP:MPA ratios greater than 3, indicating minimal potential for net acidity. Removing the mineralized samples from the dataset (six vein samples all with NP:MPA of less than 1) and considering only the 65 waste rock samples, 75 percent of these show minimal potential for net acidity.

Greenstone, calcareous quartzite, and sericitic schist demonstrate a large proportion of samples with NP:MPA ratio greater than 3, indicating overall minimal concern for net acidity from these units. Quartzite and graphitic schist units show the have a larger proportion of samples in the “uncertain” range between 1 and 3, with one quartzite sample with NP:MPA of less than one, indicating that focus of site specific assessment and field screening should be directed to these units.

Table 3. Distribution of NP:MPA in Bellekeno Samples

Lithology		NP : MPA					Total
Description	Code	≤ 1	>1 to 2	>2 to 3	>3 to 4	>4	
Calcareous Quartzite	CQTZT	0	0	0	1	11	12
Greenstone	GNST	0	0	1	0	11	12
Graphitic Schist	GSCH	1	3	2	2	5	13
Quartzite	QTZT	1	6	0	0	5	12
Sericitic Schist	SSCH	0	0	1	0	11	12
Vein	VN	6	1	0	0	3	10
	Total	8	10	4	3	46	71

Fizz Rating

The ‘fizz rating’, a ranking from 1 to 4 of effervescence to 25% HCl, is assessed by the laboratory in order to determine the strength of acid to utilize for the neutralization potential titration. Fizz rating of the Bellekeno sample set ranged from 1 to 3, with a median of 2 (slight effervescence), and mean slightly over 2. When correlated with NP, it can be seen that samples with a fizz rating of 3 (moderate effervescence, continuous bubbling) demonstrate a neutralizing potential of at least 62 kg CaCO₃/t, and an NP:MPA of at least 4.76, with minimal potential for net acidity (Figures 5 and 6). This indicates that the fizz rating parameter could serve as a potential screening tool for field classification of rock – for example, a sample with a fizz rating of at least 3 may be classified as having minimal potential for net acidity.

Figure 5. Relationships of Fizz Rating and Neutralization Potential

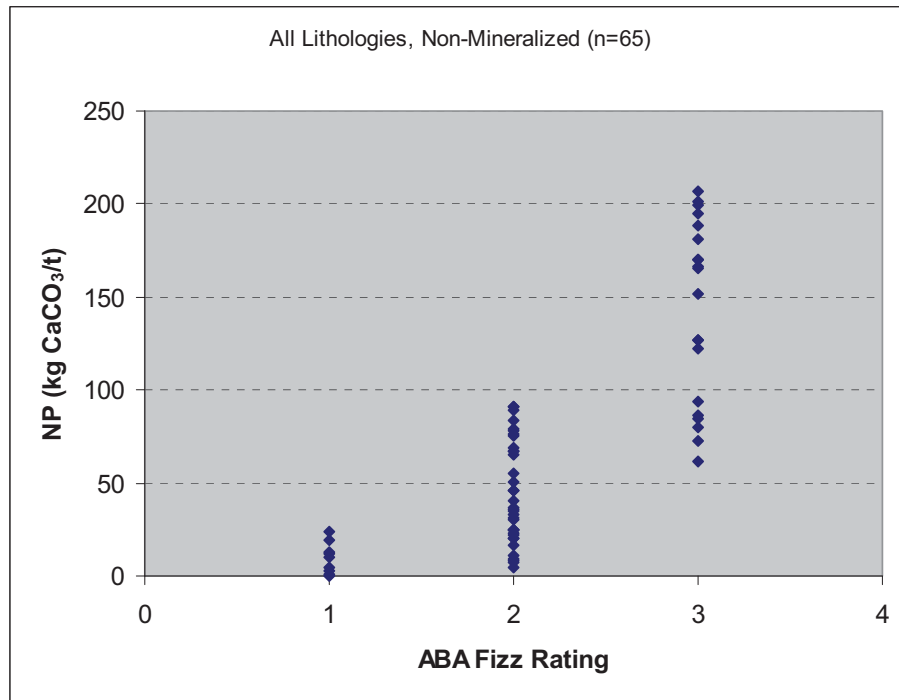
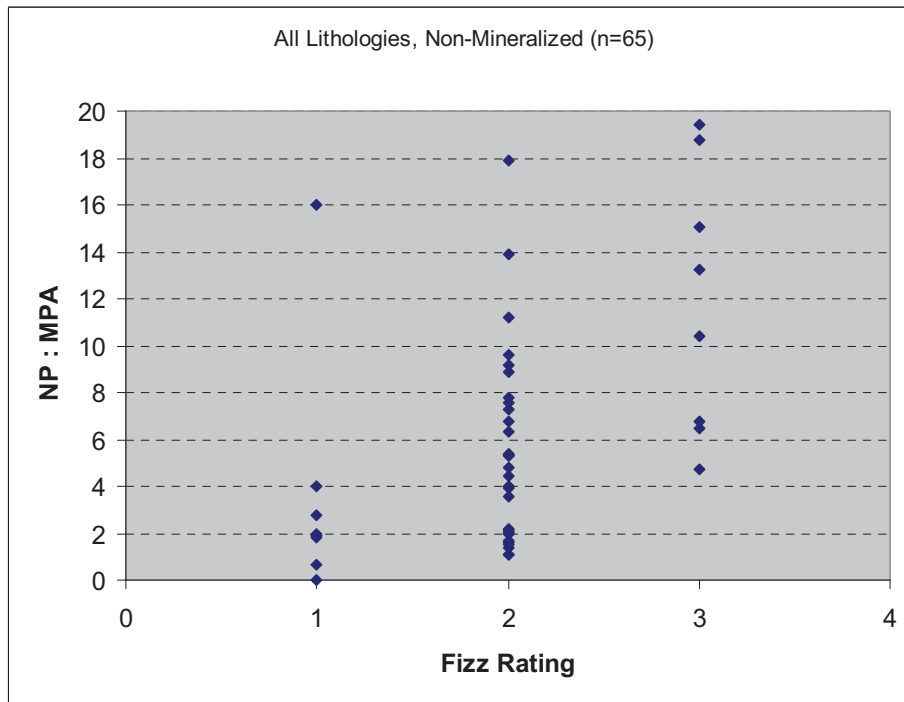


Figure 6. Relationships of Fizz Rating and NP : MPA



4.0 Analysis of Results

4.1 AML Geochemical Screening Criteria

An evaluation of testwork conducted on 47 1995-96 rock dump and pit wall samples in the Keno Silver District, rock excavated and left exposed for up to 80 years, concluded that samples showing net acidity and/or Pb and Zn metal leaching (AML) had the following geochemical characteristics (Altura Environmental Consulting, 2008a):

- Net Acidity: The two key aspects of samples demonstrating leachate $\text{pH} \leq 5.5$, are either a calcium level in the rock of $\leq 0.51\%$ or a CO_2 level of $\leq 0.6\%$, coupled with an ICP-sulphur level of $\geq 0.25\%$.
- Zinc Leaching: leaching of zinc to levels $\geq 10 \text{ mg/kg}$ appears to occur under two differing conditions: i) solubilization of zinc under net acidic conditions – independent of zinc concentration in rock, and ii) solubilization of zinc under overall neutral to alkaline conditions where Zn concentrations in rock exceed 5000 ppm.
- Lead Leaching: leaching of lead to levels $\geq 3 \text{ mg/kg}$ occurs only under neutral pH conditions, where Pb concentrations in rock exceed 5000 ppm.

The samples tested were taken from adit dump and pit samples at areas of previous mining activity in the Keno Hill area; and although occurring within the same geological units, most of the samples were comprised of material within or very close to the ore grade mineralization, and as such tend to demonstrate higher sulphur and sulphide content than the Bellekeno ABA sample suite. This relationship and other comparative graphs of the two datasets are presented in Appendix B4-4. Overall, the historic sample dataset also demonstrate lower paste pH, neutralization potential, carbonate and calcium. While this is no doubt in large part attributable to the weathered nature of the waste dump and pit wall samples versus the fresh rock of the Bellekeno dataset, due to the proximity of many of the samples to the main vein structure, differences in original sample lithology are also a likely factor.

The geochemical factors identified in the previous district-wide study provide valuable information with respect threshold criteria for determining, based on geochemical and visual characteristics, the potential for a fresh sample to generate AML.

Directly applying the above factors of $\leq 0.51\% \text{ Ca}$, and $\geq 0.25\% \text{ S}$ (via ICP) to the Bellekeno dataset results in a few samples with NP:MPA marginally above 1 being classified into the category of having low potential for net acidity. This indicates that this threshold for calcium is too low for a “fresh sample” dataset. The lower calcium threshold in the weathered samples is likely attributable to the waste dump and pit wall samples experiencing solubilization and flushing of calcium under ambient site conditions. Thus an adjustment factor for fresh rock samples of 1.5 was applied to the calcium criteria, increasing the threshold to $0.75\% \text{ Ca}$. Sulphur criteria is conservatively maintained at 0.25% ; in addition, a 1.50% upper threshold is recommended, to ensure that any high sulphur samples, regardless of calcium content, are assigned as potential net acidity producers. The 5000 ppm Pb and Zn criteria from the district-wide study are maintained.

In summary, based on the review of the Bellekeno ABA dataset coupled with the AML evaluation district-wide, the following geochemical screening criteria are recommended to identify potentially AML rock:

- a) $\text{Ca}\% \leq 0.75\%$ and $\text{S}_{\text{via ICP}} \geq 0.25\%$
- b) or $\text{S}_{\text{via ICP}} \geq 1.50\%$
- c) or $\text{Pb} \geq 5000 \text{ ppm}$
- d) or $\text{Zn} \geq 5000 \text{ ppm}$

4.2 Estimated Proportions of AML and Non-AML Rock for Bellekeno

Utilizing the screening criteria presented above in section 4.1, the 6478-sample Bellekeno waste rock database was filtered to identify potentially AML samples.

Results are shown in Table 4. The graphitic schist unit is indicated to contain the highest proportion of potentially AML samples, while the greenstone samples show the least potential for AML.

Table 4. Results of % AML Samples Identified Using AML Geochemical Screening Criteria against Bellekeno Waste Rock Drillhole Database

Lithology		Number of Samples in Database	# of Samples Screened as Potentially AML	% of Samples Screened as Potentially AML
Description	Code			
Chloritic Schist	CHSCH	222	27	12%
Calcareous Quartzite	CQTZT	505	54	11%
Greenstone	GNST	567	10	2%
Graphitic Schist	GSCH	870	562	65%
Quartzite	QTZT	3293	719	22%
Schist, Undifferentiated	SCH	775	299	39%
Sericitic Schist	SSCH	205	37	18%

Note: Lithology units with less than 40 samples not included in calculation (units CSCH and PHY)

4.3 Potential Field Screening Criteria

Based on the geochemical screening criteria identified in section 4.1 and the results of the acid base accounting, a series of potential criteria may be used in field screening of Bellekeno waste rock, in order to permit reliable identification of potentially AML rock during routine mining or other rock excavation activities. A possible “field filter” for identifying potentially AML rock is as follows:

- a) Slight or no effervescence of pulverized sample with 25% HCl (eg. presence of none or only a few bubbles), and visual estimated pyrite >0.5%, or;
- b) Any sample with one or more of the following:
 - i. visual estimated sphalerite >0.75%
 - ii. visual estimated galena >0.5%
 - iii. visual estimated pyrite >2%
 - iv. any Vein material not deemed to be in “Mineralized” category
 - v. paste pH ≤ 6.0 (to be measured on any highly altered/oxidized samples)

The above evaluations may be readily and rapidly conducted at a site in a basic field office facility, using simple instruments and materials such as a hand lens or binocular microscope, hydrochloric acid, distilled water, and pH meter.

As part of the development of a field program, the above criteria will require additional site testing, and should be modified as required to ensure and good correlation with geochemistry across all lithological units, and consistency in application between personnel.

5.0 Conclusions and Recommendations

This review of the Bellekeno geochemical and acid base accounting data, coupled with integration with studies and testwork done site-wide on exposed waste rock and pit walls, indicates that while much of the rock is geochemically benign, there is potential for a proportion of Bellekeno waste rock to produce net acidity and/or metal leaching.

To support waste rock management during future excavation activities, criteria have been derived to permit: i) estimation of expected quantities of potentially AML material for planning purposes, and ii) potential field screening criteria applicable to operation segregation of AML rock.

As part of the development of a field screening program for active rock excavation, field criteria will require additional site testing, and be modified as required to ensure and good correlation with geochemistry across all lithological units, and consistency in application between personnel.

Prepared By:

ALTURA ENVIRONMENTAL CONSULTING



Diane Lister, P.Eng.

References:

Access Mining Consultants, 1996. United Keno Hill Mines Limited Site Characterization Study, Report No. UKH/96/01.

Altura Environmental Consulting, 2008a. Review of Historic Keno Static Test Data to Define ARD/ML – Controlling and Correlating Factors. Prepared for Access Consulting Group.

BC Ministry of Energy and Mines, 1997. Draft Guidelines for and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia.

Attachments:

Appendices B1 to B4, and C1 to C2

Certificate #	Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Description
VA07091928	C212117	K-06-0011	SW Zone	36.3	37.5	SSCT	Light green-grey, fine grained mica schist with intermittent boudinized vein quartz.
TR07092775	K-07-0081	K-07-0081	East Zone	45.7	47.7	SSCT	Yellow-green fine grained mica-schist. Slightly oxidized
VA07091920	C212566	K-06-0016	SW Zone	207.3	208.4	SSCT	Yellow-green fine grained mica schist.
VA07091804	C462066	K-06-0023	SW Zone	356.8	358.5	SSCT	Sericite-Chlorite Schist Unit: Medium grey/green fine grained micaceous schist preceding a greenstone unit.
TR07093011	E600079	K-07-0078	East Zone	52.51	54.1	SSCT	Yellow-green fine grained mica-schist. Moderately friable.
TR07093907	E467959	K-07-0065	East Zone	180.96	182.08	SSCT	Yellow/green/grey fine grained mica-schist. Slightly calcareous. Quartz veins and boudins are interbedded with the schist.
TR07093920	E599704	K-07-0068	East Zone	139.38	139.77	SSCT	Yellow/green/grey fine grained mica-schist. Slightly calcareous.
TR07093369	E775513	K-07-0067	East Zone	135.63	136.25	SSCT	Light yellow-grey, fine-grained mica schist. Slightly calcareous.
TR07092771	E600542	K-07-0068	East Zone	229.1	229.9	CHSCH	Medium grey-green chlorite-rich schist with local thin quartzite beds.
VA07091806	C462793	K-06-0035	SW Zone	65.1	67.45	SSCT	Medium Grey/Green Chlorite-rich fine grained mica-schist.
TR07091923	C212729	K-06-0020	SW Zone	44.2	45.7	SSCT	Medium Grey/Green Chlorite-rich fine grained mica-schist.
VA07091226	E776315	K-07-0091a	East Zone	285.9	288	SSCT	Light-medium grey-green chlorite rich fine grained mica-schist.
TR07095899	E769248	K-07-0094	Middle East Zone	142.63	144.51	GNST	Dark grey-green greenstone
VA07091804	C462069	K-06-0023	SW Zone	359.9	361.9	GNST	Medium-dark green greenstone with abundant beige phenocrysts. Moderately calcareous.
TR07092775	E600290	K-07-0081	East Zone	51.05	51.9	GNST	Small unit of greenstone with cross-cutting quartz/siderite veins and veins. Moderately foliated.
TR07093364	E775819	K-07-0079	East Zone	86.87	89.03	GNST	Dark green, well-foliated, moderately calcareous greenstone.
VA07091921	C212639	K-06-0016	SW Zone	300.3	301.8	GNST	Medium-dark green, slightly calcareous greenstone. Slightly foliated with tiny, beige/white phenocrysts elongated approximately foliation parallel.
VA07091225	E599631	K-07-0092	Middle East Zone	116.25	118.26	GNST	Light grey-green, weakly foliated with porphyroblasts of quartz and carbonate.
TR07093366	E599612	K-07-0066	East Zone	1.34	3.35	GNST	Dark green-grey calcareous greenstone.
TR07092773	E752010	K-07-0083	East Zone	88.74	90.74	GNST	Medium grey-green calcareous greenstone
TR07092957	E775866	K-07-0082	East Zone	1.44	3.4	GNST	Medium grey-green calcareous greenstone
VA07091927	C212917	K-06-0020	SW Zone	285.6	291.05	GNST	Medium Grey-green calcareous greenstone.
TR07096383	E600841	K-07-0093	Middle East Zone	182.27	185.32	GNST	Light to medium grey-green, calcareous greenstone with trace qtz/calcite veining and elongated porphyroblasts. Moderately foliated.
VA07091226	E776319	K-07-0091a	East Zone	290.7	291.8	GNST	Light grey-green calcareous greenstone with undulating, boudinized qtz/calcite veins.
TR07092774	E600319	K-07-0081	East Zone	98.25	100.28	Q1ZT	Medium grey, moderately foliated quartzite.
VA07091804	C462078	K-06-0023	SW Zone	365.5	370.7	Q1ZT	Well foliated med-dark grey quartzite unit that has been cross cut by siderite stringers.
TR07093010	E600086	K-07-0078	East Zone	64.1	66.1	Q1ZT	Medium-grey, brittle quartzite with several cross-cutting qtz/siderite stringers.
TR07096383	E600846	K-07-0093	Middle East Zone	190.1	191.21	Q1ZT	Medium grey quartzite with slightly oxidized fractured surfaces and thin cross-cutting qtz stringers.
TR07097698	E769283	K-07-0094	Middle East Zone	196.84	197.8	Q1ZT	Light - Medium grey quartzite with iron/manganese oxide staining. Minor siderite and quartz stringers
TR07093363	E775833	K-07-0079	East Zone	131.56	133.56	Q1ZT	Medium grey, brittle quartzite. Cross cutting quartz veins/veinlets
TR07093908	C467832	K-07-0065	East Zone	28.34	29.34	Q1ZT	Bleached quartzite with magnetite staining surrounding fractures and quartz stringers.
TR07093902	E599725	K-07-0066	East Zone	155.95	156.95	Q1ZT	Brittle, light grey quartzite. Moderately foliated with stringers of quartz x-cutting foliation.
VA07091229	E600593	K-07-0092	Middle East Zone	51.55	53.52	Q1ZT	Medium grey, foliated with cross-cutting oxidized quartz stringers with slightly oxidized fracture surfaces.
TR07092952	E51981	K-07-0083	East Zone	43	45	Q1ZT	Bleached, brittle quartzite with manganese staining surrounding fractures and limonite staining on fracture surfaces.
VA07091806	C462785	K-06-0035	SW Zone	53	55	Q1ZT	Dark grey, well foliated
VA07091926	C212949	K-06-0020	SW Zone	332.2	333.7	Q1ZT	Medium-dark grey brittle quartzite with qtz stringers cross-cutting foliation. Iron Oxide staining on fractured surfaces.
TR07093900	C466994	K-07-0067	East Zone	111.1	113.1	Q1ZT	Medium-dark grey calcareous quartzite.
VA07091809	C462038	K-06-0023	SW Zone	323.1	324.6	Q1ZT	Medium-dark grey calcareous quartzite unit with cross-cutting quartz and calcite stringers.
VA07091227	E600744	K-07-0092	Middle East Zone	258	260.03	Q1ZT	Medium-dark grey calcareous quartzite with minor x-cutting quartz and calcite stringers.
TR07092959	E751851	K-07-0076	East Zone	78.73	81.55	Q1ZT	Medium grey calcareous quartzite with foliation parallel veins of calcite as well as cross-cutting quartz/calcite stringers.
TR07093366	C467574	K-07-0079	East Zone	29.39	31.39	Q1ZT	Medium-dark grey calcareous quartzite with a well developed foliation. Cross-cutting quartz and calcite stringers are present thru-out.
TR07093907	C467957	K-07-0065	East Zone	178.72	180.23	Q1ZT	Well foliated, medium to dark grey calcareous quartzite.
TR07093904	E599687	K-07-0066	East Zone	110.75	112.75	Q1ZT	Medium grey calcareous quartzite with cross-cutting quartz/calcite stringers. Slightly oxidized fractured surfaces.
TR07092951	E752037	K-07-0083	East Zone	131.41	133.5	Q1ZT	Well foliated, medium to dark grey calcareous quartzite with several foliation parallel bands of extreme calcification. Stringers of qtz and calcite are present k-cutting throughout
TR07092954	E775965	K-07-0082	East Zone	154.92	157.12	Q1ZT	Well foliated, medium to dark grey calcareous quartzite with several foliation parallel bands of extreme calcification. Stringers of qtz and calcite are present k-cutting throughout
VA07091805	C462958	K-06-0035	SW Zone	337	339	Q1ZT	Dark grey, slightly porous calcareous quartzite with bands of more intense calcification parallel to foliation.
VA07091926	C212942	K-06-0020	SW Zone	323.1	324.6	Q1ZT	Dark grey, well foliated, calcareous quartzite with stringers of qtz and calcite cross-cutting foliation. Limonite oxide stains fractured surfaces and some stringers.
TR07096384	E600885	K-07-0093	Middle East Zone	225	227	Q1ZT	Medium to dark grey, banded calcareous schist. Some bands (cm scale) are more intensely calcareous than others.
VA07091924	C215828	K-06-0023	SW Zone	45.7	47.3	GSCH	Med-dark grey moderately graphitic schistose unit with intermittent, thin beds of quartzite. Slightly gougry at times. Slightly vuggy
TR07093011	E600070	K-07-0078	East Zone	39.62	41.62	GSCH	Graphitic Schist unit with intermittent thin beds of quartzite. Slightly gougry at times. Slightly vuggy
TR07097698	E769289	K-07-0094	Middle East Zone	207.9	209.91	GSCH	Dark grey, slightly gougry, friable graphitic schist with intermittent qtz veins. Slightly oxidized - limonite staining on fractured surfaces.
TR07092956	E751924	K-07-0076	East Zone	154.04	155.91	GSCH	Dark grey slightly graphitic schist with intermittent, thin beds of quartzite. Qtz veins. Moderately oxidized.
TR07092957	E775865	K-07-0079	East Zone	160.83	163.37	GSCH	Dark grey, moderately graphitic schist unit with intermittent, thin bedded quartzite.
TR07093905	C467893	K-07-0065	East Zone	102.41	103.89	GSCH	Dark grey, graphitic schist. Sweats of calcite and vein quartz intermittent throughout.
TR07093367	E775945	K-07-0066	East Zone	60.58	62.86	GSCH	Dark grey to black graphitic schist with veins and intermittent layers of vein quartz.
TR07093901	E469665	K-07-0067	East Zone	64.91	66.98	GSCH	Dark grey to black graphitic schist with veins and intermittent layers of vein quartz.
TR07092955	E775947	K-07-0082	East Zone	130.47	132.27	GSCH	Dark grey to black graphitic schist with veins and intermittent layers of vein quartz.
VA07091807	C462772	K-06-0035	SW Zone	31	33	GSCH	Dark grey to black graphitic schist with veins and intermittent layers of vein quartz.
VA07091930	C212705	K-06-0020	SW Zone	13.5	15.2	GSCH	Dark grey to black graphitic schist with veins and intermittent layers of vein quartz. Slightly oxidized.

APPENDIX B1-1 Acid Base Accounting Data

Certificate #	Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Description
TR07092772	E600774	K-07-0092	Middle East Zone	297.77	299.8	GSCH	Dark grey to black graphitic schist with streaks of vein quartz/calcite throughout.
VA07091228	E776285	K-07-0091a	East Zone	297.45	298.45	GSCH	Dark grey to black graphitic schist with streaks of vein quartz/calcite throughout.
TR07093363	C467919	K-07-0093	East Zone	129.84	130.12	VN	Mineralized Siderite vein (sphalerite + galena veins) - clay alteration.
TR07093920	E595708	K-07-0096	East Zone	142.46	143.1	VN	Mineralized Siderite vein (sphalerite and galena veins)
TR07093368	E775550	K-07-0097	East Zone	164.24	164.94	VN	Brecciated Quartzite with siderite matrix. Main mineralized lens contains sphalerite, galena, arsenopyrite.
TR07092968	E751683	K-07-0076	East Zone	114.5	115.21	VN	Fine grained galena and sphalerite within quartz and siderite stringers that cross-cut the quartzite unit.
TR07092963	E775989	K-07-0082	East Zone	195.96	196.4	VN	Trace Galena within fractures of a siderite vein.
VA07091240	E600657	K-07-0092	Middle East Zone	158.37	158.72	VN	Trace Galena within greenstone and siderite stringers.
VA07091931	C212406	K-06-0011	SW Zone	401.3	402	VN	Tetrahedrite, siderite, galena and sphalerite - breccia.
VA07091925	C462087	K-06-0023	SW Zone	377.45	378	VN	Massive sphalerite with minor amounts of galena, pyrite and chalcopyrite within a siderite vein.
VA07091241	C463235	K-06-0038	SW Zone	310.6	311.05	VN	Fractured broken quartzite with trace siderite veining. Trace pyrite/sphalerite and possibly galena
TR07093365	E775799	K-07-0079	East Zone	61.82	61.96	VN	Massive sphalerite within a siderite vein. Massive pyrite and trace galena also present.

APPENDIX B1-1 Acid Base Accounting Data

Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	MPA [CaCO3/1000 ore]	OA-VOL08 FIZZ RATING Unity	OA-VOL08 NIP [CaCO3/1000 ore]	OA-VOL08 NP [CaCO3/1000 ore]	OA-VOL08 Unit	OA-ELE07 pH Unity	OA-VOL08 Ratio NP:MPA Unity	S-IR08 Total S %	S-GRA06 SO4 (Cb Lch) %S	S-GRA06a SO4 (HCl Lch) %S	S-CAL06 S2- (calc) %S	C-GAS05	
																	C	CO2
C21217	K-06-0011	SW Zone	36.3	37.5	SSCT	10.6	2	12	23	8.5	2.16	0.34<0.01	0.07	0.01	<0.01	0.34	0.11	0.4
E600288	K-07-0081	East Zone	45.7	47.7	SSCT	2.5	17	15	2	8.5	6.8	0.08	0.07	0.01	<0.01	0.07	0.2	0.8
C212566	K-06-0016	SW Zone	207.3	208.4	SSCT	5.3	3	75	80	7.8	15.06	0.17	0.05	0.04	0.12	0.83	0.83	3.1
C462066	K-06-0023	SW Zone	356.8	368.5	SSCT	1.3	3	84	85	8.9	8.9	0.04	0.01	<0.01	0.03	0.86	3.2	3.2
E600079	K-07-0078	East Zone	52.51	54.1	SSCT	6.3	2	27	33	7.6	5.28	0.2	0.01	0.01	0.19	0.37	2.1	2.1
E487959	K-07-0065	East Zone	180.96	182.08	SSCT	1.3	3	126	127	8.6	101.6	0.04	<0.01	0.02	0.04	1.25	4.6	4.6
E597074	K-07-0066	East Zone	139.38	139.77	SSCT	8.8	3	161	170	8.3	19.3	0.28	0.01	<0.01	0.27	1.75	6.4	6.4
E775573	K-07-0067	East Zone	136.63	136.25	SSCT	3	3	163	165	8.4	66	0.08	<0.01	0.08	1.83	1.83	6.7	6.7
E600542	K-07-0068	East Zone	229.1	229.9	CHSCH	10.6	2	40	51	8	4.8	0.34	<0.01	<0.01	0.34	1.31	4.8	4.8
C467193	K-06-0035	SW Zone	65.1	67.45	SSCT	6.9	2	30	37	8.6	5.38	0.22	0.03	0.06	0.19	0.54	2	2
C212729	K-06-0020	SW Zone	44.2	45.7	SSCT	2.8	2	22	25	8.3	8.89	0.09	0.03	0.03	0.06	0.06	0.2	0.2
E776375	K-07-0091a	East Zone	285.9	288	SSCT	5.9	3	189	195	8.4	32.84	0.19	0.01	0.03	0.18	2.13	7.8	7.8
E7768248	K-07-0094	Middle East Zone	144.51	144.63	GNST	4.7	1	8	13	8.6	2.77	0.15	0.01	0.01	0.14	0.05	0.2	0.2
C462069	K-06-0023	SW Zone	359.9	361.9	GNST	2.2	3	84	86	8.8	39.31	0.07	<0.01	0.01	0.07	0.53	1.9	1.9
E600290	K-07-0081	East Zone	51.05	51.9	GNST	5	3	161	166	8.1	33.2	0.16	<0.01	<0.01	0.16	1.86	6.8	6.8
E775819	K-07-0079	East Zone	86.87	89.03	GNST	0.9	2	45	46	8	49.07	0.03	0.01	<0.01	0.02	0.44	1.6	1.6
C212639	K-06-0016	SW Zone	300.3	301.8	GNST	3.4	2	22	25	8.6	7.27	0.11	0.01	0.02	0.1	0.13	0.5	0.5
E600631	K-07-0092	Middle East Zone	116.25	118.26	GNST	0.6	2	35	36	8.3	57.6	0.02	<0.01	0.02	0.02	0.36	1.3	1.3
E599612	K-07-0066	East Zone	1.34	3.35	GNST	0.6	1	9	10	8.8	16	0.02	0.01	<0.01	0.01	<0.05	0.2	0.2
E752010	K-07-0083	East Zone	88.74	90.74	GNST	8.3	3	206	207	8.3	220.8	0.03	<0.01	<0.01	0.03	3.01	11	11
E775866	K-07-0082	East Zone	1.44	3.4	GNST	0.3	1	12	12	8.6	38.4	0.01	<0.01	<0.01	<0.01	<0.05	<0.2	<0.2
C212917	K-06-0020	SW Zone	289.6	291.05	GNST	0.9	2	21	22	8.4	23.47	0.03	0.01	<0.01	0.02	0.08	0.3	0.3
E600841	K-07-0093	Middle East Zone	182.27	185.32	GNST	10	2	66	76	8.2	7.6	0.32	0.03	0.01	0.29	0.99	3.6	3.6
E776319	K-07-0091a	East Zone	290.7	291.8	GNST	1.3	3	72	73	8.3	58.4	0.04	<0.01	0.02	0.04	0.47	1.7	1.7
E600319	K-07-0081	East Zone	98.25	100.28	Q1ZT	5.9	2	40	46	8.9	7.75	0.19	0.01	<0.01	0.18	0.86	3.2	3.2
C462078	K-06-0023	SW Zone	369.5	370.7	Q1ZT	20.9	2	14	35	8.2	1.67	0.67	0.01	<0.01	0.66	0.42	1.6	1.6
E600086	K-07-0078	East Zone	64.1	66.1	Q1ZT	4.1	2	4	8	8	1.97	0.13	0.01	0.01	0.12	0.14	0.5	0.5
E600846	K-07-0093	Middle East Zone	190.1	191.21	Q1ZT	0.3	2	30	30	8.6	96	0.01<0.01	0.02	0.02	0.01	0.4	1.5	1.5
E769283	K-07-0094	Middle East Zone	196.84	197.8	Q1ZT	4.7	2	60	65	7.9	13.87	0.15<0.01	0.01	<0.01	0.15	0.83	3	3
E775893	K-07-0079	East Zone	111.56	113.56	Q1ZT	4.9	2	0	5	7.9	1.07	0.15	0.02	<0.01	0.13	0.08	0.3	0.3
C467832	K-07-0065	East Zone	28.34	29.34	Q1ZT	1.6	1	-1	0	6.4	0.84	0.03	0.02	0.03	0.03	<0.05	<0.2	<0.2
E599725	K-07-0066	East Zone	195.95	196.95	Q1ZT	6.6	2	2	9	7.6	1.37	0.21	0.01	0.01	0.2	0.21	0.8	0.8
E600593	K-07-0092	Middle East Zone	51.55	53.52	Q1ZT	1.6	1	1	3	7.7	1.92	0.05	0.02	0.02	0.03	<0.05	<0.2	<0.2
E751981	K-07-0083	East Zone	43	45	Q1ZT	<0.3	2	11	11	8.6	70.4	<0.01	0.01	<0.01	<0.01	0.11	0.4	0.4
C467185	K-06-0035	SW Zone	53	55	Q1ZT	6.3	2	1	7	8	1.12	0.2	0.02	<0.01	0.18	0.1	0.4	0.4
C212949	K-06-0020	SW Zone	332.2	333.7	Q1ZT	3.8	2	16	20	8.3	5.33	0.12	0.01	0.02	0.11	0.2	0.8	0.8
C468994	K-07-0067	East Zone	111.1	113.1	Q1ZT	6.9	3	192	199	8.5	28.95	0.22	0.02	<0.01	0.2	2.38	8.7	8.7
C462038	K-06-0023	SW Zone	323.1	324.6	Q1ZT	25.6	3	96	122	8.1	4.76	0.82	0.04	0.01	0.78	1.5	5.5	5.5
E600744	K-07-0092	Middle East Zone	258	260.03	Q1ZT	9.1	3	85	94	8.2	10.37	0.29	0.01	<0.01	0.28	1.61	5.9	5.9
E751851	K-07-0076	East Zone	78.73	81.55	Q1ZT	23.4	3	129	152	8.3	6.49	0.75	0.03	<0.01	0.72	1.49	5.5	5.5
E775774	K-07-0079	East Zone	29.39	31.39	Q1ZT	2.8	3	178	181	8.5	64.36	0.09	<0.01	<0.01	0.09	2.29	8.4	8.4
C467957	K-07-0065	East Zone	178.72	180.23	Q1ZT	4.4	3	197	201	8.7	45.94	0.14	0.01	0.01	0.13	2.49	9.1	9.1
E599687	K-07-0066	East Zone	110.75	112.75	Q1ZT	10	3	178	188	8.3	18.8	0.32	0.01	<0.01	0.31	2.4	8.8	8.8
E752037	K-07-0083	East Zone	131.41	133.5	Q1ZT	5.6	2	14	20	8.3	3.56	0.18	0.02	0.01	0.16	0.25	0.9	0.9
E775965	K-07-0082	East Zone	154.92	157.12	Q1ZT	4.7	2	20	25	8.3	5.33	0.15	0.01	<0.01	0.14	0.32	1.2	1.2
C462958	K-06-0035	SW Zone	337	339	Q1ZT	18.8	3	108	127	8.4	6.77	0.6	0.02	0.01	0.58	1.56	5.7	5.7
C212942	K-06-0020	SW Zone	323.1	324.6	Q1ZT	3.8	2	80	84	8.3	22.4	0.12	0.01	0.01	0.11	1.23	4.5	4.5
E600885	K-07-0093	Middle East Zone	225	227	Q1ZT	3.8	2	63	67	8.4	17.87	0.12	0.02	0.01	0.1	0.83	3.1	3.1
C215828	K-06-0023	SW Zone	45.7	47.3	GSCH	6.6	1	-7	0	7.8	0	0.21	0.01	0.01	0.2	<0.05	<0.2	<0.2
E600070	K-07-0078	East Zone	39.62	41.62	GSCH	1.3	1	4	5	7.9	4	0.04	<0.01	<0.01	0.04	<0.05	<0.2	<0.2
E768289	K-07-0094	Middle East Zone	207.9	209.91	GSCH	7.5	2	62	69	8.3	9.2	0.24	0.01	0.01	0.23	1.09	4	4
E751924	K-07-0076	East Zone	154.04	155.91	GSCH	20	2	58	78	8.4	3.9	0.64	0.03	<0.01	0.61	1.32	4.8	4.8
E775865	K-07-0079	East Zone	160.83	163.37	GSCH	32.8	2	34	67	8.4	2.04	1.08	0.04	<0.01	1.01	0.94	3.5	3.5
C467883	K-07-0065	East Zone	102.41	103.89	GSCH	14.4	2	77	91	8.3	6.33	0.46	0.02	<0.01	0.44	1.24	4.5	4.5
E775945	K-07-0066	East Zone	60.58	62.86	GSCH	1.9	3	60	62	8.4	33.07	0.06	0.01	<0.01	0.05	0.77	2.8	2.8
E468965	K-07-0067	East Zone	64.91	66.98	GSCH	7.8	2	67	75	8.8	9.6	0.25	0.01	0.01	0.24	1.19	4.4	4.4
E775947	K-07-0082	East Zone	130.47	132.27	GSCH	22.2	2	67	89	8.4	4.01	0.71	0.03	<0.01	0.68	1.28	4.7	4.7
C462772	K-06-0035	SW Zone	31	33	GSCH	19.1	2	12	31	7.9	1.63	0.31	0.02	0.01	0.59	0.57	2.1	2.1
C212705	K-06-0020	SW Zone	13.5	15.2	GSCH	9.7	1	9	19	8	1.96	0.31	0.14	0.16	0.17	0.13	0.5	0.5

APPENDIX B1-1 Acid Base Accounting Data

Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	OA-VOL08 MPA [CaCO3/1000t ore]	OA-VOL08 FIZZ RATING Unity	OA-VOL08 NMP [CaCO3/1000t ore]	OA-VOL08 NP [CaCO3/1000t ore]	OA-ELE07 pH Unity	OA-VOL08 Ratio NP:MPA Unity	S-IR08 Total S %	S-GRA06 SO4 (Cb Lch) %S	S-GRA06a SO4 (HCl Lch) %S	S-CAL06 S2- (calc) %	C-GAS05 C %	C-GAS05 CO2 %	
E600774	K-07-0092	Middle East Zone	297.77	299.8	GSCH	13.1	1	11	42	24	8.3	1.83	0.42	0.01	<0.01	0.41	0.31	1.2
E776285	K-07-0091a	East Zone	247.45	249.45	GSCH	37.2	2	42	79	79	6.9	2.12	1.19	0.02	<0.01	1.17	1.32	4.8
C467919	K-07-0065	East Zone	129.84	130.12	VN	335.9	2	-282	54	54	6.7	0.16	10.75	0.04	0.03	10.7	6.23	22.8
E899708	K-07-0066	East Zone	142.46	143.1	VN	196.6	2	-152	45	45	6.7	0.23	6.29	0.05	0.04	6.24	6.93	25
E775550	K-07-0067	East Zone	164.24	164.94	VN	176.9	2	-123	54	54	6.9	0.31	5.66	0.02	<0.01	5.64	3.46	12.9
E751883	K-07-0076	East Zone	114.5	115.21	VN	9.1	2	31	40	40	8.2	4.41	0.29	<0.01	<0.01	0.29	0.62	2.3
E775989	K-07-0082	East Zone	195.96	196.4	VN	12.8	3	157	170	170	8.4	13.27	0.41	0.01	<0.01	0.4	3.78	13.8
E600657	K-07-0092	Middle East Zone	158.37	158.72	VN	8.1	2	83	91	91	8.3	11.2	0.26	0.02	<0.01	0.24	5.29	19.4
C212406	K-06-0011	SW Zone	401.3	402	VN	378.1	2	-317	61	61	7.6	0.16	12.1	0.07	0.03	12.05	6.86	25.1
C462087	K-06-0023	SW Zone	377.45	378	VN	557.8	2	-515	43	43	6.6	0.08	17.85	0.21	0.25	17.65	1.78	6.5
C463235	K-06-0038	SW Zone	310.6	311.05	VN	36.6	2	18	55	55	7.7	1.5	1.17	0.01	0.01	1.16	1.26	4.6
E775799	K-07-0079	East Zone	61.82	61.96	VN	582.8	2	-550	33	33	5.8	0.06	18.65	0.77	0.78	17.9	3.88	14.2

APPENDIX B1-2 ICP Metals for ABA Database

Certificate #	Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm
1	VA07091928	C212117	SW Zone	36.3	37.5	SSCH	0.01	0.50	3.53	5	3130	0.9	2	0.3	0.5	10	33
2	TR07092775	K-07-0081	East Zone	45.7	47.7	SSCH	0.01	2.00	5.31	37	2290	1.6	2	0.36	4.1	13	47
3	VA07091920	K-06-0016	SW Zone	207.3	208.4	SSCH	0.01	0.50	5.6	6	920	1.3	2	2.84	0.5	9	38
4	VA07091804	K-06-0023	SW Zone	356.8	358.5	SSCH	0.01	0.50	8.49	5	3200	1.9	2	3.98	0.5	10	99
5	TR07093011	K-07-0078	East Zone	52.51	54.1	SSCH	0.01	2.90	4.32	46	1880	1.3	2	0.26	16.3	8	38
6	TR07093907	C467959	East Zone	180.96	182.08	SSCH	0.01	0.50	7.5	5	360	0.6	2	5.56	0.5	31	131
7	TR07093920	K-07-0066	East Zone	139.38	139.77	SSCH	0.01	11.80	7.25	30	310	0.8	2	5.18	19.7	35	168
8	TR07093369	K-07-0067	East Zone	135.63	136.25	SSCH	0.01	1.00	4.66	5	260	0.5	2	5.51	0.5	26	129
9	TR07092771	E600542	East Zone	229.1	229.9	SSCH	0.02	0.80	1.55	262	210	0.5	2	0.17	47.3	3	37
10	VA07091806	C462793	SW Zone	65.1	67.45	SSCH	0.01	0.50	5.58	5	7620	1.8	2	0.61	0.5	16	48
11	VA07091923	K-06-0035	SW Zone	44.2	45.7	SSCH	0.01	0.50	5.32	5	6800	1.9	2	0.46	0.5	14	50
12	VA07091226	E776315	East Zone	286.9	288	SSCH	0.01	1.40	6.53	20	410	0.7	2	7.35	0.5	29	112
13	TR07085989	E768248	Middle East Zone	142.63	144.51	GNST	0.01	0.50	8.65	7	40	0.5	2	8.34	0.5	41	98
14	VA07091804	C462069	SW Zone	359.9	361.9	GNST	0.02	0.50	7.13	13	1150	1.2	2	4.61	0.5	19	10
15	TR07092775	E600290	East Zone	51.05	51.9	GNST	0.01	3.00	7.94	47	170	1.2	2	5.38	10.8	35	112
16	TR07093364	E775819	East Zone	86.87	89.03	GNST	0.01	0.50	7.98	13	10	0.5	2	8.02	0.5	38	94
17	VA07091921	C212639	SW Zone	300.3	301.8	GNST	0.01	0.50	8.45	18	30	0.6	2	6.97	0.5	43	46
18	VA07091225	E600631	Middle East Zone	116.25	118.26	GNST	0.01	0.50	6.94	5	220	0.7	2	6.75	0.5	48	13
19	TR07093906	E599612	East Zone	1.34	3.35	GNST	0.01	0.50	7.41	5	170	0.5	4	7.09	0.7	38	136
20	TR07092773	E752010	East Zone	88.74	90.74	GNST	0.01	0.70	6.84	8	140	0.5	3	7.83	0.5	36	74
21	TR07092957	E775866	East Zone	1.44	3.4	GNST	0.01	0.50	8.21	11	60	0.5	2	7.64	0.5	42	190
22	VA07091927	C212917	SW Zone	289.6	291.05	GNST	0.02	0.50	8.18	8	250	0.5	2	8.06	0.5	41	455
23	TR07086383	E600841	Middle East Zone	182.27	185.32	GNST	0.02	0.60	4	10	570	1	2	2.78	0.5	5	82
24	VA07091226	E776319	East Zone	290.7	291.8	GNST	0.02	0.50	8.53	5	380	0.6	2	5.15	0.5	46	166
25	TR07092774	E600319	East Zone	98.25	100.28	QTZT	0.01	0.50	1.48	5	190	0.5	2	1.48	0.5	1	45
26	VA07091804	C462078	SW Zone	369.5	370.7	QTZT	0.02	2.60	1.62	35	710	0.5	2	0.91	39.8	2	38
27	TR07093010	E600086	East Zone	64.1	66.1	QTZT	0.01	0.80	1.12	13	180	0.5	2	0.12	1.1	2	42
28	TR07086383	E600846	Middle East Zone	190.1	191.21	QTZT	0.01	1.30	1.43	5	70	0.5	2	1.23	0.5	2	58
29	TR07087698	E768283	Middle East Zone	196.84	197.8	QTZT	0.02	1.60	0.43	37	50	0.5	2	2.47	3.0	1	26
30	TR07093363	E775833	East Zone	111.56	113.56	QTZT	0.01	0.70	0.37	52	100	0.5	2	0.15	0.5	1	40
31	TR07093908	C467832	East Zone	28.34	29.34	QTZT	0.01	1.80	0.29	121	40	0.5	2	0.03	1.4	1	42
32	TR07093902	E599725	East Zone	155.95	156.95	QTZT	0.01	2.20	0.88	28	210	0.5	2	0.06	6.3	2	54
33	VA07091229	E600593	Middle East Zone	51.55	53.52	QTZT	0.01	0.50	0.39	5	60	0.5	2	0.09	0.5	1	63
34	TR07092952	E751981	East Zone	43	45	QTZT	0.01	0.50	1.32	13	190	0.5	2	0.35	1.5	2	44
35	VA07091806	C462785	SW Zone	53	55	QTZT	0.01	0.50	0.75	5	150	0.5	2	0.21	0.5	1	24
36	VA07091926	C212949	SW Zone	332.2	333.7	QTZT	0.01	0.50	0.31	38	50	0.5	2	0.76	0.5	1	41
37	TR07093900	C466984	East Zone	111.1	113.1	CQTZT	0.01	0.50	1.36	6	310	0.5	2	7.47	0.5	3	35
38	VA07091809	C462038	SW Zone	323.1	324.6	CQTZT	0.01	1.20	1.37	12	420	0.5	2	5.05	0.7	3	36
39	VA07091227	E600744	Middle East Zone	258	260.03	CQTZT	0.01	0.50	0.51	5	230	0.5	2	3.71	0.5	1	30
40	TR07092959	E751851	East Zone	78.73	81.55	CQTZT	0.01	2.30	2.2	15	340	0.6	2	5.3	6.5	2	48
41	TR07093366	E775774	East Zone	29.39	31.39	CQTZT	0.01	0.50	0.8	5	200	0.5	2	6.85	0.5	4	33
42	TR07093907	C467957	East Zone	178.72	180.23	CQTZT	0.01	0.50	1.31	5	390	0.5	2	6.78	0.5	1	29
43	TR07093904	E599687	East Zone	110.75	112.75	CQTZT	0.01	0.70	1.83	12	340	0.5	2	7.17	0.8	3	38
44	TR07092951	E752037	East Zone	131.41	133.5	CQTZT	0.01	0.50	0.5	5	140	0.5	2	0.74	0.5	1	44
45	TR07092954	E775965	East Zone	154.92	157.12	CQTZT	0.01	0.50	0.41	7	90	0.5	2	0.98	0.5	1	29
46	VA07091805	C462958	SW Zone	337	339	CQTZT	0.01	0.70	1.05	9	270	0.5	2	4.26	0.5	3	47
47	VA07091926	C212942	SW Zone	323.1	324.6	CQTZT	0.01	0.50	2.03	21	210	0.5	2	3.07	0.6	11	56
48	TR07086384	E600885	Middle East Zone	225	227	CQTZT	0.01	0.50	0.47	5	240	0.5	2	2.61	0.5	1	24
49	VA07091924	C215828	SW Zone	45.7	47.3	GSCH	0.01	2.50	5.42	7	1420	1.3	2	0.07	0.6	5	60
50	TR07093011	E600070	East Zone	39.62	41.62	GSCH	0.01	0.50	7.13	24	790	1.8	2	0.25	0.5	9	96
51	TR07087698	E768289	Middle East Zone	207.9	209.91	GSCH	0.01	0.50	9.01	10	1360	2.5	2	2	0.5	14	117
52	TR07092956	E751924	East Zone	154.04	155.91	GSCH	0.01	0.50	6.51	16	880	1.8	2	2.25	0.5	9	88
53	TR07092957	E775865	East Zone	160.83	163.37	GSCH	0.10	0.60	7.51	16	1000	1.9	2	1.9	0.5	10	112

APPENDIX B1-2 ICP Metals for ABA Database

Certificate #	Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm
54	TR07093905	C467893	K-07-0065	East Zone	102.41	103.89	GSCH	0.01	0.50	5.16	7	870	1.3	2	3.56	0.5	6
55	TR07093367	E775645	K-07-0066	East Zone	60.58	62.66	GSCH	0.01	0.70	0.56	7	140	0.5	2	2.45	0.5	2
56	TR07093901	C466965	K-07-0067	East Zone	64.91	66.98	GSCH	0.01	0.70	9.16	13	1410	2.4	2	2.28	0.7	13
57	TR07092955	E775947	K-07-0082	East Zone	130.47	132.27	GSCH	0.01	0.50	8.25	5	1370	2	2	3.07	0.6	8
58	VA07091807	C462772	K-06-0035	SW Zone	31	33	GSCH	0.01	6.10	6.94	11	2240	1.8	2	0.86	0.5	9
59	VA07091930	C212705	K-06-0020	SW Zone	13.5	15.2	GSCH	0.01	0.50	10.35	10	3490	2.6	2	0.7	0.5	13
60	TR07092772	E600774	K-07-0092	Middle East Zone	297.77	299.8	GSCH	0.01	0.50	11.25	18	1360	2.9	2	0.74	0.5	15
61	VA07091228	E776285	K-07-0091a	East Zone	247.45	249.45	GSCH	0.01	0.60	9.21	64	1090	2.2	2	2.96	0.8	13
65	TR07092958	E751883	K-07-0076	East Zone	114.5	115.21	VN	0.01	2.10	2.23	34	350	0.7	2	0.81	8.3	4
66	TR07092953	E775989	K-07-0082	East Zone	195.96	196.4	VN	0.01	8.80	1.32	13	330	0.5	2	2.83	47.4	4
67	VA07091240	E600657	K-07-0092	Middle East Zone	158.37	158.72	VN	0.01	30.50	4.77	42	60	1.5	4	4.57	30.6	25
70	VA07091241	C463235	K-06-0038	SW Zone	310.6	311.05	VN	0.13	9.40	0.84	1810	100	0.5	2	1.53	36.5	7
62	TR07093903	C467919	K-07-0065	East Zone	129.84	130.12	VN	4.28	42.40	0.06	10000	10	0.5	18	0.25	1000.0	77
63	TR07093920	E599708	K-07-0066	East Zone	142.46	143.1	VN	0.73	1340.00	0.16	842	10	0.5	69	0.52	806.0	7
64	TR07093368	E775550	K-07-0067	East Zone	164.24	164.94	VN	0.12	175.00	0.62	10000	30	0.5	2	0.29	795.0	81
68	VA07091931	C212406	K-06-0011	SW Zone	401.3	402	VN	1.13	79.80	0.01	1710	10	0.5	38	0.2	1000.0	24
69	VA07091925	C462087	K-06-0023	SW Zone	377.45	378	VN	2.23	735.00	0.32	6550	10	0.5	86	0.15	1000.0	29
71	TR07093365	E775799	K-07-0079	East Zone	61.82	61.96	VN	0.60	1770.00	0.01	698	10	0.5	22	0.18	1000.0	5

APPENDIX B1-2 ICP Metals for ABA Database

Certificate #	Sample #	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%
1	VA07091928	96	2.43		0.89		0.84	1845	1	0.05	36	290		9	0.29	5	60		0.16
2	TR07092775	93	3.36	10	1.55	20	0.99	1810	1	0.07	45	350		62	0.09	8	12	46	0.22
3	VA07091920	18	2.37		1.99		0.67	635	1	0.84	13	240		17	0.07	5		122	0.21
4	VA07091804	27	4.26		2.47		2.02	844	1	2.96	41	1160		2	0.03	5		253	0.58
5	TR07093011	47	3.65	10	1.67	20	0.27	9170	2	0.04	21	320		217	0.19	5	9	30	0.18
6	TR07093907	145	7.16	20	0.39	20	3.11	989	1	0.25	79	670		9	0.04	6	28	379	0.78
7	TR07093920	142	6.77	20	0.61	10	1.99	3430	2	0.23	80	680		172	0.28	15	31	292	0.63
8	TR07093369	106	5.21	10	0.26	10	1.91	819	1	0.09	53	450		3	0.07	5	22	315	0.55
9	TR07092771	14	5.14	10	0.46	10	0.21	16050	1	0.07	7	290		65	0.33	5	5	17	0.11
10	VA07091806	62	3.29		1.8		1.24	3980	1	0.09	59	420		12	0.23	6		131	0.18
11	VA07091923	77	2.85		1.78		1.21	2550	1	0.03	48	400		6	0.08	5		103	0.21
12	VA07091226	178	7.17	20	0.33	10	2.87	934	1	0.15	67	750		7	0.23	5	24	281	0.56
13	TR07085899	233	8.14	20	0.08	10	3.67	1350	1	1.6	87	590		3	0.02	7	35	239	0.9
14	VA07091804	230	8.25		0.76		1.68	1545	1	2.69	11	1370		4	0.06	5	361		0.96
15	TR07092775	163	8.84	20	1.22	10	3.36	4670	1	0.02	86	650		594	0.19	10	34	64	0.93
16	TR07093364	180	8.37	20	0.01	10	3.61	1400	1	0.76	71	630		7	0.02	5	34	323	0.87
17	VA07091921	158	8.14		0.01		4.15	1330	1	1.46	89	680		2	0.12	9		293	0.96
18	VA07091225	306	10.75	20	0.05	10	3.07	1710	1	1.41	39	970		2	0.02	5	39	221	0.14
19	TR07093906	178	8.38	20	0.1	10	3.61	1305	1	1.58	80	590		3	0.01	5	35	219	0.9
20	TR07092773	140	7.53	20	0.11	10	3.77	1215	1	0.21	76	570		4	0.02	5	33	555	0.7
21	TR07092957	136	7.79	20	0.07	10	4	1410	1	1.32	100	510		7	0.01	7	36	242	0.78
22	VA07091927	120	7.07		0.29		5.17	1140	1	1.36	173	510		2	0.03	10	346		0.6
23	TR07086383	11	2.02	10	0.69	20	0.33	182	1	0.15	20	490		16	0.33	5	7	168	0.23
24	VA07091226	177	10.05	20	0.18	10	4.02	1500	1	0.02	99	970		4	0.03	5	36	361	0.14
25	TR07092774	7	1.29	10	0.31	10	0.39	111	1	0.06	10	370		3	0.21	5	3	40	0.11
26	VA07091804	12	2.27		0.47		0.25	3770	1	0.05	12	280		418	0.63	5		32	0.1
27	TR07093010	6	1.06	10	0.39	10	0.06	2300	1	0.03	8	240		131	0.12	5	2	23	0.1
28	TR07086383	6	0.93	10	0.18	10	0.22	241	1	0.15	7	190		5	0.01	5	2	52	0.1
29	TR07087698	10	0.84	10	0.14	10	0.1	763	2	0.01	4	390		39	0.16	12	1	48	0.04
30	TR07093363	4	0.54	10	0.11	10	0.04	221	1	0.01	5	80		13	0.14	5	1	8	0.07
31	TR07093908	11	0.55	10	0.09	10	0.01	568	1	0.01	4	60		71	0.04	5	1	5	0.04
32	VA07093902	6	1.06	10	0.32	10	0.04	2030	1	0.01	7	180		119	0.19	5	1	11	0.11
33	VA07091229	2	0.63	10	0.06	10	0.04	40	1	0.01	4	70		3	0.05	5	1	6	0.03
34	TR07092952	6	0.72	10	0.3	10	0.09	556	1	0.03	8	160		53	0.01	5	2	23	0.1
35	VA07091806	4	0.69		0.09		0.09	75	1	0.05	6	140		4	0.2	5		33	0.08
36	VA07091926	4	0.62		0.06		0.09	113	1	0.01	5	180		4	0.14	5		11	0.04
37	TR07093900	8	1.09	10	0.38	20	0.4	164	1	0.05	9	470		3	0.23	5	3	187	0.1
38	VA07091809	8	1.1		0.43		0.24	170	1	0.07	9	550		77	0.91	5		110	0.09
39	VA07091227	3	0.82	10	0.11	10	0.17	194	1	0.01	3	520		7	0.36	5	1	146	0.04
40	TR07092959	11	1.8	10	0.65	10	0.37	3030	1	0.06	16	560		327	0.8	6	4	150	0.1
41	TR07093366	5	0.81	10	0.22	10	0.41	127	1	0.05	9	560		10	0.09	5	2	156	0.05
42	TR07093907	9	1.28	10	0.36	10	0.66	161	1	0.05	9	540		9	0.14	5	3	137	0.06
43	TR07093904	8	1.28	10	0.61	10	0.38	333	1	0.06	14	540		19	0.33	5	4	172	0.11
44	TR07092951	3	0.55	10	0.14	10	0.08	63	1	0.02	5	250		4	0.22	5	1	31	0.06
45	TR07092954	6	0.44	10	0.12	10	0.06	181	1	0.01	5	230		12	0.16	5	1	31	0.05
46	VA07091805	9	0.97		0.35		0.39	202	1	0.04	13	470		28	0.58	5		81	0.08
47	VA07091926	30	2.2		0.25		0.49	334	1	0.04	24	380		6	0.13	5		82	0.21
48	TR07086384	1	0.41	10	0.13	10	0.12	83	1	0.01	1	250		3	0.12	5	1	144	0.05
49	VA07091924	47	1.96		0.76		0.25	155	1	0.36	24	320		18	0.17	13		162	0.27
50	TR07093011	19	3.37	10	1.21	30	0.28	152	1	0.27	40	720		14	0.03	5	12	145	0.3
51	TR07087698	26	5.03	20	1.69	40	0.75	289	2	0.34	56	1250		9	0.23	7	16	288	0.24
52	TR07092956	24	3.47	10	1.44	30	0.66	388	3	0.2	37	700		18	0.6	5	11	206	0.24
53	TR07092957	27	3.77	20	1.43	30	0.68	253	2	0.37	40	1050		27	0.99	6	13	269	0.32

APPENDIX B1-2 ICP Metals for ABA Database

Certificate #	Sample #	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%
54	TR07093905	19	2.41	20	1.18	30	0.52	213	1	0.21	29	710	17	0.46	5	9	220	20	0.28
55	TR07093367	6	0.77	10	0.13	10	0.16	552	1	0.04	4	280	49	0.06	5	2	60	20	0.07
56	TR07093901	28	5.11	20	1.65	30	0.83	372	1	0.36	53	1310	24	0.23	6	16	268	20	0.42
57	TR07092955	27	3.7	20	1.73	30	0.75	196	1	0.28	42	850	17	0.73	5	14	249	20	0.38
58	VA07091807	112	3.41		1.27		0.72	343	2	0.4	59	520	23	0.65	15		218		0.33
59	VA07091930	38	4.95		1.93		0.62	252	1	0.46	67	910	12	0.3	8		235		0.4
60	TR07092772	29	5.36	30	1.84	40	0.81	226	1	0.35	65	1210	24	0.41	7	19	256	20	0.31
61	VA07091228	26	5.04	20	1.58	30	0.91	358	1	0.47	53	1550	30	1.35	13	15	268	20	0.45
65	TR07092958	10	2.86	10	0.57	10	0.51	3510	1	0.05	16	320	394	0.27	5	5	30	20	0.14
66	TR07092953	3	5.07	10	0.44	10	0.96	18800	1	0.03	6	510	2680	0.43	10	3	36	20	0.05
67	VA07091240	165	13.5	10	1.47	10	1.43	40900	1	0.02	27	450	3540	0.27	51	25	43	20	0.67
70	VA07091241	15	4.15		0.26		0.11	10950	1	0.03	12	180	1600	1.25	22		10		0.04
62	TR07093903	620	24.5	10	0.01	10	0.42	69800	1	0.01	83	10	974	8.28	202	1	3	20	0.01
63	TR07093920	3340	22.6	10	0.05	10	0.27	80000	1	0.01	3	40	10000	5.59	1520	1	11	20	0.01
64	TR07093368	248	14.7	10	0.18	10	0.32	39300	1	0.01	43	70	6710	5.98	176	1	4	20	0.02
68	VA07091931	962	27.8		0.01		0.24	84300	1	0.01	11	10	6060	9.52	64		1		0.01
69	VA07091925	1760	16.2		0.07		0.15	36000	1	0.01	11	20	10000	10	661		2		0.01
71	TR07093365	4090	18.65	10	0.01	10	0.3	54300	1	0.01	1	10	1460	10	1730	1	1	20	0.01

	Certificate #	Sample #	TI_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
1	VA07091928	C212117			63	10	85
2	TR07092775	E600288	10	10	98	10	483
3	VA07091920	C212566			45	10	47
4	VA07091804	C462066			88	10	54
5	TR07093011	E600079	10	10	94	10	1250
6	TR07093907	C467959	10	10	261	10	86
7	TR07093920	E599704	10	10	254	10	1500
8	TR07093369	E775513	10	10	192	10	67
9	TR07092771	E600542	10	10	29	10	3320
10	VA07091806	C462793			91	10	110
11	VA07091923	C212729			105	10	100
12	VA07091226	E776315	10	10	269	10	105
13	TR07085899	E768248	10	10	308	10	96
14	VA07091804	C462069			184	10	101
15	TR07092775	E600290	10	10	316	10	1095
16	TR07093364	E775819	10	10	296	10	93
17	VA07091921	C212639			355	10	87
18	VA07091225	E600631	10	10	411	10	127
19	TR07093906	E599612	10	10	318	10	90
20	TR07092773	E752010	10	10	269	10	79
21	TR07092957	E775866	10	10	311	10	99
22	VA07091927	C212917			289	10	78
23	TR07086383	E600841	10	10	66	10	61
24	VA07091226	E776319	10	10	414	10	139
25	TR07092774	E600319	10	10	29	10	28
26	VA07091804	C462078			34	10	2960
27	TR07093010	E600086	10	10	22	10	223
28	TR07086383	E600846	10	10	25	10	26
29	TR07087698	E768283	10	10	8	10	246
30	TR07093363	E775833	10	10	5	10	96
31	TR07093908	C467832	10	10	4	10	250
32	TR07093902	E599725	10	10	14	10	620
33	VA07091229	E600593	10	10	10	10	34
34	TR07092952	E751981	10	10	22	10	181
35	VA07091806	C462785			13	10	14
36	VA07091926	C212949			5	10	49
37	TR07093900	C466994	10	20	27	10	30
38	VA07091809	C462038			32	10	70
39	VA07091227	E600744	10	10	10	10	25
40	TR07092959	E751851	10	10	44	10	709
41	TR07093366	E775774	10	10	20	10	31
42	TR07093907	C467957	10	10	28	10	38
43	TR07093904	E599687	10	10	38	10	61
44	TR07092951	E752037	10	10	8	10	8
45	TR07092954	E775965	10	10	7	10	35
46	VA07091805	C462958			26	10	79
47	VA07091926	C212942			67	10	104
48	TR07086384	E600885	10	10	8	10	12
49	VA07091924	C215828			95	10	64
50	TR07093011	E600070	10	10	103	10	74
51	TR07087698	E768289	10	10	161	10	119
52	TR07092956	E751924	10	10	107	10	83
53	TR07092957	E775865	10	10	133	10	93

APPENDIX B1-2 ICP Metals for ABA Database

Certificate #	Sample #	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
54	TR07093905	C467893	10	10	93	10
55	TR07093367	E775645	10	10	15	10
56	TR07093901	C466965	10	10	167	10
57	TR07092955	E775947	10	10	137	10
58	VA07091807	C462772			170	10
59	VA07091930	C212705			181	10
60	TR07092772	E600774	10	10	179	10
61	VA07091228	E776285	10	10	166	10
65	TR07092958	E751883	10	10	42	10
66	TR07092953	E775989	10	10	27	10
67	VA07091240	E600657	20	10	250	10
70	VA07091241	C463235			19	10
62	TR07093903	C467919	40	10	1	10
63	TR07093920	E599708	10	10	2	50
64	TR07093368	E775550	20	10	10	10
68	VA07091931	C212406			1	20
69	VA07091925	C462087			3	50
71	TR07093365	E775799	10	10	1	50

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Assay Notes																
Certificate #			Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Description		Lith Unit	Assay Notes				
								Mini gy Log								
1	VA07091928	C212117	K-06-0011	SW Zone	36.3	37.5	SSCH	SSCH	Light green-grey, fine grained mica schist with intermitted boudinized vein quartz.					Mineralogy Comments		tetrahectrite/siderite/galenasphalerite
2	TR07092775	E600288	K-07-0081	East Zone	45.7	47.7	SSCH	SSCH	Yellow-green fine grained mica-schist. Slightly oxidized							
3	VA07091920	C212566	K-06-0016	SW Zone	207.3	208.4	SSCH	SSCH	Yellow-green fine grained mica schist.							208.25 - 208.4 Quartz veinlet with chlorite-rich stringers cutting perp. To CA.
4	VA07091804	C462086	K-06-0023	SW Zone	356.8	358.5	SSCH	SSCH	Sericite/Chloritic Schist Unit. Medium grey/green fine grained micaceous schist preceding a greenstone unit.							
5	TR07093011	E600079	K-07-0078	East Zone	52.51	54.1	SSCH	SSCH	Yellow-green fine grained mica-schist. Moderately friable.							trace clay @ 53.95
6	TR07093907	C467959	K-07-0065	East Zone	180.96	182.08	SSCH	SSCH	Yellow/green/grey fine grained mica-schist. Slightly calcareous. Quartz sweat and boudins are interbedded with the schist.							180.96-182.08: sericite schist with increased amount of clay on fractures. Clay is green-grey
7	TR07093920	E599704	K-07-0066	East Zone	139.38	139.77	SSCH	SSCH	Yellow/green/grey fine grained mica-schist. Slightly calcareous.							
8	TR07093369	E775513	K-07-0067	East Zone	135.63	136.25	SSCH	SSCH	Light yellow-grey, fine-grained mica schist. Slightly calcareous.							
9	TR07092771	E600542	K-07-0086	East Zone	229.1	229.9	SSCH	CHSCH	Medium gray-green chlorite-rich schist with local thin quartzite beds.							
10	VA07091806	C462783	K-06-0035	SW Zone	65.1	67.45	SSCH	SSCH	Medium Grey/Green Chlorite-rich fine grained mica-schist.							
11	VA07091923	C212729	K-06-0020	SW Zone	44.2	45.7	SSCH	SSCH	Medium Grey/Green Chlorite-rich fine grained mica-schist.							
12	VA07091226	E776315	K-07-0091a	East Zone	286.9	288	SSCH	SSCH	Light-medium grey-green chlorite rich fine grained mica-schist.							
13	TR07095899	E768248	K-07-0084	Middle East Zone	142.63	144.51	GNST	GNST	Dark grey-green greenstone							Large amount of massive pyrite on a fracture surface at 144.21m.
14	VA07091804	C462069	K-06-0023	SW Zone	359.9	361.9	GNST	GNST	Medium-dark green greenstone with abundant beige phenocrysts. Moderately calcareous.							Primary qtz and secondary calcite stringer zone in mafic tuff like greenstone with interbedded days-silt Mn in tuff.
15	TR07092775	E600290	K-07-0081	East Zone	51.05	51.9	GNST	GNST	Small unit of greenstone with cross-cutting quartz/siderite veins and sweat. Moderately foliated.							51.05-51.90: Quartz, calcite and siderite stringers are present throughout greenstone. Calcite and siderite seem secondary to quartz. Sphalerite, pyrite and trace galena are present within siderite stringers.
16	TR07093364	E775819	K-07-0079	East Zone	86.87	89.03	GNST	GNST	Dark green, well-foliated, moderately calcareous greenstone.							
17	VA07091921	C212639	K-06-0016	SW Zone	300.3	301.8	GNST	GNST	Medium-dark green, slightly calcareous greenstone. Slightly foliated with tiny, beige/white phenocrysts elongated approximately foliation parallel.							
18	VA07091225	E600631	K-07-0092	Middle East Zone	116.25	118.26	GNST	GNST	Light grey-green, weakly foliated with porphyroblasts of quartz and carbonate.							
19	TR07093906	E598612	K-07-0066	East Zone	1.34	3.35	GNST	GNST	Dark green-grey calcareous greenstone.							trace carb on fractures
20	TR07092773	E752010	K-07-0083	East Zone	88.74	90.74	GNST	GNST	Medium grey-green calcareous greenstone							
21	TR07092957	E775866	K-07-0082	East Zone	1.44	3.4	GNST	GNST	Medium grey-green calcareous greenstone							
22	VA07091927	C212917	K-06-0020	SW Zone	289.6	291.05	GNST	GNST	Medium Grey-green calcareous greenstone.							
23	TR07096383	E600841	K-07-0093	Middle East Zone	182.27	185.32	GNST	GNST	Light to medium grey-green, calcareous greenstone with trace qtz/calcite veining and elongated porphyroblasts. Moderately foliated.							
24	VA07091226	E776319	K-07-0091a	East Zone	290.7	291.8	GNST	GNST	Light grey-green calcareous greenstone with undulating, boudinized qtz/calcite veins.							carb stringer // to foliation
25	TR07092774	E600319	K-07-0081	East Zone	98.25	100.28	Q1ZT	Q1ZT	Medium grey, moderately foliated quartzite.							
26	VA07091804	C462078	K-06-0023	SW Zone	369.5	370.7	Q1ZT	Q1ZT	Well foliated med-dark grey quartzite unit that has been cross cut by siderite stringers.							Sample adjacent to vein zone
27	TR07093010	E600086	K-07-0078	East Zone	64.1	66.1	Q1ZT	Q1ZT	Medium-grey, brittle quartzite with several cross-cutting qtz/siderite stringers.							qtz and siderite veinlet, trace sphalerite @ 65.9
28	TR07096383	E600846	K-07-0093	Middle East Zone	190.1	191.21	Q1ZT	Q1ZT	Medium grey quartzite with slightly oxidized fractured surfaces and thin cross-cutting qtz stringers.							
29	TR07087698	E768283	K-07-0084	Middle East Zone	196.84	197.8	Q1ZT	Q1ZT	Light - Medium grey quartzite with iron/manganese oxide staining. Minor siderite and quartz stringers							Possible minor contamination. Sample occurs after high silver standard
30	TR07093363	E775833	K-07-0079	East Zone	111.56	113.56	Q1ZT	Q1ZT	Medium grey, brittle quartzite. Cross-cutting quartz veins/veinlets.							Large amount of disseminated pyrite within Q1ZT.
31	TR07093908	C467832	K-07-0065	East Zone	28.34	29.34	Q1ZT	Q1ZT	Bleached quartzite with manganese staining surrounding fractures and quartz stringers.							28.34-29.34: manganese oxide in quartz veinlets
32	TR07093902	E598725	K-07-0066	East Zone	155.95	156.95	Q1ZT	Q1ZT	Brittle, light grey quartzite. Moderately foliated with stringers of quartz x-cutting foliation.							greenish clay on fractures
33	VA07091229	E600593	K-07-0092	Middle East Zone	51.55	53.52	Q1ZT	Q1ZT	Medium grey, foliated with cross-cutting oxidized quartz stringers with slightly oxidized fracture surfaces.							

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Certificate #			Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Lith Unit Mini gy Log	Description	Assay Notes	Mineralogy Comments
34	TR07092952	E751981	K-07-0083	East Zone	43	45	QTZT	QTZT		Bleached, brittle quartzite with manganese staining surrounding fractures and limonite staining on fracture surfaces.		
35	VA07091806	C462785	K-06-0035	SW Zone	53	55	QTZT	QTZT		Dark grey, well foliated		
36	VA07091926	C212949	K-06-0020	SW Zone	332.2	333.7	QTZT	QTZT		Medium-dark grey brittle quartzite with qtz stringers cross-cutting foliation. Iron Oxide staining on fractured surfaces.		
37	TR07093900	C466994	K-07-0067	East Zone	111.1	113.1	QQTZT	QQTZT		Medium-dark grey calcareous quartzite.		111.10-115.10m: Pervasive CaCO3 throughout section. Perhaps some of QTZT is CaCO3 rich from origin and has been put into sweats/veinlets through metamorphism.
38	VA07091809	C462038	K-06-0023	SW Zone	323.1	324.6	QQTZT	QQTZT		Medium-dark grey calcareous quartzite unit with cross-cutting quartz and calcite stringers.		
39	VA07091227	E600744	K-07-0092	Middle East Zone	258	260.03	QQTZT	QQTZT		Medium-dark grey calcareous quartzite with minor x-cutting quartz and calcite stringers.		
40	TR07092959	E751851	K-07-0076	East Zone	78.73	81.55	QQTZT	QQTZT		Medium grey calcareous quartzite with foliation parallel sweats of calcite as well as cross-cutting quartz/calcite stringers.	Possible minor contamination. Sample occurs after high silver standard	
41	TR07093366	E775774	K-07-0079	East Zone	29.39	31.39	QQTZT	QQTZT		Medium-dark grey calcareous quartzite with a well developed foliation. Cross-cutting quartz and calcite stringers are present thru-out.		No qtz veining, all carbonate veinlets and sweats, only limonite mineralization.
42	TR07093907	C467957	K-07-0065	East Zone	178.72	180.23	QQTZT	QQTZT		Well foliated, medium to dark grey calcareous quartzite.		178.72-180.23: calcite-bearing quartz veinlets
43	TR07093904	E599687	K-07-0066	East Zone	110.75	112.75	QQTZT	QQTZT		Medium grey calcareous quartzite with cross-cutting quartz/calcite stringers. Slightly oxidized fractured surfaces.		
44	TR07092951	E752037	K-07-0083	East Zone	131.41	133.5	QQTZT	QQTZT		Well foliated, medium to dark grey calcareous quartzite with several foliation parallel bands of extreme calcification. Stringers of qtz and calcite are present x-cutting throughout		
45	TR07092954	E775965	K-07-0082	East Zone	154.92	157.12	QQTZT	QQTZT		Well foliated, medium to dark grey calcareous quartzite with several foliation parallel bands of extreme calcification. Stringers of qtz and calcite are present x-cutting throughout		Large qtz veins crosscut by several smaller qtz veinlets.
46	VA07091805	C462998	K-06-0035	SW Zone	337	339	QQTZT	QQTZT		Dark grey, slightly porous calcareous quartzite with bands of more intense calcification parallel to foliation.		335.0-339.0 - Calcareous, white, vuggy stringers that cross cut perpendicular to foliation (~40 degrees TCA) and are often fractured, showing limonite staining +/- pyrite on fractured surfaces.
47	VA07091926	C212942	K-06-0020	SW Zone	323.1	324.6	QQTZT	QQTZT		Dark grey, well foliated, calcareous quartzite with stringers of qtz and calcite cross-cutting foliation. Limonite oxide stains fractured surfaces and some stringers.		
48	TR07096384	E500885	K-07-0093	Middle East Zone	225	227	QQTZT	QQTZT		Medium to dark grey, banded calcareous schist. Some bands (cm scale) are more intensely calcareous than others.	225.00-_____m:chlorite along fractures.	
49	VA07091924	C215828	K-06-0023	SW Zone	45.7	47.3	GSCH	GSCH		Med-dark grey moderately graphitic schistose unit with intermittent, thin beds of quartzite.	Possible minor contamination. Sample occurs after high silver standard	
50	TR07093011	E600070	K-07-0078	East Zone	39.62	41.62	GSCH	GSCH		Graphitic Schist unit with intermittent thin beds of quartzite. Slightly gougy at times. Slightly vuggy sweats of quartz.	qtz slightly vuggy	
51	TR07087698	E768289	K-07-0094	Middle East Zone	207.9	209.91	GSCH	GSCH		Dark grey, slightly gougy, friable graphitic schist with intermittent qtz sweats. Slightly oxidized - limonite staining on fractured surfaces.		
52	TR07092956	E751924	K-07-0076	East Zone	154.04	155.91	GSCH	GSCH		Dark grey slightly graphitic schist with intermittent, thin beds of quartzite. Qtz sweats. Moderately oxidized.		154.04-155.91m: schist with broken siderite in a small fault zone. Increased disseminated pyrite.
53	TR07092957	E775865	K-07-0079	East Zone	160.83	163.37	GSCH	GSCH		Dark grey, moderately graphitic schist unit with intermittent, thin bedded quartzite.		
54	TR07093905	C467893	K-07-0065	East Zone	102.41	103.89	GSCH	GSCH		Dark grey, graphitic schist. Sweats of calcite and vein quartz intermittent throughout.		
55	TR07093367	E775645	K-07-0066	East Zone	60.58	62.66	GSCH	GSCH		Dark grey to black graphitic schist with sweats and intermittent layers of vein quartz.		
56	TR07093901	C466985	K-07-0067	East Zone	64.91	66.98	GSCH	GSCH		Dark grey to black graphitic schist with sweats of calcite and quartz. Trace limonite on fracture surfaced.		
57	TR07092955	E775947	K-07-0082	East Zone	130.47	132.27	GSCH	GSCH		Dark grey to black graphitic schist with sweats of calcite and quartz.		

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Certificate #				Sample #	Hole ID	BK Area	From (m)	To (m)	Lith Unit	Lith Unit Mini gy Log	Description	Assay Notes	Mineralogy Comments
58	VA07091807	C462772	K-06-0035	SW Zone	31	33	GSCH	GSCH	Dark grey to black graphitic schist with sweats of quartz.		Possible minor contamination. Sample occurs after high silver standard		
59	VA07091930	C212705	K-06-0020	SW Zone	13.5	15.2	GSCH	GSCH	Dark grey to black graphitic schist with sweats of vein quartz throughout. Slightly oxidized.		Sample adjacent to vein zone		
60	TR07092772	E600774	K-07-0092	Middle East Zone	297.77	299.8	GSCH	GSCH	Dark grey to black graphitic schist with sweats of vein quartz/calcite throughout.				
61	VA07091228	E776285	K-07-0091a	East Zone	247.45	249.45	GSCH	GSCH	Dark grey to black graphitic schist with sweats of vein quartz/calcite throughout.				
65	TR07092958	E751883	K-07-0076	East Zone	114.5	115.21	VN	VN	Fine grained galena and sphalerite within quartz and siderite stringers that cross-cut the quartzite unit.				
66	TR07092953	E775989	K-07-0082	East Zone	195.96	196.4	VN	VN	Trace Galena within fractures of a siderite vein.				Galena within a fracture in a siderite vein, coating parts of the fracture.
67	VA07091240	E600657	K-07-0092	Middle East Zone	158.37	158.72	VN	VN	Trace Galena within greenstone and siderite stringers.				158.37-158.72: siderite vein about 4cm in width with galena. Galena within quartz veinlet and within greenstone.
70	VA07091241	C463235	K-06-0038	SW Zone	310.6	311.05	VN	VN	Fractured broken quartzite with trace siderite veining. Trace pyrite/sphalerite and possibly galena				311.05-311.9 - fractured/broken qtz and qtz with limonite on fractured surfaces possibly siderite? Tr py/sphalerite
62	TR07093903	C467919	K-07-0065	East Zone	129.84	130.12	VN	VN	Mineralized Siderite vein (sphalerite + galena veinlets) - clay alteration.				129.84-130.12: strongly altered siderite vein that crumbles to a fine grained breccia. Sphalerite and galena veinlets. White clay alteration. sphalerite vein in siderite. Less alteration and more intact rock. Pyrite throughout
63	TR07093920	E599708	K-07-0066	East Zone	142.46	143.1	VN	VN	Mineralized Siderite vein (sphalerite and galena veinlets)				142.46-146.9: ORE ZONE. Ore zone can be divided into 4 sections. 1. 142.46-143.9 - massive siderite vein with 2 smaller 15-20 cm sphalerite and gn vns (mostly sphalerite) 143.58-143.63- sphalerite vein is brecciated by siderite. Siderite also has minor am
64	TR07093368	E775550	K-07-0067	East Zone	164.24	164.94	VN	VN	Brecciated Quartzite with siderite matrix. Main mineralized lens contains sphalerite, galena, arsenopyrite.				
68	VA07091931	C212406	K-06-0011	SW Zone	401.3	402	VN	VN	Tetrahedrite, siderite, galena and sphalerite - breccia.				
69	VA07091925	C462087	K-06-0023	SW Zone	377.45	378	VN	VN	Massive sphalerite with minor abours of galena, pyrite and chalcopyrite within a siderite vein.				
71	TR07093365	E775799	K-07-0079	East Zone	61.82	61.96	VN	VN	Massive sphalerite within a siderite vein. Massive pyrite and trace galena also present.				Massive sphalerite body begins here, within a siderite vein. Small amounts of massive pyrite also present.

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Certificate # Sample # Alteration Comments			Vein - Gangue Minerals			Vein-Sulphide Minerals						Disseminated Sulphide Minerals				Oxide Minerals		
			VG_Quartz	VG_Siderite	VG_Carbonate	VS_Pyrite	VS_Galenite	VS_Sphalerite	VS_Sulphosalite	VS_Arsenopyrite	VS_Pyrite	DS_Pyrite	DS_Galenite	DS_Sphalerite	DS_Arsenopyrite	DS_Pyrite	OT_Limonite	OT_Gypsum
1	VA07091928	C212117	5	0.01	0	0	0	0	0	0	0	0	0	0	0	0.01	0	
2	TR07092775	E600288	1													0.5		
3	VA07091920	C212566	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	VA07091804	C462066	5	0	1	0.1	0	0	0	0	0	0	0	0	0	0	0	
5	TR07093011	E600079	5													0.5		
6	TR07093907	C467959	15			0.1												
7	TR07093920	E599704	3		1		0	0.3										
8	TR07093369	E775513	3		8										0.01			
9	TR07092771	E600542	20	10			0.5											
10	VA07091806	C462793	10	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	
11	VA07091923	C212729	5	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	
12	VA07091226	E776315	20			0.5												
13	TR07095899	E768248				0.1	0.2											
14	VA07091804	C462069	5	0	5	1	0.1	0.1	0.1	0	0	0	0	0	0	0	0	
15	TR07092775	E600290	0.5	5	1	0.5	0.1	1								0.5		
16	TR07093364	E775819			5											0.1		
17	VA07091921	C212639	1	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	
18	VA07091225	E600631	0.5			0.5												
19	TR07093906	E599612				0.01										0.01		
20	TR07092773	E752010	6			0.5										0.01		
21	TR07092957	E775866																
22	VA07091927	C212917	1	0	1	0.01	0	0	0	0	0	0	0	0	0	0	0	
23	TR07096383	E600841	0.01			0.01										0.01		
24	VA07091226	E776319	3			0.1												
25	TR07092774	E600319	1			0.01												
26	VA07091804	C462078	5	1	0.1	1	0	0	0	0	0	0	0	0	0	0	0	
27	TR07093010	E600086	1	0.1				0.01								0.01		
28	TR07096383	E600846	0.01	0.1	0.01											0.01		
29	TR07087698	E768283	2	0.1	0.5	0.2										0.01		
30	TR07093363	E775833	6				0.01					0.1				0.05		
31	TR07093908	C467832	3				0.01											
32	TR07093902	E599725			0.3	0.1		0.01							0.1			
33	VA07091229	E600593	2			0.01	0.01								0.01	0.01		

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Certificate #			Alteration Comments	Vein - Gangue Minerals			Vein-Sulphide Minerals						Disseminated Sulphide Minerals				Oxide Minerals		
				VG_Quartz	VG_Siderite	VG_Carbonate	VS_Pyrite	VS_Galenite	VS_Sphalerite	VS_Sulphosals	VS_Arsenopyrite	VS_Pyrite	DS_Pyrite	DS_Galenite	DS_Sphalerite	DS_Arsenopyrite	DS_Pyrite	OT_Limonite	OT_Gypsum
34	TR07092952	E751981	hematite and limonite on fractures. Suspected Mn oxides as stringers.															0.01	
35	VA07091806	C462785		10	0	0	0.01	0	0	0	0							0.1	0
36	VA07091926	C212949		2	0	2	2	0	0	0	0							0	0
37	TR07093900	C466984	109.00-160.00m: section has abundant carbonate veining. Veins (stringers) are often very small and abundant giving Q1ZT1 a pervasive CaCO3 alteration appearance. In other areas however it is clearly visible that CaCO3 is confined to stringers and Q1ZT1	0.5		3											0.01		
38	VA07091809	C462038		5	0	5	0.1	0	0.1	0	0							0	0
39	VA07091227	E600744		1		0.1							0.01						
40	TR07092959	E751851				0.01							0.01						
41	TR07093366	E775774	Strong carbonate mineralization/alteration as sweats from Q1ZT1 gives homogenous look although foliation oriented at 45 degrees TCA.			2												0.1	
42	TR07093907	C467957	176.53-180.96: light to medium grey with white calcareous speckles. No reaction in schist beds	1		0.1							0.1						
43	TR07093904	E596687	weakly calcareous quartzite. CaCO3 alteration varies within unit. Sometimes seen in coarse grain bands (lighter grey) ranging from 1cm-30cm. Calcareous bands stronger reaction to HCL than rest of rock. Some sections do not appear calcareous 7/5-15-77-15 is	0.1		0.1											0.01		
44	TR07092951	E752037	calcareous zones in the Q1ZT1 appear as speckled areas 1-20cm wide or as qtz-carbonate stringers. Weak oxidation on some fractures.	1		0.05													
45	TR07092954	E775965		10		1	0.05						0.01					0.01	
46	VA07091805	C462998		1	0	5	0.1	0	0	0	0							0.1	0
47	VA07091926	C212942		5	0	1	0.01	0	0	0	0							0	0
48	TR07086384	E600885											0.01						
49	VA07091924	C215828		30	0	0	0	0	0	0	0							0	0
50	TR07093011	E500070		15															
51	TR07087698	E768289		3			0.1						0.01				0.1		
52	TR07092956	E751924	154.04-179.43m: calcareous Q1ZT1. Q1ZT1 has a lighter, speckled appearance. CaCO3 is also found in stringers parallel to foliation. Weak grey to grey-green clay is found on some fractures.		1	0.1							0.05						
53	TR07092957	E775885	Clay is fairly prominent throughout most of this interval, particularly on fracture surfaces.	7		2							0.01			0	0.1		
54	TR07093905	C467893	101.02-103.89: weak calcification occurring in 1-5 mm bands throughout interval. White to yellow-grey clay	5			0.01						0.01						
55	TR07093367	E775645		5	0	0.5											0.1		
56	TR07093901	C466965		6			0.01										0.01		
57	TR07092955	E775947		2		0.2							0.01				0.05	0.01	

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Certificate #		Sample #	Alteration Comments	Vein - Gangue Minerals				Vein-Sulphide Minerals				Disseminated Sulphide Minerals				Oxide Minerals		
				VG_Quartz1	VG_Siderite	VG_Carbonate	VS_Pyrite	VS_Galenite	VS_Sphalerite	VS_Sulphosals	VS_Arsenopyrite	VS_Pyrite-Syn	DS_Galenite	DS_Sphalerite	DS_Arsenopyrite	DS_Pyrite-Syn	OT_Limonite	OT_Gypsum
58	VA07091807	C462772		20	0	0	0	0.01	0	0	0	0					1	0
59	VA07091930	C212705		5	0	0	0	0	0	0	0						0	0
60	TR07092772	E600774		4		0.01										0.1		
61	VA07091228	E776285		1		0.1	0.01									0.3		
65	TR07092958	E751883	108.57-119.98m: minor clay alteration (white, grey-green) on some fractures. Minor oxidation in localized blebs throughout unit.		0.5			0.05										
66	TR07092953	E775989		0	0.4			0.5	0.01			0.01						
67	VA07091240	E500657		14	10	5	0.01						0.01					
70	VA07091241	C463235		25	0.1	1	0.1	0	0.01	0	0						0.1	0
62	TR07093903	C467919			65	0	1		30									
63	TR07093920	E599708			50	0.1	2	3	15									
64	TR07093368	E775550		2	20			1	8		4							
68	VA07091931	C212406			35	0	10	10	35	0	0						0	0
69	VA07091925	C462087		10	20	0	10	15	30	0	0						0	0
71	TR07093365	E775799	Strong oxidation present with a lot of pervasive hematite, along with what might be some MnO ₂ , a dark grey to black metallic mineral that is present on fractures.		45				50							2		

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Beleskeno Geoenvironmental
Characterization

Certificate #		Sample #	Total_Pyr ite	Total_Gal ena	Total_Sph alerite	Total_Ars enopyrite	Total_Pyr ite_Syn	Calc_Tota l_Sx	Carbonate Alteration CaCO3_Int
1	VA07091928	C212117	0	0	0	0	0	0	
2	TR07092775	E600288	0	0	0	0	0	0	
3	VA07091920	C212566	0	0	0	0	0	0	
4	VA07091804	C462066	0.1	0	0	0	0	0.1	
5	TR07093011	E600079	0	0	0	0	0	0	
6	TR07093907	C467959	0	0	0	0	0	0	1
7	TR07093920	E599704	0	0	0.3	0	0	0.3	
8	TR07093369	E775513	0	0	0	0	0.01	0.01	
9	TR07092771	E600542	0.5	0	0.5	0	0	1	
10	VA07091806	C462793	0.1	0	0	0	0	0.1	
11	VA07091923	C212729	0.01	0	0	0	0	0.01	
12	VA07091226	E776315	0	0	0	0	0	0	0
13	TR07095899	E768248	0.2	0	0	0	0	0.2	
14	VA07091804	C462069	1	0.1	0.1	0	0	1.2	
15	TR07092775	E600290	0.5	0.1	1	0	0	1.6	
16	TR07093364	E775819	0	0	0	0	0	0	
17	VA07091921	C212639	0.1	0	0	0	0	0.1	
18	VA07091225	E600631	0	0	0	0	0	0	1
19	TR07093906	E599612	0	0	0	0	0	0	
20	TR07092773	E752010	0	0	0	0	0	0	2
21	TR07092957	E775866	0	0	0	0	0	0	
22	VA07091927	C212917	0.01	0	0	0	0	0.01	
23	TR07096383	E600841	0	0	0	0	0	0	
24	VA07091226	E776319	0	0	0	0	0	0	
25	TR07092774	E600319	0	0	0	0	0	0	3
26	VA07091804	C462078	1	0	0	0	0	1	
27	TR07093010	E600086	0	0	0.01	0	0	0.01	
28	TR07096383	E600846	0	0	0	0	0	0	
29	TR07087698	E768283	0.2	0	0	0	0	0.2	2
30	TR07093363	E775833	0.11	0	0	0	0	0.11	
31	TR07093908	C467832	0.01	0	0	0	0	0.01	
32	TR07093902	E599725	0	0	0.01	0	0.1	0.11	
33	VA07091229	E600593	0.01	0	0	0	0.01	0.02	

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Bellekeno Geoenvironmental
Characterization

Certificate # Sample #		Total_Pyr ite	Total_Gal ena	Total_Sph alerite	Total_Ars enopyrite	Total_Pyr ite_Syn	Calc_Tota l_Sx	Carbonate Alteration CaCO3_Int
34	TR07092952	E751981	0	0	0	0	0	0
35	VA07091806	C462785	0.01	0	0	0	0	0.01
36	VA07091926	C212949	2	0	0	0	0	2
37	TR07093900	C466984	0	0	0	0	0.01	0.01
								2
38	VA07091809	C462038	0.1	0	0.1	0	0	0.2
39	VA07091227	E600744	0.01	0	0	0	0	0.01
								1
40	TR07092959	E751851	0.01	0	0	0	0	0.01
								2
41	TR07093366	E775774	0	0	0	0	0	0
								3
42	TR07093907	C467957	0.1	0	0	0	0	0.1
								3
43	TR07093904	E596687	0	0	0	0	0.01	0.01
								1
44	TR07092951	E752037	0	0	0	0	0	0
								1
45	TR07092954	E775965	0.06	0	0	0	0	0.06
46	VA07091805	C462998	0.1	0	0	0	0	0.1
47	VA07091926	C212942	0.01	0	0	0	0	0.01
48	TR07096384	E600885	0.01	0	0	0	0	0.01
								2
49	VA07091924	C215828	0	0	0	0	0	0
50	TR07093011	E500070	0	0	0	0	0	0
51	TR07097698	E768289	0.11	0	0	0	0.1	0.21
52	TR07092956	E751924	0.05	0	0	0	0	0.05
								2
53	TR07092957	E775865	0.01	0	0	0	0.1	0.11
54	TR07093905	C467893	0.02	0	0	0	0	0.02
								1
55	TR07093367	E775645	0	0	0	0	0.1	0.1
56	TR07093901	C466965	0.01	0	0	0	0.01	0.02
57	TR07092955	E775947	0.01	0	0	0	0.05	0.06

APPENDIX B2-1 Mineralogy / Alteration Data for ABA Database

Bellekeno Geoenvironmental
Characterization

Certificate #	Sample #	Total Sulphides					Carbonate Alteration	
		Total_Pyr ite	Total_Gal ena	Total_Sph alerite	Total_Ars enopyrite	Total_Pyr ite_Syn	Calc_Tota l_Sx	CaCO3_Int
58	VA07091807	C462772	0.01	0	0	0	0.01	
59	VA07091830	C212705	0	0	0	0	0	
60	TR07092772	E600774	0	0	0	0	0.1	
61	VA07091228	E776285	0.01	0	0	0	0.3	
65	TR07092958	E751883	0	0.05	0	0	0.05	
66	TR07092953	E775989	0.01	0.5	0.01	0	0	
67	VA07091240	E500657	0.01	0.01	0	0	0.02	1
70	VA07091241	C463235	0.1	0	0.01	0	0	
62	TR07093903	C467919	1	0	30	0	0	31
63	TR07093920	E599708	2	3	15	0	0	20
64	TR07093368	E775550	0	1	8	4	0	13
68	VA07091931	C212406	10	10	35	0	0	55
69	VA07091925	C462087	10	15	30	0	0	55
71	TR07093365	E775799	0	0	50	0	2	52

APPENDIX B3-1 Summary Statistics for ABA Database

All Samples

Sample	FIZZ RATING	paste_pH	NP_kgCaCO 3/t	MPA_kgCaC O3/t	NNP_kgCaC O3/t	NP-MPA	St_%	SO4_CblCh %	SO4_HCl%	S2_%	Cinorg_%	CO2_%	Au_ppm	Ag_ppm
No. of observations	71	71	71	71	71	71	71	71	71	71	71	71	71	71
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	1.000	5.800	0.000	0.300	-550.000	0.000	0.010	0.010	0.010	0.010	0.050	0.200	0.010	0.500
Maximum	3.000	8.900	207.000	582.800	206.000	220.800	18.650	0.770	0.780	17.900	6.860	25.100	4.280	1770.000
1st Quartile	2.000	7.950	23.500	2.650	11.000	2.005	0.085	0.010	0.010	0.075	0.205	0.800	0.010	0.500
Median	2.000	8.300	54.000	6.300	34.000	6.770	0.200	0.010	0.010	0.180	0.830	3.100	0.010	0.600
3rd Quartile	3.000	8.400	87.500	12.950	81.500	22.935	0.415	0.020	0.010	0.405	1.585	5.800	0.010	2.050
Mean	2.155	8.113	67.817	38.924	28.859	20.280	1.245	0.032	0.030	1.216	1.289	4.731	0.141	60.025
Standard deviation (n)	0.620	0.602	57.659	111.213	130.028	33.488	3.559	0.093	0.096	3.493	1.536	5.621	0.583	272.005
Variation coefficient	0.288	0.074	0.850	2.857	4.506	1.651	2.858	2.893	3.177	2.872	1.192	1.188	4.128	4.531
Skewness (Pearson)	-0.115	-1.756	1.008	3.790	-2.545	3.525	3.790	7.167	6.961	3.752	2.105	2.105	5.780	5.174
Kurtosis (Pearson)	-0.500	3.135	-0.030	13.762	8.366	16.289	13.762	53.234	50.393	13.411	4.403	4.394	35.349	26.441
Geometric mean	2.053	8.088		6.762			0.216	0.016	0.014	0.196	0.606	2.253	0.017	1.467
Geometric standard deviation	1.389	1.084		5.195			5.175	2.252	2.220	5.460	4.051	3.973	3.822	6.801

Non-Mineralized Samples

Sample	FIZZ RATING	paste_pH	NP_kgCaCO 3/t	MPA_kgCaC O3/t	NNP_kgCaC O3/t	NP-MPA	St_%	SO4_CblCh %	SO4_HCl%	S2_%	Cinorg_%	CO2_%	Au_ppm	Ag_ppm
No. of observations	65	65	65	65	65	65	65	65	65	65	65	65	65	65
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	1.000	6.400	0.000	0.300	-7.000	0.000	0.010	0.010	0.010	0.010	0.050	0.200	0.010	0.500
Maximum	3.000	8.900	207.000	37.200	206.000	220.800	1.190	0.140	0.160	1.170	5.290	19.400	0.130	30.500
1st Quartile	2.000	8.000	22.000	2.500	14.000	3.560	0.080	0.010	0.010	0.070	0.200	0.800	0.010	0.500
Median	2.000	8.300	55.000	5.600	40.000	7.600	0.180	0.010	0.010	0.160	0.770	2.800	0.010	0.500
3rd Quartile	3.000	8.500	91.000	10.000	84.000	28.950	0.320	0.020	0.010	0.290	1.320	4.800	0.010	1.300
Mean	2.169	8.242	69.615	8.238	61.354	22.137	0.263	0.017	0.015	0.249	0.961	3.529	0.014	1.840
Standard deviation (n)	0.646	0.417	59.879	8.569	59.343	34.412	0.274	0.018	0.020	0.269	0.982	3.590	0.018	4.165
Variation coefficient	0.298	0.051	0.860	1.040	0.967	1.554	1.041	1.031	1.295	1.083	1.022	1.017	1.286	2.263
Skewness (Pearson)	-0.176	-1.765	0.899	1.772	1.021	3.405	1.772	5.234	6.084	1.816	1.853	1.860	5.375	5.384
Kurtosis (Pearson)	-0.672	5.305	-0.326	2.765	-0.096	15.134	2.759	32.436	40.100	2.940	4.683	4.740	28.322	32.322
Geometric mean	2.058	8.230		4.715			0.151	0.014	0.012	0.136	0.505	1.880	0.012	0.893
Geometric standard deviation	1.410	1.055		3.248			3.229	1.725	1.663	3.405	3.710	3.635	1.591	2.541

APPENDIX B3-1 Summary Statistics for ABA Database

All Samples

Sample	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm
No. of observations	71	71	71	71	71	71	71	71	71	71	71	71	71	71
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	20	0	20
Minimum	0.010	5.000	10.000	0.500	2.000	0.030	0.500	1.000	1.000	1.000	0.410	10.000	0.010	10.000
Maximum	11.250	10000.000	7620.000	2.900	86.000	8.340	1000.000	81.000	455.000	4090.000	27.800	30.000	2.470	40.000
1st Quartile	0.820	5.000	100.000	0.500	2.000	0.410	0.500	2.000	33.000	8.000	1.095	10.000	0.115	10.000
Median	3.530	12.000	250.000	0.500	2.000	2.280	0.500	9.000	46.000	27.000	3.410	10.000	0.350	10.000
3rd Quartile	7.190	34.500	875.000	1.300	2.000	5.165	3.550	24.500	97.000	141.000	7.165	20.000	1.195	20.000
Mean	4.041	464.113	761.972	0.921	5.211	2.922	83.206	15.155	67.901	209.254	5.230	13.725	0.633	14.902
Standard deviation (n)	3.364	1819.749	1344.129	0.643	13.413	2.685	259.995	17.546	64.303	647.976	5.712	5.225	0.651	8.716
Variation coefficient	0.832	3.921	1.764	0.698	2.574	0.919	3.125	1.158	0.947	3.097	1.092	0.381	1.028	0.585
Skewness (Pearson)	0.315	4.577	3.416	1.383	4.826	0.607	3.035	1.702	3.228	4.815	2.069	0.935	1.005	1.540
Kurtosis (Pearson)	-1.413	20.013	12.894	0.716	23.293	-1.041	7.351	2.889	16.101	23.291	4.400	-0.293	-0.316	1.016
Geometric mean	2.033	20.825	253.186	0.762	2.528	1.385	1.892	7.223	42.606	33.521	3.048	12.874	0.301	13.140
Geometric standard deviation	4.683	6.488	5.019	1.786	2.193	4.460	10.199	3.771	3.376	6.034	2.979	1.419	4.265	1.595

Non-Mineralized Samples

Sample	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm
No. of observations	65	65	65	65	65	65	65	65	65	65	65	65	65	65
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	18	0	18
Minimum	0.290	5.000	10.000	0.500	2.000	0.030	0.500	1.000	7.000	1.000	0.410	10.000	0.010	10.000
Maximum	11.250	1810.000	7620.000	2.900	4.000	8.340	47.400	48.000	455.000	306.000	13.500	30.000	2.470	40.000
1st Quartile	1.310	5.000	150.000	0.500	2.000	0.740	0.500	2.000	37.000	8.000	1.060	10.000	0.140	10.000
Median	4.680	11.000	310.000	0.500	2.000	2.610	0.500	8.000	48.000	24.000	3.290	10.000	0.390	10.000
3rd Quartile	7.410	21.000	920.000	1.300	2.000	5.300	0.800	16.000	99.000	106.000	5.210	20.000	1.220	20.000
Mean	4.396	48.492	831.077	0.960	2.077	3.167	4.717	13.123	73.800	59.031	3.798	14.043	0.686	15.319
Standard deviation (n)	3.297	223.032	1384.536	0.659	0.364	2.676	10.994	14.136	64.044	72.397	3.066	5.323	0.654	8.956
Variation coefficient	0.750	4.599	1.666	0.686	0.175	0.845	2.331	1.077	0.868	1.226	0.807	0.379	0.953	0.585
Skewness (Pearson)	0.190	7.589	3.279	1.253	4.777	0.485	2.883	1.137	3.386	1.360	0.916	0.810	0.899	1.414
Kurtosis (Pearson)	-1.445	56.876	11.744	0.356	21.592	-1.151	7.189	-0.105	16.809	0.966	0.153	-0.510	-0.529	0.624
Geometric mean	2.753	13.183	335.465	0.792	2.056	1.626	1.068	6.488	56.704	24.028	2.559	13.153	0.374	13.449
Geometric standard deviation	3.074	2.982	3.939	1.807	1.138	4.288	4.064	3.658	2.075	4.278	2.626	1.428	3.575	1.615

APPENDIX B3-1 Summary Statistics for ABA Database

All Samples

Sample	Mg_%	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm
No. of observations	71	71	71	71	71	71	71	71	71	71	71	71	71	71
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.010	40.000	1.000	0.010	1.000	10.000	2.000	0.010	5.000	1.000	1.000	20.000	0.010	10.000
Maximum	5.170	84300.000	3.000	2.960	173.000	1550.000	10000.000	10.000	1730.000	39.000	555.000	20.000	1.440	40.000
1st Quartile	0.230	217.000	1.000	0.020	8.000	245.000	5.500	0.070	5.000	1.500	31.000	20.000	0.065	10.000
Median	0.490	819.000	1.000	0.060	21.000	470.000	17.000	0.200	5.000	5.000	131.000	20.000	0.180	10.000
3rd Quartile	1.225	2425.000	1.000	0.310	54.500	660.000	74.000	0.420	8.000	20.500	240.500	20.000	0.435	10.000
Mean	1.065	7313.408	1.113	0.319	34.634	495.915	652.070	0.937	67.915	12.118	142.606	20.000	0.309	10.980
Standard deviation (n)	1.295	17995.246	0.358	0.588	33.389	349.441	1978.207	2.295	278.188	12.633	123.622	0.000	0.337	4.540
Variation coefficient	1.216	2.461	0.322	1.845	0.964	0.705	3.034	2.448	4.096	1.043	0.867	0.000	1.090	0.413
Skewness (Pearson)	1.512	3.065	3.323	2.763	1.361	0.933	3.700	3.168	5.136	0.862	0.735	0.000	1.477	5.420
Kurtosis (Pearson)	1.034	8.590	11.081	7.709	2.347	0.575	13.160	8.664	25.697	-0.757	0.027	0.000	1.603	30.358
Geometric mean	0.486	986.764	1.077	0.083	19.555	336.640	29.957	0.197	8.896	5.694	70.353	20.000	0.156	10.559
Geometric standard deviation	3.958	6.657	1.258	5.347	3.300	3.064	10.098	5.271	3.612	3.906	4.644	1.000	3.691	1.263

Non-Mineralized Samples

Sample	Mg_%	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm
No. of observations	65	65	65	65	65	65	65	65	65	65	65	65	65	65
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.010	40.000	1.000	0.010	1.000	60.000	2.000	0.010	5.000	1.000	5.000	20.000	0.030	10.000
Maximum	5.170	40900.000	3.000	2.960	173.000	1550.000	3540.000	1.350	51.000	39.000	555.000	20.000	1.440	20.000
1st Quartile	0.220	202.000	1.000	0.030	8.000	290.000	4.000	0.060	5.000	2.000	40.000	20.000	0.090	10.000
Median	0.620	568.000	1.000	0.070	24.000	510.000	13.000	0.190	5.000	9.000	145.000	20.000	0.210	10.000
3rd Quartile	1.430	1710.000	1.000	0.350	56.000	680.000	49.000	0.330	7.000	23.000	249.000	20.000	0.550	10.000
Mean	1.137	2393.108	1.123	0.348	35.492	539.231	170.662	0.264	7.215	13.064	155.431	20.000	0.336	10.213
Standard deviation (n)	1.330	5882.948	0.372	0.607	33.614	333.367	572.609	0.291	6.316	12.719	121.431	0.000	0.339	1.443
Variation coefficient	1.169	2.458	0.332	1.747	0.947	0.618	3.355	1.101	0.875	0.974	0.781	0.000	1.008	0.141
Skewness (Pearson)	1.380	4.885	3.142	2.619	1.373	1.042	4.660	1.904	5.386	0.750	0.668	0.000	1.399	6.635
Kurtosis (Pearson)	0.629	26.724	9.773	6.811	2.440	0.704	21.725	3.508	33.102	-0.937	0.043	0.000	1.346	42.022
Geometric mean	0.513	678.023	1.084	0.101	20.721	437.764	18.966	0.140	6.264	6.602	95.620	20.000	0.199	10.149
Geometric standard deviation	4.150	4.449	1.270	5.042	3.141	2.010	6.078	3.558	1.546	3.729	3.240	1.000	2.921	1.106

Bellekeno Geoenvironmental
Characterization

APPENDIX B3-1
Summary Statistics for ABA Database

All Samples

Sample	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	71	71	71	71
No. of missing values	20	0	0	0
Minimum	10.000	1.000	10.000	8.000
Maximum	20.000	414.000	50.000	10000.000
1st Quartile	10.000	17.000	10.000	65.500
Median	10.000	63.000	10.000	100.000
3rd Quartile	10.000	174.500	10.000	366.500
Mean	10.196	108.380	11.831	1272.423
Standard deviation (n)	1.386	114.677	8.103	2836.453
Variation coefficient	0.136	1.058	0.685	2.229
Skewness (Pearson)	6.930	1.036	4.420	2.487
Kurtosis (Pearson)	46.020	-0.093	17.818	4.708
Geometric mean	10.137	45.790	10.809	184.078
Geometric standard deviation	1.102	4.931	1.397	6.191

Non-Mineralized Samples				
Sample	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	65	65	65	65
No. of missing values	18	0	0	0
Minimum	10.000	4.000	10.000	8.000
Maximum	20.000	414.000	10.000	5810.000
1st Quartile	10.000	25.000	10.000	61.000
Median	10.000	88.000	10.000	96.000
3rd Quartile	10.000	181.000	10.000	161.000
Mean	10.213	118.108	10.000	466.800
Standard deviation (n)	1.443	115.083	0.000	1052.599
Variation coefficient	0.141	0.974	0.000	2.255
Skewness (Pearson)	6.635	0.936		3.290
Kurtosis (Pearson)	42.022	-0.294		10.866
Geometric mean	10.149	61.195	10.000	127.306
Geometric standard deviation	1.106	3.695	1.000	4.115

APPENDIX B3-1 Summary Statistics for ABA Database

Mineralized Samples

Sample	FIZZ RATING	paste_pH	NP_kgCaCO 3/t	MPA_kgCaC O3/t	NNP_kgCaC O3/t	NP:MPA	St_ %	SO4_CbLch %	SO4_HCl%	S2-_%	Cinorg_%	CO2_%	Au_ppm	Ag_ppm
No. of observations	6	6	6	6	6	6	6	6	6	6	6	6	6	6
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	2.000	5.800	33.000	176.900	-550.000	0.060	5.660	0.020	0.010	5.640	1.780	6.500	0.120	42.400
Maximum	2.000	7.600	61.000	582.800	-123.000	0.310	18.650	0.770	0.780	17.900	6.860	25.100	4.280	1770.000
1st Quartile	2.000	6.625	43.500	231.425	-465.500	0.100	7.405	0.043	0.030	7.355	3.565	13.225	0.633	103.600
Median	2.000	6.700	49.500	357.000	-299.500	0.160	11.425	0.060	0.035	11.375	5.055	18.500	0.930	455.000
3rd Quartile	2.000	6.850	54.000	512.875	-184.500	0.213	16.413	0.175	0.198	16.250	6.680	24.450	1.955	1188.750
Mean	2.000	6.717	48.333	371.350	-323.167	0.167	11.883	0.193	0.190	11.697	4.840	17.750	1.515	690.367
Standard deviation (n)	0.000	0.527	9.123	157.652	162.968	0.085	5.045	0.265	0.276	4.856	1.922	7.009	1.397	664.314
Variation coefficient	0.000	0.079	0.189	0.425	-0.504	0.511	0.425	1.372	1.454	0.415	0.397	0.395	0.922	0.962
Skewness (Pearson)		-0.087	-0.307	0.136	-0.217	0.360	0.136	1.591	1.488	0.093	-0.314	-0.327	1.070	0.509
Kurtosis (Pearson)		-0.163	-0.978	-1.497	-1.472	-1.024	-1.497	0.795	0.551	-1.511	-1.434	-1.408	-0.214	-1.355
Geometric mean	2.000	6.696	47.412	335.883		0.144	10.748	0.088	0.064	10.619	4.371	16.041	0.910	317.904
Geometric standard deviation	1.000	1.091	1.245	1.656		1.865	1.656	3.726	4.991	1.642	1.699	1.697	3.424	4.722

APPENDIX B3-1 Summary Statistics for ABA Database

Mineralized Samples

Sample	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm
No. of observations	6	6	6	6	6	6	6	6	6	6	6	6	6	6
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Minimum	0.010	698.000	10.000	0.500	2.000	0.150	795.000	5.000	1.000	248.000	14.700	10.000	0.010	10.000
Maximum	0.620	10000.000	30.000	0.500	86.000	0.520	1000.000	81.000	17.000	4090.000	27.800	10.000	0.180	10.000
1st Quartile	0.023	1059.000	10.000	0.500	19.000	0.185	854.500	11.250	1.000	705.500	16.813	10.000	0.010	10.000
Median	0.110	4130.000	10.000	0.500	30.000	0.225	1000.000	26.500	1.000	1361.000	20.625	10.000	0.030	10.000
3rd Quartile	0.280	9137.500	10.000	0.500	61.250	0.280	1000.000	65.000	2.500	2945.000	24.025	10.000	0.065	10.000
Mean	0.197	4966.667	13.333	0.500	39.167	0.265	933.500	37.167	4.000	1836.667	20.742	10.000	0.055	10.000
Standard deviation (n)	0.218	4062.350	7.454	0.000	29.464	0.123	94.099	30.803	5.859	1420.832	4.635	0.000	0.060	0.000
Variation coefficient	1.107	0.818	0.559	0.000	0.752	0.464	0.101	0.829	1.465	0.774	0.223	0.000	1.100	0.000
Skewness (Pearson)	1.005	0.190	1.789		0.413	1.275	-0.711	0.478	1.730	0.486	0.147		1.268	
Kurtosis (Pearson)	-0.389	-1.761	1.200		-1.275	0.274	-1.490	-1.493	1.084	-1.363	-1.386		0.194	
Geometric mean	0.076	2949.403	12.009	0.500	23.731	0.243	928.504	23.100	1.926	1235.474	20.221	10.000	0.029	10.000
Geometric standard deviation	5.754	3.421	1.566	1.000	3.888	1.554	1.122	3.222	3.171	2.899	1.282	1.000	3.489	1.000

APPENDIX B3-1 Summary Statistics for ABA Database

Mineralized Samples

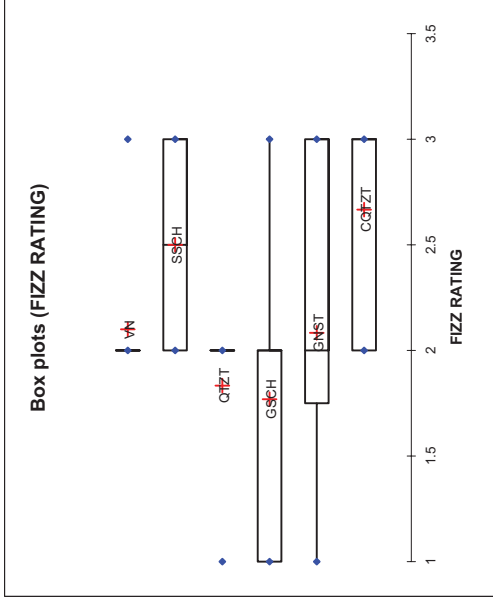
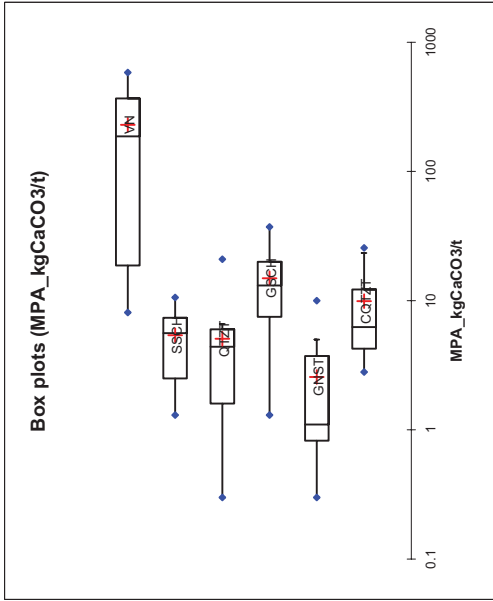
Sample	Mg_%	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm
No. of observations	6	6	6	6	6	6	6	6	6	6	6	6	6	6
No. of missing values	0	0	0	0	0	0	0	0	0	2	0	2	0	2
Minimum	0.150	36000.000	1.000	0.010	1.000	10.000	974.000	5.590	64.000	1.000	1.000	20.000	0.010	10.000
Maximum	0.420	84300.000	1.000	0.010	83.000	70.000	10000.000	10.000	1730.000	1.000	11.000	20.000	0.020	40.000
1st Quartile	0.248	43050.000	1.000	0.010	5.000	10.000	2610.000	6.555	182.500	1.000	1.250	20.000	0.010	10.000
Median	0.285	62050.000	1.000	0.010	11.000	15.000	6385.000	8.900	431.500	1.000	2.500	20.000	0.010	15.000
3rd Quartile	0.315	77450.000	1.000	0.010	35.000	35.000	9177.500	9.880	1305.250	1.000	3.750	20.000	0.010	25.000
Mean	0.283	60616.667	1.000	0.010	25.333	26.667	5867.333	8.228	725.500	1.000	3.667	20.000	0.012	20.000
Standard deviation (n)	0.082	18802.608	0.000	0.000	29.267	22.111	3611.887	1.824	665.582	0.000	3.448	0.000	0.004	12.247
Variation coefficient	0.289	0.310	0.000	0.000	1.155	0.829	0.616	0.222	0.917	0.000	0.940	0.000	0.319	0.612
Skewness (Pearson)	0.046	-0.088			1.103	1.072	-0.216	-0.452	0.518		1.429		1.789	0.816
Kurtosis (Pearson)	-0.503	-1.616			-0.310	-0.356	-1.497	-1.547	-1.493		0.539		1.200	-1.000
Geometric mean	0.271	57505.755	1.000	0.010	10.441	19.560	4236.604	8.007	397.670	1.000	2.533	20.000	0.011	16.818
Geometric standard deviation	1.412	1.438	1.000	1.000	5.129	2.305	2.748	1.300	3.734	1.000	2.494	1.000	1.327	1.942

Bellekeno Geoenvironmental
Characterization

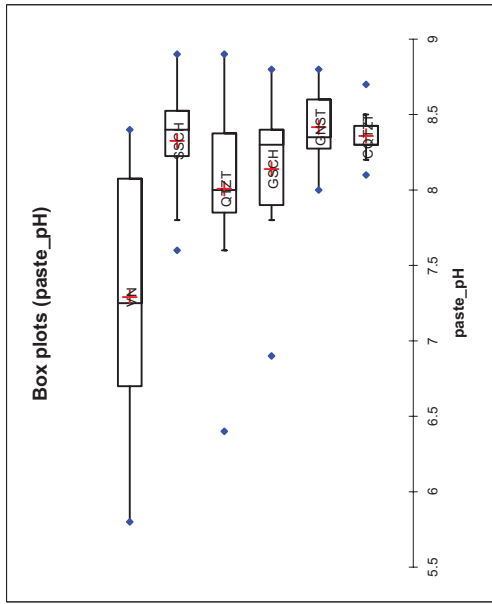
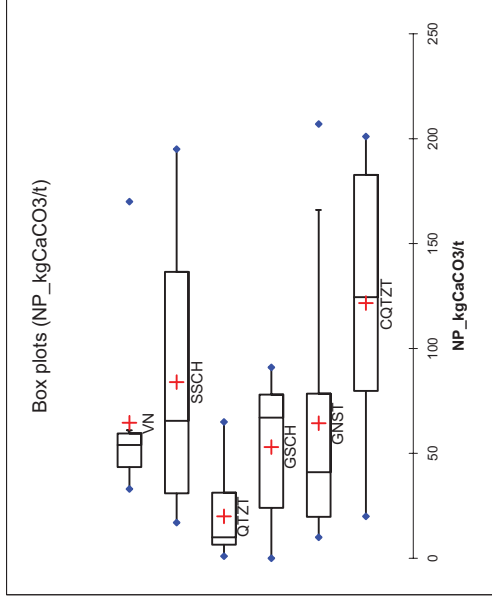
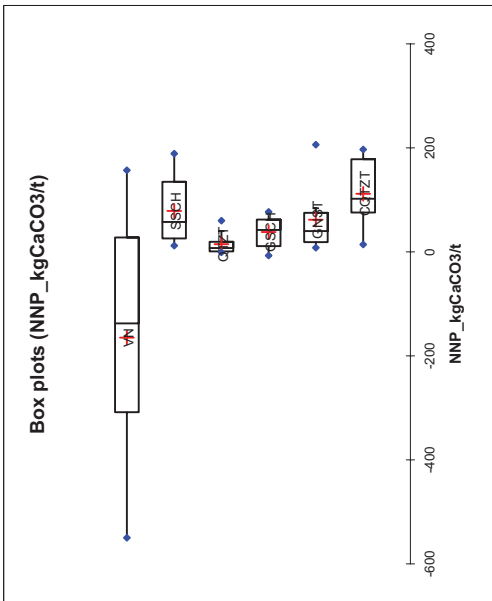
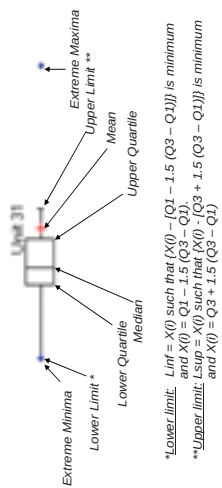
APPENDIX B3-1
Summary Statistics for ABA Database

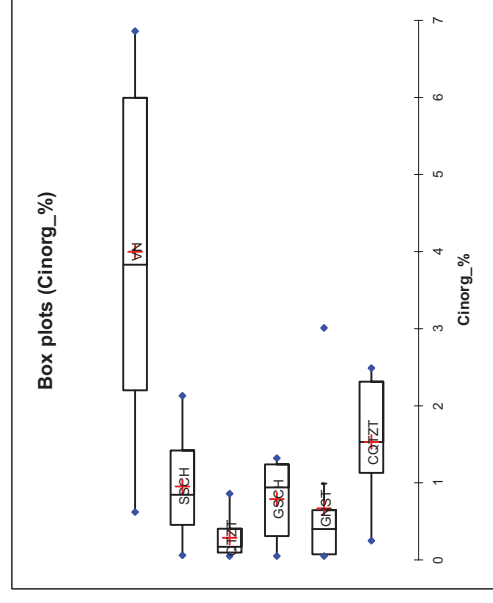
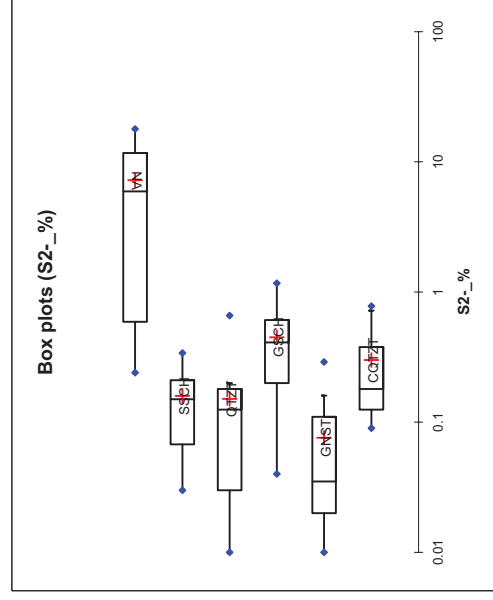
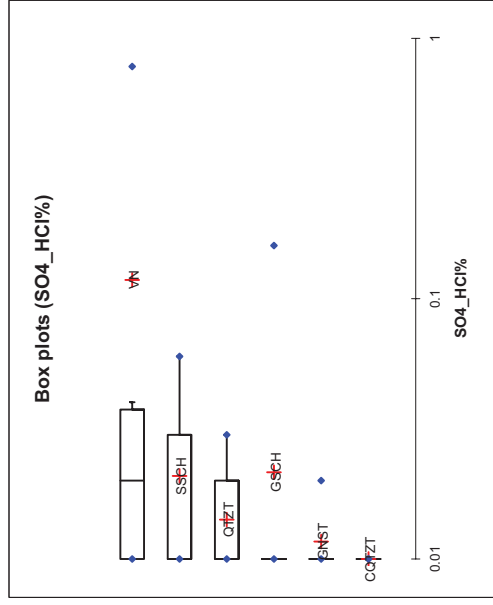
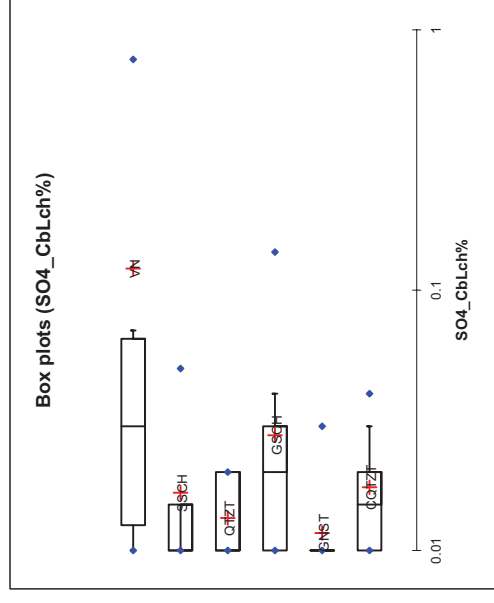
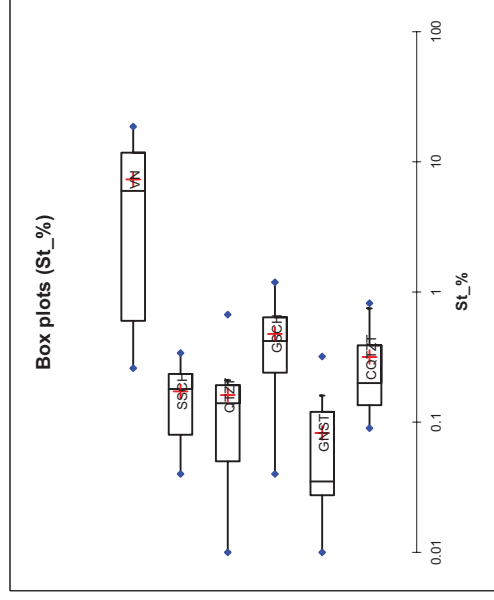
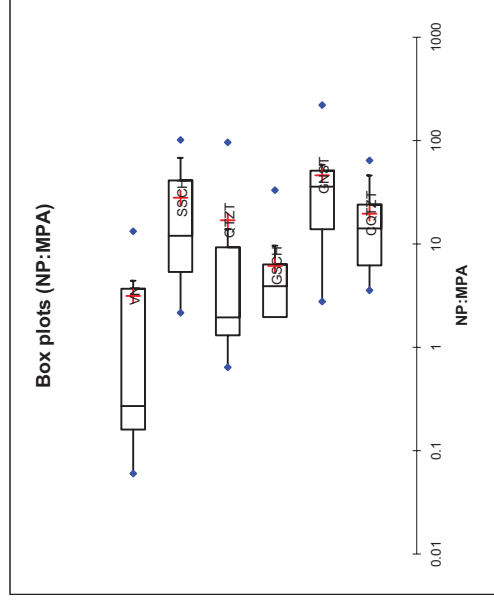
Mineralized Samples

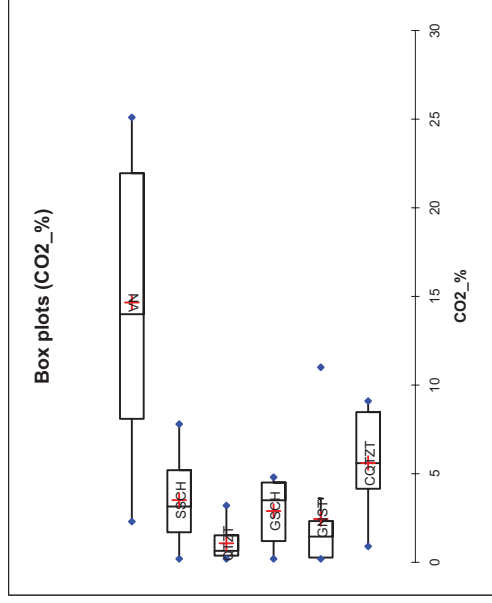
Sample	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	6	6	6	6
No. of missing values	2	0	0	0
Minimum	10.000	1.000	10.000	10000.000
Maximum	10.000	10.000	50.000	10000.000
1st Quartile	10.000	1.000	12.500	10000.000
Median	10.000	1.500	35.000	10000.000
3rd Quartile	10.000	2.750	50.000	10000.000
Mean	10.000	3.000	31.667	10000.000
Standard deviation (n)	0.000	3.215	18.634	0.000
Variation coefficient	0.000	1.072	0.588	0.000
Skewness (Pearson)		1.596	-0.089	
Kurtosis (Pearson)		0.824	-1.897	
Geometric mean	10.000	1.979	25.099	10000.000
Geometric standard deviation	1.000	2.499	2.217	1.000

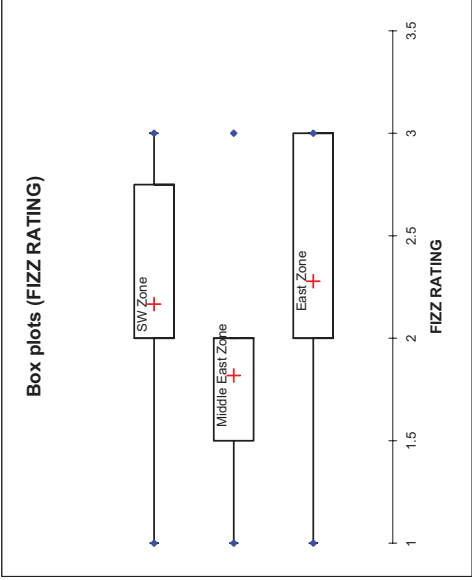
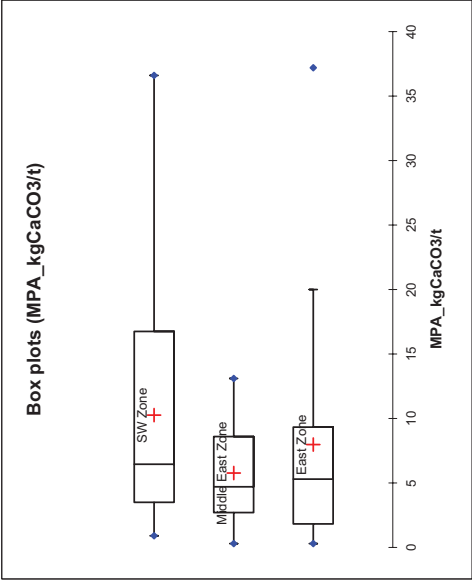


LEGEND FOR BOX PLOTS:

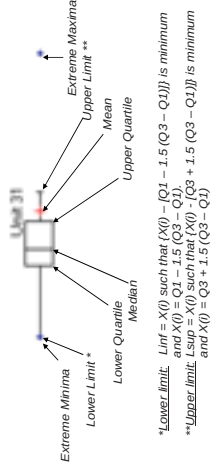




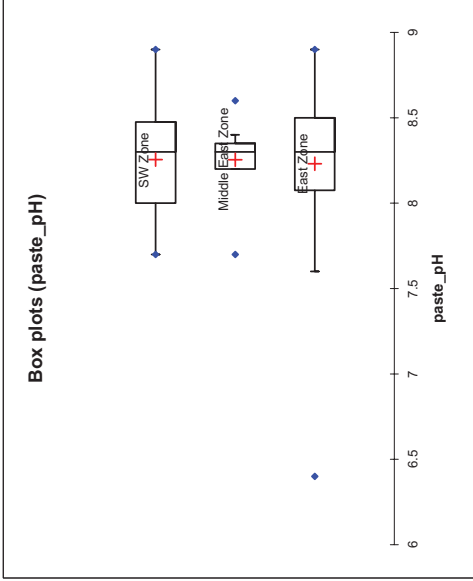
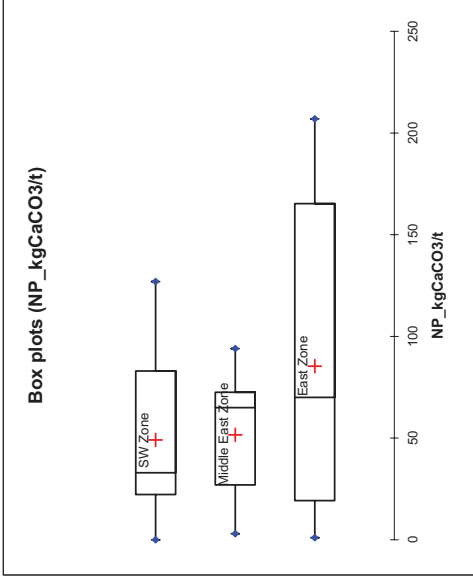
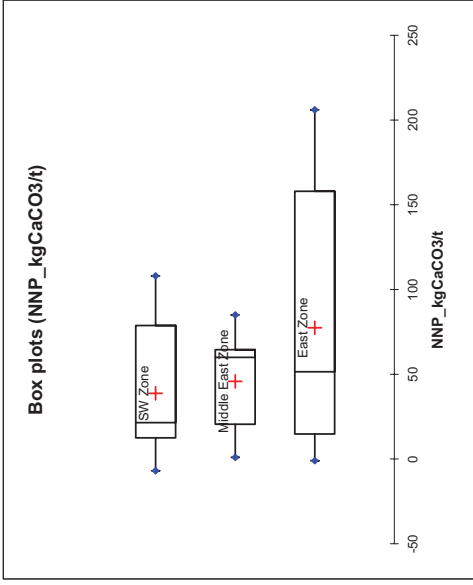


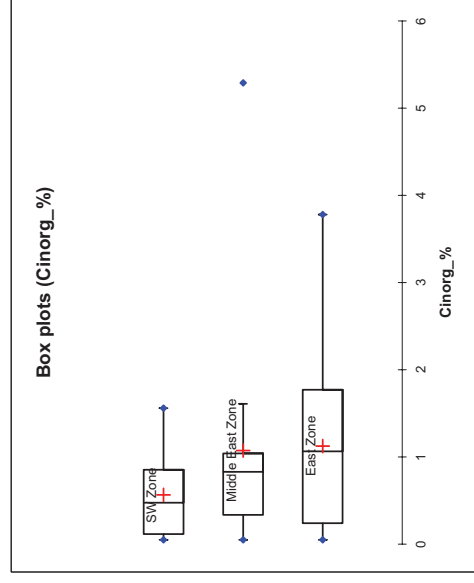
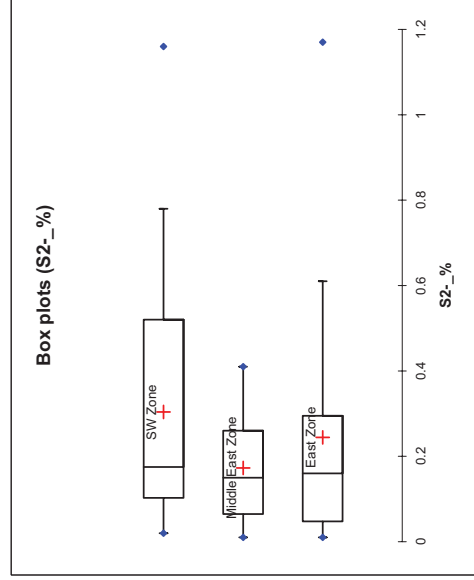
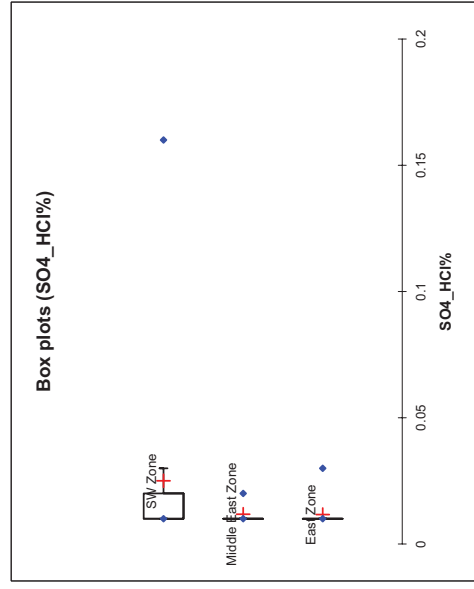
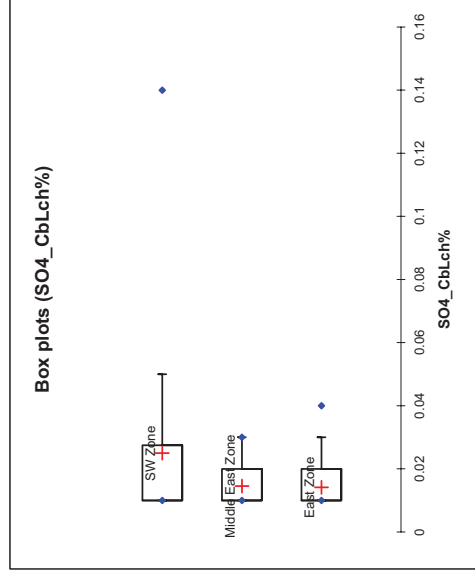
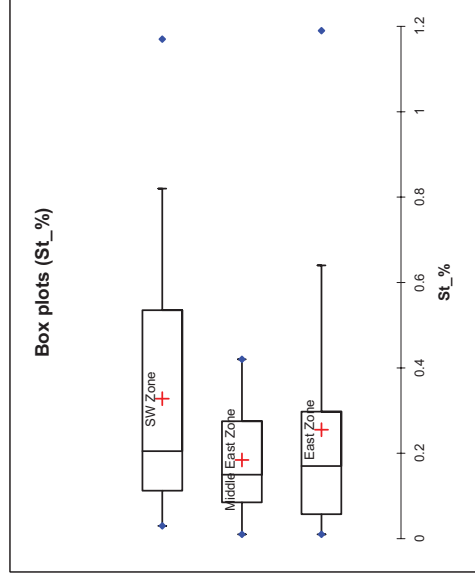
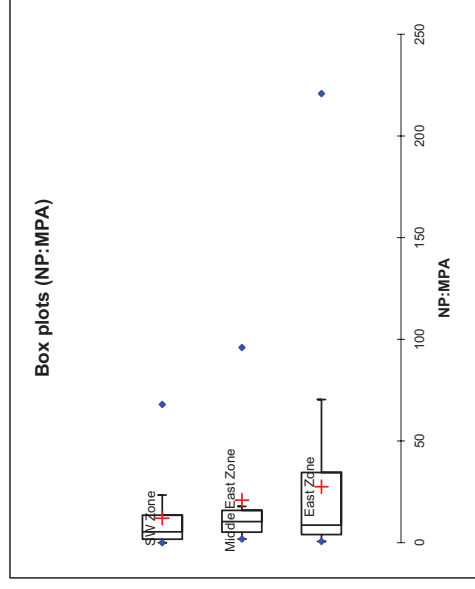


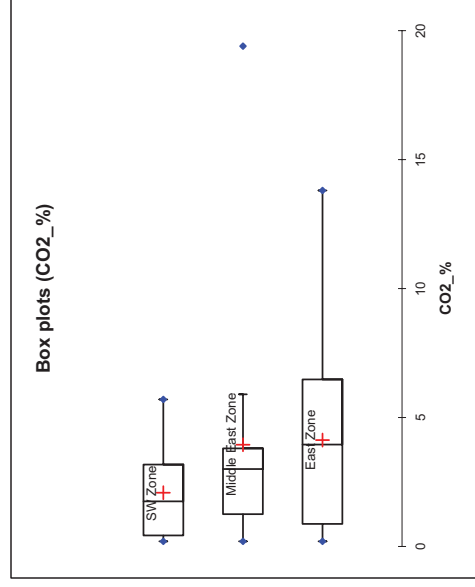
LEGEND FOR BOX PLOTS:

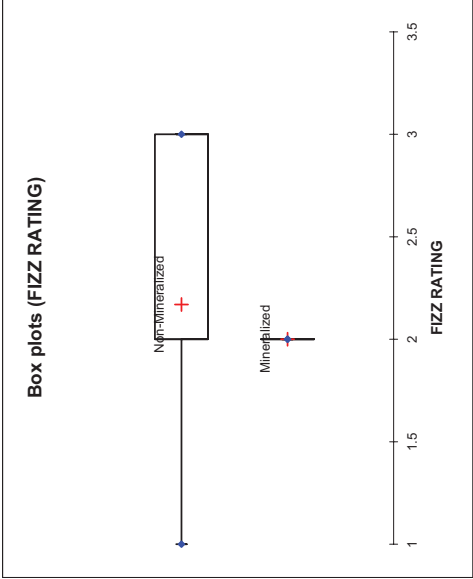
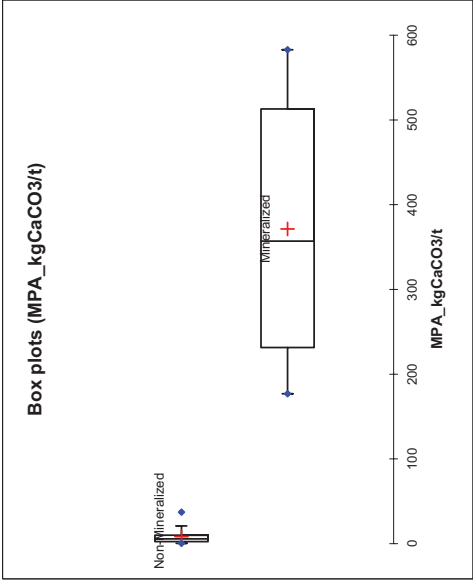


*Lower Limit: $Linf = X(t)$ such that $(X(t) - [Q1 - 1.5(Q3 - Q1)])$ is minimum and $X(t) = Q1 - 1.5(Q3 - Q1)$.
**Upper Limit: $Lsup = X(t)$ such that $(X(t) - [Q3 + 1.5(Q3 - Q1)])$ is minimum and $X(t) = Q3 + 1.5(Q3 - Q1)$.

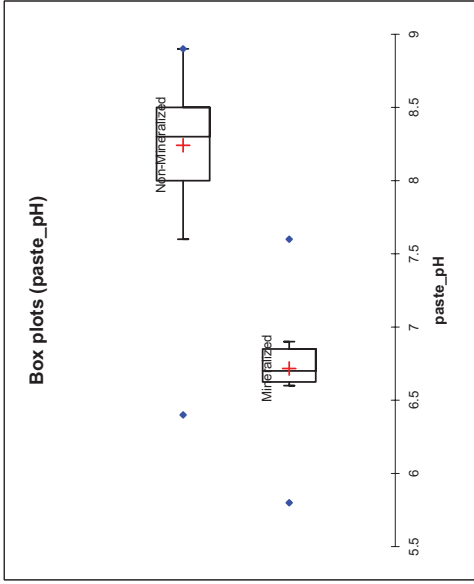
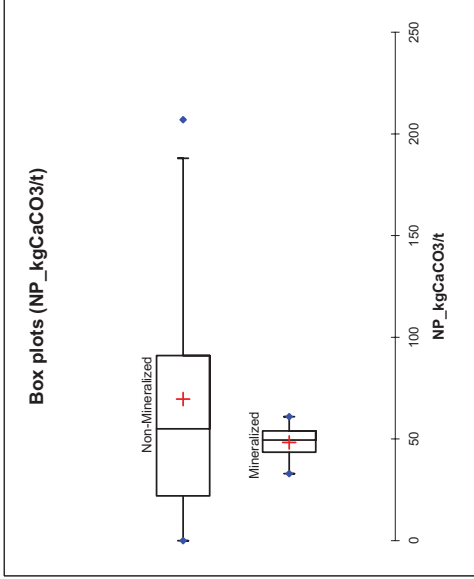
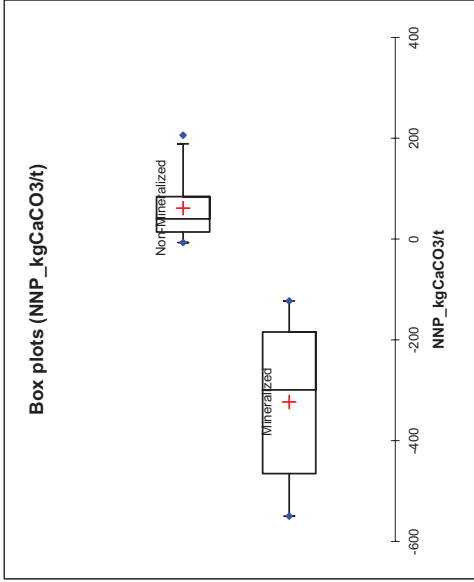
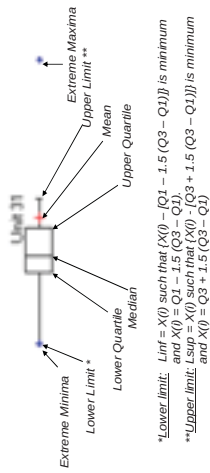


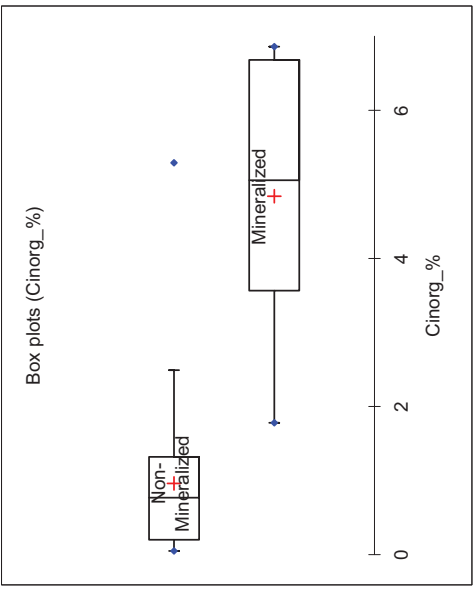
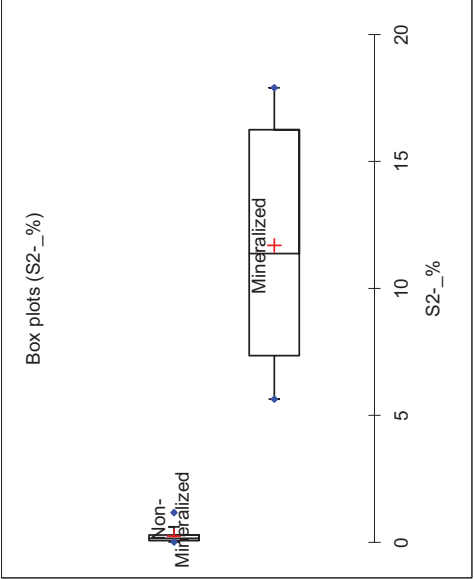
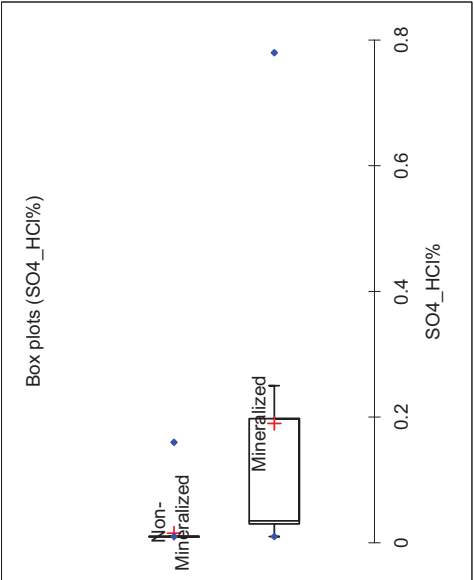
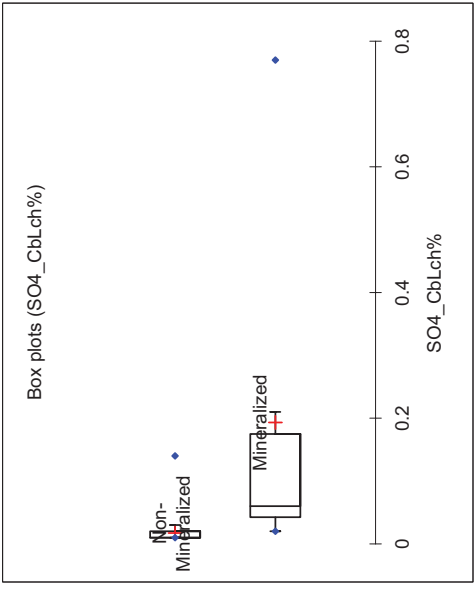
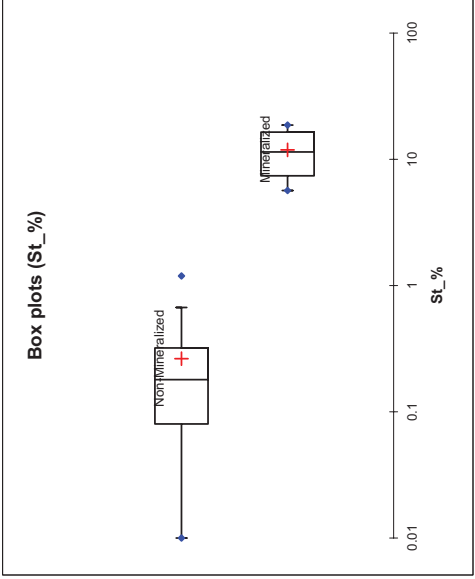
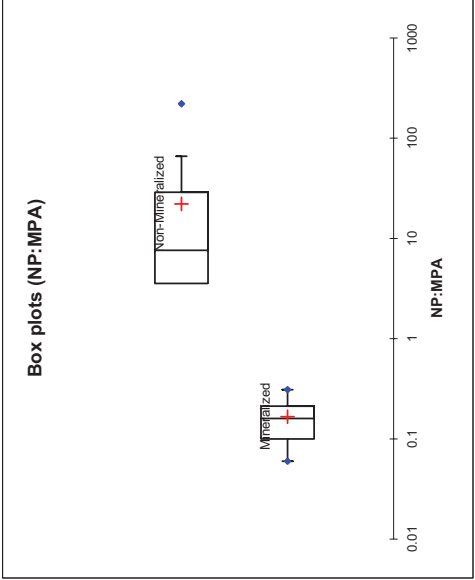


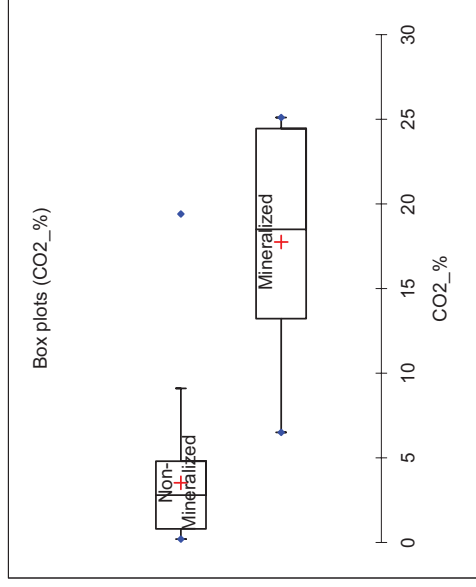


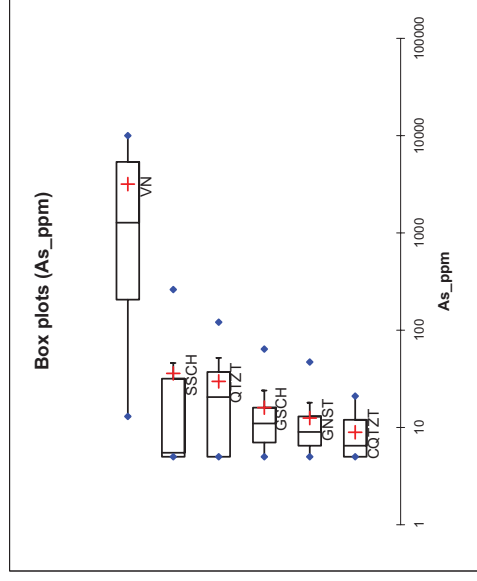
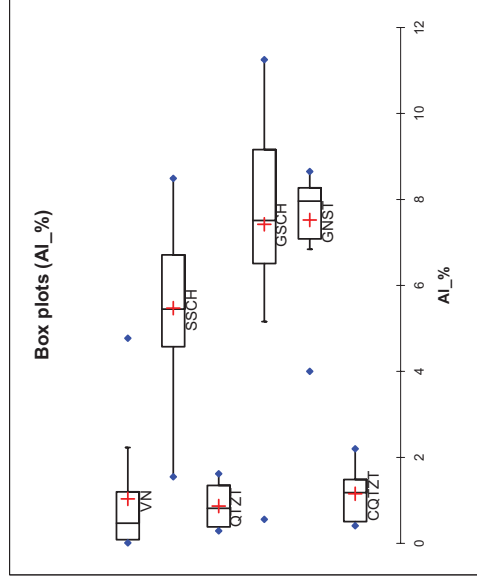


LEGEND FOR BOX PLOTS:

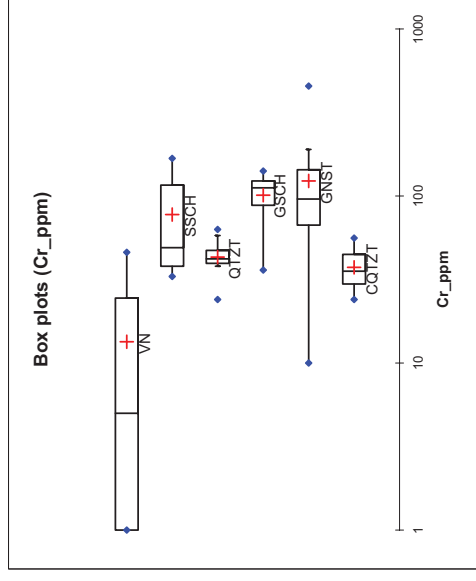
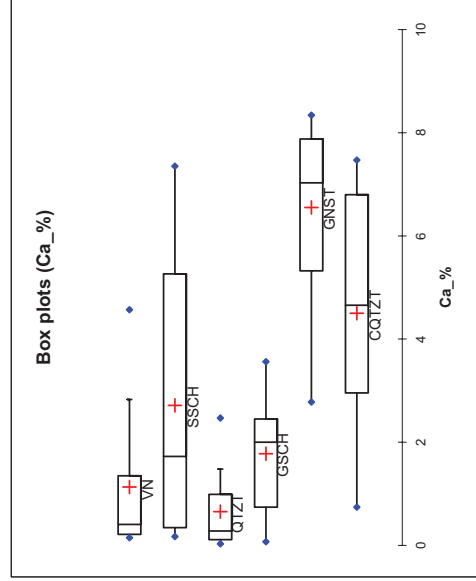
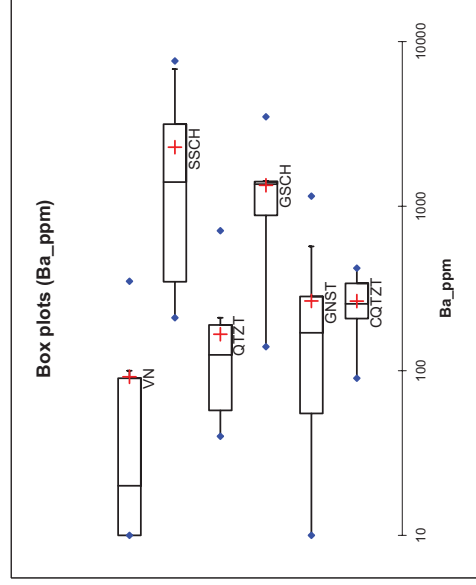
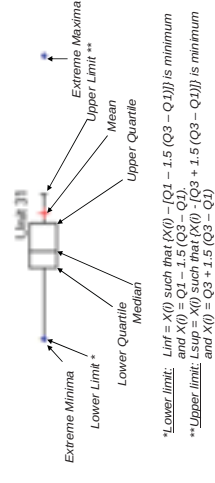


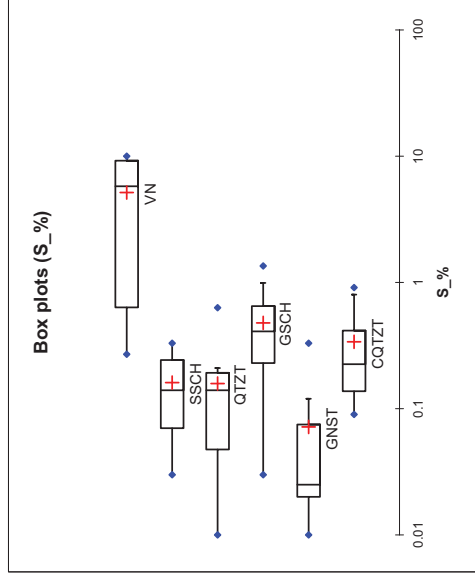
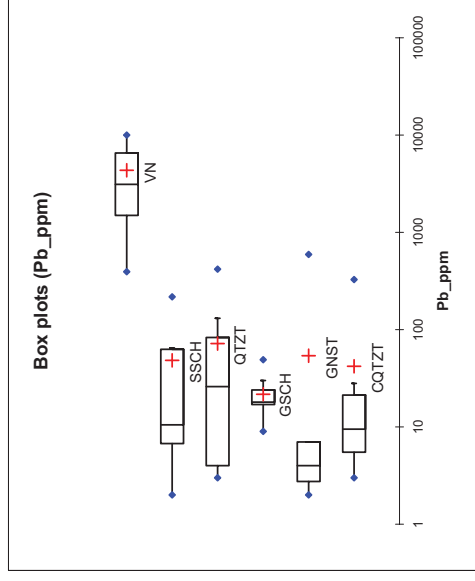
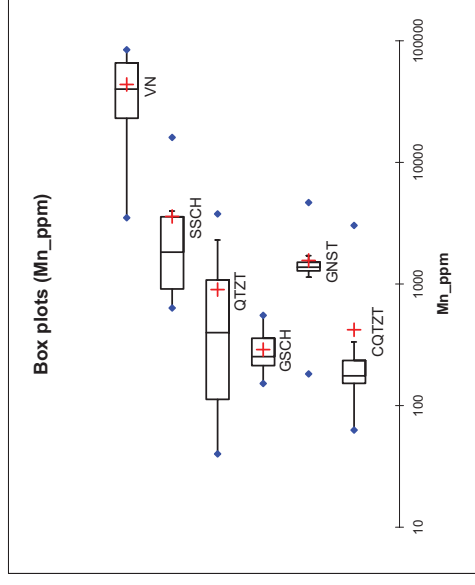
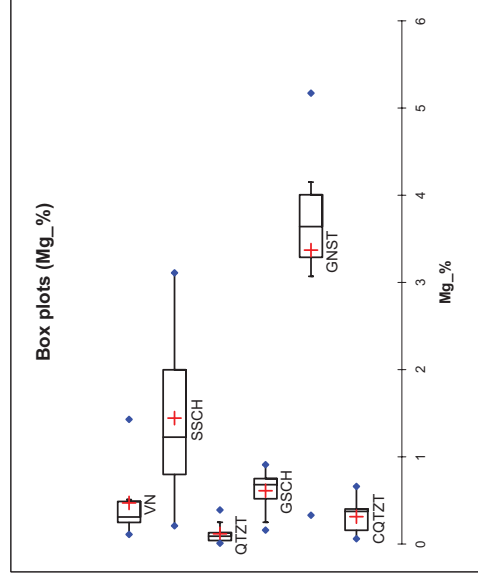
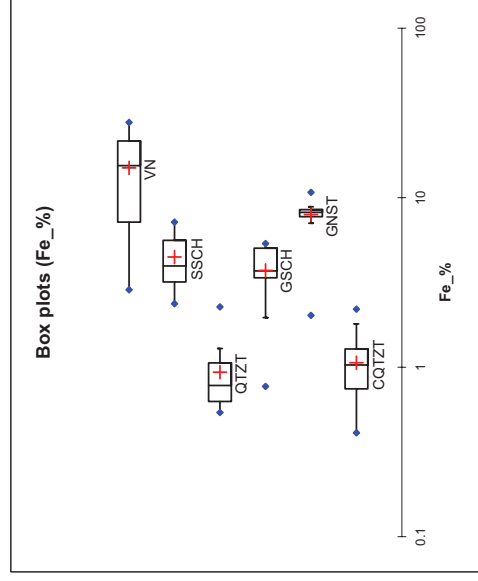
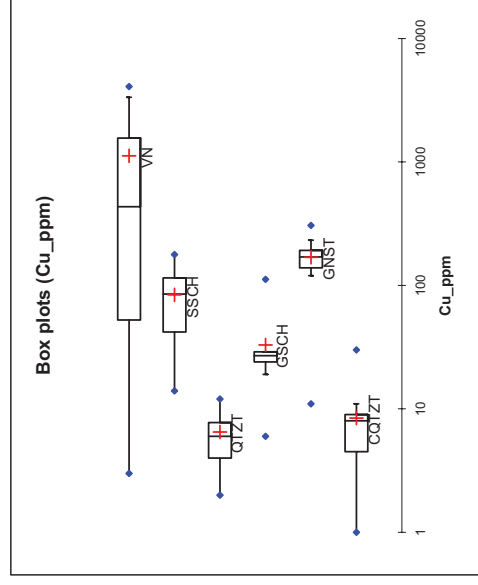


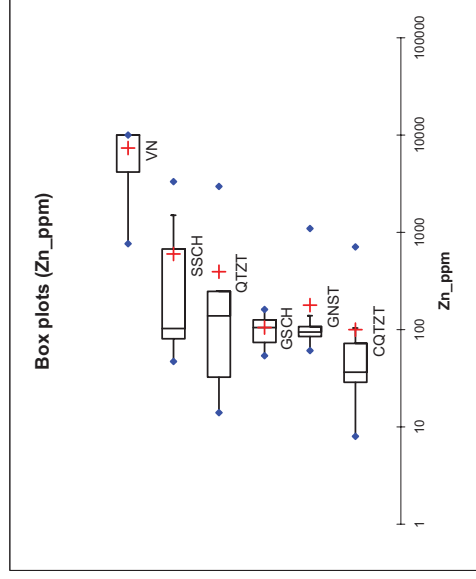
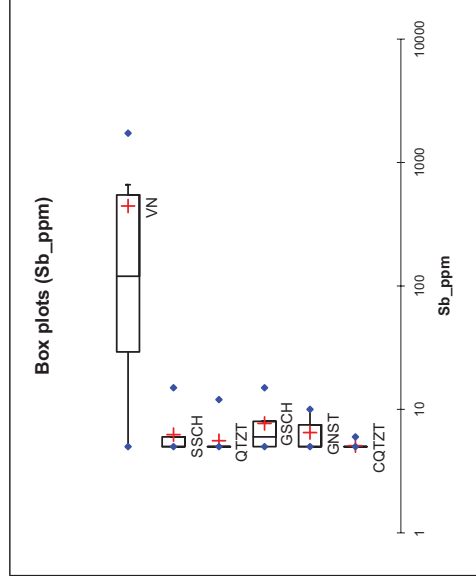


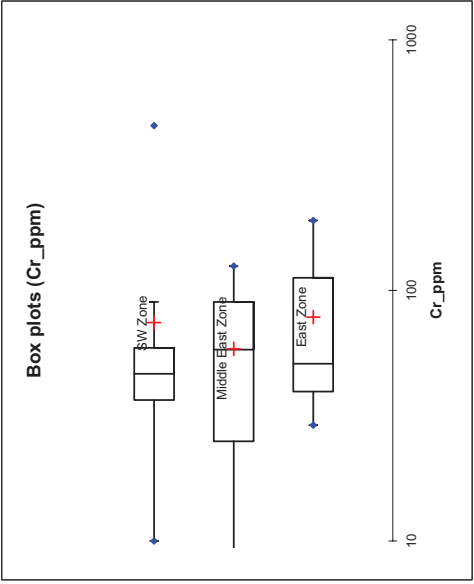
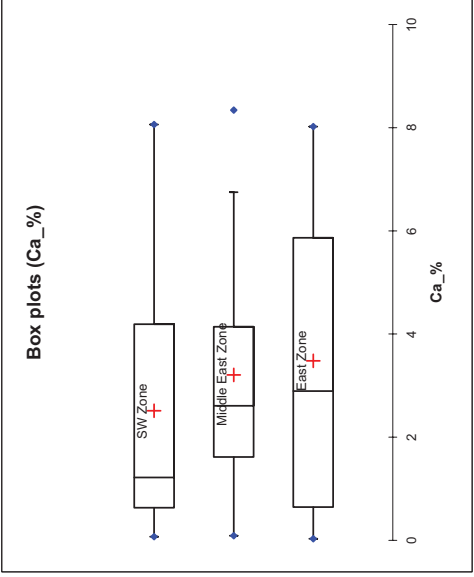
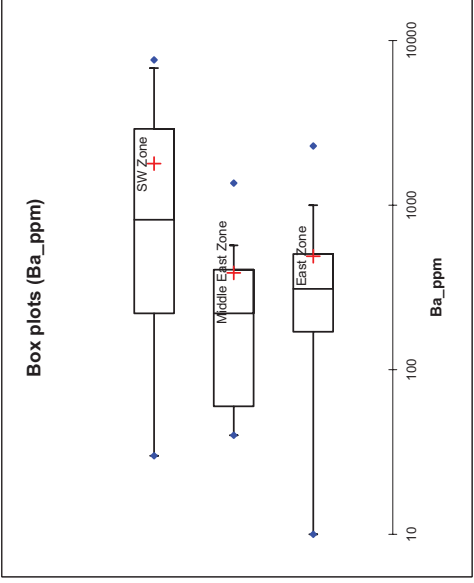
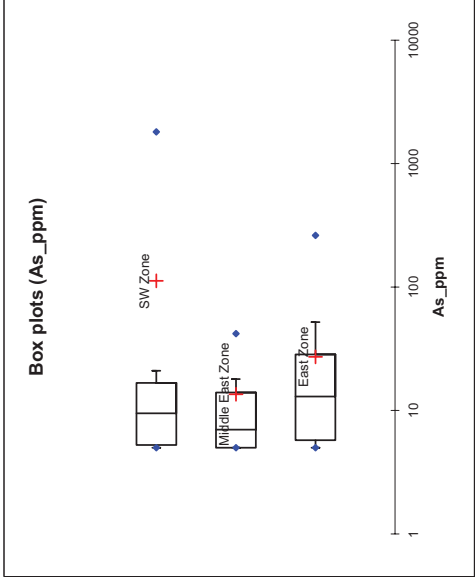
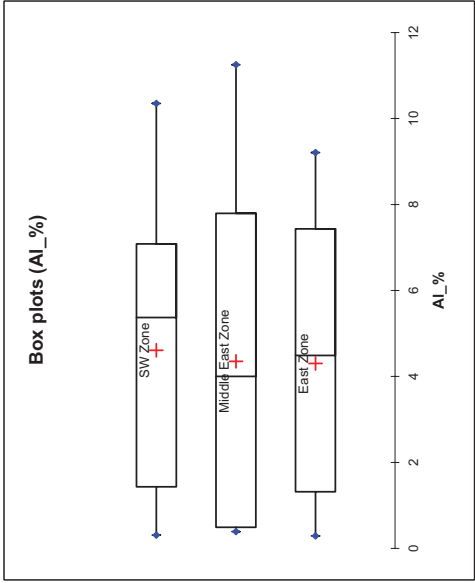


LEGEND FOR BOX PLOTS:

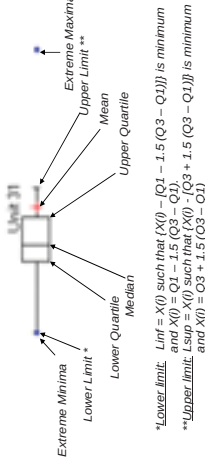


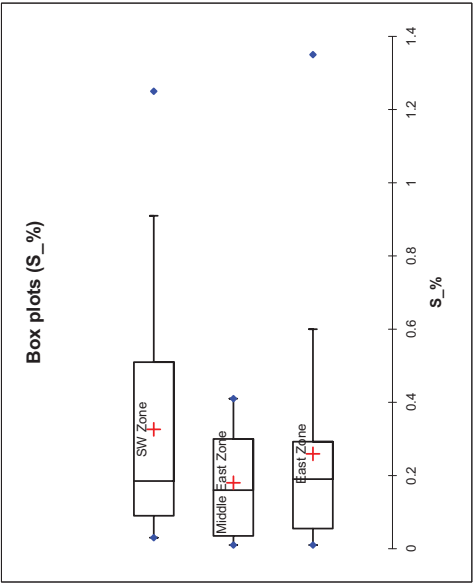
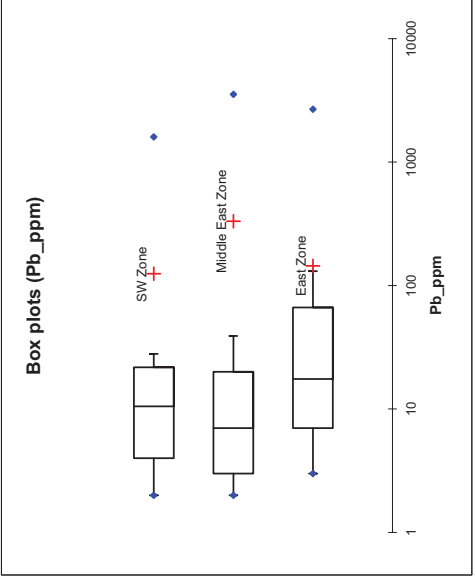
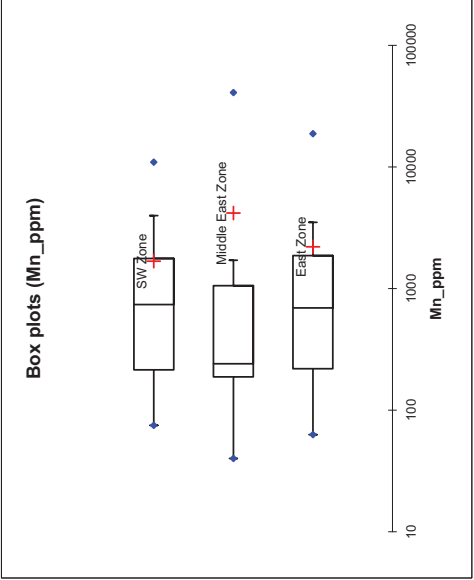
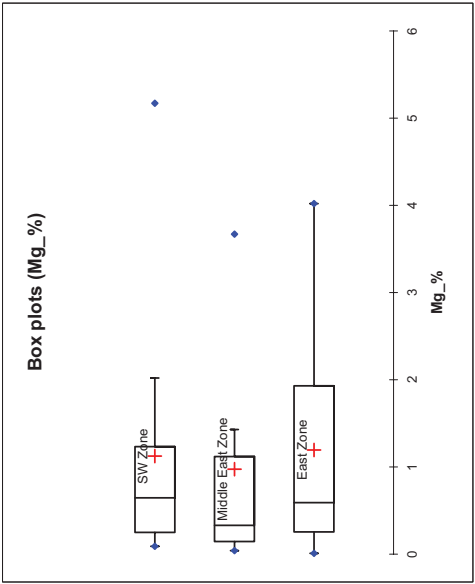
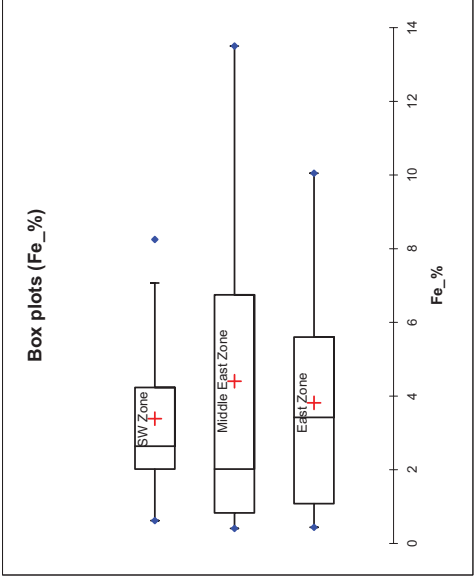
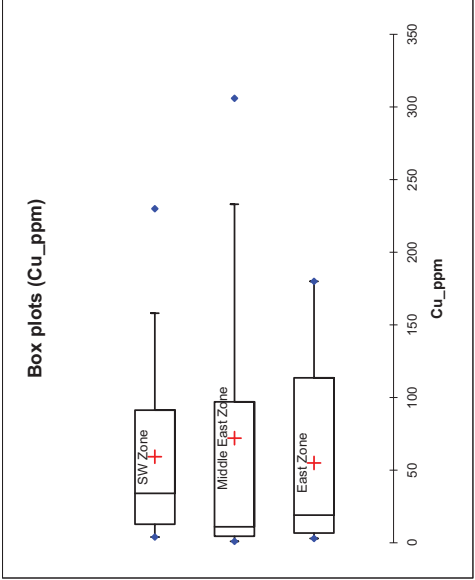


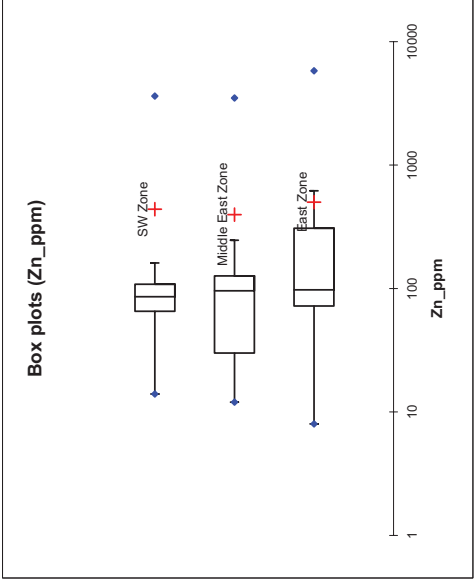
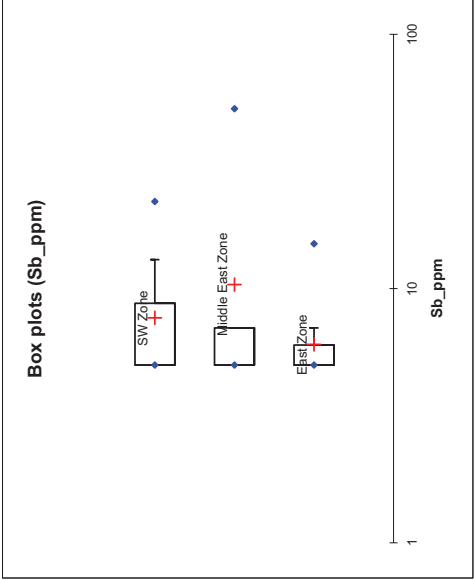


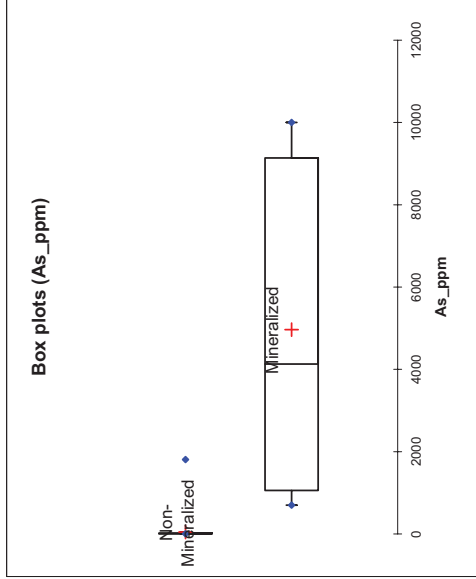
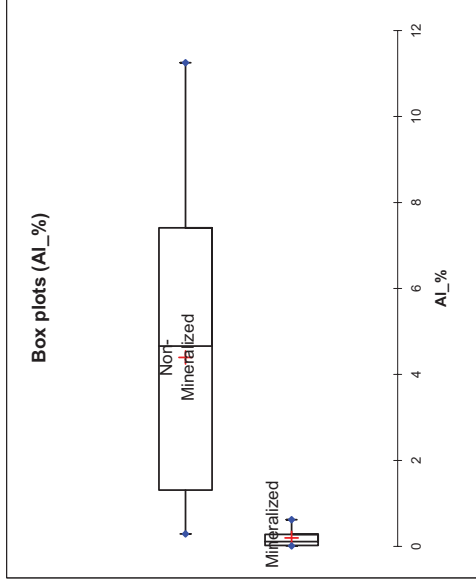


LEGEND FOR BOX PLOTS:

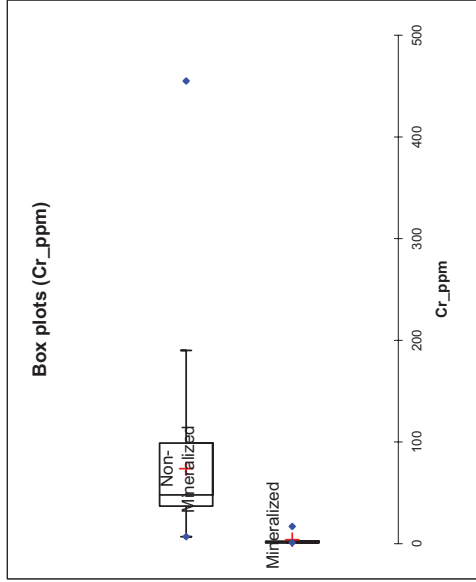
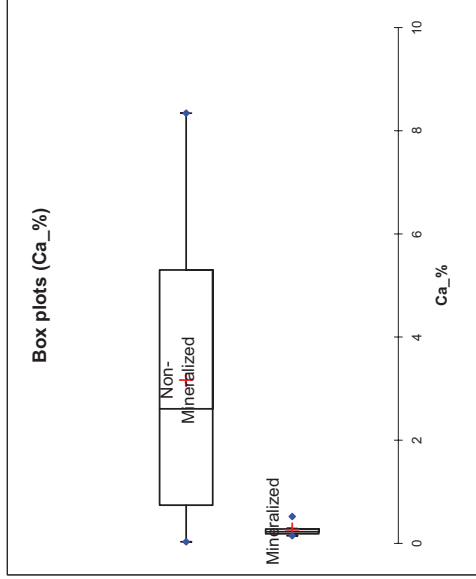
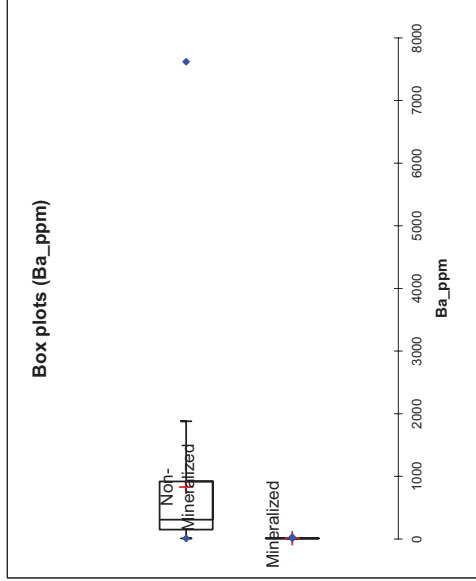
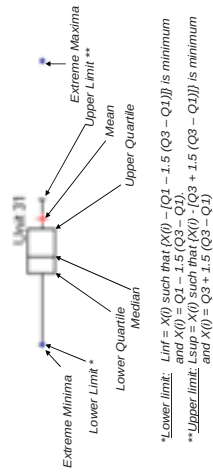


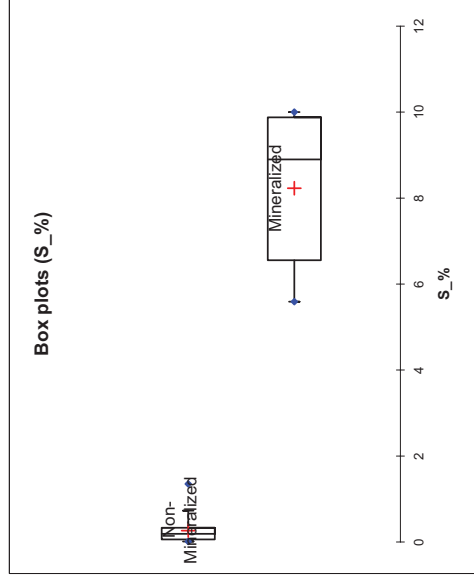
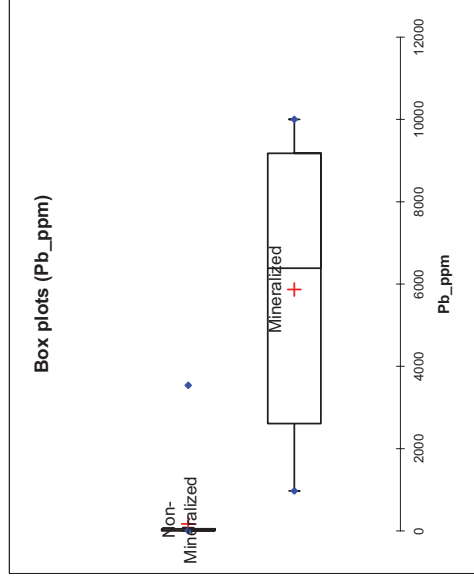
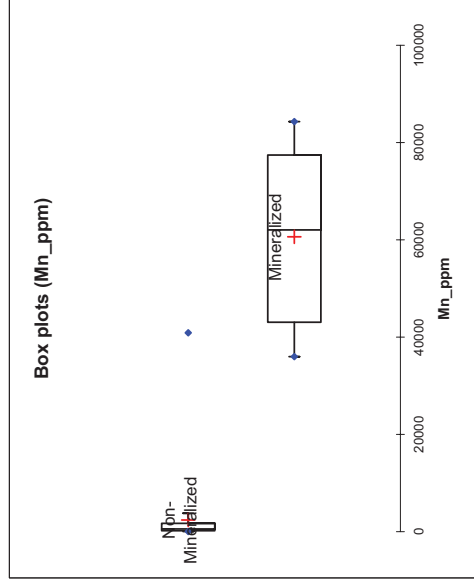
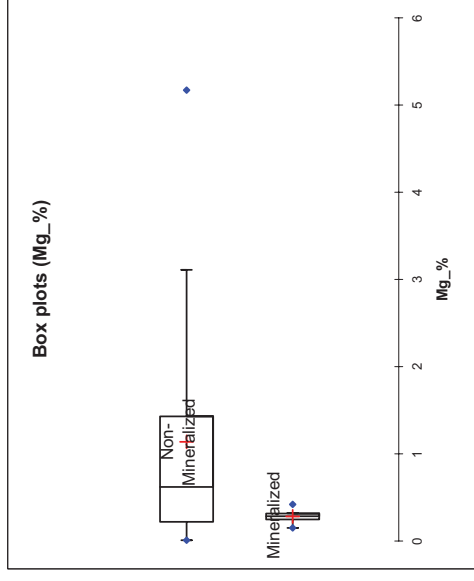
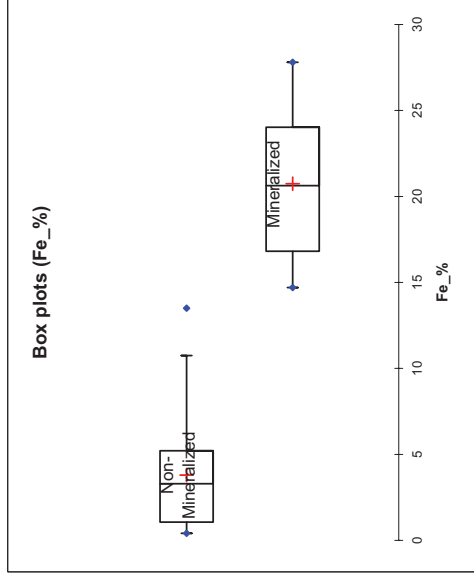
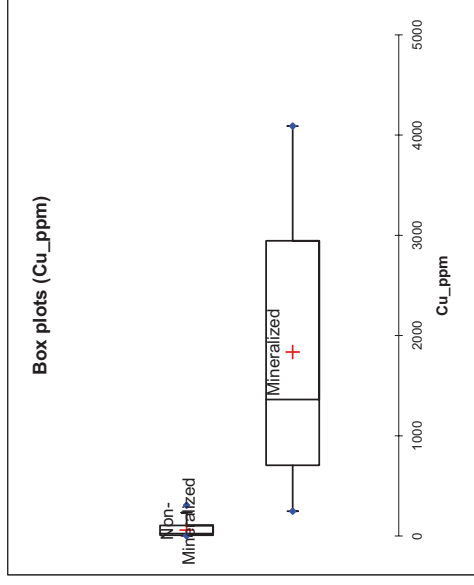


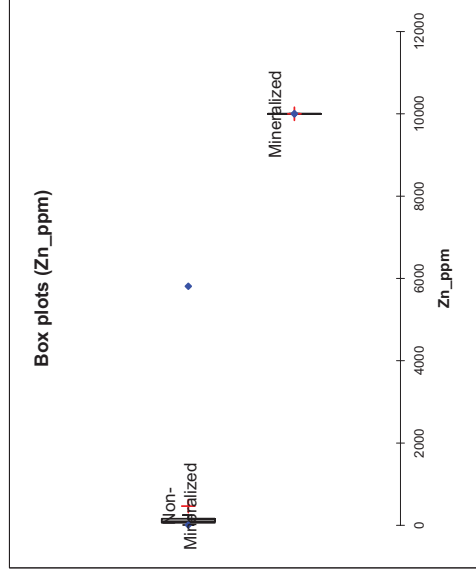
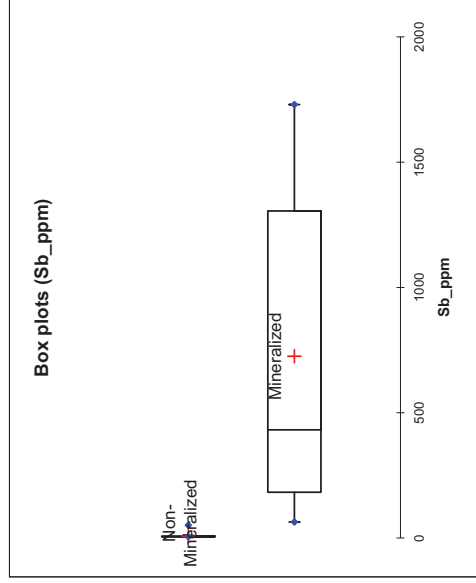


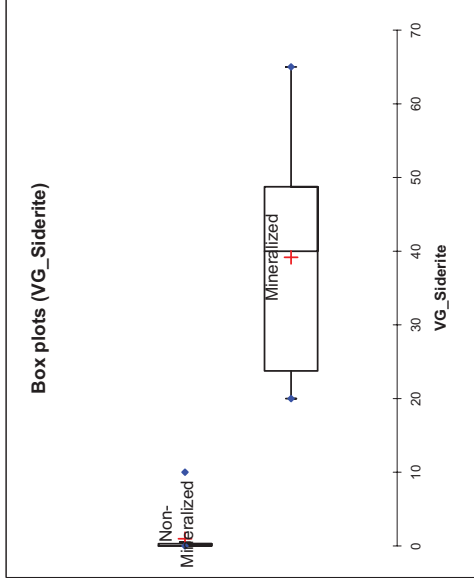
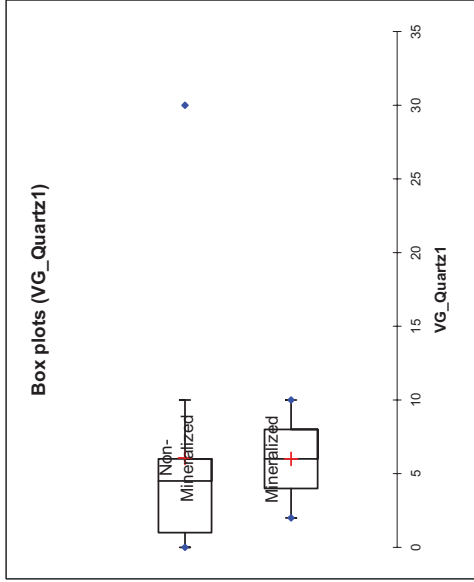


LEGEND FOR BOX PLOTS:

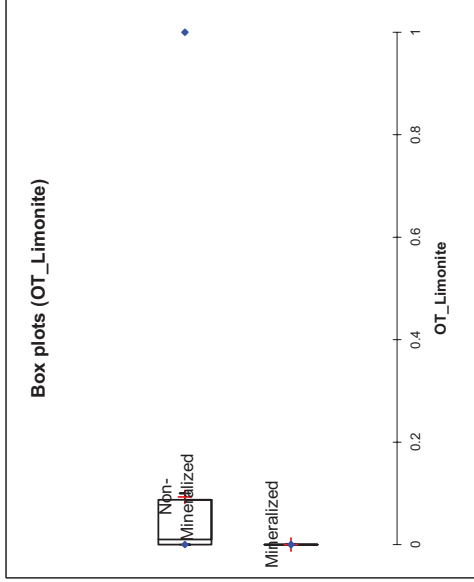
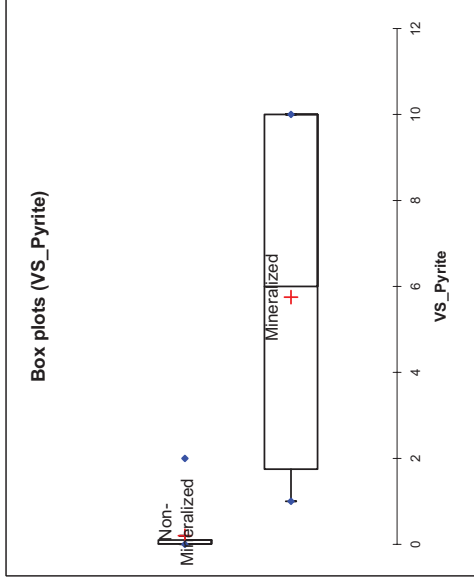
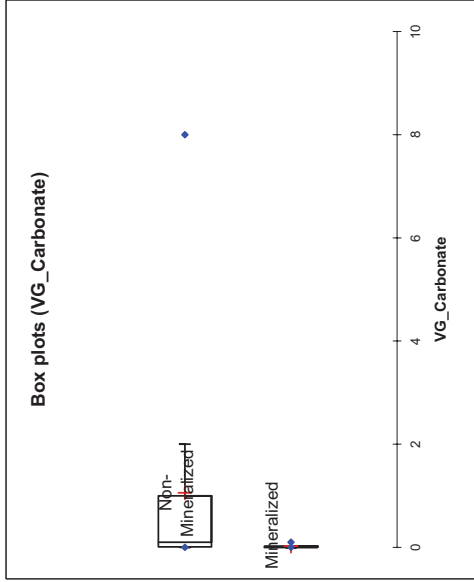
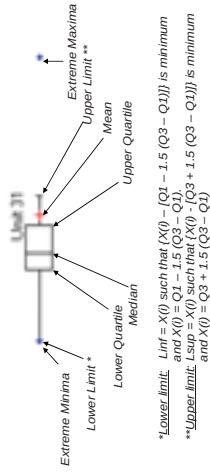


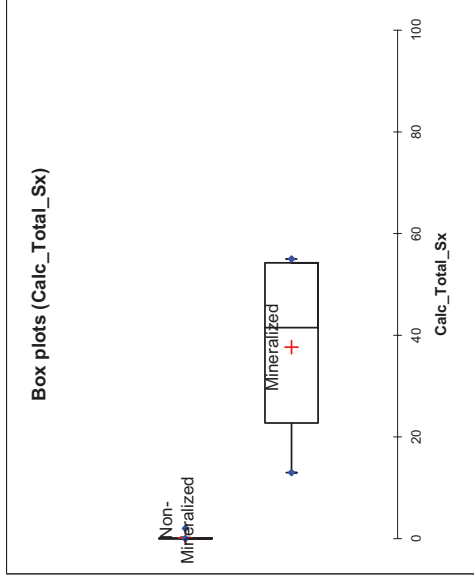
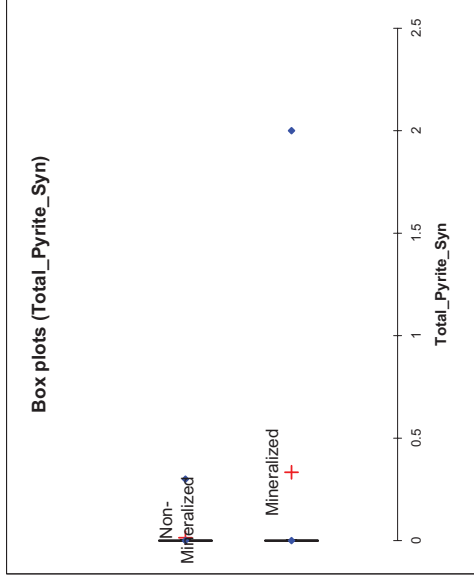
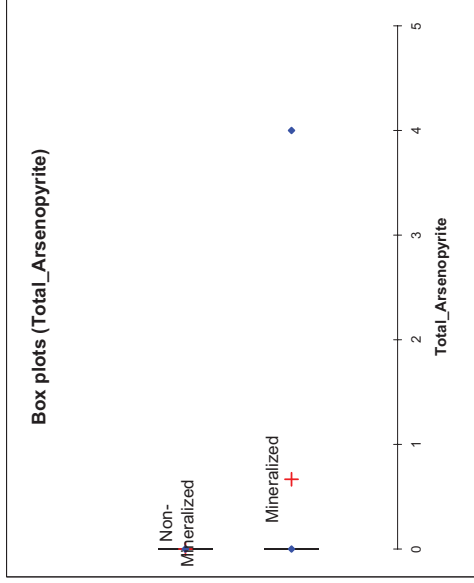
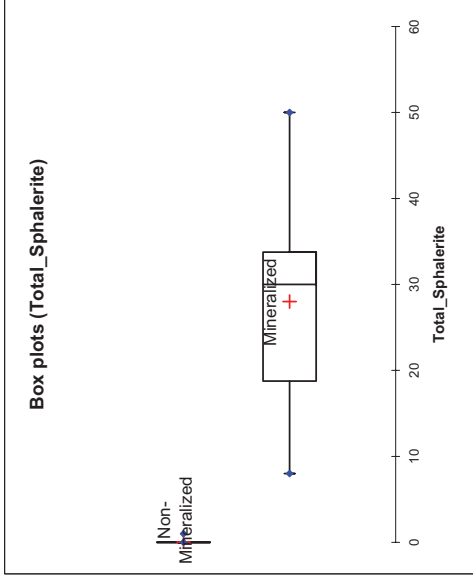
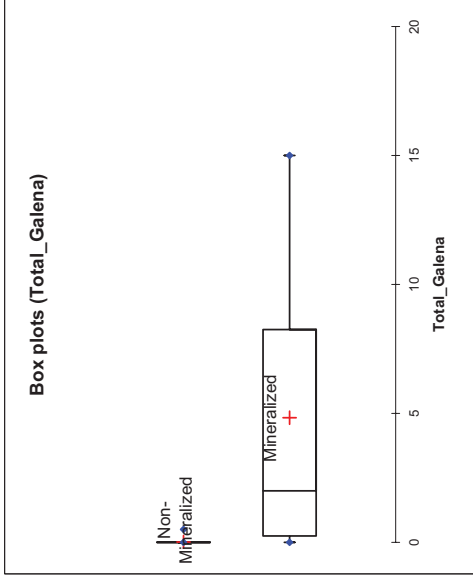
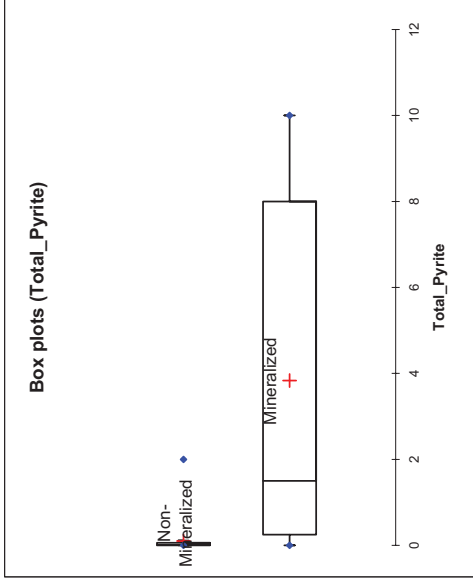


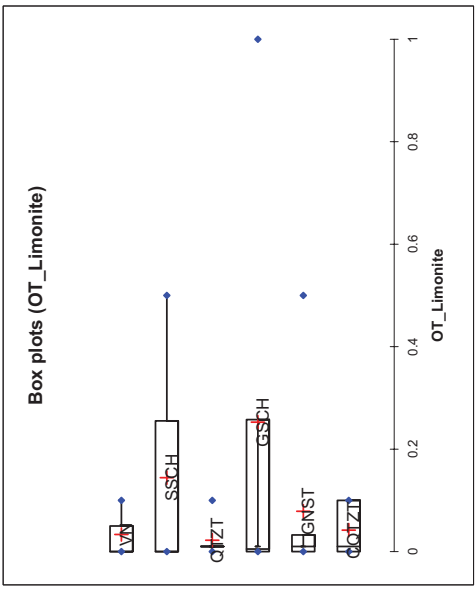
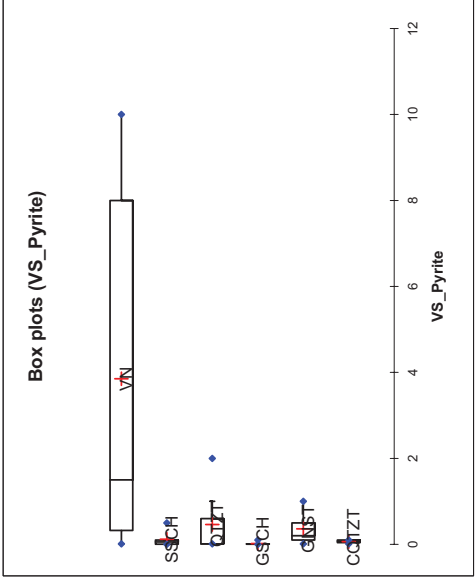
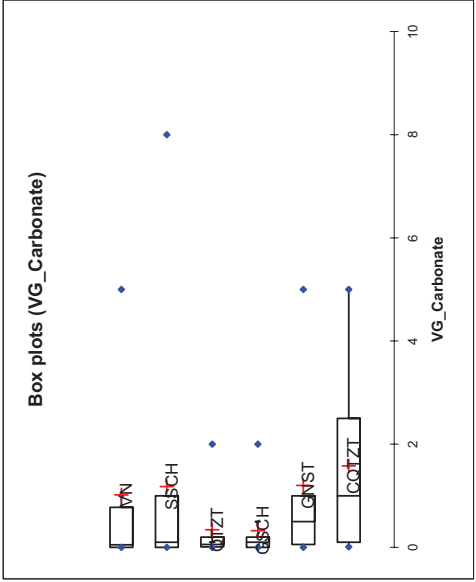
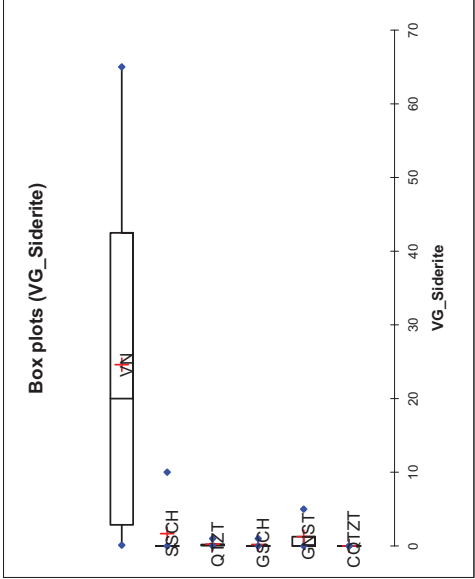
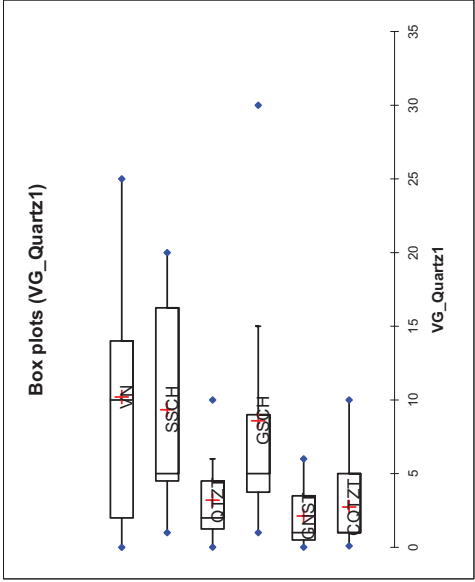




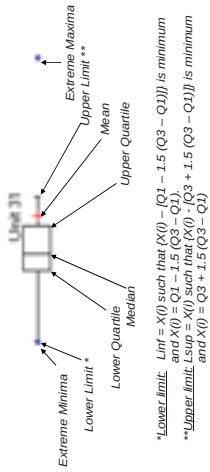
LEGEND FOR BOX PLOTS:

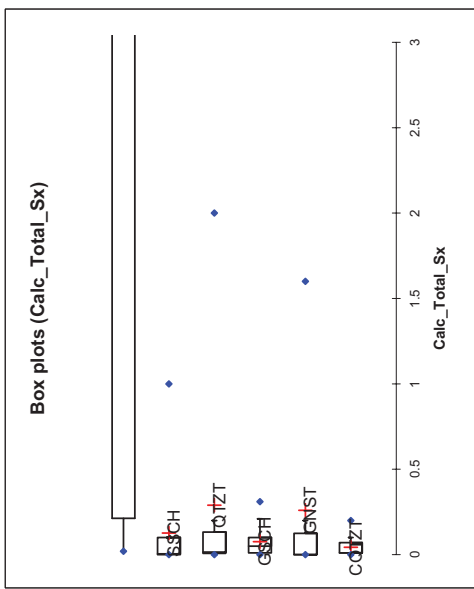
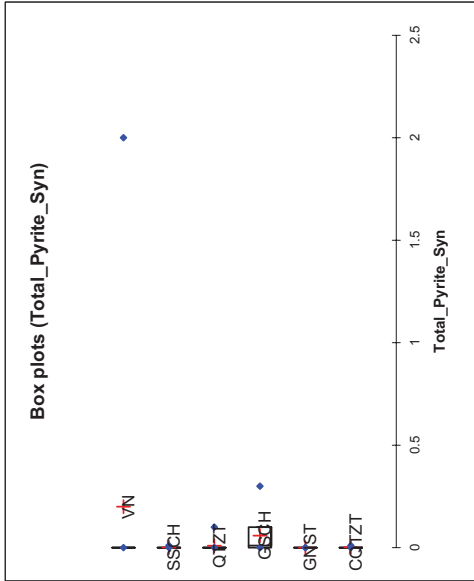
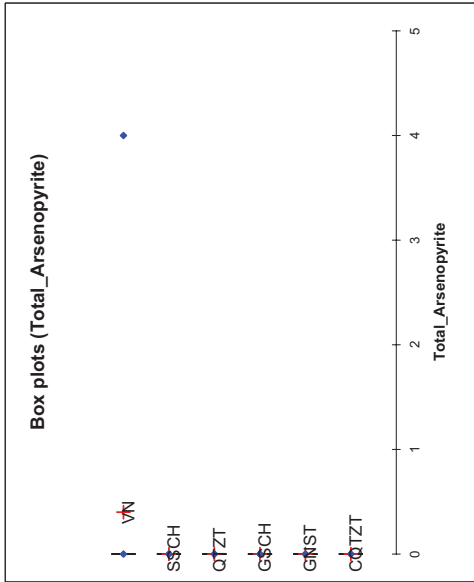
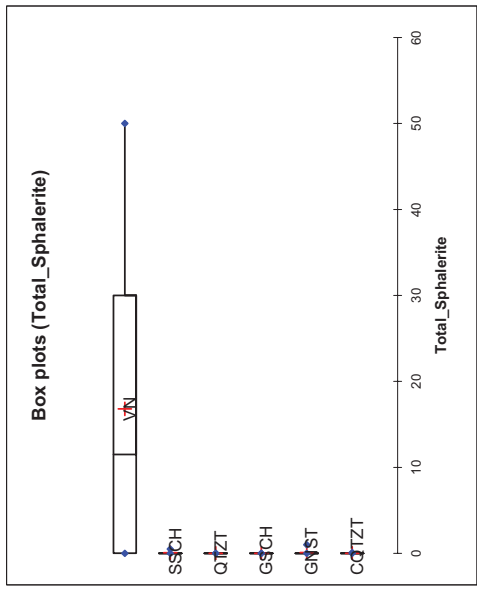
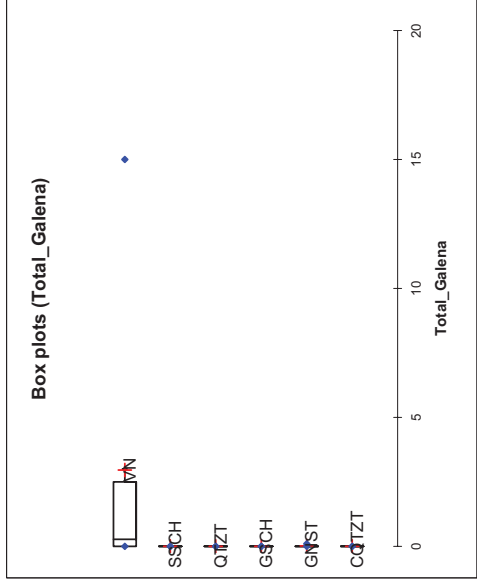
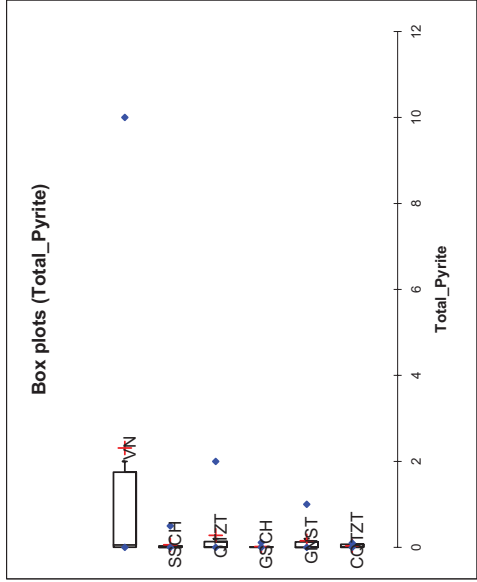




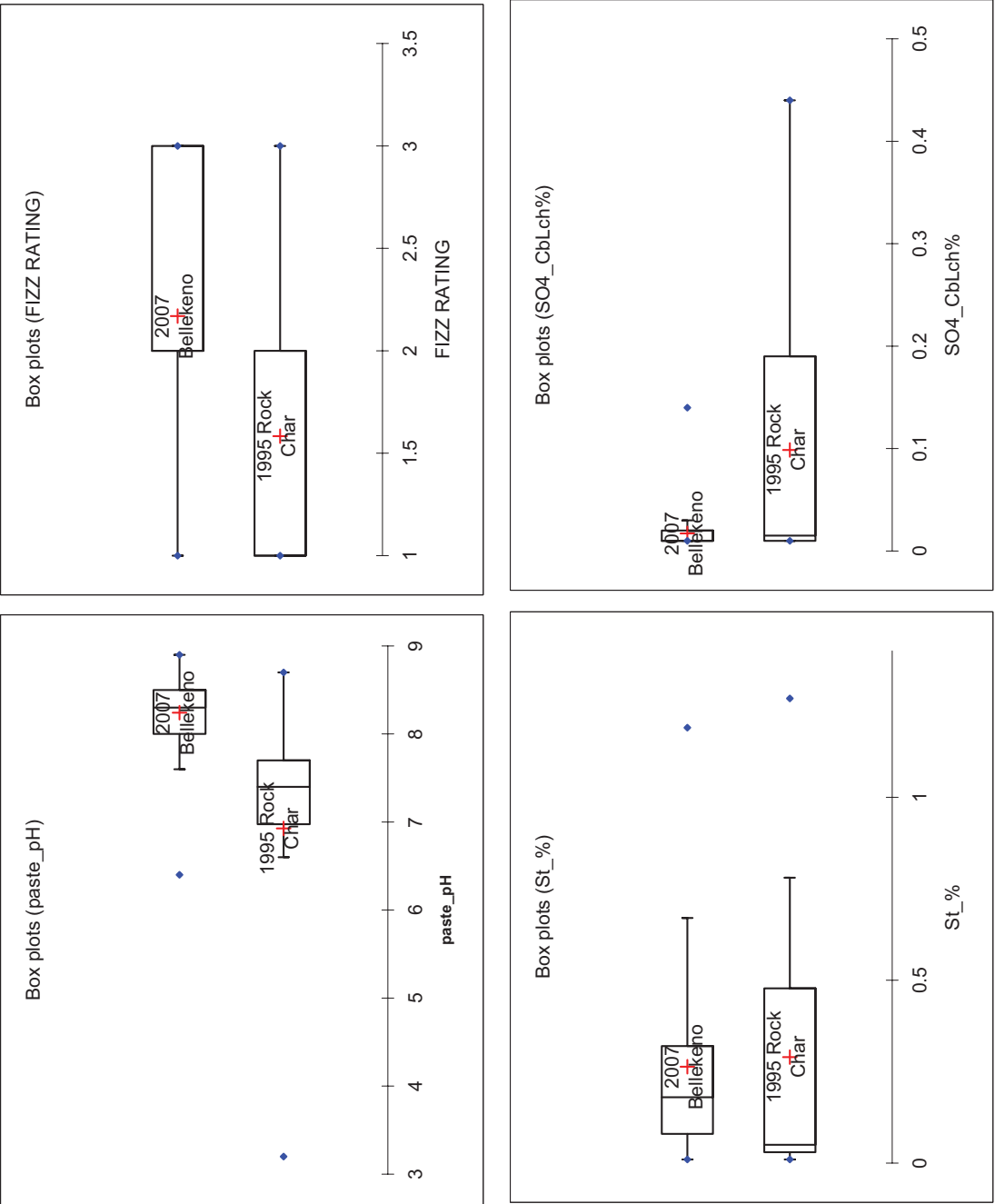


LEGEND FOR BOX PLOTS:

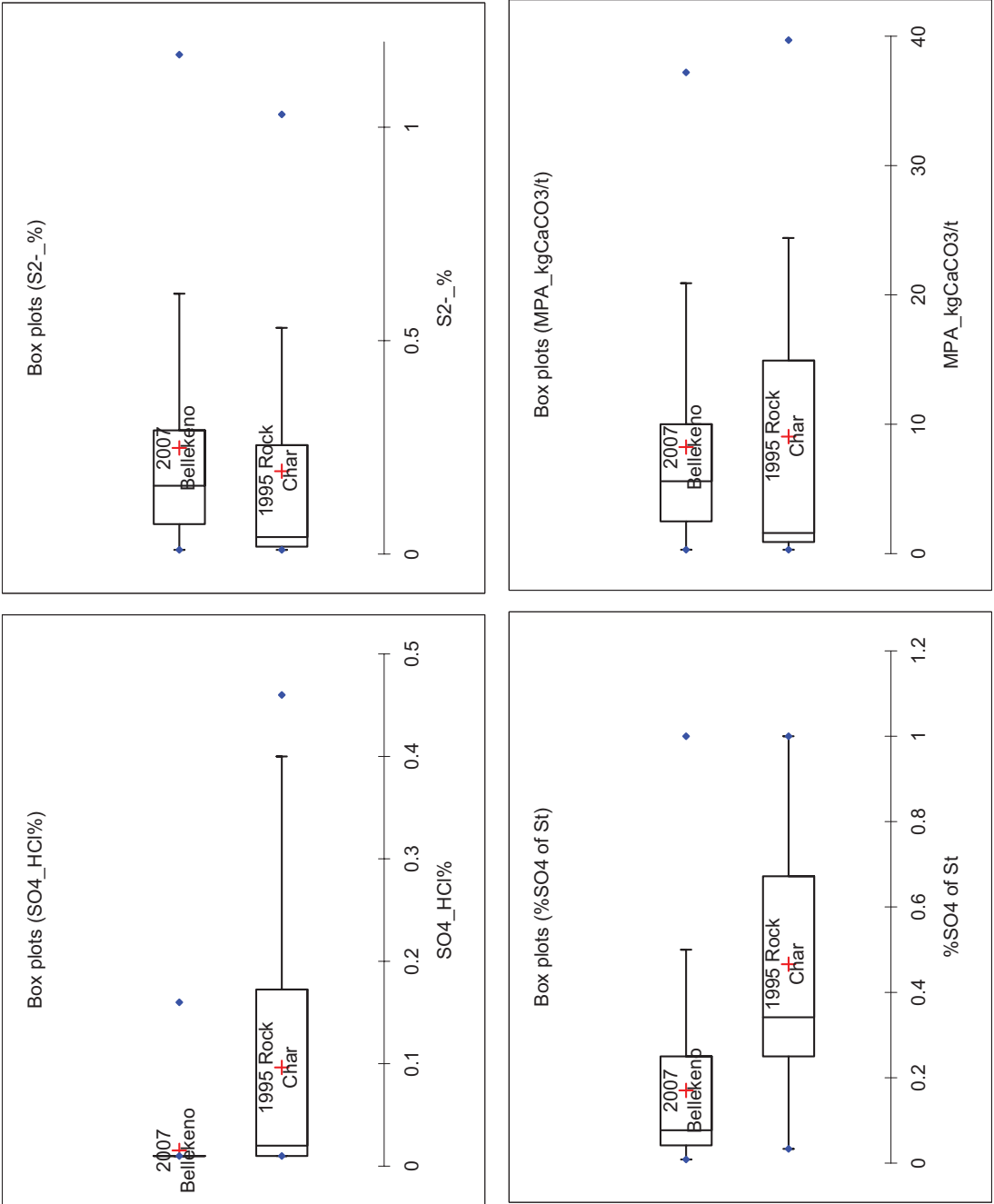




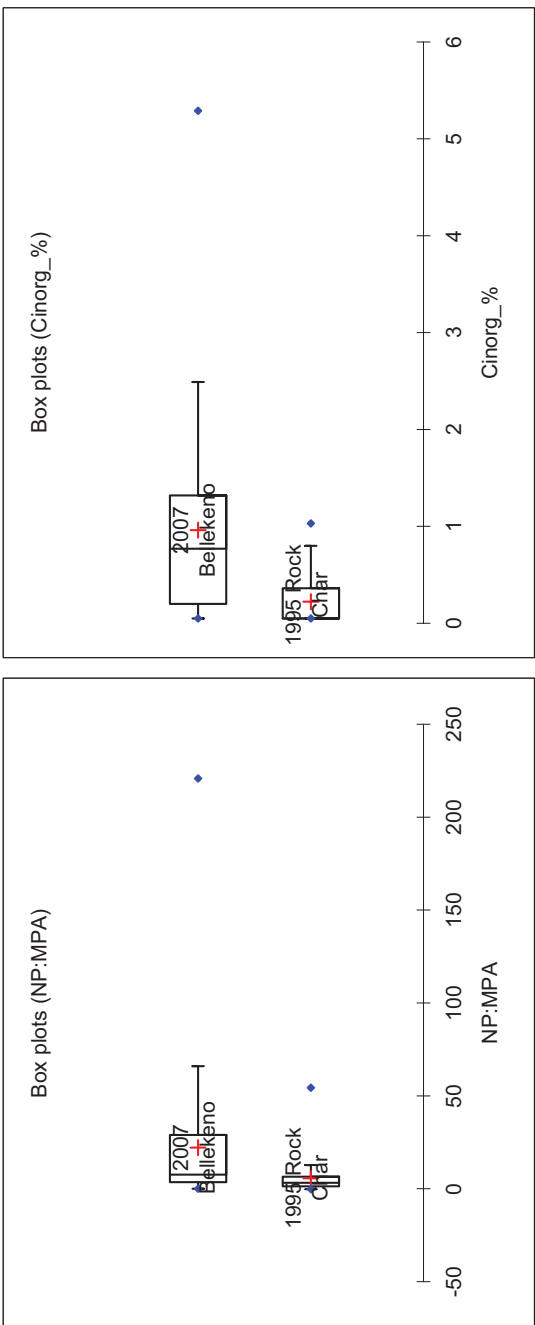
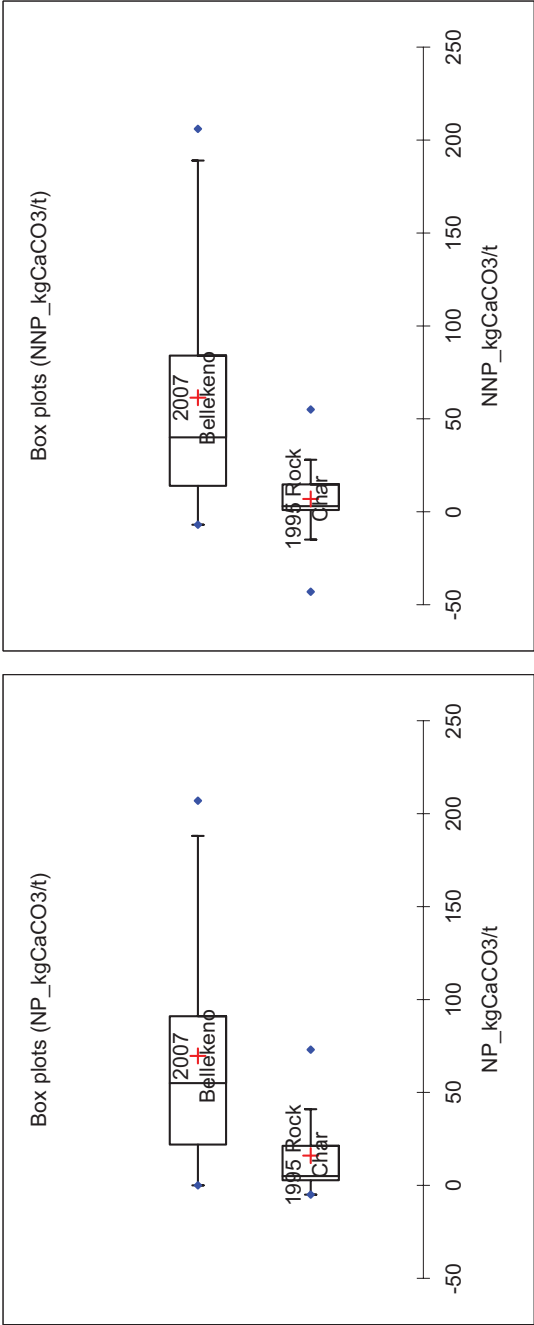
**APPENDIX B4-4 Comparison of ABA Parameters Between 2007 Bellekeno
and 1995-96 Keno Site-Wide Samples**



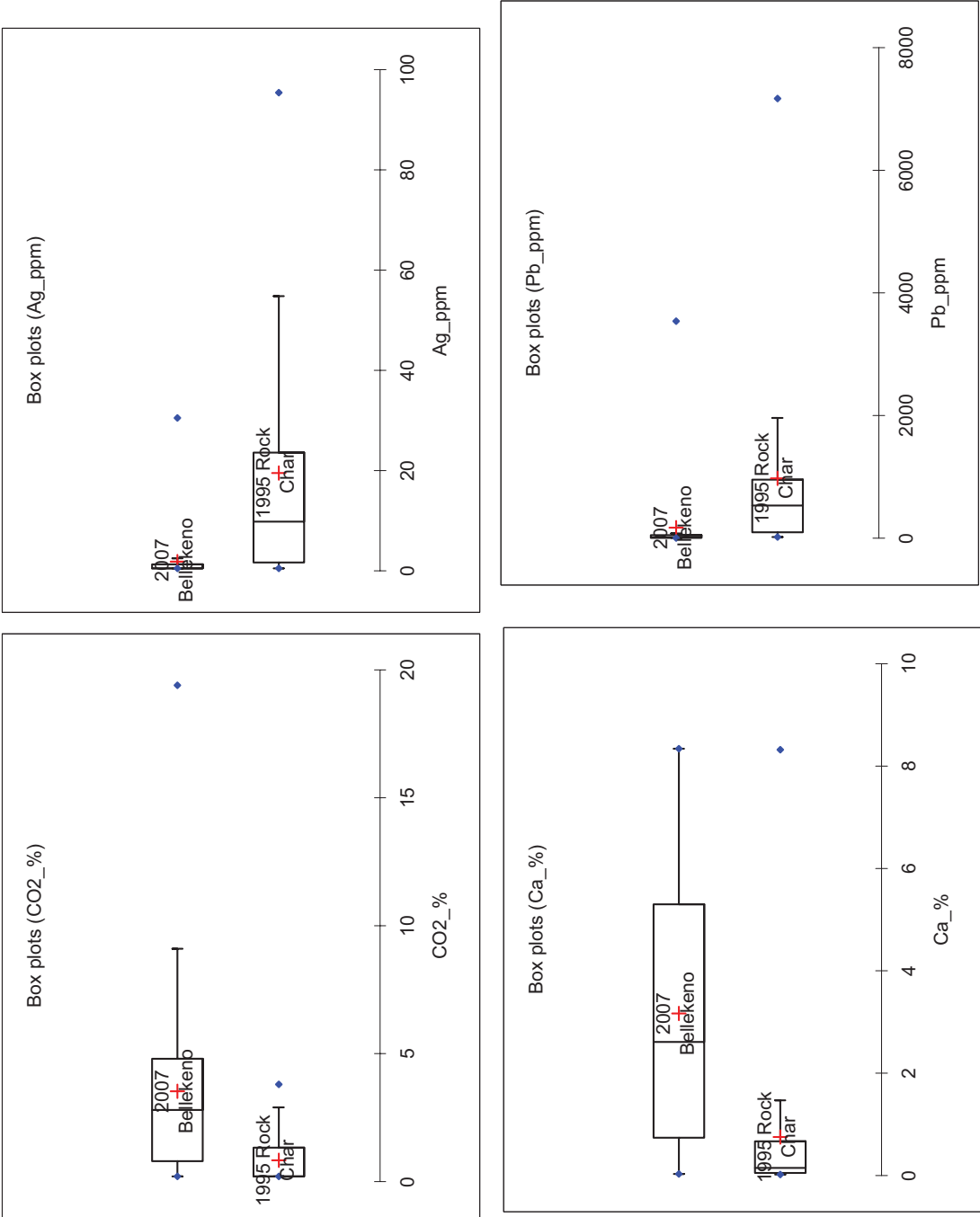
**APPENDIX B4-4 Comparison of ABA Parameters Between 2007 Bellekeno
and 1995-96 Keno Site-Wide Samples**



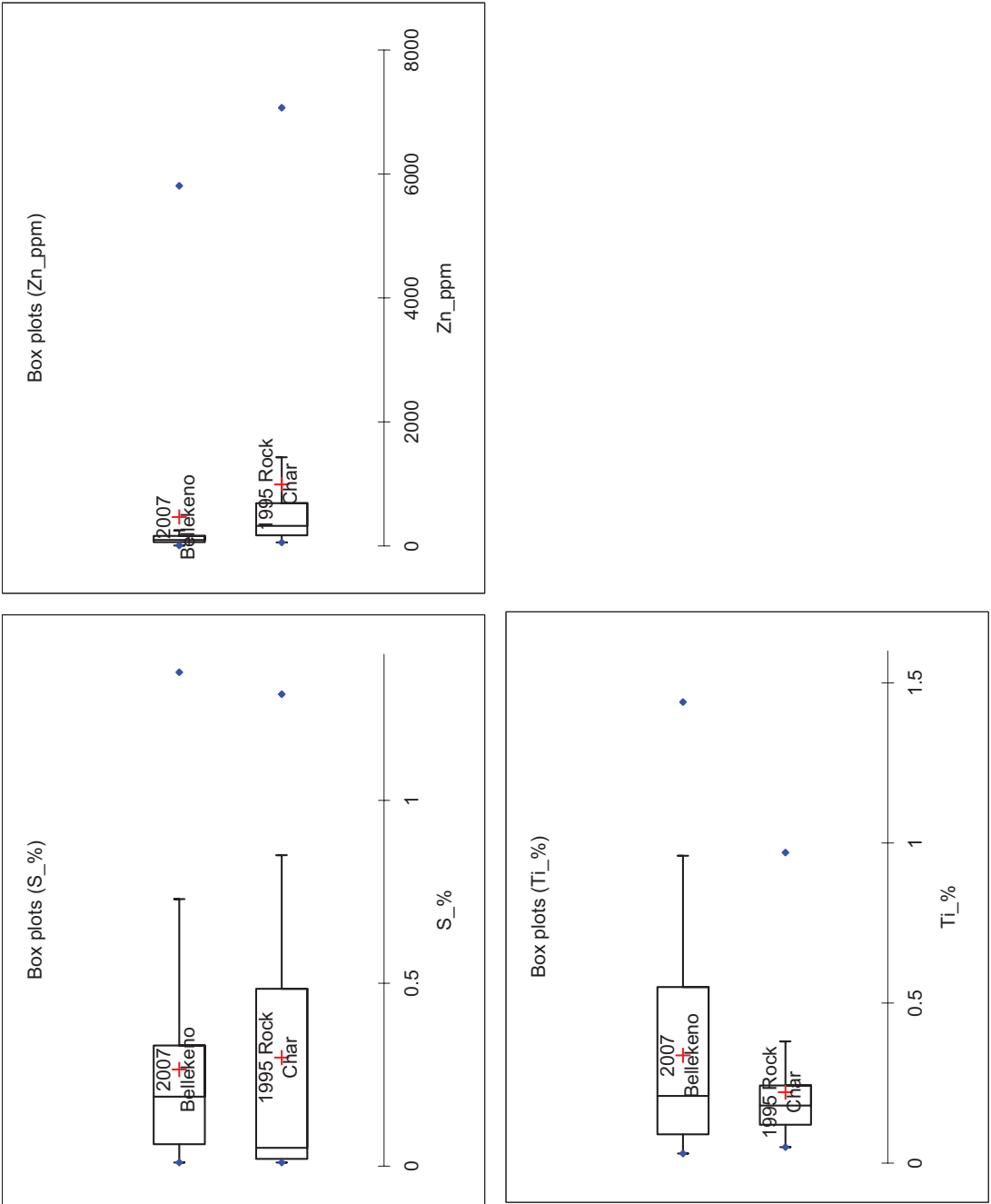
**APPENDIX B4-4 Comparison of ABA Parameters Between 2007 Bellekeno
and 1995-96 Keno Site-Wide Samples**



**APPENDIX B4-4 Comparison of ABA Parameters Between 2007 Bellekeno
and 1995-96 Keno Site-Wide Samples**



**APPENDIX B4-4 Comparison of ABA Parameters Between 2007 Bellekeno
and 1995-96 Keno Site-Wide Samples**



APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

(<100 ppm Ag, <10000 ppm Pb, <10000 ppm Zn)

All Lithologies:

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2188	0	0
Minimum	0.010	0.500	0.130	5.000	10.000	0.500	2.000	0.010	0.500	1.000	1.000	1.000	0.120	10.000	0.010	10.000	0.010
Maximum	3.160	90.700	13.900	10000.000	7620.000	4.100	27.000	23.400	144.000	75.000	1240.000	933.000	39.600	40.000	6.360	60.000	12.550
1st Quartile	0.010	0.500	0.900	5.000	140.000	0.500	2.000	0.390	0.500	2.000	37.000	7.000	1.023	10.000	0.190	10.000	0.140
Median	0.010	0.500	2.720	9.000	380.000	0.600	2.000	1.205	0.500	4.000	50.000	18.000	2.020	10.000	0.470	10.000	0.320
3rd Quartile	0.010	0.700	5.730	17.000	860.000	1.200	2.000	2.908	1.000	9.000	72.000	37.000	3.288	10.000	0.980	20.000	0.670
Mean	0.016	1.344	3.461	45.032	573.989	0.871	2.125	2.083	3.907	8.192	60.297	37.609	2.746	11.956	0.705	14.093	0.662
Standard deviation (n)	0.059	3.980	2.759	349.773	600.296	0.511	0.820	2.327	11.723	10.482	42.837	61.496	2.586	4.178	0.687	7.687	0.991
Variation coefficient	3.716	2.961	0.797	7.767	1.046	0.586	0.386	1.117	3.001	1.280	0.710	1.635	0.942	0.349	0.975	0.545	1.498
Skewness (Pearson)	35.697	11.417	0.570	20.616	2.697	1.448	15.943	1.874	5.358	2.217	6.480	4.444	2.840	1.903	1.671	2.000	3.281
Kurtosis (Pearson)	1602.047	175.187	-0.938	508.887	14.941	1.764	370.783	5.642	34.082	4.327	114.868	30.692	16.748	2.729	3.248	3.710	16.468
Geometric mean	0.012	0.728	2.216	11.567	331.031	0.759	2.075	1.013	0.974	4.305	50.639	18.201	1.950	11.424	0.435	12.712	0.314
Geometric standard deviation	1.608	2.148	2.865	2.764	3.173	1.649	1.190	3.936	3.489	3.104	1.884	3.190	2.284	1.323	2.850	1.515	3.474

CHSCH: Chloritic Schist

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168	0	0
Minimum	0.010	0.500	0.150	5.000	20.000	0.500	2.000	0.100	0.500	3.000	3.000	1.000	0.150	10.000	0.020	10.000	0.050
Maximum	0.840	9.200	10.450	341.000	4220.000	2.700	7.000	21.000	120.500	47.000	764.000	282.000	12.400	30.000	4.250	60.000	12.550
1st Quartile	0.010	0.500	5.743	5.000	602.500	1.025	2.000	1.065	0.500	9.000	41.250	22.000	2.740	10.000	1.420	10.000	0.760
Median	0.010	0.500	6.940	6.000	850.000	1.400	2.000	2.560	0.500	12.000	54.000	31.000	3.455	20.000	2.025	20.000	0.960
3rd Quartile	0.010	0.500	7.900	12.000	1187.500	1.775	2.000	4.545	0.500	19.750	81.000	54.000	5.135	20.000	2.695	30.000	1.760
Mean	0.016	0.677	6.681	15.014	1020.405	1.423	2.054	3.252	2.527	15.878	74.495	49.459	4.181	16.111	1.967	24.444	1.428
Standard deviation (n)	0.056	0.759	1.742	33.525	719.501	0.532	0.421	2.887	12.052	9.910	76.812	50.544	2.219	5.241	0.940	14.229	1.254
Variation coefficient	3.541	1.121	0.261	2.233	0.705	0.374	0.205	0.888	4.768	0.624	1.031	1.022	0.531	0.325	0.478	0.582	0.878
Skewness (Pearson)	14.269	7.523	-0.822	7.032	1.778	0.073	9.391	2.078	8.008	1.301	5.007	2.490	1.442	-0.067	-0.307	0.614	3.908
Kurtosis (Pearson)	206.062	72.303	1.145	55.909	3.747	-0.556	95.872	7.502	68.062	0.966	34.174	6.548	2.102	-1.160	-0.519	-0.513	26.922
Geometric mean	0.011	0.574	6.317	8.839	780.674	1.309	2.033	2.154	0.666	13.335	57.030	34.423	3.680	15.193	1.519	20.367	1.109
Geometric standard deviation	1.542	1.537	1.513	2.176	2.356	1.543	1.127	2.711	2.512	1.807	2.039	2.328	1.684	1.425	2.661	1.866	2.022

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

(<100 ppm Ag, <10000 ppm Pb, <10000

All Lithologies:

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478
No. of missing values	0	0	0	0	0	0	0	0	2188	0	2188	0	2188	2188	0	0	0
Minimum	17,000	1,000	0.010	1,000	20,000	2,000	0.010	5,000	1,000	1,000	20,000	0.010	10,000	10,000	2,000	10,000	2,000
Maximum	100,000	28,000	4.250	1560,000	4670,000	8970,000	10,000	208,000	45,000	852,000	20,000	2,380	50,000	20,000	1620,000	290,000	9950,000
1st Quartile	153,000	1,000	0.030	7,000	260,000	7,000	0.120	5,000	1,000	45,000	20,000	0.070	10,000	10,000	18,000	10,000	45,000
Median	306,000	1,000	0.080	19,000	400,000	14,000	0.320	5,000	3,000	89,000	20,000	0.160	10,000	10,000	50,000	10,000	86,000
3rd Quartile	1093,750	1,000	0.240	40,000	580,000	30,000	0.620	5,000	10,000	152,000	20,000	0.270	10,000	10,000	115,000	10,000	166,000
Mean	1482,709	1,324	0.248	27,524	466,334	94,935	0.447	6,351	8,198	108,309	20,000	0.240	10,042	10,019	89,554	10,105	360,394
Standard deviation (n)	4550,571	1,337	0.427	33,959	355,395	367,142	0.474	7,165	10,594	88,880	0,000	0.286	0.889	0.431	109,457	3,880	974,496
Variation coefficient	3,069	1,010	1.725	1.234	0.762	3.867	1.060	1.128	1.292	0.821	0,000	1.188	0.089	0.043	1.222	0.384	2.704
Skewness (Pearson)	10,001	8,511	3.040	16,089	3,629	10,654	3.634	15,391	1,806	1,771	0,000	3.005	29,692	23,092	3,072	61,316	5,153
Kurtosis (Pearson)	149,067	99,660	10,346	655,053	23,610	160,712	37,729	324,700	2,080	6,598	0,000	11,097	1102,212	531,252	18,807	4243,224	31,128
Geometric mean	429,926	1,153	0.088	16,171	373,466	18,367	0.243	5,670	3,977	70,595	20,000	0.153	10,025	10,013	46,069	10,032	104,106
Geometric standard deviation	3,944	1,496	4.334	3,086	1,989	4,475	3.689	1,416	3,303	2,976	1,000	2,510	1,049	1,030	3,414	1,076	3,785

CHSCH: Chloritic Schist

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
No. of missing values	0	0	0	0	0	0	0	0	168	0	168	0	168	168	0	0	0
Minimum	98,000	1,000	0.010	1,000	130,000	2,000	0.010	5,000	1,000	6,000	20,000	0.010	10,000	10,000	3,000	10,000	11,000
Maximum	3760,0	11,000	3.510	310,000	3760,000	958,000	1,550	22,000	40,000	608,000	20,000	1,560	10,000	10,000	464,000	10,000	9310,000
1st Quartile	442,250	1,000	0.190	21,000	300,000	13,000	0.120	5,000	9,000	90,250	20,000	0.190	10,000	10,000	51,000	10,000	66,000
Median	608,500	1,000	0.420	28,500	460,000	19,000	0.245	5,000	13,000	135,000	20,000	0.290	10,000	10,000	76,500	10,000	81,500
3rd Quartile	1098,750	1,000	0.920	47,000	757,500	25,000	0.430	5,000	26,000	222,500	20,000	0.458	10,000	10,000	181,000	10,000	106,750
Mean	1112,356	1,293	0.644	39,595	667,162	31,338	0.336	5,649	17,667	169,590	20,000	0.406	10,000	10,000	121,640	10,000	236,640
Standard deviation (n)	2798,484	1,219	0.632	35,079	637,557	83,559	0.309	2,402	10,490	113,809	0,000	0.327	0,000	0,000	96,623	0,000	910,228
Variation coefficient	2,516	0.943	0.981	0.886	0.956	2.866	0.921	0.425	0.594	0.671	0,000	0.807	0,000	0,000	0.794	0,000	3.846
Skewness (Pearson)	10,772	5,796	1.670	3,483	2,593	8,835	1.546	4,870	0.571	1,440	0,000	1.762	0,000	0,000	1,221	0,000	7,980
Kurtosis (Pearson)	131,027	36,594	3.068	18,273	7,133	85,679	2,249	25,147	-0.806	2,335	0,000	2.511	0,000	0,000	0.545	0,000	68,081
Geometric mean	693,775	1,129	0.372	30,574	499,257	17,040	0.210	5,406	14,181	135,363	20,000	0.315	10,000	10,000	90,610	10,000	95,880
Geometric standard deviation	2,157	1,486	3.300	2,049	2,035	2,567	2.951	1,284	2,114	2,057	1,000	2,007	1,000	1,000	2,178	1,000	2,334

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock
CQTZ1: Calcareous Quartzite

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.010	0.500	0.140	5.000	10.000	0.500	2.000	0.030	0.500	1.000	1.000	1.000	0.340	10.000	0.030	10.000	0.020
Maximum	0.330	34.000	8.780	7480.000	1440.000	2.300	18.000	23.400	118.000	25.000	123.000	157.000	39.600	20.000	2.310	40.000	1.170
1st Quartile	0.010	0.500	0.560	5.000	120.000	0.500	2.000	1.120	0.500	1.000	30.000	4.000	0.670	10.000	0.150	10.000	0.100
Median	0.010	0.500	0.840	8.000	190.000	0.500	2.000	2.340	0.500	1.000	37.000	7.000	0.940	10.000	0.230	10.000	0.170
3rd Quartile	0.010	0.700	1.670	14.000	330.000	0.500	2.000	3.690	1.400	3.000	48.000	12.000	1.600	10.000	0.430	10.000	0.280
Mean	0.015	1.174	1.381	55.457	270.416	0.572	2.149	2.803	5.130	2.420	41.091	11.865	1.543	10.079	0.342	11.604	0.221
Standard deviation (n)	0.020	2.625	1.325	426.054	235.243	0.216	1.095	2.428	15.171	2.801	16.590	15.687	2.736	0.886	0.310	4.494	0.185
Variation coefficient	1.364	2.235	0.960	7.683	0.870	0.377	0.510	0.866	2.957	1.157	0.404	1.322	1.772	0.088	0.906	0.387	0.838
Skewness (Pearson)	9.827	7.763	2.225	14.165	2.073	3.935	10.879	2.100	4.675	4.050	1.573	4.066	10.005	11.102	2.363	3.137	1.990
Kurtosis (Pearson)	127.521	77.007	5.532	219.762	4.827	17.846	132.661	10.402	24.053	22.297	3.527	23.386	120.600	121.258	7.143	10.717	4.874
Geometric mean	0.012	0.702	0.995	10.420	200.740	0.550	2.072	1.707	1.066	1.739	38.060	7.518	1.094	10.055	0.254	11.076	0.165
Geometric standard deviation	1.616	2.070	2.156	2.834	2.156	1.286	1.222	3.349	3.918	2.051	1.523	2.422	1.978	1.063	2.110	1.313	2.175

CSCH: Carcareous Schist

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.010	0.500	1.690	5.000	70.000	0.500	2.000	1.670	0.500	1.000	30.000	5.000	1.080	10.000	0.330	10.000	0.230
Maximum	0.040	5.200	9.470	43.000	1580.000	2.300	2.000	9.560	1.700	32.000	129.000	170.000	7.110	20.000	2.120	40.000	0.950
1st Quartile	0.010	0.500	5.370	8.750	635.000	1.300	2.000	2.510	0.500	6.000	84.500	18.750	2.753	10.000	1.188	20.000	0.518
Median	0.010	0.500	6.955	12.500	910.000	1.700	2.000	3.270	0.500	9.000	101.000	22.000	3.525	15.000	1.365	30.000	0.670
3rd Quartile	0.010	0.800	8.158	18.000	1145.000	2.025	2.000	5.153	0.500	11.000	113.250	26.000	4.758	20.000	1.570	30.000	0.730
Mean	0.011	0.892	6.701	13.889	872.778	1.642	2.000	3.877	0.581	9.056	97.306	25.611	3.732	15.000	1.318	28.889	0.630
Standard deviation (n)	0.005	0.946	1.888	8.144	341.041	0.465	0.000	1.833	0.273	5.060	21.038	25.000	1.265	5.000	0.347	8.089	0.145
Variation coefficient	0.464	1.061	0.282	0.586	0.391	0.283	0.000	0.473	0.470	0.559	0.216	0.976	0.339	0.333	0.264	0.280	0.230
Skewness (Pearson)	5.031	3.332	-0.475	1.589	-0.452	-0.501	-0.501	1.040	3.452	2.339	-0.854	5.315	0.342	0.000	-0.763	-0.425	-0.561
Kurtosis (Pearson)	24.709	10.952	-0.348	3.446	-0.424	-0.553	-0.553	0.728	10.483	9.203	0.882	27.929	-0.205	-2.000	1.229	-0.233	0.329
Geometric mean	0.011	0.696	6.365	11.856	769.205	1.560	2.000	3.495	0.547	7.811	94.376	21.752	3.503	14.142	1.254	27.495	0.610
Geometric standard deviation	1.291	1.797	1.425	1.783	1.835	1.416	1.000	1.581	1.345	1.810	1.314	1.633	1.455	1.421	1.430	1.409	1.317

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock
CQTZ1: Calcareous Quartzite

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	35,000	1,000	0.010	1,000	20,000	2,000	0.010	5,000	1,000	2,000	20,000	0.010	10,000	10,000	5,000	10,000	7,000
Maximum	100000.0	5,000	0.920	61,000	2560,000	5430,000	10,000	158,000	21,000	833,000	20,000	0.410	50,000	20,000	281,000	20,000	9920,000
1st Quartile	117,000	1,000	0.010	4,000	260,000	6,000	0.110	5,000	1,000	40,000	20,000	0.050	10,000	10,000	10,000	10,000	25,000
Median	190,000	1,000	0.020	7,000	320,000	11,000	0.200	5,000	2,000	73,000	20,000	0.070	10,000	10,000	17,000	10,000	49,000
3rd Quartile	588,000	1,000	0.060	12,000	480,000	40,000	0.390	5,000	3,000	118,000	20,000	0.110	10,000	10,000	32,000	10,000	174,000
Mean	1870.836	1.071	0.051	9.754	385.723	87.727	0.322	6.083	2.721	88.693	20,000	0.091	10.119	10.040	27.323	10.020	471.089
Standard deviation (n)	7831.206	0.392	0.075	8.722	232.342	347.706	0.540	7.805	2.713	74.702	0.000	0.066	1.987	0.628	28.799	0.445	1333.664
Variation coefficient	4.186	0.366	1.476	0.894	0.602	3.964	1.675	1.283	0.987	0.842	0.000	0.729	0.196	0.063	1.054	0.044	2.831
Skewness (Pearson)	9.784	6.769	5.503	2.186	3.892	10.583	12.159	15.574	2.531	2.771		2.144	18.007	15.796	3.182	22.405	4.486
Kurtosis (Pearson)	109.803	52.174	46.785	6.110	29.707	138.119	204.227	285.899	7.934	19.350		5.209	338.532	247.504	15.908	500.002	22.145
Geometric mean	322.932	1.040	0.030	7.003	335.889	16.960	0.205	5.439	1.968	59.764	20,000	0.075	10.054	10.027	19.128	10.014	81.499
Geometric standard deviation	4.555	1.221	2.608	2.303	1.713	4.671	2.534	1.375	2.104	2.791	1.000	1.809	1.090	1.045	2.224	1.031	5.057

CSCH: Carcareous Schist

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	96,000	1,000	0.020	11,000	410,000	8,000	0.180	5,000	3,000	76,000	20,000	0.080	10,000	10,000	28,000	10,000	54,000
Maximum	1620,000	2,000	0.390	58,000	1340,000	335,000	2.590	8,000	33,000	420,000	20,000	0.500	10,000	10,000	312,000	10,000	224,000
1st Quartile	172,000	1,000	0.158	31,000	797,500	16,000	0.278	5,000	9,000	224,750	20,000	0.278	10,000	10,000	100,250	10,000	95,250
Median	254,500	1,000	0.270	42,500	975,000	19,000	0.460	5,000	12,000	263,500	20,000	0.325	10,000	10,000	128,000	10,000	110,500
3rd Quartile	302,000	1,000	0.350	51,000	1142,500	25,250	1.163	5,000	15,250	310,750	20,000	0.393	10,000	10,000	148,750	10,000	133,000
Mean	293.333	1.083	0.250	40.583	961.111	31.278	0.773	5.389	12.611	269.472	20,000	0.325	10,000	10,000	124.111	10,000	115.944
Standard deviation (n)	250.705	0.276	0.101	11.762	219.959	54.226	0.700	0.859	4.957	71.828	0.000	0.092	0.000	0.000	45.671	0.000	33.184
Variation coefficient	0.855	0.255	0.403	0.290	0.229	1.734	0.905	0.159	0.393	0.267	0.000	0.284	0.000	0.000	0.368	0.000	0.286
Skewness (Pearson)	4.154	3.015	-0.456	-0.508	-0.183	4.982	1.273	2.056	1.638	-0.016		-0.156			1.545		1.262
Kurtosis (Pearson)	18.979	7.091	-0.943	-0.560	-0.628	24.534	0.257	2.826	5.687	0.144		-0.057			5.868		2.331
Geometric mean	246.708	1.059	0.219	38.445	933.471	21.334	0.544	5.332	11.708	258.381	20,000	0.309	10,000	10,000	115.922	10,000	111.692
Geometric standard deviation	1.695	1.214	1.855	1.435	1.289	1.927	2.266	1.152	1.499	1.369	1.000	1.416	1.000	1.000	1.483	1.000	1.316

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

GNST: Greenstone

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	567	567	567	567	567	567	567	567	567	567	567	567	567	567	567	567	567
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	0	86
Minimum	0.010	0.500	1.910	5.000	10.000	0.500	2.000	0.220	0.500	1.000	1.000	1.000	1.190	10.000	0.010	10.000	0.290
Maximum	0.460	79.400	13.900	518.000	6790.000	4.100	9.000	10.800	64.200	59.000	511.000	753.000	17.150	40.000	6.360	60.000	5.430
1st Quartile	0.010	0.500	7.105	5.000	80.000	0.500	2.000	5.360	0.500	33.000	26.500	142.000	7.450	20.000	0.120	10.000	2.395
Median	0.010	0.500	7.930	6.000	140.000	0.500	2.000	7.080	0.500	39.000	98.000	173.000	8.220	20.000	0.180	10.000	3.300
3rd Quartile	0.010	0.700	8.405	13.000	355.000	0.800	2.000	7.745	0.500	41.000	163.500	209.500	9.380	20.000	0.430	10.000	3.935
Mean	0.015	1.838	7.659	14.062	426.420	0.756	2.235	6.378	2.822	35.880	101.637	184.501	8.565	18.420	0.505	10.769	3.104
Standard deviation (n)	0.029	6.608	1.147	30.185	780.456	0.506	0.902	1.934	8.333	8.936	80.624	104.769	2.289	4.373	0.800	4.329	1.034
Variation coefficient	1.949	3.595	0.150	2.147	1.830	0.689	0.404	0.303	2.952	0.249	0.793	0.568	0.267	0.237	1.584	0.402	0.333
Skewness (Pearson)	11.703	8.003	-0.888	11.082	3.616	3.094	4.733	-1.236	4.512	-1.382	0.913	1.884	0.490	-0.609	2.881	7.481	-0.561
Kurtosis (Pearson)	157.542	74.100	3.672	159.431	15.616	11.719	24.501	1.033	21.022	2.111	1.853	6.167	1.199	1.913	9.756	63.752	-0.395
Geometric mean	0.012	0.728	7.556	8.837	179.005	0.666	2.144	5.828	0.805	34.020	52.273	152.271	8.239	17.782	0.226	10.425	2.862
Geometric standard deviation	1.580	2.371	1.192	2.151	3.365	1.561	1.276	1.702	3.027	1.479	4.751	2.128	1.340	1.327	3.404	1.229	1.578

GSCH: Graphitic Schist

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	870	870	870	870	870	870	870	870	870	870	870	870	870	870	870	870	870
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	747	0	747
Minimum	0.010	0.500	0.150	5.000	20.000	0.500	2.000	0.030	0.500	1.000	5.000	2.000	0.120	10.000	0.010	10.000	0.030
Maximum	0.470	13.900	11.250	812.000	6400.000	2.900	6.000	22.400	62.600	75.000	1240.000	246.000	10.300	30.000	3.730	40.000	12.450
1st Quartile	0.010	0.500	3.625	6.000	680.000	0.900	2.000	0.290	0.500	6.000	56.000	24.000	2.190	10.000	0.670	20.000	0.380
Median	0.010	0.500	5.115	11.000	1020.000	1.300	2.000	0.480	0.500	8.000	73.000	34.000	2.840	20.000	1.055	20.000	0.520
3rd Quartile	0.010	0.600	6.448	18.000	1330.000	1.600	2.000	1.018	0.800	11.000	91.000	45.000	3.460	20.000	1.490	30.000	0.710
Mean	0.013	0.719	5.110	16.957	1059.103	1.302	2.103	0.928	0.913	8.761	78.548	36.929	2.930	15.610	1.133	24.797	0.647
Standard deviation (n)	0.024	0.877	2.039	35.156	573.826	0.493	0.413	1.481	2.639	4.775	54.600	20.041	1.122	6.001	0.593	9.401	0.785
Variation coefficient	1.771	1.220	0.399	2.073	0.542	0.378	0.197	1.596	2.892	0.545	0.695	0.543	0.383	0.384	0.523	0.379	1.213
Skewness (Pearson)	14.481	8.267	0.172	15.427	2.103	0.410	4.895	7.740	17.150	4.078	12.623	2.431	1.185	0.555	0.767	0.147	9.697
Kurtosis (Pearson)	230.865	89.899	-0.090	313.348	11.633	-0.086	27.688	92.360	359.523	45.057	243.700	15.907	4.355	-0.611	0.560	-0.880	122.155
Geometric mean	0.011	0.601	4.603	11.662	913.060	1.204	2.077	0.562	0.655	7.694	71.260	32.220	2.714	14.513	0.967	22.829	0.517
Geometric standard deviation	1.456	1.565	1.670	2.062	1.806	1.509	1.154	2.522	1.690	1.713	1.514	1.727	1.514	1.465	1.856	1.534	1.838

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

GNST: Greenstone

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	567		567	567	567	567	567	567	567	567	567	567	567	567	567	567	567
No. of missing values	0	0	0	0	0	0	0	0	0	86	0	86	0	86	0	0	0
Minimum	144.000	1.000	0.010	1.000	320.000	2.000	0.010	5.000	7.000	2.000	20.000	0.130	10.000	10.000	25.000	10.000	45.000
Maximum	50400.000	6.000	4.250	190.000	4270.000	3540.000	1.830	83.000	45.000	823.000	20.000	2.380	30.000	20.000	1070.000	60.000	7110.000
1st Quartile	1257.500	1.000	0.875	42.000	530.000	2.000	0.010	5.000	32.000	187.500	20.000	0.760	10.000	10.000	272.000	10.000	90.000
Median	1440.000	1.000	1.430	74.000	630.000	5.000	0.030	5.000	35.000	215.000	20.000	0.890	10.000	10.000	300.000	10.000	111.000
3rd Quartile	1842.500	1.000	1.620	100.000	790.000	15.500	0.070	8.000	37.000	246.000	20.000	1.075	10.000	10.000	339.000	10.000	158.000
Mean	2952.674	1.131	1.259	70.783	822.011	94.605	0.082	8.187	33.994	220.056	20.000	0.975	10.187	10.125	312.614	10.141	357.774
Standard deviation (n)	5798.270	0.542	0.637	35.924	573.017	352.846	0.174	8.126	5.160	98.212	0.000	0.372	1.501	1.110	135.399	2.296	864.728
Variation coefficient	1.964	0.479	0.506	0.508	0.697	3.730	2.133	0.993	0.152	0.446	0.000	0.381	0.147	0.110	0.433	0.226	2.417
Skewness (Pearson)	5.059	5.878	-0.178	-0.038	3.002	6.210	5.235	5.646	-2.009	1.839		1.199	8.852	8.785	2.120	19.344	4.514
Kurtosis (Pearson)	27.728	41.556	0.869	-0.551	10.055	45.682	35.203	40.557	6.264	9.131		1.645	86.786	75.179	8.383	389.743	21.568
Geometric mean	1771.247	1.075	0.882	55.405	716.882	9.080	0.033	6.825	33.429	190.137	20.000	0.910	10.124	10.087	284.544	10.063	154.935
Geometric standard deviation	2.129	1.299	3.249	2.471	1.587	5.724	3.232	1.645	1.228	2.019	1.000	1.461	1.102	1.080	1.606	1.097	2.581

GSCH: Graphitic Schist

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	870		870	870	870	870	870	870	870	870	870	870	870	870	870	870	870
No. of missing values	0	0	0	0	0	0	0	0	0	747	0	747	0	747	0	0	0
Minimum	53.000	1.000	0.010	1.000	20.000	2.000	0.010	5.000	2.000	11.000	20.000	0.010	10.000	10.000	3.000	10.000	6.000
Maximum	15600.000	28.000	2.510	1580.000	3810.000	1310.000	3.370	33.000	33.000	485.000	20.000	0.760	10.000	10.000	552.000	20.000	4880.000
1st Quartile	151.000	1.000	0.140	30.000	370.000	11.000	0.400	5.000	8.000	80.000	20.000	0.190	10.000	10.000	75.000	10.000	67.000
Median	244.000	1.000	0.220	42.000	535.000	15.000	0.720	5.000	11.000	102.000	20.000	0.260	10.000	10.000	123.500	10.000	101.000
3rd Quartile	399.750	2.000	0.290	52.000	670.000	20.000	1.038	5.000	15.000	145.000	20.000	0.330	10.000	10.000	205.000	10.000	152.750
Mean	418.795	1.676	0.236	46.423	555.480	22.275	0.754	5.669	11.553	120.784	20.000	0.262	10.000	10.000	143.371	10.011	130.859
Standard deviation (n)	996.016	1.842	0.177	60.768	272.789	67.275	0.490	2.151	5.009	62.998	0.000	0.103	0.000	0.000	84.742	0.339	213.051
Variation coefficient	2.378	1.099	0.752	1.309	0.491	3.020	0.649	0.379	0.434	0.522	0.000	0.392	0.000	0.000	0.591	0.034	1.628
Skewness (Pearson)	11.116	6.952	5.977	18.999	2.839	13.184	1.158	5.465	0.654	1.719		0.697			0.809	29.445	15.240
Kurtosis (Pearson)	145.124	69.671	64.630	448.608	24.065	201.916	2.915	42.552	1.273	4.138		1.667			0.485	865.001	300.393
Geometric mean	266.091	1.364	0.195	38.955	499.526	14.695	0.568	5.460	10.384	107.480	20.000	0.240	10.000	10.000	117.620	10.008	100.874
Geometric standard deviation	2.134	1.699	1.908	1.733	1.606	1.910	2.433	1.267	1.638	1.619	1.000	1.579	1.000	1.000	1.964	1.024	1.900

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

PHY: Phyllite

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.010	0.500	3.920	5.000	400.000	0.800	2.000	0.040	0.500	1.000	56.000	6.000	1.720	10.000	0.620	20.000	0.160
Maximum	0.030	7.840	7.840	15.000	1630.000	1.800	2.000	2.990	4.800	8.000	95.000	36.000	3.240	20.000	1.440	30.000	0.610
1st Quartile	0.010	0.500	4.060	5.000	860.000	1.000	2.000	0.050	0.500	2.000	58.000	13.000	2.060	10.000	0.760	20.000	0.260
Median	0.020	0.500	4.270	7.000	1060.000	1.400	2.000	0.050	0.500	4.000	67.000	14.000	2.180	10.000	0.800	20.000	0.320
3rd Quartile	0.030	0.500	6.050	8.000	1280.000	1.500	2.000	0.580	0.600	5.000	74.000	15.000	2.670	20.000	1.030	20.000	0.540
Mean	0.020	0.540	5.228	8.000	1046.000	1.300	2.000	0.742	1.380	4.000	70.000	16.800	2.374	14.000	0.930	22.000	0.378
Standard deviation (n)	0.009	0.080	1.516	3.688	411.806	0.358	0.000	1.143	1.710	2.449	14.071	10.107	4.899	0.529	0.287	4.000	0.170
Variation coefficient	0.447	0.148	0.290	0.461	0.394	0.275	0.000	1.540	1.239	0.612	0.201	0.602	0.223	0.350	0.309	0.182	0.450
Skewness (Pearson)	0.000	1.500	0.784	1.148	-0.183	-0.079	0.000	1.386	1.498	0.408	0.803	1.111	0.482	0.408	0.818	1.500	0.184
Kurtosis (Pearson)	-1.750	0.250	-1.007	-0.228	-0.951	-1.354		0.077	0.247	-1.033	-0.704	-0.130	-1.055	-1.833	-0.699	0.250	-1.559
Geometric mean	0.018	0.535	5.031	7.319	946.787	1.248	2.000	0.177	0.815	3.170	68.696	14.260	2.317	13.195	0.890	21.689	0.338
Geometric standard deviation	1.739	1.162	1.353	1.571	1.710	1.387	1.000	6.849	2.703	2.281	1.238	1.889	1.277	1.462	1.383	1.199	1.729

QTZT: Quartzite

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	890	0
Minimum	0.010	0.500	0.130	5.000	10.000	0.500	2.000	0.010	0.500	1.000	3.000	1.000	0.230	10.000	0.010	10.000	0.010
Maximum	3.160	90.700	10.350	10000.000	3650.000	2.500	27.000	12.550	120.000	42.000	223.000	933.000	30.800	30.000	3.690	40.000	3.440
1st Quartile	0.010	0.500	0.560	5.000	100.000	0.500	2.000	0.300	0.500	1.000	35.000	6.000	0.780	10.000	0.150	10.000	0.090
Median	0.010	0.500	1.210	9.000	230.000	0.500	2.000	0.990	0.500	2.000	42.000	9.000	1.270	10.000	0.310	10.000	0.180
3rd Quartile	0.010	1.000	2.530	20.000	490.000	0.700	2.000	2.260	2.900	4.000	54.000	18.000	2.070	10.000	0.590	10.000	0.320
Mean	0.018	1.664	1.812	64.542	357.965	0.644	2.115	1.530	5.618	3.257	46.896	15.972	1.669	10.183	0.427	11.973	0.242
Standard deviation (n)	0.079	4.595	1.659	454.399	365.606	0.295	0.933	1.604	13.906	3.457	18.223	25.754	1.573	1.371	0.374	4.804	0.252
Variation coefficient	4.468	2.761	0.916	7.040	1.021	0.457	0.441	1.048	2.475	1.061	0.389	1.612	0.943	0.135	0.875	0.401	1.041
Skewness (Pearson)	28.757	9.729	1.547	16.451	2.196	2.531	17.485	1.667	4.085	3.798	1.942	16.485	5.965	7.664	1.907	2.641	4.223
Kurtosis (Pearson)	978.856	130.082	2.162	319.028	7.894	6.823	392.334	3.490	18.925	24.449	8.973	509.926	69.479	61.036	5.421	7.378	34.123
Geometric mean	0.012	0.826	1.224	12.715	217.393	0.601	2.063	0.753	1.291	2.277	43.965	10.300	1.299	10.127	0.301	11.354	0.157
Geometric standard deviation	1.680	2.392	2.457	3.185	2.910	1.399	1.185	4.072	4.277	2.231	1.425	2.397	1.967	1.098	2.369	1.342	2.713

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

PHY: Phyllite

Statistic	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sc ppm	Sr ppm	Th ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
No. of observations	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	110.000	1.000	0.220	14.000	300.000	5.000	0.020	5.000	6.000	55.000	20.000	0.150	10.000	10.000	65.000	10.000	40.000
Maximum	509.000	13.000	1.020	66.000	520.000	18.000	0.840	8.000	12.000	216.000	20.000	0.350	10.000	10.000	613.000	10.000	463.000
1st Quartile	159.000	1.000	0.260	22.000	380.000	9.000	0.020	5.000	7.000	90.000	20.000	0.210	10.000	10.000	83.000	10.000	53.000
Median	194.000	2.000	0.340	23.000	460.000	15.000	0.030	6.000	7.000	125.000	20.000	0.260	10.000	10.000	112.000	10.000	66.000
3rd Quartile	210.000	2.000	0.460	23.000	470.000	16.000	0.090	8.000	10.000	164.000	20.000	0.280	10.000	10.000	156.000	10.000	97.000
Mean	236.400	3.800	0.460	29.600	426.000	12.600	0.200	6.400	8.400	130.000	20.000	0.250	10.000	10.000	205.800	10.000	143.800
Standard deviation (n)	140.551	4.622	0.292	18.511	77.356	4.841	0.321	1.356	2.245	56.217	0.000	0.067	0.000	0.000	205.910	0.000	160.718
Variation coefficient	0.595	1.216	0.634	0.625	0.182	0.384	1.605	0.212	0.267	0.432	0.000	0.269	0.000	0.000	1.001	0.000	1.118
Skewness (Pearson)	1.273	1.465	1.225	1.369	-0.494	-0.485	1.476	0.212	0.556	0.213	0.000	-0.024	0.000	0.000	1.419	0.000	1.449
Kurtosis (Pearson)	-0.019	0.203	-0.144	0.104	-1.103	-1.354	0.216	-1.770	-1.304	-1.193	0.000	-1.009	0.000	0.000	0.137	0.000	0.180
Geometric mean	205.072	2.204	0.391	25.486	418.363	11.422	0.062	6.258	8.119	116.994	20.000	0.240	10.000	10.000	142.023	10.000	91.127
Geometric standard deviation	1.762	2.860	1.831	1.771	1.243	1.703	4.868	1.266	1.334	1.703	1.000	1.378	1.000	1.000	2.413	1.000	2.624

QTZT: Quartzite

Statistic	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	S %	Sb ppm	Sc ppm	Sr ppm	Th ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
No. of observations	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293
No. of missing values	0	0	0	0	0	0	0	0	0	890	0	890	0	890	0	0	0
Minimum	17.000	1.000	0.010	1.000	20.000	2.000	0.010	5.000	1.000	1.000	20.000	0.010	10.000	10.000	2.000	10.000	2.000
Maximum	86200.000	24.000	2.120	101.000	3170.000	8970.000	5.820	208.000	36.000	428.000	20.000	1.040	20.000	10.000	663.000	290.000	9950.000
1st Quartile	128.000	1.000	0.010	5.000	200.000	7.000	0.140	5.000	1.000	20.000	20.000	0.060	10.000	10.000	11.000	10.000	33.000
Median	242.000	1.000	0.040	9.000	310.000	13.000	0.310	5.000	2.000	57.000	20.000	0.090	10.000	10.000	24.000	10.000	68.000
3rd Quartile	1105.000	1.000	0.100	18.000	450.000	81.000	0.550	5.000	4.000	102.000	20.000	0.150	10.000	10.000	49.000	10.000	305.000
Mean	1739.010	1.220	0.072	13.777	345.333	138.784	0.410	6.470	3.074	69.702	20.000	0.116	10.012	10.000	37.105	10.173	479.543
Standard deviation (n)	4816.526	1.081	0.099	13.068	225.845	455.294	0.419	8.727	3.269	59.704	0.000	0.086	0.353	0.000	39.992	5.349	1138.569
Variation coefficient	2.770	0.886	1.377	0.949	0.654	3.281	1.021	1.349	1.063	0.857	0.000	0.742	0.035	0.000	1.078	0.526	2.374
Skewness (Pearson)	7.937	9.942	6.474	1.906	2.831	8.932	3.447	14.091	3.607	1.276	0.000	2.717	28.249	0.000	3.317	45.745	4.009
Kurtosis (Pearson)	96.369	136.359	89.170	4.556	21.927	113.042	24.473	254.601	21.444	2.185	0.000	15.402	796.001	0.000	25.434	2305.978	18.385
Geometric mean	404.231	1.102	0.040	9.028	281.801	23.424	0.243	5.631	2.160	43.056	20.000	0.093	10.009	10.000	23.253	10.045	106.123
Geometric standard deviation	4.694	1.405	2.965	2.638	1.965	5.633	3.323	1.442	2.201	3.088	1.000	1.918	1.025	1.000	2.687	1.098	4.985

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

SCH: Schist

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147	0	0
Minimum	0.010	0.500	0.170	5.000	10.000	0.500	2.000	0.020	0.500	1.000	3.000	2.000	0.130	10.000	0.010	10.000	0.050
Maximum	0.300	23.400	11.150	3150.000	3400.000	3.700	6.000	21.100	24.500	41.000	247.000	256.000	10.350	30.000	3.850	50.000	11.750
1st Quartile	0.010	0.500	3.375	6.000	570.000	0.900	2.000	0.440	0.500	5.000	53.000	19.000	2.150	10.000	0.630	10.000	0.350
Median	0.010	0.500	5.030	10.000	900.000	1.200	2.000	0.900	0.500	8.000	70.000	28.000	2.770	10.000	0.950	20.000	0.510
3rd Quartile	0.010	0.600	6.625	16.000	1225.000	1.600	2.000	1.980	0.500	11.000	88.000	40.000	3.645	20.000	1.450	30.000	0.720
Mean	0.014	0.750	5.104	26.644	948.194	1.287	2.065	1.516	0.968	8.467	72.916	33.837	2.994	13.854	1.078	22.325	0.621
Standard deviation (n)	0.016	1.159	2.241	141.371	523.324	0.550	0.306	1.768	2.321	5.044	27.137	25.205	1.325	5.275	0.566	9.544	0.620
Variation coefficient	1.105	1.546	0.439	5.306	0.552	0.428	0.148	1.159	2.396	0.596	0.372	0.745	0.443	0.381	0.544	0.428	0.999
Skewness (Pearson)	10.440	12.214	0.194	16.491	1.090	0.559	6.175	3.508	7.092	2.595	1.042	3.095	1.361	0.890	0.842	0.357	9.184
Kurtosis (Pearson)	155.092	202.576	-0.591	326.764	2.292	0.031	50.066	23.237	54.451	12.634	3.098	15.696	3.723	-0.368	0.609	-0.610	139.164
Geometric mean	0.012	0.609	4.515	11.341	790.979	1.167	2.049	0.913	0.621	7.225	67.999	27.656	2.722	12.984	0.908	20.175	0.505
Geometric standard deviation	1.543	1.591	1.723	2.285	1.976	1.579	1.116	2.827	1.821	1.808	1.474	1.882	1.570	1.419	1.930	1.594	1.820

SSCH: Serfetic Schist

Statistic	Au_ppm	Ag_ppm	Al_%	As_ppm	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Co_ppm	Cr_ppm	Cu_ppm	Fe_%	Ga_ppm	K_%	La_ppm	Mg_%
No. of observations	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205	205
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0
Minimum	0.010	0.500	0.390	5.000	30.000	0.500	2.000	0.150	0.500	3.000	12.000	5.000	0.920	10.000	0.130	10.000	0.130
Maximum	0.080	38.800	10.300	390.000	7620.000	3.200	6.000	20.500	144.000	40.000	203.000	276.000	9.300	30.000	4.570	40.000	4.530
1st Quartile	0.010	0.500	5.140	5.000	630.000	1.100	2.000	0.730	0.500	9.000	40.000	22.000	2.510	10.000	1.300	10.000	0.770
Median	0.010	0.500	6.310	6.000	860.000	1.400	2.000	1.720	0.500	12.000	51.000	35.000	3.150	10.000	2.020	20.000	0.890
3rd Quartile	0.010	0.500	7.280	15.000	1240.000	1.700	2.000	4.150	0.500	15.000	68.000	63.000	3.950	20.000	2.460	30.000	1.190
Mean	0.012	0.970	6.133	19.166	1179.171	1.421	2.337	2.814	2.349	13.273	61.249	49.249	3.476	14.000	1.911	20.182	1.133
Standard deviation (n)	0.008	2.894	1.597	44.867	1110.368	0.487	0.843	2.769	11.776	7.068	33.008	41.080	1.384	5.257	0.827	9.998	0.722
Variation coefficient	0.662	2.983	0.260	2.341	0.942	0.343	0.361	0.984	5.013	0.532	0.539	0.834	0.398	0.376	0.433	0.495	0.637
Skewness (Pearson)	6.031	11.323	-0.323	6.119	3.057	0.390	2.912	2.090	10.087	1.500	1.876	2.206	1.330	0.781	-0.101	0.509	2.253
Kurtosis (Pearson)	41.772	140.897	0.408	42.234	11.645	0.561	8.280	7.633	109.756	2.139	3.839	6.423	1.829	-0.616	-0.259	-0.947	5.499
Geometric mean	0.011	0.619	5.861	9.666	887.065	1.331	2.240	1.739	0.700	11.747	54.644	37.634	3.240	13.126	1.656	17.767	0.979
Geometric standard deviation	1.378	1.819	1.408	2.473	2.097	1.462	1.300	2.834	2.497	1.633	1.590	2.057	1.449	1.424	1.866	1.674	1.686

APPENDIX C1-1 Bellekeno Waste Rock Drillhole Database
Summary Statistics

Bellekeno Non-Mineralized Rock

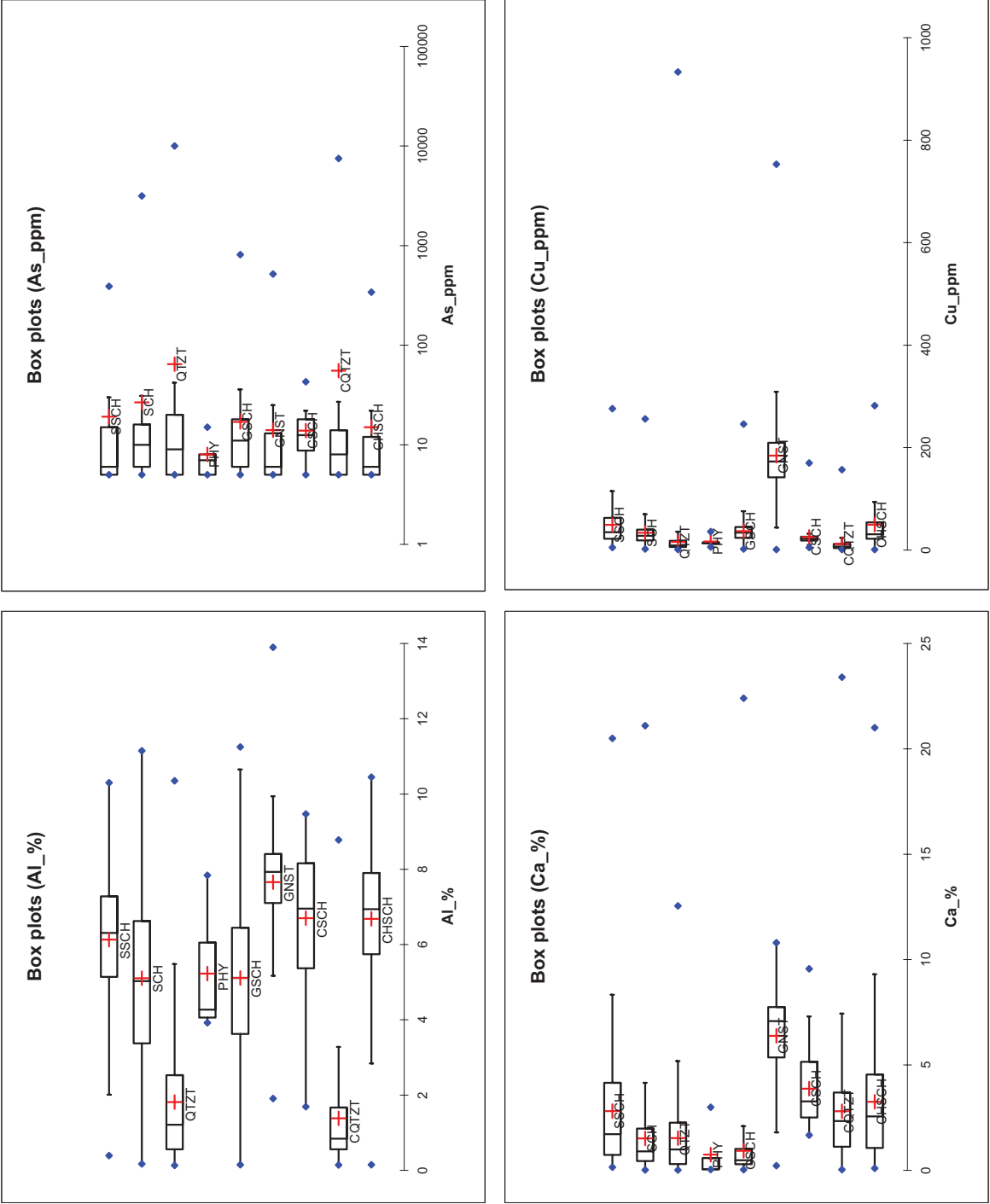
SCH: Schist

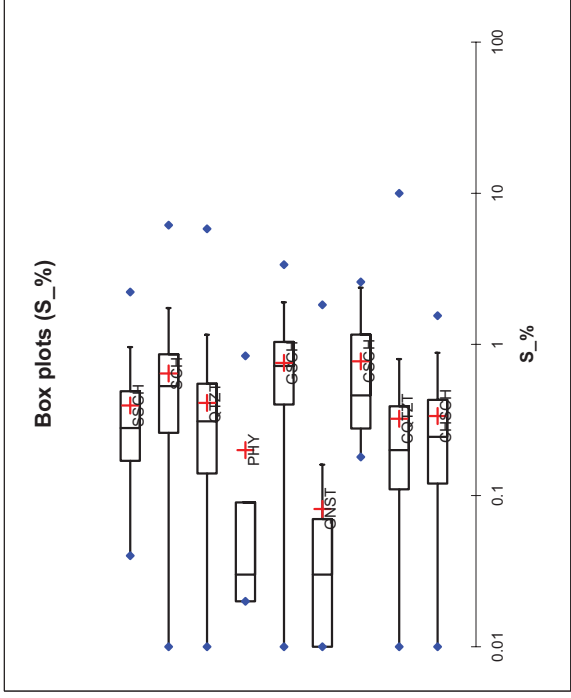
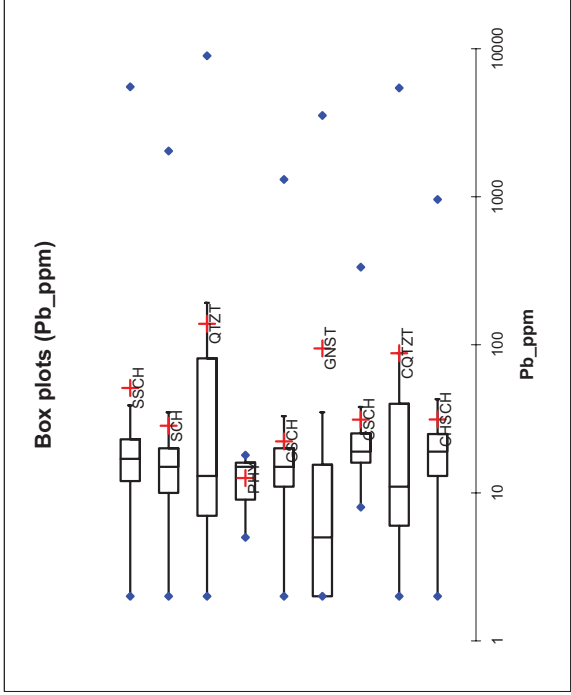
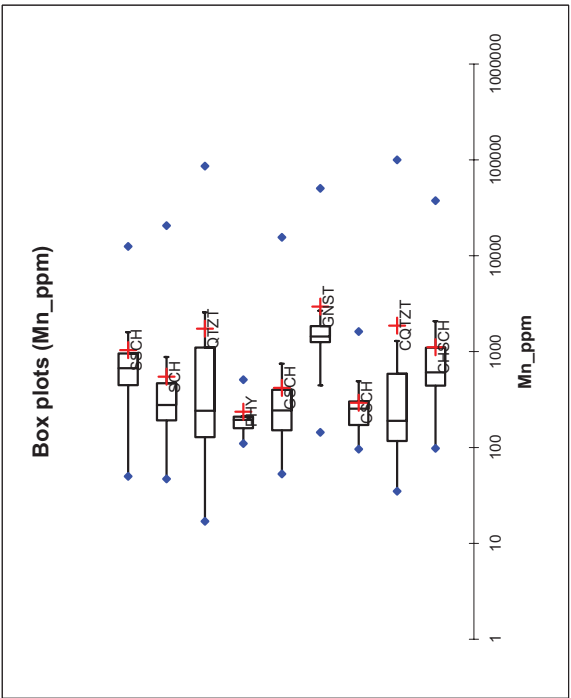
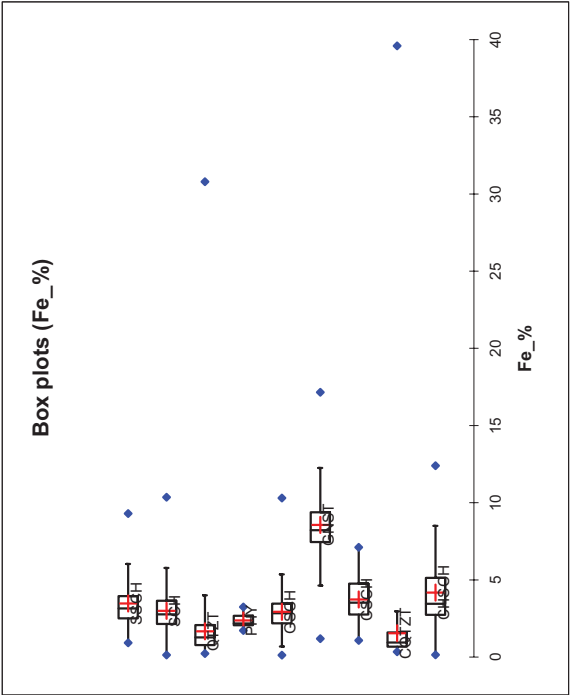
Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	775		775	775		775	775		775	775		775	775		775		775
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	47,000	1,000	0.010	1,000	80,000	2,000	0.010	5,000	1,000	9,000	20,000	0.010	10,000	10,000	2,000	10,000	10,000
Maximum	20600.000	18,000	2.800	194,000	4670.000	2040.000	6.160	30,000	36,000	734,000	20,000	1.390	10,000	10,000	1620.000	20,000	2030.000
1st Quartile	192,000	1,000	0.120	26,000	360,000	10,000	0.260	5,000	7,000	88,000	20,000	0.170	10,000	10,000	66,000	10,000	62,500
Median	278,000	1,000	0.200	36,000	510,000	15,000	0.530	5,000	10,000	133,000	20,000	0.230	10,000	10,000	100,000	10,000	89,000
3rd Quartile	469,000	1,000	0.290	49,000	740,000	20,000	0.860	5,000	13,000	193,000	20,000	0.300	10,000	10,000	141,000	10,000	121,000
Mean	547,116	1,578	0.237	38,418	595,548	28,414	0.643	5,845	10,167	149,275	20,000	0.246	10,000	10,000	112,997	10,013	126,310
Standard deviation (n)	1334,902	1,668	0.202	17,679	362,697	95,595	0.549	2,286	5,048	83,232	0,000	0.117	0,000	0,000	92,314	0,359	192,656
Variation coefficient	2.440	1.057	0.851	0.460	0.609	3.364	0.854	0.391	0.496	0.558	0,000	0.476	0,000	0,000	0.817	0.036	1.525
Skewness (Pearson)	9.591	5.086	4.566	1.316	3.257	14.281	2.580	4.502	1.383	1.650		2.845			8.819	27.785	6.429
Kurtosis (Pearson)	110.925	32.525	40.361	7.531	24.796	264.957	14.955	28.329	4.624	5.503		19.405			127.369	770.001	46.655
Geometric mean	321,727	1,285	0.185	34,065	515,980	15,259	0.439	5,598	8,904	129,021	20,000	0.223	10,000	10,000	94,002	10,009	91,737
Geometric standard deviation	2,250	1,680	2.049	1,718	1,698	2,253	2.709	1,295	1,743	1,742	1,000	1.585	1,000	1,000	1,852	1,025	1,935

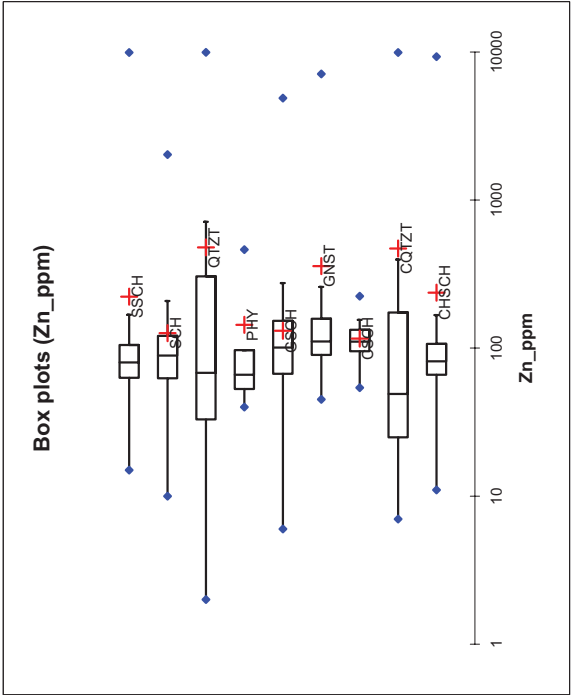
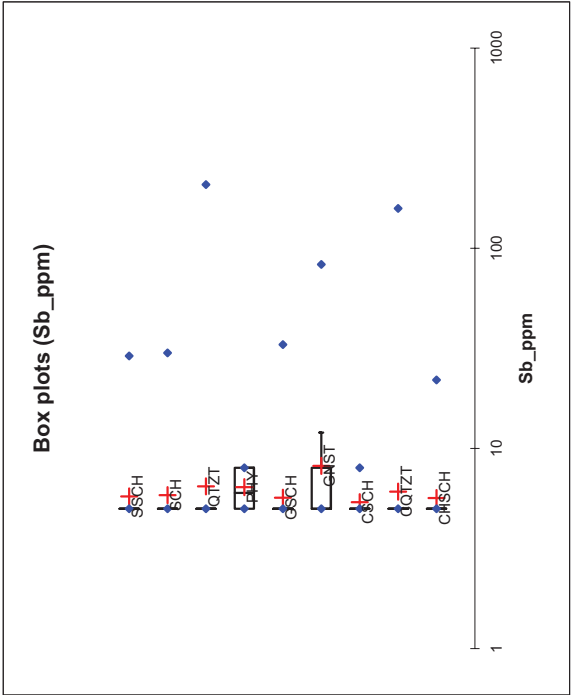
SSCH: Serfclitic Schist

Statistic	Mn_ppm	Mo_ppm	Na_%	Ni_ppm	P_ppm	Pb_ppm	S_%	Sb_ppm	Sc_ppm	Sr_ppm	Th_ppm	Ti_%	Tl_ppm	U_ppm	V_ppm	W_ppm	Zn_ppm
No. of observations	205		205	205		205	205		205	205		205	205		205		205
No. of missing values	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	50,000	1,000	0.010	4,000	70,000	2,000	0.040	5,000	1,000	4,000	20,000	0.040	10,000	10,000	8,000	10,000	15,000
Maximum	12500.000	22,000	2.090	189,000	1770.000	5530.000	2.220	29,000	31,000	852,000	20,000	0.890	10,000	10,000	1185,000	10,000	9920.000
1st Quartile	447,000	1,000	0.130	20,000	280,000	12,000	0.170	5,000	9,000	80,000	20,000	0.180	10,000	10,000	50,000	10,000	63,000
Median	673,000	1,000	0.330	29,000	360,000	17,000	0.280	5,000	12,000	122,000	20,000	0.220	10,000	10,000	70,000	10,000	80,000
3rd Quartile	958,000	1,000	0.650	47,000	530,000	23,000	0.490	5,000	21,000	218,000	20,000	0.300	10,000	10,000	106,000	10,000	105,000
Mean	1036,268	1,707	0.424	35,673	454,732	51,127	0.394	5,756	14,582	164,707	20,000	0.268	10,000	10,000	107,756	10,000	222,317
Standard deviation (n)	1434,008	2,815	0.361	22,706	289,938	385,087	0.357	2,594	7,852	125,104	0,000	0.146	0,000	0,000	135,084	0,000	876,379
Variation coefficient	1.384	1.649	0.852	0.636	0.638	7.532	0.905	0.451	0.539	0.760	0,000	0.543	0,000	0,000	1.254	0,000	3.942
Skewness (Pearson)	5.039	5.308	1.389	2.191	2,210	14,050	2.255	5,530	0.777	2.130		1.978			4.730		9.057
Kurtosis (Pearson)	29.977	29,547	2.585	9.525	5,786	196,885	5.960	37,561	-0.603	6.748		4.374			28,044		88,025
Geometric mean	714,813	1,228	0.277	30,007	391,532	17,511	0.286	5,489	12,459	129,108	20,000	0.239	10,000	10,000	77,174	10,000	92,981
Geometric standard deviation	2,158	1,780	2.777	1,810	1,682	2,314	2.238	1,298	1,842	2,052	1,000	1.602	1,000	1,000	2,069	1,000	2,346

Bellekeno Non-Mineralized Rock









**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX D
TYPICAL WASTE CONTAINMENT FACILITY DESIGN
KENO HILL SILVER DISTRICT, YT
CONSTRUCTION SPECIFICATIONS
ISSUED FOR USE**

July 2008

Prepared by: EBA Engineering Consultants Ltd.

Alexco Resource Canada Corp.

TYPICAL WASTE CONTAINMENT FACILITY DESIGN
KENO HILL SILVER DISTRICT, YT
CONSTRUCTION SPECIFICATIONS
ISSUED FOR USE

W14101142

July 2008



TABLE OF CONTENTS

<u>Section</u>		<u>Number of Pages</u>
Section 1001	Definitions	1
Section 1002	General	2
Section 1003	Fill Materials	2
Section 1004	Fill Placement	2
Section 1005	Liner System	11
Section 1006	Quality Assurance	5
Section 1007	Design Alternatives	2
Section 1008	Operation and Maintenance	2

APPENDICES

Appendix A Construction Drawings



Section 1001

DEFINITIONS

DEFINITIONS

1.0 General

- .1 Definitions of terms used throughout the Construction Specifications are presented in this Section.

2.0 Definitions

Construction Drawings:	the drawings, as issued for construction, of the Typical Waste Containment Facility Design.
Construction Specifications:	this document.
Contract:	the legal and binding agreement between the Contractor and Alexco Resource Corp. regarding construction of the Waste Containment Facility.
Contractor:	the general contractor responsible for constructing the Waste Containment Facility.
Engineer:	the Professional Geotechnical Engineer registered in the Yukon who is associated with the construction process.
Owner:	Alexco Resource Corp.
Site:	the area in which construction of the Waste Containment Facility or related activity is occurring.
Unsuitable:	not meeting the requirements stated herein or not receiving the Engineer's approval.
Facility:	all components of the Waste Containment Facility.

END OF SECTION



Section 1002

GENERAL

GENERAL

1.0 General

- .1 Alexco Resource Canada Corp. intends to construct a containment facility to store waste rock from the Bellekeno advanced underground exploration and development program. As the company advances through the Keno Hill Silver District, it is anticipated further underground exploration and development programs will require similar containment facilities. Therefore, a typical design has been developed to account for the various potential site and construction material conditions.
- .2 The Facility is to be located within previously disturbed areas, all of which will be incorporated within a district wide closure plan. This district wide closure plan is required under the water license QZ06-074.
- .3 Site specific conditions and Facility location have not been provided or considered. Once Facility location and site specific conditions are known, they must be reviewed by the Engineer. Furthermore, the base of the Facility must be approved by the Engineer prior to fill placement.
- .4 The Facility will be lined with a suitable geomembrane. Water in the Facility will flow towards the vertical culvert and pond within the voids of the waste material.
- .5 Water in the Facility will be monitored and tested on a regular basis. Based on water quality analysis, the waste water will be extracted via pump truck and discharged to the environment or treated in a designated treatment facility.
- .6 Once the Facility reaches its ultimate capacity, the Facility will be capped and reclaimed.

2.0 Scope of Work

- .1 The scope of work for the construction of the Facility is as follows:
 - a. Construct the liner subgrade and berms with Zone B material at the specified grade. This could include cut/fill operations should the foundation material be satisfactory;
 - b. If required, install a geotextile layer to act as separator for Zone A and Zone B materials;
 - c. Construct the liner bedding with Zone A material;

- d. Install the liner system consisting of a suitable liner material and if required, protective geotextile layers above and below the liner, and a geocomposite reinforcing layer;
- e. Place and compact cover material, Zone A material, over the liner system;
- f. Install vertical culvert as specified on the Construction Drawings;
- g. Place and compact the waste material;
- h. Regrade the waste material and place and compact capping material;
- i. Install vegetative cover.

END OF SECTION



Section 1003

FILL MATERIALS

FILL MATERIALS

1.0 General

- .1 This section describes the construction material specifications for the Waste Containment Facility.

2.0 Reference Standards

- .1 The most recent copy of American Society for Testing Materials, ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.

3.0 Material Sources

- .1 No material of any type shall be borrowed or excavated without the Owner's prior approval.
- .2 Pits and quarries shall be maintained and managed in accordance with the requirements set out in the Owner's Land Use and Quarry Permits.
- .3 Zone A material shall be obtained from sources approved by the Owner, provided the final product meets the requirements specified herein. Processing may be required to achieve the specified gradation.
- .4 Zone B material shall be obtained from sources approved by the Owner, provided the final product meets the requirements specified herein. Processing may be required to achieve the specified gradation.
- .5 The parent rock from which all fill materials are derived shall consist of sound, hard, durable material free from soft, thin, elongated or laminated particles and shall contain no unsuitable substances. The potential quarry source shall be approved by the Engineer.
- .6 The quarry source for the Facility fill materials shall be inspected by the Engineer throughout material processing to ensure the product meets the requirements stated herein.

4.0 Material Specifications

.1 Zone A Material

The Zone A material shall consist of hard, durable particles, shall be free of roots, topsoil, and deleterious material and shall have a particle size distribution, as measured by ASTM C136, as presented in Table 1003.1.

TABLE 1003.1: ZONE A MATERIAL (10 MM MINUS) - PARTICLE SIZE DISTRIBUTION LIMITS

Sieve Size (mm)	% Passing Fine Limit	% Passing Coarse Limit
10	100	100
5	80	100
2	55	100
0.63	25	65
0.25	10	40
0.08	2	15

.2 Zone B Material

The Zone B material shall be free of roots, topsoil and other deleterious material and shall have a particle size distribution within the limits presented in Table 1003.2.

TABLE 1003.2: ZONE B MATERIAL (200 MM MINUS) - PARTICLE SIZE DISTRIBUTION LIMITS

Sieve Size (mm)	% Passing Fine Limit	% Passing Coarse Limit
200	100	100
100	85	100
50	65	100
25	40	100
5	20	55
2	0	20

END OF SECTION



Section 1004

FILL PLACEMENT

FILL PLACEMENT

1.0 General

- .1 The fill placement methods to be used during construction of the Waste Containment Facility are described in this Section.
- .2 Construction shall be performed in accordance with the best modern practice and with equipment best adapted to the work being performed. Embankment materials shall be placed so that each zone is homogeneous; free of stratifications; ice chunks, lenses or pockets; and layers of material with different texture grading not conforming to the requirements stated herein.
- .3 No fill material shall be placed on any part of the foundation until it has been prepared, as specified herein. Placement of fill material shall conform to the lines, grades and elevations shown on the Construction Drawings.
- .4 Embankment construction shall not proceed when the work cannot be performed in accordance with the requirements of the Construction Specifications. Any part of the embankment that has been damaged by the action of rain, snow or any other cause shall be removed and replaced with the appropriate material conforming to the requirements stated herein.
- .5 Stockpiling, loading, transporting, placing, and spreading of all materials shall be carried out in such a manner to avoid segregation. Segregated materials shall be removed and replaced with the materials meeting the requirements stated herein.
- .6 The Contractor shall remove all debris, vegetation or any other material not conforming to the requirements stated herein. The Contractor shall dispose of these materials in an area approved by the Owner.

2.0 Zone B Material Placement

- .1 The Zone B material shall be placed to the design elevation as specified in the Construction Drawings in lifts no greater than 500 mm in uncompacted thickness.
- .2 The design elevation for the top of the Zone B berm material shall be no less than 0.5 m above original ground.
- .3 Moisture condition and compact using the minimum number of passes established in accordance with section 1006.4.2.

3.0 Zone A Material Placement

- .1 The Zone A material shall be placed as bedding for the liner system (minimum 300 mm thick) to the design grade specified in the Construction Drawings.
- .2 Subsequent to the liner installation, the Zone A material shall be placed as liner system cover material. The liner system cover material shall be placed to the minimum thickness specified in Table 1004.1 dependent on the type of liner selected.

TABLE 1004.1: RECOMMENDED MINIMUM COVER THICKNESSES

Liner Material	Minimum Required Thickness
Enviro Liner® 4040 (Without Geocomposite)	1.3 m
Enviro Liner® 4040 (With Geocomposite)	0.3 m
HDPE 60	0.3 m
PVC 40 (With Geocomposite)	0.3 m

- .3 The Construction Drawings are based on the selection of Enviro Liner® 4040 with the installation of a geocomposite reinforcing material. Other design alternatives are detailed in Section 1007.
- .4 Zone A material shall be placed in lifts not exceeding 300 mm in uncompacted thickness. Vehicle traffic is prohibited from maneuvering within the Facility until the cover material has reached the minimum thickness required as specified in Table 1004.1.
- .5 Moisture condition and compact with using the minimum number of passes established in accordance with section 1006.4.1.
- .6 Equipment with ground pressures higher than 380 kPa should not be permitted inside the Facility once the liner system has been placed. Care is required to provide the appropriate thickness of fill beneath a vehicle when placing material above the liner system to ensure it is not damaged. Traffic in the area should be restricted to low ground pressure equipment.

END OF SECTION



Section 1005

LINER SYSTEM

LINER SYSTEM

1.0 General

- .1 The product and installation specifications for the non-woven geotextile, liner systems and geocomposite materials to be used in the Waste Containment Facility are presented in this section.
- .2 The liner system will be provided by the Owner and installed by the Contractor.

2.0 Reference Standards

- .1 The most recent copy of the following American Society for Testing Materials standards:
 - a. ASTM D638 Standard Methods for Tensile Properties of Plastics.
 - b. ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - c. ASTM D1004 Standard Test Methods for Initial Tear Resistance of Plastic Film and Sheeting.
 - d. ASTM D1603 Standard Test Methods for Carbon Black in Olefin Plastics.
 - e. ASTM D1777 Standard Test Methods for Thickness of Textile Materials.
 - f. ASTM D4533 Standard Test Methods for Trapezoidal Tearing Strength of Geotextiles.
 - g. ASTM D4632 Standard Test Methods for Grab Breaking Load and Elongation of Geotextile.
 - h. ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile.

- i. ASTM D4833 Standard Test Methods for Index Puncture Resistance for Geotextile, Geomembranes, and Related Products.
 - j. ASTM D5199 Standard Test Methods for Measuring the Nominal Thickness of Geosynthetics.
 - k. ASTM D5261 Standard Test Methods for Measuring Mass per Unit Area of Geotextiles.
 - l. ASTM D5994 Standard Test Methods for Measuring Core Thickness of textured Geomembranes
- .2 Federal Test Method
- a. FTM Standard 101.

3.0 Materials

.1 Geotextile

- a. The non-woven geotextile shall have a weight of 542 g/m². The manufacturer shall, prior to shipment of materials, provide to the Engineer a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1005.1.

TABLE 1005.1: RECOMMENDED MINIMUM GEOTEXTILE PROPERTIES

Physical Property	Minimum Average Roll Value (Weakest Principle Direction)
Thickness – Typical (ASTM D5199)	3.6 mm
Grab Tensile Strength (ASTM D4632)	1690 N
Elongation at Failure (ASTM D4632)	50 %
Trapezoidal Tear Strength (ASTM D4533)	645 N
Puncture (ASTM D4833)	1070 N
Apparent Opening Size (ASTM D4751)	150 microns
Weight – Typical (ASTM D5261)	542 g/m ²

- b. Any visible damage to the shipment of geotextile shall be noted on the freight receipt and project records.
- c. Storage of geotextile rolls on site shall be in a secure location that will minimize exposure to the elements, UV light and physical damage.

.2 Enviro Liner® 4040

- a. The Enviro Liner® shall be 1.0 mm (40 mil) thick geomembrane or equivalent. The manufacturer shall, prior to shipment of materials, provide to the Engineer a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1005.2.

TABLE 1005.2: RECOMMENDED MINIMUM GEOMEMBRANE PROPERTIES

Property	Enviro Liner® 4040
Minimum Average Thickness (ASTM D5994)	1.0 mm
Relative Density (ASTM D792)	0.939
Tensile Strength at Yield (ASTM D638)	26.6 N/mm
Elongation at Yield (ASTM D638)	800 %
Tear Resistance (ASTM D1004)	98 N
Puncture Resistance (FTMS 101)	271 N
Carbon Black Content (ASTM D1603)	2.0 – 3.0 %

- b. The liner material supplied under the specifications shall not have any blisters, holes, undispersed raw materials or any signs of contamination or inclusions of foreign matter. Such defects shall be repaired using techniques in accordance with manufacturer's recommendations. Excessive defects may be grounds for rejecting the entire roll of liner.
- c. Storage of geomembrane rolls on site shall be in a secure location that will minimize exposure to the elements and physical damage.
- d. Enviro Liner® geomembrane is suitable for secondary containment of hydrocarbons and other chemicals, and primary containment of water and water based effluents or as approved by manufacturer.

.3 HDPE Liner

- a. The HDPE geomembrane shall be 1.5 mm (60 mil) thick geomembrane or equivalent. The manufacturer shall, prior to shipment of materials, provide to the Engineer a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1005.3.

TABLE 1005.3: RECOMMENDED MINIMUM GEOMEMBRANE PROPERTIES

Property	Textured HDPE 60
Minimum Average Thickness (ASTM D5994)	1.5 mm
Relative Density (ASTM D792)	0.94
Tensile Strength at Yield (ASTM D638)	22.0 kN/m
Elongation at Yield (ASTM D638)	12 %
Tear Resistance (ASTM D1004)	187 N
Puncture Resistance (FTMS 101)	480 N
Carbon Black Content (ASTM D1603)	2.0 – 3.0 %

- b. The liner material supplied under the specifications shall not have any blisters, holes, undispersed raw materials or any signs of contamination or inclusions of foreign matter. Such defects shall be repaired using welding techniques in accordance with manufacturer's recommendations. Excessive defects may be grounds for rejecting the entire roll of liner.
- c. Extrusion resin used for extrusion joining of sheets and for repairs should be HDPE from the same resin batch as the sheet resin. Physical properties must be the same as the liner sheets.
- d. HDPE liner is suitable for containment of hydrocarbons and chemicals as well as water and water based effluents or as approved by manufacturer.
- e. Storage of geomembrane rolls on site shall be in a secure location that will minimize exposure to the elements and physical damage.

.4 PVC Liner

- a. The PVC geomembrane shall be 0.95 mm (38 mil) thick geomembrane or equivalent. The manufacturer shall, prior to shipment of materials, provide to the

Engineer a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1005.4.

TABLE 1005.4: RECOMMENDED MINIMUM GEOMEMBRANE PROPERTIES

Property	PVC 40
Minimum Average Thickness (ASTM D5994)	0.95 mm
Tensile Strength at Yield (ASTM D638)	17 N/mm
Elongation at Yield (ASTM D638)	430 %
Tear Resistance (ASTM D1004)	44 N

- b. The liner material supplied under the specifications shall not have any blisters, holes, undispersed raw materials or any signs of contamination or inclusions of foreign matter. Such defects shall be repaired using techniques in accordance with manufacturer's recommendations. Excessive defects may be grounds for rejecting the entire roll of liner.
- c. PVC liner is suitable for containment of water and water based effluents or as approved by manufacturer. It is not suitable for containment of hydrocarbons.
- d. Storage of geomembrane rolls on site shall be in a secure location that will minimize exposure to the elements, UV light and physical damage.

.5 Geocomposite

- a. The geocomposite reinforcing material shall be 5 mm (200 mil) thick or equivalent. The manufacturer shall, prior to shipment of materials, provide to the Engineer a signed manufacturing certification that materials to be shipped to site have test values that meet or exceed the requirements listed in Table 1005.5.

TABLE 1005.5: RECOMMENDED MINIMUM GEOCOMPOSITE PROPERTIES

Property	Geo-Comp 5
Minimum Average Thickness (ASTM D5994)	5 mm
Relative Density (ASTM D792)	0.94
Tensile Strength at Yield (ASTM D638)	79 N/cm
Puncture Resistance (FTMS 101)	489 N
Carbon Black Content (ASTM D1603)	2.0 %

- b. The geocomposite material supplied under the specifications shall not have defects or any signs of contamination or inclusions of foreign matter. Excessive defects may be grounds for rejecting the entire roll of geocomposite.

4.0 Installation - Enviro Liner® 4040 Design (with Geocomposite)

- .1 The liner system consists of the following layers (starting from the top layer):
 - Geo-Comp 5 or equivalent geocomposite
 - Enviroliner 4040 or equivalent geomembrane
- .2 The liner should line the entire surface of the Facility, which includes the crest of the berms, inside slopes, and floor. The geocomposite material is only required on the floor and approach berm of the Facility.
- .3 The Contractor shall ensure that the integrity of the liner system and its components are not compromised during construction. Precautions the Contractor may take to avoid damaging the liner system may include, but will not be limited to, providing light plants in the work area to improve visibility or using pylons to mark the lift/liner system interface.
- .4 Any damage to the liner system and/or its components shall be repaired as soon as possible. Fill placement shall cease immediately in an area where the integrity of the liner system has been compromised. Fill surrounding the damaged liner system may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Hand excavation shall be used to expose damaged portions of the liner for repair.
- .5 The liner system shall be anchored at the top of the berm so that movement downslope does not occur during backfilling at any stage of construction.
- .6 The Contractor shall take the necessary steps to ensure that backfilling does not induce tensile stress in the liner system. Care shall be taken to avoid making sharp turns, sudden stops or sudden starts adjacent to the liner system. Non-essential heavy equipment traffic in the immediate vicinity of the liner system shall not be permitted.

Enviro Liner® Installation

- .7 The Enviro Liner® should be deployed subsequent to the placement of Zone A bedding material.

- .8 The Engineer should walk the liner to observe for any defects caused by on-site equipment and tools. Any liner area showing injury due to excessive scuffing, puncture, or distress from any cause should be replaced or repaired with an additional piece of Enviro Liner® installed as per the manufacturer's specifications over the defective area. All patches should have rounded edges and extend a minimum of 150 mm beyond the affected area.
- .9 Low ground pressure equipment should be used to deploy the liner material. No equipment shall be allowed on the liner.

Geocomposite Reinforcing Installation

- .10 The geocomposite material should be deployed subsequent to the placement of the Liner.
- .11 No equipment is permitted on the liner material during the placing of the geocomposite reinforcing material. The geocomposite reinforcing material must be rolled out by hand and the cover material placed in accordance with Section 1004.

Material Quantities

- .12 Estimated material quantities required for the lined pad are listed in Table 1005.6

TABLE 1005.6: MATERIAL QUANTITY ESTIMATES

Material	Total Area (m ²)
Enviro Liner® 4040	1900
Geo-Comp 5	905

5.0 Installation - HDPE 60 Design

- .1 The liner system consists of the following layers (starting from the top layer):
 - HDPE 60 mil or equivalent geomembrane
- .2 The liner should line the entire surface of the Facility, which includes the crest of the berms, inside slopes, and floor.
- .3 The Contractor shall ensure that the integrity of the liner system and its components are not compromised during construction. Precautions the Contractor may take to

avoid damaging the liner system may include, but will not be limited to, providing light plants in the work area to improve visibility or using pylons to mark the lift/liner system interface.

- .4 Any damage to the liner system and/or its components shall be repaired as soon as possible. Fill placement shall cease immediately in an area where the integrity of the liner system has been compromised. Fill surrounding the damaged liner system may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Hand excavation shall be used to expose damaged portions of the liner for repair.
- .5 The liner system shall be anchored at the top of the berm so that movement downslope does not occur during backfilling at any stage of construction.
- .6 The Contractor shall take the necessary steps to ensure that backfilling does not induce tensile stress in the liner system. Care shall be taken to avoid making sharp turns, sudden stops or sudden starts adjacent to the liner system. Non-essential heavy equipment traffic in the immediate vicinity of the liner system shall not be permitted.

HDPE Liner Installation

- .7 The HDPE liner should be deployed subsequent to the placement of Zone A bedding material. The liner should be placed with no horizontal seams on the slopes. Tie-in seams should be located on the floor at a minimum of 1.5 m from the toe of the slopes.
- .8 The liner panels shall be welded together along the full length of the seam to the top of the berm.
- .9 Both the wedge and the extrusion welding equipment should be qualified by conducting trial seam tests prior to start-up each day and at approximately 4-hour intervals during seaming operations. During the trial seam, the minimum peel and shear strength criteria set by the manufacturer for the 60 mil HDPE geomembrane should be met. The industry-accepted peel and shear strengths for 60 mil HDPE geomembrane are 78 ppi (pounds/inch) and 120 ppi, respectively.
- .10 The Engineer should walk the liner to observe for any defects caused by on-site equipment and tools. Any liner area showing injury due to excessive scuffing, puncture, or distress from any cause should be replaced or repaired with an additional

piece of HDPE liner extrusion welded over the defective area. All patches should have rounded edges and extend a minimum of 150 mm beyond the affected area.

- .11 Low ground pressure equipment should be used to deploy the liner material. No track-wheel equipment shall be allowed on the liner. Equipment travel on the liner material should be kept to a minimum.

Material Quantities

- .12 Estimated material quantities required for the lined pad are listed in Table 1005.7

TABLE 1005.7: MATERIAL QUANTITY ESTIMATES

Material	Total Area (m ²)
HDPE 60 Liner	1900

6.0 Installation - PVC 40 Design

- .1 The liner system consists of the following layers (starting from the top layer):
 - Geo-Comp 5 or equivalent geocomposite
 - PVC 40 mil or equivalent geomembrane
- .2 The liner system should line the entire surface of the Facility, which includes the crest of the berms, inside slopes, and floor. The geocomposite material is only required on the floor and approach berm of the Facility.
- .3 The Contractor shall ensure that the integrity of the liner system and its components are not compromised during construction. Precautions the Contractor may take to avoid damaging the liner system may include, but will not be limited to, providing light plants in the work area to improve visibility or using pylons to mark the lift/liner system interface.
- .4 Any damage to the liner system and/or its components shall be repaired as soon as possible. Fill placement shall cease immediately in an area where the integrity of the liner system has been compromised. Fill surrounding the damaged liner system may have to be excavated, without further damaging the integrity of the liner, to permit repairs to be made. Hand excavation shall be used to expose damaged portions of the liner for repair.

- .5 The liner system shall be anchored at the top of the berm so that movement downslope does not occur during backfilling at any stage of construction.
- .6 The Contractor shall take the necessary steps to ensure that backfilling does not induce tensile stress in the liner system. Care shall be taken to avoid making sharp turns, sudden stops or sudden starts adjacent to the liner system. Non-essential heavy equipment traffic in the immediate vicinity of the liner system shall not be permitted.

PVC Liner Installation

- .7 The PVC liner should be deployed subsequent to the placement of Zone A bedding material.
- .8 The Engineer should walk the liner to observe for any defects caused by on-site equipment and tools. Any liner area showing injury due to excessive scuffing, puncture, or distress from any cause should be replaced or repaired with an additional piece of PVC liner installed as per the manufacturer's specifications over the defective area. All patches should have rounded edges and extend a minimum of 150 mm beyond the affected area.
- .9 Low ground pressure equipment should be used to deploy the liner material. No equipment shall be allowed on the liner.

Geocomposite Reinforcing Installation

- .10 The geocomposite material should be deployed subsequent to the placement of the Liner.
- .11 No equipment is permitted on the liner material during the placing of the geocomposite reinforcing material. The geocomposite reinforcing material must be rolled out by hand and the cover material placed in accordance with Section 1004.

Material Quantities

.12 Estimated material quantities required for the lined pad are listed in Table 1005.8

TABLE 1005.8: MATERIAL QUANTITY ESTIMATES

Material	Total Area (m ²)
PVC 40 Liner	1900
Geo-Comp 5	905

END OF SECTION



Section 1006

QUALITY ASSURANCE

QUALITY ASSURANCE

1.0 General

- .1 The quality assurance testing suggested is described in this section.

2.0 Reference Standards

- .1 The most recent edition of the following American Society for Testing Materials standards:
 - a. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - b. ASTM D698 – Standard -Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
 - d. ASTM D4437 – Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
- .2 Geosynthetic Research Institute
 - a. GRI Test Method GM6 – Pressurized Air Channel Test for Dual Seamed Geomembranes.

3.0 Fill Particle Size Testing Requirements

- .1 Zone A Material
 - a. Samples of the Zone A material should be evaluated from locations within the borrow source prior to construction. One sample will be evaluated every 500 m³ placed during construction to ensure the placed gradation meets the specification stated herein. The required tests and testing frequency for the Zone A material are presented in Table 1006.1.

TABLE 1006.1: TESTING AND FREQUENCY OF ZONE A MATERIAL

Test	Test Frequency
Particle Size Analysis	One (1) test every 500 m ³ during construction.

.2 Zone B Material

- a. Samples of the Zone B material will be evaluated from the foundation material within the Facility prior to construction and every 2000 m³ placed during construction to ensure the placed gradation meets the specification stated herein. The required tests and testing frequency for the Zone B material are presented in Table 1006.2.

TABLE 1006.2: TESTING AND FREQUENCY OF ZONE B MATERIAL

Test	Test Frequency
Particle Size Analysis	One (1) location within the Facility and One (1) test every 2000 m ³ during construction.

4.0 Fill Compaction Testing Requirements

.1 Zone A Material

- a. Compact each lift with a minimum of six passes using a large smooth-drum, vibratory compactor. The optimum vibratory frequency and number of passes should be determined during construction using proof-roll tests, which demonstrate optimum compaction. The Engineer should inspect the compaction effort to ensure that this effort results in a density equivalent to about 95% MDD.

.2 Zone B Material

- a. Compact each lift with a minimum of six passes using a large smooth-drum, vibratory compactor. The optimum vibratory frequency and number of passes should be determined during construction using proof-roll tests, which demonstrate optimum compaction. The Engineer should inspect the compaction effort to ensure that this effort results in a density equivalent to about 98% MDD.
- b. The foundation material (Zone B or subcut material) should also be compacted as specified in section 1006.4.1.

5.0 Geomembrane Testing Requirements

.1 General

- a. The Contractor is responsible for obtaining mill certificates from the manufacturer and forwarding them to the Engineer.
- b. If applicable, the Contractor shall record all seam parameters (i.e. time, date, operator, welding speed and temperature) on the liner.
- c. If applicable, the Contractor shall be responsible for completing the vacuum box testing and pressure testing for the appropriate seams. The Contractor shall mark the test number and parameters on the liner.
- d. If applicable, the Contractor shall supply and use a field tensiometer for testing liner seams for shear and peel strength.
- e. The Contractor is responsible for maintaining testing records.
- f. All coupons and test specimens remain the property of the Owner.

.2 Qualifying Welds

- a. Qualifying seams shall be conducted on fragmented pieces of material at the following times:
 - At the start of each shift of production seaming, and at 4 hour intervals during production seaming;
 - When a new operator or new machine starts welding;
 - When a machine is restarted after repairs;
 - When welding is stopped for sixty (60) minutes or more;
 - When there is a change in the ambient conditions; and
 - At the discretion of the Engineer.
- b. Qualifying seams shall be 1 m long, and shall be subject to shear and peel testing. The test seam shall meet the minimum requirements stated herein for seam strength, when tested on a field tensiometer. If a qualifying seam fails, the seaming procedure shall be reviewed and the test shall be repeated.

.3 Non-Destructive Testing

- a. Test all wedge-welded seams over their full length using a vacuum unit or air pressure test.
 - Seam intersections will also be subject to vacuum box testing, regardless of seaming method employed.
 - The Contractor shall supply all apparatus and personnel for this type of test.
 - The tests shall be witnessed and documented by the Engineer.
- b. Clean all seams to permit proper inspection.
- c. Repair any seams which fail non-destructive testing in accordance with this Specification. Repairs shall be fully documented by the Contractor.

.4 Vacuum Box Testing

- a. Extrusion welded seams should be tested using either vacuum box testing or pick-testing. Vacuum box testing involves placing the extrusion weld under a vacuum. The weld is first coated with a soapy water solution and any holes in a weld would be indicated by a stream of bubbles when vacuum is applied.
- b. No leaks shall be permitted while conducting vacuum box testing.
- c. Pick-testing is conducted on uneven surfaces where a vacuum cannot be maintained. During pick testing, attention should be paid to the following specific items:
 - The width of the weld;
 - Weld bond to the underlying geomembrane;
 - Joints between three panels (“T” joints);
 - Defects such as bubbles created within the weld due to moisture; and
 - Textured weld surfaces due to temperature fluctuation in the extrusion welder.

.5 Air Pressure Testing

- a. Wedge welded seams should be air-pressure tested over their full lengths using an air pressure test. Air pressure testing involves pressurizing the air channel located between the dual tracks of the seams to a minimum pressure of 40 psi for a period of five minutes.
- b. During the test, the air pressure is not allowed to drop more than 4 psi (10% allowance). Any leaks and bubbling in the seams found during the non-destructive tests must be repaired by extruding a patch of HDPE material over the defect.
- c. Air pressure testing shall be carried out according to GRI Test Method GM6, Pressurized Air Channel Test for Dual Seamed Geomembranes.

.6 Destructive Testing for Production Seams

- a. Cut-out coupons shall be taken at a minimum frequency of one (1) per 150 m of seam, or once per seam. Coupons shall be cut by the contractor at the location directed by the Engineer. Coupons shall generally be taken from a location that does not affect the performance of the liner. All cut-outs shall have rounded corners. Care shall be taken to ensure that no slits penetrate the parent liner.
- b. All holes left by cut outs shall be patched immediately.

.7 Testing of Repairs

- a. All repairs shall be tested using the Vacuum Box in accordance with test method ASTM 4437.

END OF SECTION



Section 1007

DESIGN ALTERNATIVES

DESIGN ALTERNATIVES

1.0 General

- .1 This section provides design alternatives for the Facility should the fill materials available on or near site not adhere to the gradation specifications stated in Tables 1003.1 and 1003.2.
- .2 Should Zone A, Zone B or both materials not meet the gradation specifications stated in Tables 1003.1 and 1003.2 then the recommended design alternatives are available in Table 1007.1.

TABLE 1007.1: RECOMMENDED DESIGN ALTERNATIVES FOR GRADATION NON-COMPLIANCE				
		Zone B		
		Meets Specifications	Gradation Below Fine Limit	Gradation Above Coarse Limit
Zone A	Meets Specifications	This section does not apply	This section does not apply	See Section 1007.2
	Gradation Below Fine Limit	See Section 1007.2	See Section 1007.2	See Section 1007.2
	Gradation Above Coarse Limit	See Section 1007.3	See Section 1007.3	See Section 1007.4

2.0 Detailed Design Alternatives – Non-Compliance Criteria I

- .1 If the fill materials do not comply with gradation specifications as per Table 1007.1 geotextile material is required at the interface between Zone A and Zone B materials.
- .2 The geotextile material should be deployed prior to the placement of Zone A material.
- .3 The geotextile should be placed with a minimum overlap of 150 mm and connected at the seam by heat bonding. If heat bonding is not available an overlap of 300 mm should be used. Horizontal seams should be kept to a minimum on the side slopes. If a horizontal seam is unavoidable, the overlap shall be capped with a 300 mm wide strip of the same geotextile and heat bonded to the underlying material.
- .4 Any tears or holes made in the geotextile should be repaired by placing a patch of geotextile on the defect and held in place by heat bonding. The patch should extend at least 300 mm beyond the damage, in all directions.

3.0 Detailed Design Alternatives – Non-Compliance Criteria II

- .1 If the fill materials do not comply with gradation specifications as per Table 1007.1 geotextile material is required above and below the liner system.
- .2 The geotextile material should be deployed prior to the deployment of the liner system as well as subsequent to the deployment of the liner system.
- .3 The geotextile should be placed with a minimum overlap of 150 mm and connected at the seam by heat bonding. If heat bonding is not available an overlap of 300 mm should be used. Horizontal seams should be kept to a minimum on the side slopes. If a horizontal seam is unavoidable, the overlap shall be capped with a 300 mm wide strip of the same geotextile and heat bonded to the underlying material.
- .4 Any tears or holes made in the geotextile should be repaired by placing a patch of geotextile on the defect and held in place by heat bonding. The patch should extend at least 300 mm beyond the damage, in all directions.

4.0 Detailed Design Alternatives – Non-Compliance Criteria III

- .1 If the fill materials do not comply with gradation specifications as per Table 1007.1 geotextile material is required above and below the liner system as well as at the interface between Zone A and Zone B materials.
- .2 The geotextile material should be placed prior to the placing of Zone A material, prior to the deployment of the liner system as well as subsequent to the deployment of the liner system.
- .3 The geotextile should be placed with a minimum overlap of 150 mm and connected at the seam by heat bonding. If heat bonding is not available an overlap of 300 mm should be used. Horizontal seams should be kept to a minimum on the side slopes. If a horizontal seam is unavoidable, the overlap shall be capped with a 300 mm wide strip of the same geotextile and heat bonded to the underlying material.
- .4 Any tears or holes made in the geotextile should be repaired by placing a patch of geotextile on the defect and held in place by heat bonding. The patch should extend at least 300 mm beyond the damage, in all directions.

END OF SECTION



Section 1008

OPERATION AND MAINTENANCE



OPERATION AND MAINTENANCE

5.0 General

- .1 This section provides a general guideline for the operation and maintenance of the Waste Containment Facility.

6.0 Geomembrane Lined Pad

- .1 Structure Maintenance
 - a. This section refers to the structure as the berm, side slopes, and floor of the Facility.
 - b. The structure shall be inspected regularly. Attention shall be concentrated on the following:
 - Eroded and/or damaged granular slope and floor surfaces and
 - Exposed liner material
 - c. Any identified problems should be repaired immediately. The repair can be conducted by reconstructing the damaged or eroded slopes with a material of similar gradation to Zone A material. Any exposed liner material can be recovered with Zone A material; however, if the liner material is damaged, liner installation personnel shall be retained to repair the liner.
- .2 Surface Water Management
 - a. The Facility is designed to drain all surface water to the installed vertical culvert. Each month, the water level must be inspected, pumped and disposed of appropriately.
 - b. The frequency of monitoring must be increased during times of high precipitation or snow melt within the Facility.

7.0 Filling Procedure

- .1 The filling procedure for the Facility is as follows:
 - a. Waste material is not to exceed a height of 3.0 m above the level of the top of the berm unless approved by the Engineer;
 - b. Waste material is not to be placed higher than relative elevation 0.5 m below the crest of the liner unless approved by the Engineer.

8.0 Closure

- .1 Upon reaching capacity the Facility will be capped with material meeting the specifications outlined in Table 1008.1 or as approved by the Engineer.

TABLE 1008.1: CAPPING MATERIAL- PARTICLE SIZE DISTRIBUTION LIMITS

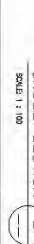
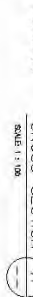
Sieve Size (mm)	% Passing Fine Limit	% Passing Coarse Limit
100	100	100
50	95	100
25	90	100
20	85	100
5	65	90
0.63	35	60
0.08	5	20

- .2 The capping material shall have a minimum thickness of 0.5 m.
- .3 The vegetative cover must be capable of self-regeneration without continuous dependence on fertilizer or re-seeding.
- .4 The vegetative cover must have sufficient density and species diversity to stabilize the surface against the effects of long term erosion.
- .5 Closure monitoring should include inspection for any ponding water. If ponded water is present capping material should be added or re-graded.

END OF SECTION

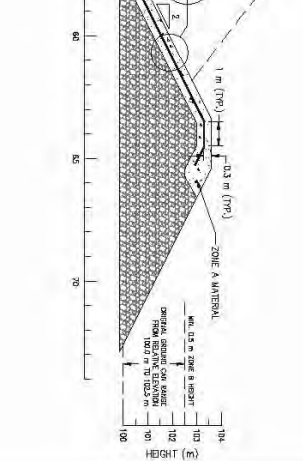
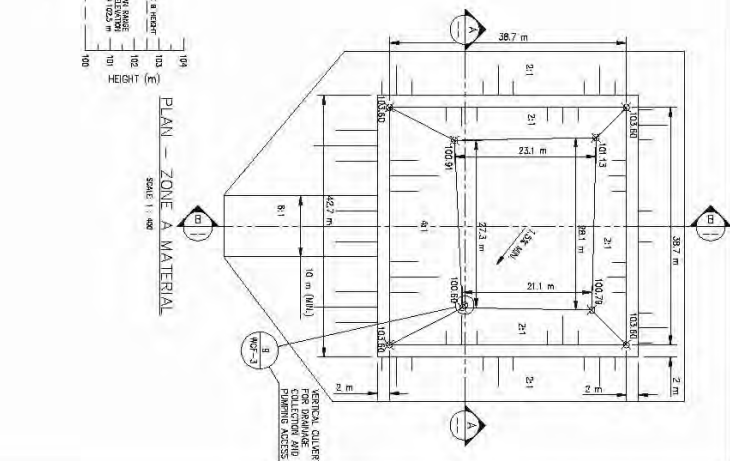
APPENDIX

APPENDIX A CONSTRUCTION DRAWINGS



- [illegible]

PROJECT NO.	0110142	OFFICE	DES	CAD	REV	REVISIONS
DATE	08/26/2008	WABE	JTP	JPS	0	
		DRAWING NO.	0000	APP	01/1/08	
		1 of 4	KIT	ATT	B	
						WC-1



- TYPICAL WASTE CONTAINMENT FACILITY DESIGN**
- KENDO HILL SILVER DISTRICT, YT
- ZONE A MATERIAL PLAN & CROSS SECTIONS**
- | PRODUCT No. | CROSS SECTION | NO. | CON. | REV. | DRAWING |
|-----------------|------------------|-----|------|------|---------|
| VY-010142 | WASTE | JPT | P8 | 0 | WCF-2 |
| DATE: MAR. 2006 | SHEET NO. 2 OF 4 | KRT | ART | B | |

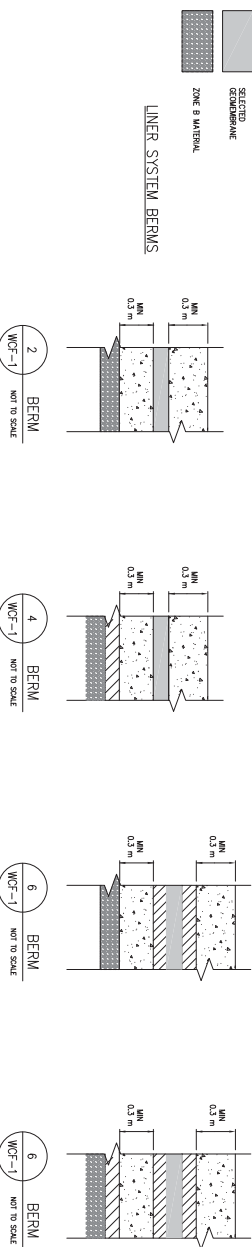
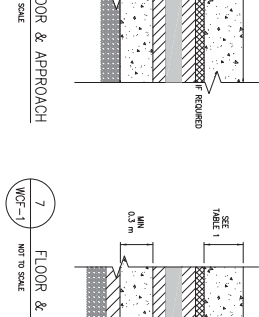
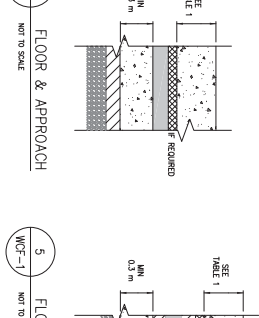
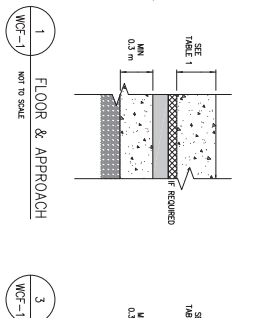
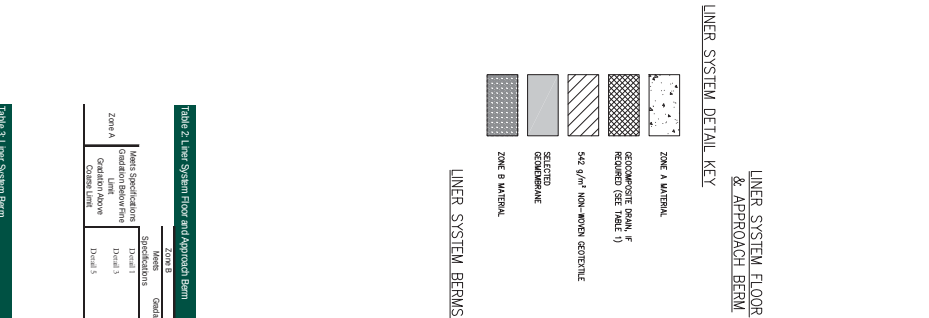


Table 2. Limit System Floor and Approach Beam			
Zone A	Zone B		
	Meets Specifications	Generation Below Fire Limit	Generation Above Coarse Limit
Meets Specifications	Deadall 1	Deadall 3	Deadall 5
Generation Above Limit	Deadall 3	Deadall 5	Deadall 7
Coarse Limit	Deadall 5	Deadall 7	

Size (mm)	% Passing Fine Limit	% Passing Coarse Limit
10	300	100
5	80	100
2	55	100
0.075	25	65
0.25	10	40
0.075	2	15

Zone B		
Mats	Grassland Below Fine Limit	Grassland Above Coarse Limit
Specifications		
Dredal 1	Dredal 1	Dredal 3
Dredal 3	Dredal 3	Dredal 5
Dredal 5	Dredal 5	Dredal 7

Screen Size (mm)	% Passing Fine Limit	% Passing Coarse Limit
200	100	100
100	85	100
50	65	100
25	40	100
5	20	55
2	0	20

Layer Material	Drainage Composite	Minimum Required Thickness
Ember Layer 400 (Without Geocomposite)	Required	1.5 m
Ember Layer 400 (With Geocomposite)	Required	0.3 m
HDPPE 60	Not Required	0.3 m
PVC 40 (With Geocomposite)	Required	0.3 m

1. CONTAINMENT FACILITY SIZED FOR 1900 m³ OF GEOMEMBRANE. CONFIGURATION OF BASE AREA CAN BE MODIFIED SHOULD SITE CONDITIONS WARRANT. HOWEVER, SPECIFIED BERM CROSS-SECTION, ALL MATERIALS, LINES SYSTEMS AND GENERAL DESIGN CRITERIA MUST BE ADHERED TO.
2. SPECIFIC CONDITIONS AND FACILITY LOCATION HAVE NOT BEEN PROVIDED OR CONSIDERED. ONCE FACILITY LOCATION AND SITE SPECIFIC CONDITIONS ARE KNOWN, THEY MUST BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

[illegible]

**ORIGINAL
SIGNED AND SEALED**

Permit: J. B. Hayes/Triple, P. 2066
Date: July 6, 2008

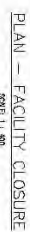
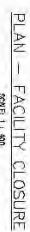
Seal: James Hayes, P. Eng.
Date: July 6, 2008

The original Professional Seal and Permit #1 is being submitted for review and registration with the Engineering Council of Alberta and is being controlled by EBA Engineering Consultants Ltd.

PERMIT

PROFESSIONAL SEAL

 ALEXCO	TYPICAL WASTE CONTAMINATION FACILITY DESIGN KENO HILL SILVER DISTRICT, YT									
	DETAILS									
 B&B Engineering Consultants Ltd.	PROJECT NO. DATE 10/06/2008	OTHER SHEETS 3 of 4	DGS 2008 10/06/2008	DGS 2008 10/06/2008	REV 10/06/2008	DOWNSIDE 10/06/2008	WCF-3			



POLYMER No.	OFFICE	DWG	SIB	REV	DESCRIPTION
WY107642	WBSSE	JTP	PP	0	WCE
DATE OF REV					



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX E
CONCEPTUAL TAILINGS AND WASTE ROCK
MANAGEMENT PLANS
BELLEKENO PROJECT
NEAR KENO CITY, YUKON**

December 2008

Prepared by: EBA Engineering Consultants Ltd.

December 12, 2008

EBA File: W14101178.001

Alexco Resource Canada Corp.
#3-161 Industrial Road
Whitehorse, YT Y1A 2V3

Attention: Mr. Ethan Allen, M. Sc.
Geologist, Mine Permitting Assistant

**Subject: Conceptual Tailings and Waste Rock Management Plans
Bellekeno Project near Keno City, Yukon**

1.0 INTRODUCTION

Alexco Resource Canada Corp. (Alexco) is proposing to construct a silver, lead and zinc concentrating mill near Keno City, Yukon. Alexco retained EBA Engineering Consultants Ltd. (EBA) to provide conceptual level designs for tailings management, stormwater management and waste rock disposal for three of the initial nine sites, Mackeno, Bellekeno, and Onek. EBA conducted those designs and reviewed each one with Alexco at a meeting on December 1, 2008 to aid Alexco in final site selection process. Subsequently, on December 3, 2008 Alexco selected the Mackeno site from the initial list of nine potential sites for the mill and dry-stacked tailings disposal and the Bellekeno site for waste rock disposal.

EBA has completed the conceptual design of the dry-stacked tailings facility and stormwater management system at Mackeno and waste rock disposal plan at Bellekeno. This letter summarizes the conceptual design, design assumptions, stability calculations, potential risk and mitigations, and closure plans. Foundation soil descriptions and other geotechnical recommendations followed herein are summarized in a letter submitted to Alexco on December 9, 2008.

2.0 MACKENO DRY-STACKED TAILINGS FACILITY

Alexco is proposing to construct a concentrating mill and dry-stacked tailings facility (DSTF) at the Mackeno site. This section summarizes the design assumptions, conceptual design, stability calculations, potential risks and mitigations, and closure plans for the DSTF facility at the Mackeno site.

2.1 MACKENO DRY-STACKED TAILINGS FACILITY DESIGN ASSUMPTIONS

EBA used the following assumptions, provided by Alexco, in the design of the DSTF at the Mackeno site.

- Tailings discharge rate of 7.75 dmt/hr (dry-metric tonnes per hour) for years 1 and 2 and 13.95 dmt/hr for years 3 through 5;

- Tailings specific gravity of 3.95;
- Tailings moisture content of 20% (mass of water divided by the mass of dry solids);
- Only 50% of all tailings generated will be stored on surface;
- Design storm for water management is 1:200 year return period rainfall event;
- Peak flow determined from Figure B 2 of 1996 UKHM Closure Plan – Appendix B using 1000 minute duration;
- Temporary wet tailings storage area sized for 1500 m³ of wet tailings; and
- Water treatment settling pond sized for 24 hour detention at a flow of 10 L/s.

Assumptions made by EBA:

- Placed dry density of tailings is 1800 kg/m³;
- Bleed water resulting from compaction of the tailings pile will be 10% of porewater;
- Compacted tailings has an internal friction angle of 26 degrees;
- The compacted tailings are cohesionless;
- Runoff coefficient of 1 (Rational Method C value) selected for DSTF;
- Simple triangular hydrograph assumed to calculate runoff volume from the DSTF for the design storm;
- Total runoff volume for the design storm is 1,200 m³;
- Foundation soils for the DSTF are sand and gravel with a bulk unit weight of 2150 kg/m³;
- Foundation soils are cohesionless with an internal friction angle of 32 degrees; and
- Design seismic event was selected to be 1:500 year return period, as recommended in Mined Rock and Overburden Piles Investigation and Design Manual (BC Mine Waste Rock Pile Research Committee, 1991).

2.2 MACKENO DRY-STACKED TAILINGS FACILITY CONCEPTUAL DESIGN

The conceptual design of the DSTF involves the construction of drainage works, placement and compaction of the filtered tailings and construction of an emergency wet tailings handling area.

The drainage works for the facility consist of a drainage blanket, graded east towards Christal Lake, a seepage and runoff collection ditch, an outer diversion berm, and a seepage and runoff collection sump. The drainage blanket is designed to be at least 0.6 m thick and only buried a maximum of 0.1 m below the existing ground surface. The drainage blanket will be constructed from non-AML waste rock produced during the development of the Bellekeno mine. The drainage blanket may

have a non-woven geotextile placed across its surface, if piping of the tailings through waste rock is a concern through review of the tailings and waste rock particle size distributions.

Thus, the tailings will be placed at least 0.5 m above the existing ground surface which will keep the groundwater in the area from infiltrating into the tailings pile. The seepage and runoff collection ditch will be deep enough to intersect water running through the drainage blanket. It will also route tailings seepage water and runoff from the tailings footprint to the seepage and runoff collection sump. The outer diversion berm will direct water from outside of the facility around the facility into the nearby Mackeno Creek or Christal Lake. The seepage and runoff collection sump will have a volume of 1,200 m³ which is the full volume of the 1:200 year design rainfall event.

The filtered tailings will have a moisture content of approximately 20%, which should be just above the optimum moisture content for compaction. The tailings will be placed in 200 mm lifts and compacted with a 10-tonne vibratory compactor, similar to the process used at the existing Minto Mine. Tailings will be compacted to at least 95% of the maximum dry density using standard effort (as per ASTM D698). The pile will be a heaped fill and have a slope down to the existing ground on all sides. The slope of the tailings will be 4H:1V on all sides of the DSTF. The stability of the pile was checked using Geostudio 2007 – SlopeW module. The factors of safety calculated for the DSTF and the guidelines set forth by the BC Mine Waste Rock Pile Research Committee (1991) are summarized in Table 1.

TABLE 1: DSTF SLOPE STABILITY FACTOR OF SAFETY SUMMARY		
Stability Condition	Factor of Safety	
	Suggested Minimum	Calculated for DSTF
Stability of Surface		
Short Term (during construction)	1.0	1.7
Long-Term (reclamation – abandonment)	1.1	1.7
Deep-Seated Stability		
Short Term (static)	1.1 – 1.3	1.9
Long-Term (static)	1.3	1.9
Pseudo-Static	1.0	1.2

The temporary wet tailings storage area is sized to hold 1500 m³ of wet tailings (tailings at 60% solids). This volume is estimated to be approximately one week of year 1 production. The tailings will require time to drain prior to being moved to the DSTF. The berm between the temporary wet tailings storage area and the seepage and runoff collection pond will be a permeable dyke, which will allow water to flow through while retaining the coarse tailings particles. The entire facility will be lined with a fine-grained till which can be sourced from the area. The till will have a low permeability substantially reducing the amount of water that will infiltrate into the groundwater

beneath the facility. Using a till will also allow Alexco to operate heavy equipment in the facility to excavate the drained tailings and accumulated sediments and haul them to the DSTF for disposal.

A geomembrane lined settlement pond has also been included in the design. This pond is sized to hold 1,000 m³ of water or a flow of 10 L/s for 24 hours. There will be a lime mixing plant next to this pond to treat the water, if necessary. The settlement pond is designed as a flow through structure. If treatment is necessary the water will be pumped from the seepage and runoff collection pond through the lime mixing plant and into the settling pond. The water will exit the settling pond through the south end spillway and be routed into the Mackeno Stream. If treatment is not necessary the runoff water will flow over the seepage and runoff collection pond spillway and into Mackeno Creek.

2.3 MACKENO DRY-STACKED TAILINGS FACILITY RISKS AND MITIGATIONS

The risks and associated mitigations of the DSTF are summarized in Table 2.

TABLE 2: DSTF RISK AND MITIGATION SUMMARY TABLE			
Risk	Design Constraint	Mitigation	Discussion
Deep seated slope failure	Minimum FS = 1.3 (static); 1.0 (pseudo-static 1:500 year event)	Facility is designed to the applicable guidelines.	Probability of exceedance of the design seismic event is 10% in 50 years.
Surface slope failure	Minimum FS = 1.1 (static)	Facility is designed to the applicable guidelines	Surface failures can be repaired without major effort.
Pile Erosion	Minimize surface runoff	Diversion berm included upgradient and the facility is heaped above existing grade minimizing surface water runoff.	Diversion berm is sized for the 1:200 year inflow design flood.
Toe Liquefaction	Compact tailings and construct waste rock drain	Tailings are specified to be compacted with a steel drum vibratory compactor. Tailings are placed on waste rock blanket to facilitate drainage.	Compaction of foundation soils may be required at the toe during construction of DSTF.
Snow and ice buried during pile construction	Operational issue	Operational procedures will be developed to minimize this.	Buried snow and ice could affect the stability and capacity of the facility.
Frost Heave	Limit excess pore water in frost susceptible materials	Waste rock blanket promotes drainage and limits excess pore water in facility	Frost heaving deforms the structure and affects the stability of the facility.
Leaking from capping material upon closure	Monitor pile upon closure	Monitoring stations located down-gradient from the facility will detect leaks and then repairs can be made. Bioreactor will be installed if necessary.	Capping material can be repaired by mechanical means if a leak is detected

2.4 MACKENO DRY-STACKED TAILINGS FACILITY CLOSURE PLAN

Since the DSTF will be constructed as a heaped fill, progressive reclamation is not feasible. Closure activities will commence once the milling is completed and tailings are no longer being produced. A geosynthetic membrane will be placed over the surface of the compacted tailings to prevent infiltration of runoff water in perpetuity. The liner will not extend into the drainage blanket but will cover the 5 m offset distance from the toe of the DSTF to the edge of the drainage blanket. The liner will be capped with 0.6 m of soil over the crest and 0.9 m of soil over the toe and drainage blanket. The cover soil will be seeded with grass and other small plants native to the area. The conceptual closure plan and section are shown in Figures 4 and 5.

All water diversion structures, with the exception of the drainage blanket and the outer diversion berm, will be removed and the site will be graded towards Christal Lake.

The pile will require an annual geotechnical inspection for at least 5 years after closure. The requirement for annual geotechnical inspections should be reviewed after 5 years.

3.0 NON-AML WASTE ROCK DISPOSAL AREA

Alexco is proposing to dispose of non-AML waste rock at the Bellekeno site. This section summarizes the design assumptions, conceptual design, stability calculations, potential risks and mitigations, and closure plans for the Non-AML Waste Rock Disposal Area (WRDA) at the Bellekeno site.

3.1 NON-AML WASTE ROCK DISPOSAL AREA ASSUMPTIONS

Alexco provided the following assumptions to EBA for use in design of the WRDA

- Total volume of waste rock to be generated: 500,000 dmt;
- Volume of non-AML waste rock will be 75% of the total;
- Placed density of the waste rock will be 1800 kg/m³;
- Waste Rock used in construction of DSTF can be subtracted from total to be stored; and
- Total volume to be stored is 200,000 m³.

EBA's design assumptions are as follows:

- An internal friction angle of 36 degrees for waste rock;
- The waste rock is cohesionless;
- Foundation soils for the waste rock storage facility are permafrost sand and gravel with a bulk unit weight of 2140 kg/m³;
- Foundation soils have an undrained shear strength of 10 kPa with an internal friction angle of 28 degrees;
- Active layer of the permafrost is 1 m thick and the groundwater surface is 0.5 m above the permafrost boundary, simulating early summer ground conditions;
- Shear failure will not occur through the permafrost, but along the frozen/unfrozen boundary; and
- Design seismic event was selected to be 1:500 year return period, as recommended in Mined Rock and Overburden Piles Investigation and Design Manual (BC Mine Waste Rock Pile Research Committee, 1991).

3.2 NON-AML WASTE ROCK DISPOSAL FACILITY CONCEPTUAL DESIGN

The waste rock will be hauled from the Bellekeno adit directly to the WRDA. The WRDA will be constructed as a wrap around dump, so the lower benches will be constructed first. The lowest bench will follow the existing road alignment and have a slope to the existing ground surface of 2.5H:1V. The waste rock will be dumped in 10 m benches and allowed to fall to the bench below it at the natural angle of repose of the rock. The stability of the pile was checked using Geostudio 2007 – SlopeW module. The factors of safety calculated for the waste WRDA and the guidelines set forth by the BC Mine Waste Rock Pile Research Committee (1991) are summarized in Table 3. The WRDA will not need re-contouring at closure as the long-term stability of the pile should meet the guidelines. Waste rock piles in the area have been standing at the natural angle of repose without significant stability problems for over 30 years.

TABLE 3: WRDA SLOPE STABILITY FACTOR OF SAFETY SUMMARY		
Stability Condition	Factor of Safety	
	Suggested Minimum	Calculated for WRDA
Stability of Surface		
Short Term (during construction)	1.0	1.1
Long-Term (reclamation – abandonment)	1.1	1.1
Deep-Seated Stability		
Short Term (static)	1.1 – 1.3	1.7
Long-Term (static)	1.3	1.7
Pseudo-Static	1.0	1.2

3.3 NON-AML WASTE ROCK DISPOSAL AREA RISKS AND MITIGATIONS

The risks and associated mitigations of the Non-AML WRDA are summarized in Table 4.

TABLE 4: NON-AML WRDA RISK AND MITIGATION SUMMARY			
Risk	Design Constraint	Mitigation	Discussion
Deep seated slope failure	Minimum FS = 1.3 (static); 1.0 (pseudo-static 1:500 year event)	Waste rock pile is designed to the applicable guidelines.	Probability of exceedance of the design seismic event is 10% in 50 years.
Surface slope failure	Minimum FS = 1.1 (static)	Waste rock pile is designed to the applicable guidelines.	Surface failures can be repaired without major effort.
Sediment transport	Setback distance of 30 m from water bodies	Pile location minimizes sediment from being transported into adjacent streams.	Sediment picked up by surface runoff can filter out in natural vegetation in the area prior to discharging into receiving water bodies.
Toe liquefaction	Consider liquefaction during conceptual design	The foundation soils not susceptible to liquefaction in frozen state.	Review of liquefaction potential will be conducted for unfrozen soils in detailed design.
Snow and ice buried during pile construction	Operational issue	Operational procedures will be developed to minimize this.	Buried snow and ice can affect the stability and capacity of the facility.
Contaminated waste rock	Operational issue	Waste rock containing contaminant will not be placed in waste rock pile.	Contaminated rock will be placed in the previously constructed contaminated waste rock facility.

3.4 NON-AML WASTE ROCK DISPOSAL AREA CLOSURE

No additional re-contouring will be required at closure for the WRDA. However, the condition of the permafrost beneath the WRDA should be monitored throughout operation and at least 10 years past closure. The requirement for ground temperature monitoring should be reviewed 10 years after closure. An annual geotechnical inspection should be conducted on the WRDA for at least 5 years after closure. The requirement for an annual geotechnical inspection should be reviewed 5 years after closure.

A toe buttress may be required along the alluvial terrace below the toe of the WRDA in the area currently being placer mined. This is necessary to improve the overall stability of the embankment in the event of an earthquake, or other seismic event. Adequate backfilling or re-contouring by the placer miner may alleviate this concern, but this should be re-examined at closure.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the General Conditions attached to this letter.

5.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

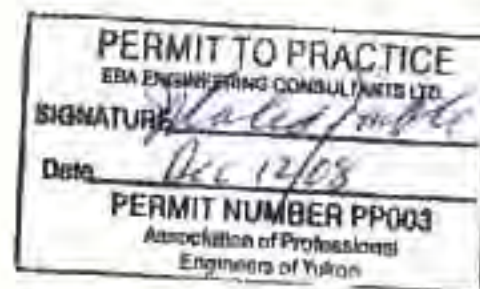
EBA Engineering Consultants Ltd.



Christopher J. Dixon, P.Eng.
Geotechnical Engineer, Yukon Region
Direct Line: 867.668.2271 x241
cdixon@eba.ca



J. Richard Trimble, M.Sc. (Eng.), P.Eng.
Project Director, Yukon Region
Direct Line: 867.668.2271 x222
rtrimble@eba.ca



DESIGN REPORT – GENERAL CONDITIONS

This Design Report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This Design Report pertains to a specific site, a specific development, and a specific scope of work. The Design Report may include plans, drawings, profiles and other support documents that collectively constitute the Design Report. The Report and all supporting documents are intended for the sole use of EBA’s Client. EBA does not accept any responsibility for the accuracy of any of the data, analyses or other contents of the Design Report when it is used or relied upon by any party other than EBA’s Client, unless authorized in writing by EBA. Any unauthorized use of the Design Report is at the sole risk of the user.

All reports, plans, and data generated by EBA during the performance of the work and other documents prepared by EBA are considered its professional work product and shall remain the copyright property of EBA.

2.0 ALTERNATIVE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless so stipulated in the Design Report, EBA was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project specific design.

4.0 CALCULATIONS AND DESIGNS

EBA has undertaken design calculations and has prepared project specific designs in accordance with terms of reference that were previously set out in consultation with, and agreement of, EBA’s client. These designs have been prepared to a standard that is consistent with industry practice. Notwithstanding, if any error or omission is detected by EBA’s Client or any party that is authorized to use the Design Report, the error or omission should be immediately drawn to the attention of EBA.

5.0 GEOTECHNICAL CONDITIONS

A Geotechnical Report is commonly the basis upon which the specific project design has been completed. It is incumbent upon EBA’s Client, and any other authorized party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the geotechnical information that was reasonably acquired to facilitate completion of the design.

If a Geotechnical Report was prepared for the project by EBA, it will be included in the Design Report. The Geotechnical Report contains General Conditions that should be read in conjunction with these General Conditions for the Design Report.

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgemental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

9.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

10.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

11.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

12.0 DRAINAGE SYSTEMS

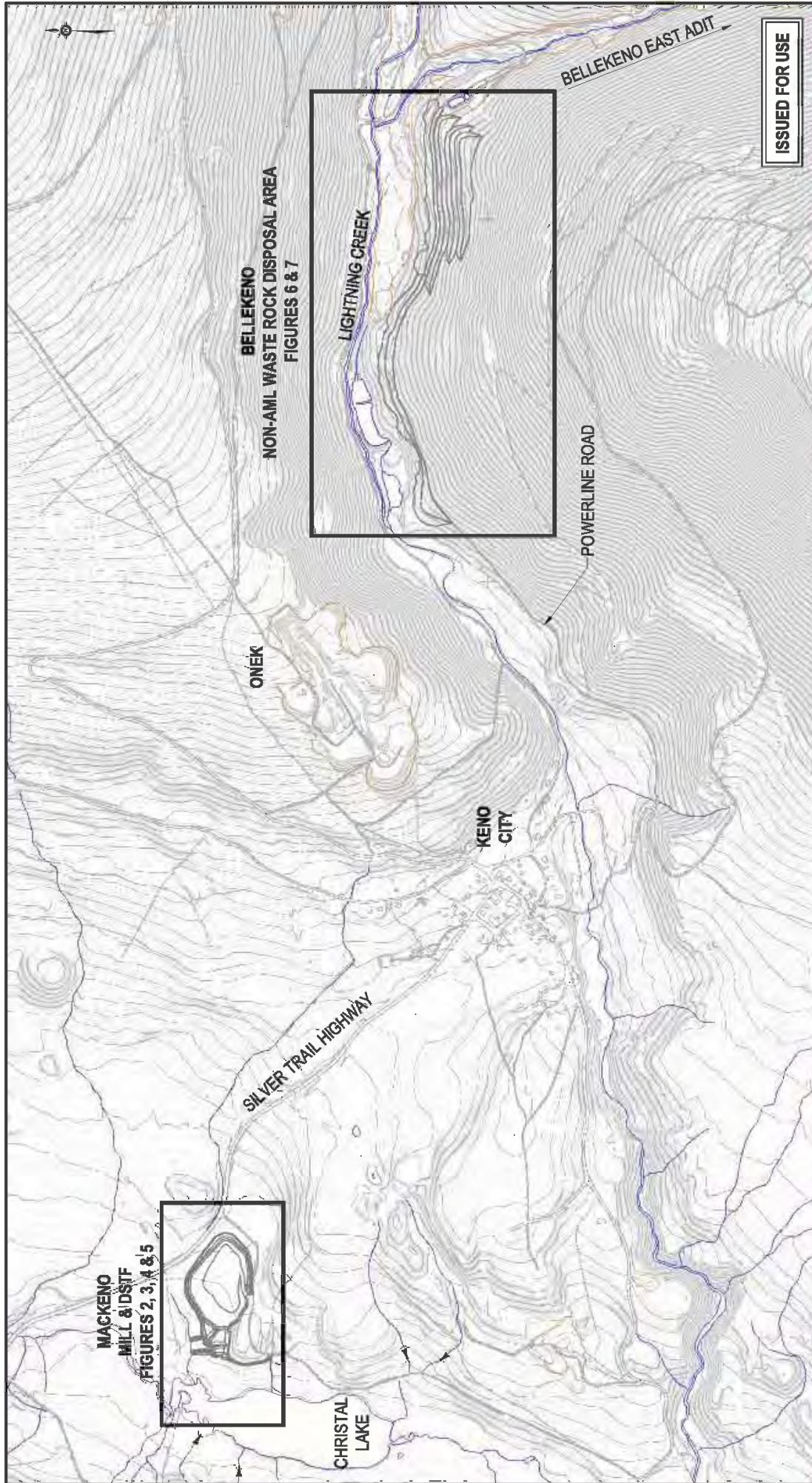
Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

13.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

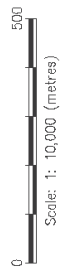
14.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.



ISSUED FOR USE

NOTE
BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.

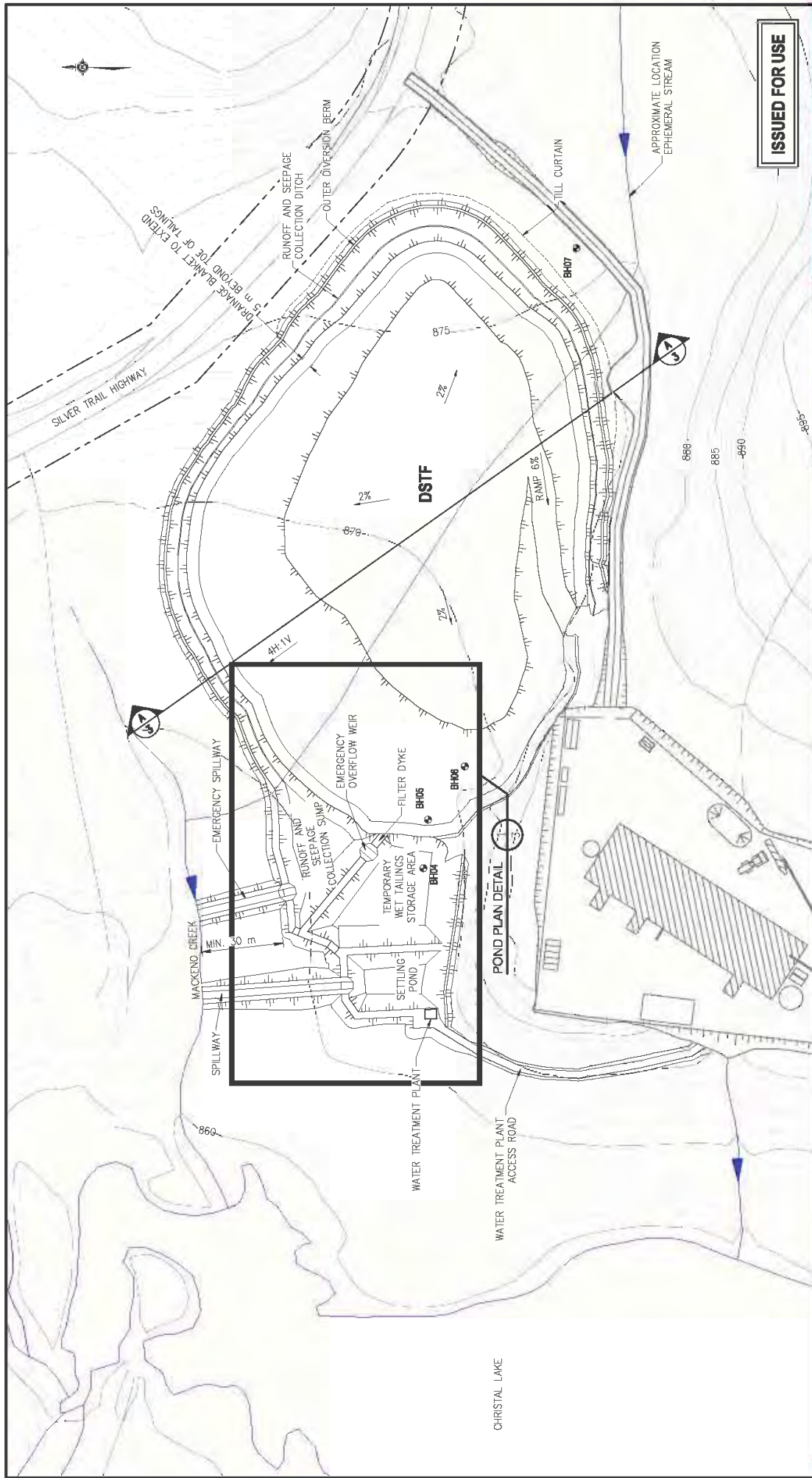


ALEXCO

EBA Engineering Consultants Ltd.

ENGINEERING SUPPORT SERVICES BELLEKENO MINE PROJECT, YUKON				
GENERAL LOCATION PLAN				
PROJECT NO.	DATE	DATE	DATE	REV
W4401178.001	KJT	CJD		1
DATE	DATE	DATE	DATE	DATE
EBA-WPSE				DECEMBER 11, 2008

Figure 1



LEGEND/NOTES:

- 1. BOREHOLE LOCATION
- 2. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
- 3. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

Scale: 1: 1,500 (metres)

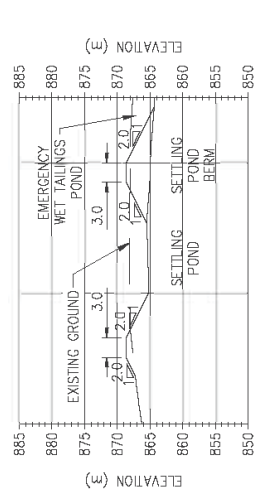
ANTICIPATED VOLUMES	
DRAINAGE STRUCTURES	DSTF
RUNOFF AND SEEPAGE COLLECTION SUMP CAPACITY = 1,200 m ³	CAPACITY = 140,000 m ³
TEMPORARY WET TAILINGS STORAGE AREA CAPACITY = 1,500 m ³	DRAINAGE BLANKET EXCAVATION = 3,100 m ³
SETTLING POND CAPACITY = 1,000 m ³	DRAINAGE BLANKET FILL = 20,000 m ³
SUMP AND PONDS EXCAVATION = 8,200 m ³	
SUMP AND PONDS FILL = 3,100 m ³	
DIVERSION BERMS AND DITCHES CUT = 3,000 m ³	
DIVERSION BERMS AND DITCHES FILL = 1,500 m ³	
FILTER DYKE FILL = 1,250 m ³	

ALEXCO

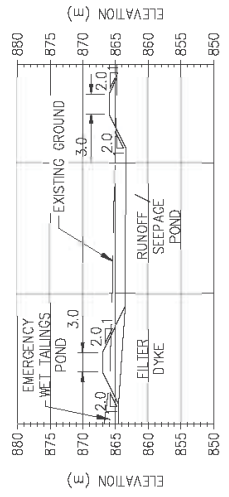
EBA Engineering Consultants Ltd.

ENGINEERING SUPPORT SERVICES		MACKENO TAILINGS AND STORMWATER MANAGEMENT PLAN	
PROJECT NO.	W2410178.001	DATE	DECEMBER 11, 2008
BY	KIT	CHK	1
APP'D		C.D.	
EBA-WISE		Figure 2	

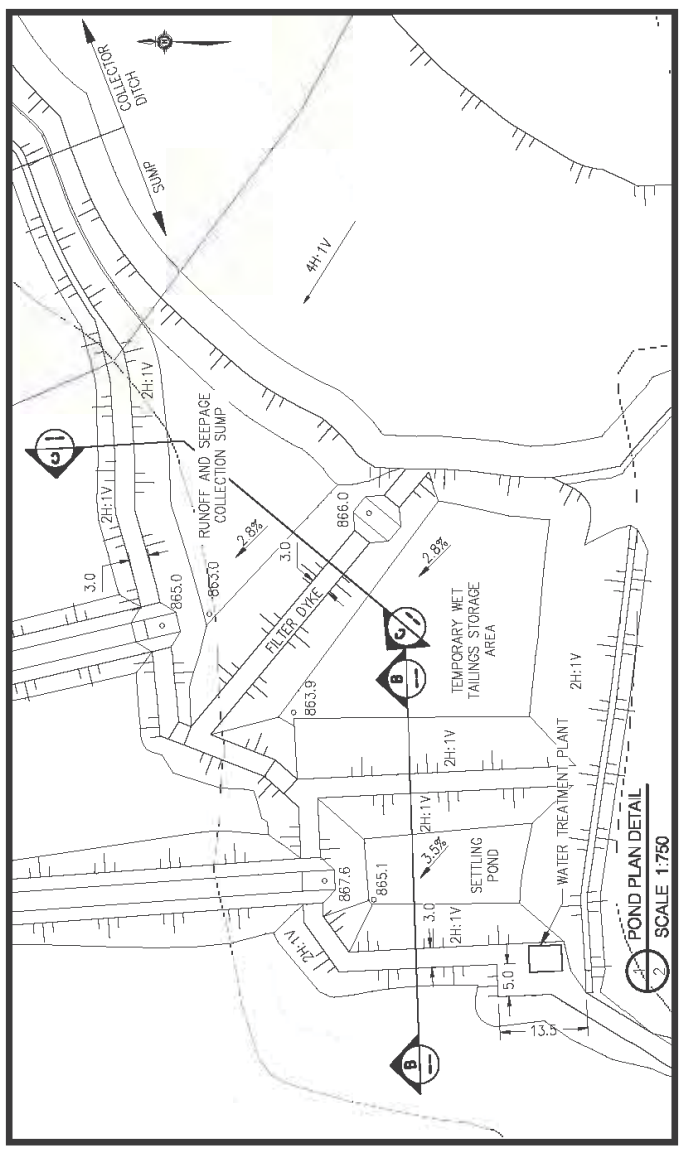
ISSUED FOR USE



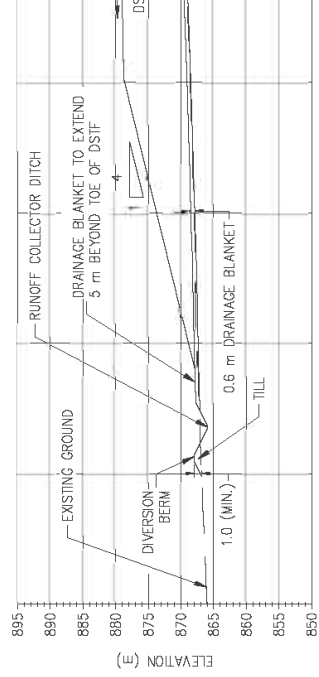
B **SETTLING POND SECTION**
SCALE 1:750



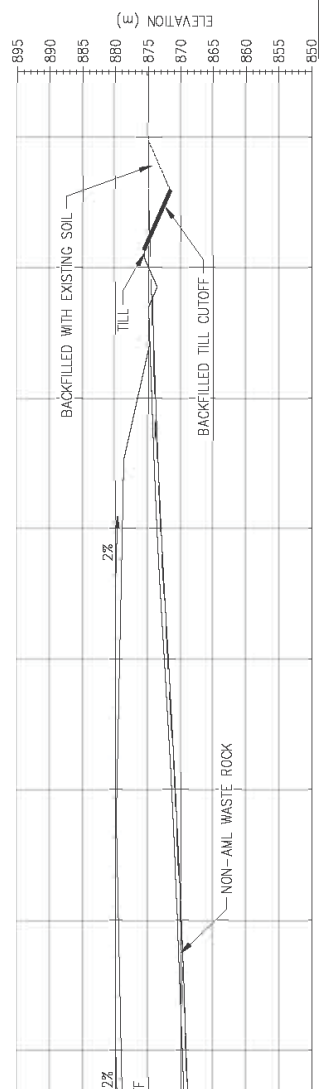
C **RUNOFF/SEEPAGE POND SECTION**
SCALE 1:750



A **POND PLAN DETAIL**
SCALE 1:750



A **DRY-STACKED TAILINGS PILE SECTION**
SCALE 1:750



B **DRY-STACKED TAILINGS PILE SECTION**
SCALE 1:750

NOTE
1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED
2. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
3. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON

MACKENO TAILINGS AND STORMWATER
MANAGEMENT DETAILS AND SECTIONS

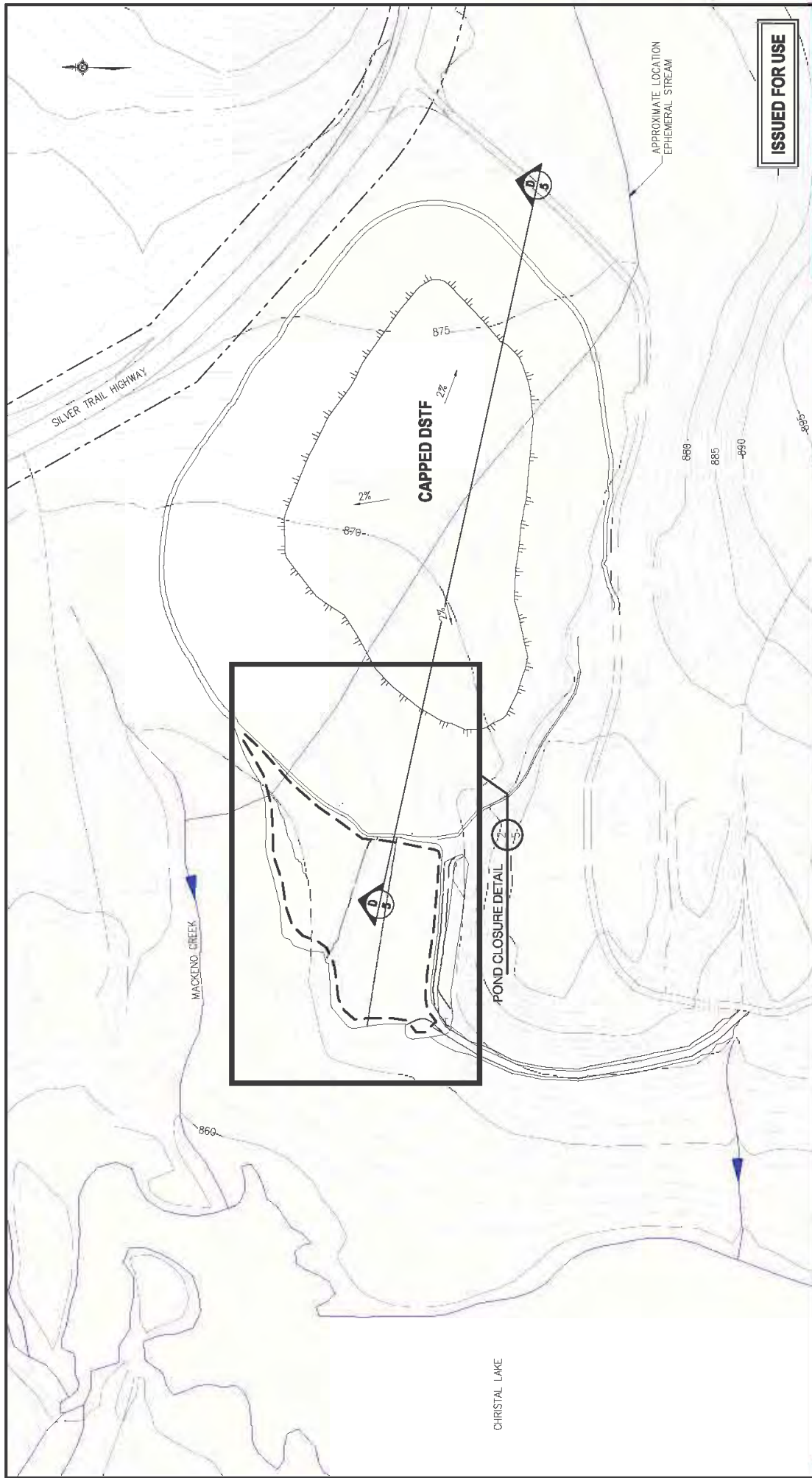
PROJECT NO.	WY1401178.001	DATE	DEC 11	REV	1
PROJECT NAME	WY1401178.001	DATE	DEC 11	REV	1
PROJECT NAME	WY1401178.001	DATE	DEC 11	REV	1
PROJECT NAME	WY1401178.001	DATE	DEC 11	REV	1

EBA Engineering Consultants Ltd.

DECEMBER 11, 2008

Scale: 1: 750 (metres)

Figure 3



ENGINEERING SUPPORT SERVICES
BELLEND MINE PROJECT, YUKON

MACKENO CLOSURE PLAN

PROJECT NO. W2410178.001
DATE: 12/11/2008
BY: EBA-WHE

DESIGN: KJT
CHECK: CJD
REV: 0

DECEMBER 11, 2008

Figure 4

ALEXCO

EBA Engineering Consultants Ltd.

CONCEPTUAL DESIGN VOLUMES

DRAINAGE STRUCTURES

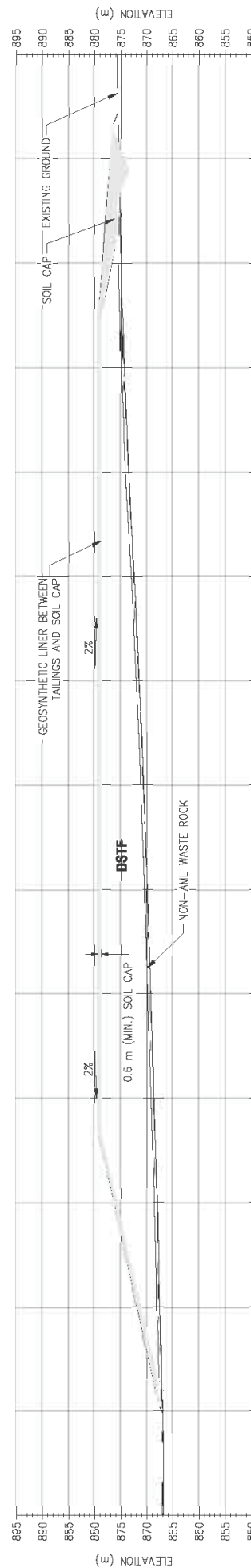
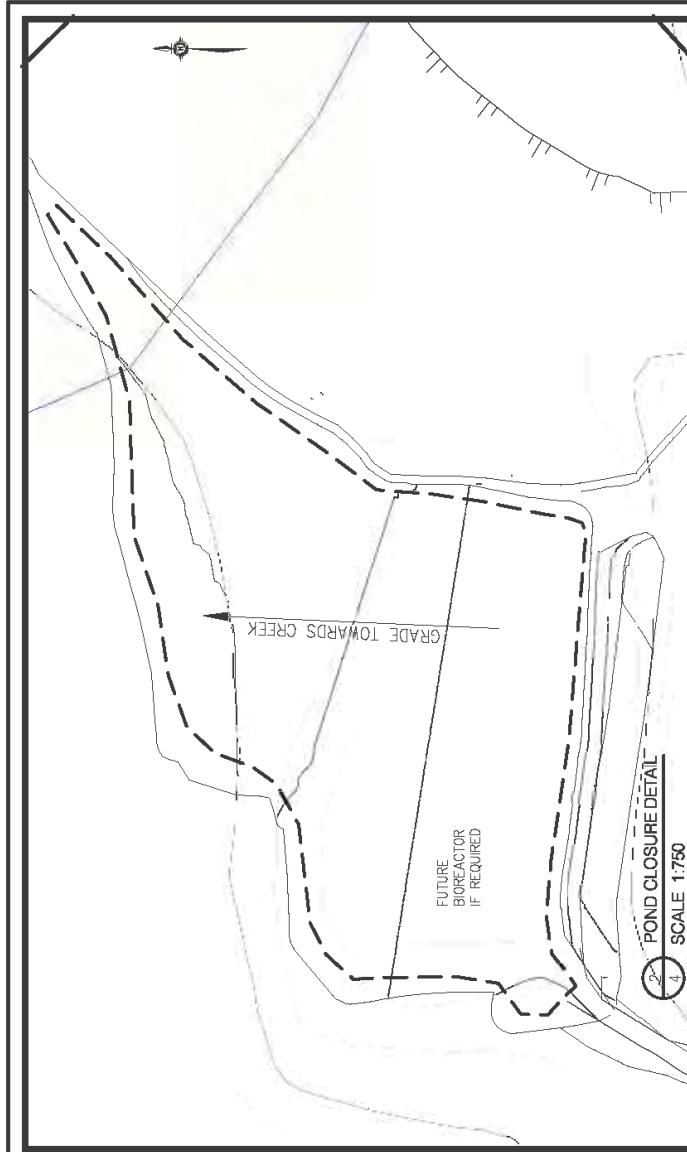
POND CLOSURE - CUT = 2,700 m³

POND CLOSURE - FILL = 4,300 m³

LEGEND/NOTES:

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

Scale: 1: 1,500 (metres)



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON

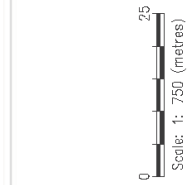
ALEXCO

EBA Engineering Consultants Ltd.

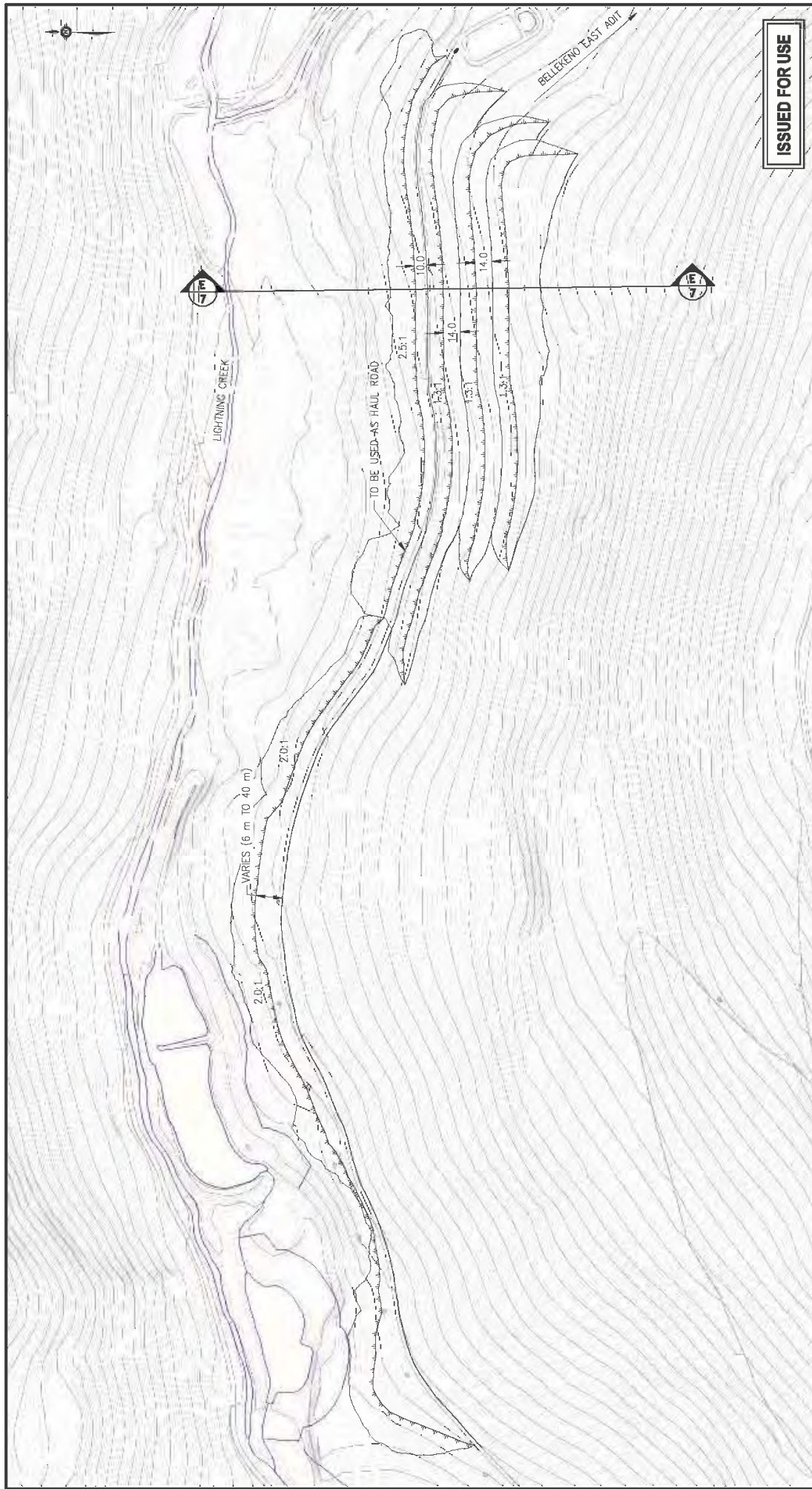
MACKENO CLOSURE
DETAIL AND SECTION

PROJECT NO. W440178.001
DATE: KIT
BY: EBA-WHSE
DATE: DECEMBER 11, 2008

Figure 5



- NOTE**
1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED
 2. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
 3. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION





**WASTE ROCK DISPOSAL AREA
PROFILE**

PROJECTING	DAYS	DATE
W14101178.001	KJT	DECEMBER 11, 2008
OFFICE		
EBA-WHSE		

Figure 7



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX F
MSDS DATA SHEETS
FOR MILL CHEMICALS**



Material Safety Data Sheet

Preparation Date: 16-Jun-2004

Revision Date: 30-Jul-2008

Revision Number: 1

SECTION 1 – PRODUCT AND COMPANY IDENTIFICATION

Supplier(s):

Orica Canada Inc.

Maple Street

Brownsburg, QC

For MSDS Requests: 1-450-533-4201

Orica USA Inc.

33101 E. Quincy Avenue

Watkins, CO 80137-9406

For MSDS Requests: 1-303-268-5000

Product Name:

Ammonium Nitrate Fuel Oil

Product Code:

125

Alternate Name(s):

AMEX™, AMEX HD™, ANFO

UN-No:

UN0331

Recommended Use:

A booster sensitive blasting agent.

Emergency Telephone Number: FOR CHEMICAL EMERGENCIES (24 HOUR) INVOLVING TRANSPORTATION, SPILL, LEAK, RELEASE, FIRE OR ACCIDENTS: **IN CANADA CALL:** THE ORICA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-877-561-3636. **IN THE U.S. CALL: CHEMTREC 1-800-424-9300. IN THE U.S.:** FOR LOST, STOLEN, OR MISPLACED EXPLOSIVES CALL: BATF 1-800-800-3855. FORM ATF F 5400.0 MUST BE COMPLETED AND LOCAL AUTHORITIES (STATE/MUNICIPAL POLICE, ETC.) MUST BE ADVISED.

SECTION 2 – HAZARD IDENTIFICATION

Emergency Overview:

Risk of explosion by shock, fire or other sources of ignition. If misused or disposed of improperly, material could explode and cause death or serious injury. This product contains one or more substances, which are classified in the EU as carcinogenic, mutagenic and/ or reprotoxic. Irritating to eyes, respiratory system and skin. Harmful if swallowed. Oxidizing agent.

Appearance:

Off-white prills

Physical State:

Solid

Odor:

Diesel fuel oil

SECTION 3 – COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name

Ammonium Nitrate

Fuels, Diesel, no. 2

CAS-No

6484-52-2

68476-34-6

Weight %

60-82

5-10

SECTION 4 – FIRST AID MEASURES

General Advice:

In case of accident or if you feel unwell, seek medical advice IMMEDIATELY (show the product label where possible).

Eye Contact:

Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Immediate medical attention is required.

Skin Contact:

Wash off immediately with soap and plenty of water, removing all contaminated clothes and shoes. If skin irritation persists, call a physician.

Inhalation:

Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical advice IMMEDIATELY.

Ingestion:

Immediate medical attention is required. Do not induce vomiting. Clean mouth with water and afterwards drink plenty of water. If spontaneous vomiting occurs, have victim lean forward with head positioned to avoid breathing in of vomitus, rinse mouth and administer more water. Never give anything by mouth to and unconscious person.

Notes to physician:

Symptomatic. Administer oxygen if there are signs of cyanosis. If clinical condition deteriorates, administer 10cc Methylene Blue intravenously. It is unlikely for this to be required with methemoglobin level of less than 40%.

SECTION 5 – FIRE-FIGHTING MEASURES

Flammable properties:	Not itself combustible but assists fire in burning materials. The product does not flash. Rate of burning: does not sustain burning at atmospheric pressure.
Suitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Evacuate surrounding areas. When controlling fire before involvement of explosives, fire-fighters should wear positive pressure self-containing breathing apparatus (SCBA) and full turnout gear. Water may be applied through fixed extinguishing system (sprinklers) as long as people need not be present for the system to operate.
Unsuitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Attempts to smother a fire involving this product will be ineffective as it is its own oxygen source. Smother this product could lead to decomposition and explosion. This product is more sensitive to detonation if contaminated with organic or oxidisable material or if heated while confined. Unless the mass of product on fire is flooded with water, re-ignition is possible.
Specific hazards arising from the chemical:	This product is a high explosive with mass detonation hazard. DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area to a safe distance. Guard against re-entry. Thermal decomposition can lead to release of irritating gases and vapors.
Protective equipment and precautions for firefighters:	As in any fire, wear self-contained breathing apparatus pressure-demand, NIOSH approved (or equivalent) and full protective gear.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods for containment:	Avoid dust formation. Do not breathe dust.
Methods for cleaning up:	Avoid the use of metal tools containing iron and/or copper. Be careful to avoid shock, friction, and contact with grit. Collect product for recovery or disposal. For release to land, contain discharge by constructing dykes or applying inert absorbent; for release to water, utilize damming and/or water diversion to minimize the spread of contamination. Collect contaminated soil and water, and absorbent for proper disposal. Notify applicable government authority if release is reportable or could adversely affect the environment.
Other information:	Deactivating chemicals: Not applicable.

SECTION 7 – HANDLING AND STORAGE

Handling:	This product is an explosive and should only be used under the supervision of trained personnel. The use of coveralls is recommended. Use good industrial hygiene and housekeeping practices. Keep away from open flames, hot surfaces and sources of ignition.
Storage:	Store under moderate temperatures recommended by a technical services representative. Store under dry conditions in a well ventilated magazine that has been approved for either detonator storage or explosive storage. Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, spark and flames. Keep containers closed. Explosives should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials; combustibles, and sources of heat. Keep away from incompatibles. Ideal storage temperature is 10-27°C (50-80°F). Do not expose sealed containers to temperatures above 40°C (104°F).

SECTION 8 – EXPOSURE CONTROLS/PERSONAL PROTECTION

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Fuels, Diesel, no. 2	TWA: 100 mg/ m ³ Skin		

Other exposure guidelines:	Ammonium Nitrate: ORICA Guideline 5 mg/m ³ (internal TWA).
Engineering Measures:	No information available.
Personal Protective Equipment	
Eye/Face Protection:	Tightly fitting safety goggles.
Skin Protection:	User should verify impermeability under normal conditions of use prior to general use. Impervious butyl rubber gloves.
Respiratory Protection:	In case of insufficient ventilation wear suitable respiratory equipment. A NIOSH-approved respirator, if required.

Hygiene Measures: Handle in accordance with good industrial hygiene and safety practice. Recommendations listed in this section indicate the type of equipment, which will provide protection against over exposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Off-white prills	Odor:	Diesel fuel oil
Physical State:	Solid	Viscosity:	No information available
pH:	No data available	Flash Point:	52 °C/ 126 °F (Diesel fuel)
Autoignition Temperature:	230- 265 °C	Boiling Point/Range:	None
Melting Point/Range:	170 °C/ 338 °F	Flammable Limits (Upper):	Not Applicable
Flammable Limits (Lower):	Not Applicable	Explosion Power:	350-400 kJ/ 100g
Specific Gravity:	No data available	Water Solubility:	Dissolves slowly with prolonged exposure to water
Other Solubility:	Not available	Vapor Pressure:	0.4 mmHg @ 20 °C /68 °F (diesel fuel oil)
Oxidizing Properties:	Oxidizer	Partition Coefficient (n-octanol/water):	No data available

SECTION 10 – STABILITY AND REACTIVITY

Stability:	Stable under normal conditions. Decomposition Temperature: Ammonium Nitrate will spontaneously decompose at 210 °C (410 °F).
Conditions to avoid:	Keep away from open flames, hot surfaces and sources of ignition. Not expected to be sensitive to static discharge. Not expected to be sensitive to mechanical impact.
Incompatible materials:	Avoid oxidizable materials, metal powder, bronze & copper alloys, fuels (e.g. lubricants, machine oils), fluorocarbon lubricants, acids, corrosive liquids, chlorate, sulphur, sodium nitrite, charcoal, coke and other finely divided combustibles. Strong oxidizing and reducing agents.
Hazardous decomposition products:	The following toxic decomposition products may be released. At temperatures above 210 °C, decomposition may be explosive, especially if confined. Nitrogen oxides (NOx). Carbon oxide. Hydrocarbons.
Hazardous Polymerization:	None under normal processing. Hazardous polymerization does not occur. Explosive material under shock conditions.

SECTION 11 – TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information: Irritating to eyes. May cause skin irritation. Harmful if swallowed.

Chemical name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Ammonium Nitrate	2217 mg/kg Rat	3000 mg/kg Rabbit	88.8 mg/L Rat 4 h
Fuels, Diesel, no. 2	>5000 mg/kg Rat	>5000 mg/kg Rabbit	

Subchronic Toxicity (28 Days): Ammonium Nitrate: Ingestion may cause methemoglobinemia. Initial manifestation of methemoglobinemia is cyanosis, characterized by navy lips, tongue and mucous membranes, with skin color being slate grey. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia. If ingested, nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include methemoglobinemia, nausea, dizziness, increased heart rate, hypotension, fainting and, possibly shock.

Chronic Toxicity: May cause methemoglobinemia.
Carcinogenicity: The table below lists whether each agency has listed any ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
Fuels, Diesel, no. 2	A3			

Legend: A3: Confirmed animal carcinogen.
Mutagenic effects: There is no evidence of mutagenic potential.

Irritation: Irritating to eyes. May cause irritation of respiratory tract. May cause skin irritation in susceptible persons.

Reproductive effects: No information is available and no adverse reproductive effects are anticipated.

Developmental effects: No information is available and no adverse developmental effects are anticipated.

Target Organ: Eyes, skin, respiratory system, blood, kidney, liver, urinary tract, blood, endocrine system, immune system & gastrointestinal tract (GI).

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity effects: Dissolves slowly in water. Harmful to aquatic life at low concentrations.
Environmental Effects: Can be dangerous if allowed to enter drinking water intakes. Do not contaminate domestic or irrigation water supplies, lakes, streams, ponds, or rivers.

Persistence/Degradability: Some water resistance but soluble with extended time periods.

Mobility in Environmental media: Dissolves slowly in water.

SECTION 13 – DISPOSAL CONSIDERATIONS

Waste Disposal Method: Burn under supervision of an expert at an explosive burning ground or destroy by detonation in boreholes, in accordance with applicable local, provincial and federal regulations. Call upon the services of an Orica Technical Representative.

SECTION 14 – TRANSPORT INFORMATION

DOT Proper Shipping Name: Explosive, blasting type B
Hazard Class: 1.5D
UN-No: UN0331
Packing group: II

TDG Proper Shipping Name: Explosive, blasting type B
Hazard Class: 1.5D
UN-No: UN0331
Packing group: II

Transportation Emergency Telephone Number: 1-877-561-3636 or CHEMTREC: 1-800-424-9300

SECTION 15 – REGULATORY INFORMATION

CANADIAN CLASSIFICATION: This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS contains all the information required by the CPR

WHMIS hazard class: This product is an explosive and is not regulated by WHMIS.

USA CLASSIFICATION:

SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements, Ammonium Nitrate (6484-52-2) & Fuels, Diesel no.2 (68476-34-6).

SARA 311/312 Hazardous Categorization

Acute Health Hazard: Yes
Chronic Health Hazard: Yes
Fire Hazard: Yes
Reactive Hazard: Yes
Sudden Release of Pressure Hazard: No

Ozone Protection and 40 CFR 42: No reportable quantities of ozone depleting agents

Other Regulations/Legislations which apply to this product: New Jersey Right-to-Know, Pennsylvania Right-to-Know, Massachusetts Right-to-Know, Rhode Island Right-to-Know, Florida, New Jersey Special Health Hazard Substance List, Minnesota Hazardous Substance List, California Director's List of Hazardous Substances, California Proposition 65.

TSCA: Complies

DSL: Complies

NDSL: Complies

The components in the product are on the following international inventory lists:

Chemical Name	TSCA	DSL	NDSL	ENCS	EINECS	ELINCS	CHINA	KECL	PICCS	AICS
Ammonium Nitrate	X	X	-	-	X	-	X	X	X	X
Fuels, Diesel, no. 2	X	X	-	X	X	-	X	X	X	X

Legend: X – Listed

SECTION 16 – OTHER INFORMATION

Prepared by: Safety Health & Environment
303-268-5000

Preparation Date: 16-Jun-2004

Revision Date: 30-Jul-2008

The information contained herein is offered only as guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Orica will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

End of MSDS



Material Safety Data Sheet

Preparation Date: 21-May-2005

Revision Date: 22-Oct-2008

Revision Number: 1

SECTION 1 – PRODUCT AND COMPANY IDENTIFICATION

Supplier(s):

Orica Canada Inc.

Maple Street

Brownsburg, QC

For MSDS Requests: 1-450-533-4201

Orica USA Inc.

33101 E. Quincy Avenue

Watkins, CO 80137-9406

For MSDS Requests: 1 303-268-5000

Product Name:

B-line™, Boostercord™, Cordtex™, Powercord™, Primaflex™

Product Code:

40040

Alternate Name(s):

Uniline, B-Line, Trunkline, Powercord 100, Powercord 150, Powercord 200, Powercord O 200, Boostercord, Primaflex, Anoline, X-245, X-247, Cordtex 7.5, Cordtex SHD, Cordtex 15, Cordtex LT, Cordtex AP, Cordtex 18, Cordtex 25, Cordtex Premium, Cordtex 40, Cordtex TL, Cordtex 50, Cordtex XTL, Cordtex 60, T-line, Special, 4400 M/S, Poly, Low Flash 25

UN-No:

UN0065

Recommended Use:

Used for initiation of explosive mixtures.

Emergency Telephone Number: FOR CHEMICAL EMERGENCIES (24 HOUR) INVOLVING TRANSPORTATION, SPILL, LEAK, RELEASE, FIRE OR ACCIDENTS: **IN CANADA CALL:** THE ORICA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-877-561-3636. **IN THE U.S. CALL: CHEMTREC 1-800-424-9300. IN THE U.S.:** FOR LOST, STOLEN, OR MISPLACED EXPLOSIVES CALL: BATF 1-800-800-3855. FORM ATF F 5400.0 MUST BE COMPLETED AND LOCAL AUTHORITIES (STATE/MUNICIPAL POLICE, ETC.) MUST BE ADVISED.

SECTION 2 – HAZARD IDENTIFICATION

Emergency Overview:

Danger. Explosive. Risk of explosion by shock, friction, fire or other sources of ignition. This product is an article. No exposure to hazardous chemicals is expected to occur during intended product use. Misuse of the product may result in exposure to hazardous chemicals.

Appearance:

Cords covered with PVC or polyethylene plastic and/ or wax textiles

Physical State:

Solid

Odor:

Odorless

SECTION 3 – COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name

Pentaerythritol Tetranitrate (PETN)

CAS-No

115-77-5

Weight %

60-100

SECTION 4 – FIRST AID MEASURES

General Advice:

Not applicable; this is a packaged product that will not result in exposure to the contents under normal conditions of use. In the event of contact, administer first aid appropriate for symptoms present.

Eye Contact:

Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Immediate medical attention is required.

Skin Contact:

Wash off immediately with soap and plenty of water, removing all contaminated clothes and shoes. If skin irritation persists, call a physician.

Inhalation:

Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is not breathing AND no pulse. Obtain medical advice IMMEDIATELY.

Ingestion:

Immediate medical attention is required. Do not induce vomiting. Clean mouth with water and afterwards drink plenty of water. If spontaneous vomiting occurs, have victim lean forward with head positioned to avoid breathing in of vomitus, rinse mouth and administer more water. Never give anything by mouth to and unconscious person.

Notes to physician: Symptomatic. Administer oxygen if there are signs of cyanosis. If clinical condition deteriorates, administer 10cc Methylene Blue intravenously. It is unlikely for this to be required with methemoglobin level of less than 40%.

SECTION 5 – FIRE-FIGHTING MEASURES

Flammable properties: Product burns if ignited, with possible transition to detonation. May ignite or explode if heated under confinement.

Suitable extinguishing media: DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Evacuate surrounding areas. When controlling fire before involvement of explosives, fire-fighters should wear positive pressure self-containing breathing apparatus (SCBA) and full turnout gear. Water may be applied through fixed extinguishing system (sprinklers) as long as people need not be present for the system to operate.

Unsuitable extinguishing media: DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Attempts to smother a fire involving this product will be ineffective as it is its own oxygen source. Smother this product could lead to decomposition and explosion. This product is more sensitive to detonation if contaminated with organic or oxidisable material or if heated while confined. Unless the mass of product on fire is flooded with water, re-ignition is possible.

Specific hazards arising from the chemical: This product is a high explosive with mass detonation hazard. DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area to a safe distance. Guard against re-entry. Thermal decomposition can lead to release of irritating gases and vapors.

Protective equipment and precautions for firefighters: As in any fire, wear self-contained breathing apparatus pressure-demand, NIOSH approved (or equivalent) and full protective gear.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods for containment: No information available.

Methods for cleaning up: Review fire and explosion hazards before proceeding with clean up. Remove and protect ignition sources. Wear protective equipment during clean up. Mop up water using non-sparking tools. It is suggested that only personnel trained in Emergency Response should respond. Verify complete account of product(s). Notify authorities and follow applicable spill reporting requirements.

SECTION 7 – HANDLING AND STORAGE

Handling: This product is an explosive and should only be used under the supervision of trained personnel. Protect containers from physical damage. Keep away from incompatible materials, heat, sparks, flames and other ignition sources. Avoid rough handling.

Storage: Store under moderate temperatures recommended by a technical services representative. Store under dry conditions in a well ventilated magazine that has been approved for either detonator storage or explosive storage. Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, sparks and flames. Keep containers closed. Explosives should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials, combustibles, and sources of heat. Keep away from incompatibles.

SECTION 8 – EXPOSURE CONTROLS/ PERSONAL PROTECTION

Engineering Measures: Full-handling precautions should be taken at all times.

Personal Protective Equipment

Eye/Face Protection: Tightly fitting safety goggles

Skin Protection: Long sleeved clothing.

Respiratory Protection: No special protective equipment required.

Hygiene Measures: Handle in accordance with good industrial hygiene and safety practice.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Cords covered with PVC or polyethylene plastic and/or wax and textiles	Odor:	None
Physical State:	Solid	Viscosity:	No information available
pH:	No data available	Flash Point:	Not applicable
Autoignition Temperature:	No data available	Boiling Point/Range:	Not applicable
Melting Point/Range:	No data available	Flammable Limits (Upper):	Not applicable
Flammable Limits (Lower):	Not applicable	Explosion Power:	No data available
Specific Gravity:	No data available	Water Solubility:	Negligible
Other Solubility:	Not applicable	Vapor Pressure:	No data available
Oxidizing Properties:	Not available	Partition Coefficient (n-octanol/water):	No data available

SECTION 10 – STABILITY AND REACTIVITY

Stability:	Can explode from impact, heat or friction. PETN explodes at 190 - 210°C (374 - 410°F). Stable up to approximately 70°C.
Conditions to avoid:	Keep away from heat, impact, and friction. Some cords have limited tensile strength and abrasion resistance. Refer to the Product Bulletin for proper applications and use procedures. Damaged cords can lead to misfired holes - potentially, the most hazardous of all blasting situations. Avoid abrasion of cord on hole collars or casing pipes.
Incompatible materials:	Strong oxidizing agents. The PVC/polyethylene plastic or wax covering will, in time, be affected by diesel oil.
Hazardous decomposition products:	Carbon oxide. Nitrogen oxides (NOx). Hydrocarbons.

SECTION 11 – TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information:	Irritating to eyes. May cause skin irritation. Harmful if swallowed.
Chronic Toxicity:	Not available.
Carcinogenicity:	The ingredients of this product are not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by TNTP (National Toxicology Program).
Mutagenic effects:	There is no evidence of mutagenic potential.
Irritation:	Irritating to eyes. May cause irritation of respiratory tract. May cause skin irritation in susceptible persons.
Reproductive effects:	No information is available and no adverse reproductive effects are anticipated.
Developmental effects:	No information is available and no adverse developmental effects are anticipated.
Target Organ:	Eyes, skin, respiratory system, blood, liver, urinary tract, gastrointestinal tract (GI), endocrine system, & immune system.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity effects:	There is no known ecological information for this product.
Persistence/Degradability:	Not applicable.
Mobility in Environmental media:	Not applicable.

SECTION 13 – DISPOSAL CONSIDERATIONS

Waste Disposal Method:	Burn under supervision of an expert at an explosive burning ground or destroy by detonation in boreholes, in accordance with applicable local, provincial and federal regulations. Call upon the services of an Orica Technical Representative.

SECTION 14 – TRANSPORT INFORMATION

DOT Proper Shipping Name: Cord, Detonating
Hazard Class: 1.1D
UN-No: UN0065
Packing group: II
TDG Proper Shipping Name: Cord, Detonating
Hazard Class: 1.5D
UN-No: UN0065
Packing group: II

SECTION 15 – REGULATORY INFORMATION

CANADIAN CLASSIFICATION: This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS contains all the information required by the CPR

WHMIS hazard class: This product is an explosive and is not regulated by WHMIS.

USA CLASSIFICATION:

SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements,

SARA 311/312 Hazardous Categorization

Acute Health Hazard: No

Chronic Health Hazard: No

Fire Hazard: No

Reactive Hazard: Yes

Sudden Release of Pressure Hazard: No

Ozone Protection and 40 CFR 42: No reportable quantities of ozone depleting agents

Other Regulations/Legislations which apply to this product: No information available.

TSCA: Complies

DSL: Complies

NDSL: Complies

SECTION 16 – OTHER INFORMATION

Prepared by: Safety Health & Environment
303-268-5000

Preparation Date: 21-May-2005

Revision Date: 22-Oct-2008

REFERENCES:

RTECS-Registry of Toxic Effects of Chemical Substances, CCINFODisc, Canadian Centre for Occupational Health and Safety, National Institute for Occupational Safety and Health, U.S. Dept. of Health & Human Services, Cincinnati, 1998.

Clayton, G.D. and Clayton, F.E., Eds., Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. IIA, B, C, John Wiley and Sons, New York, 1981.

Supplier's Material Safety Data Sheets.

CHEMINFO, HSDB, & NIOSH through "CCINFODisc", Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada, 1998.

"CHEMINFO", "CHRIS", "TOG", "DOT", through "CCINFODisc", Occupational Health and Safety, Hamilton, Ontario, Canada.

Documentation of the Threshold Limit Values and Biological Exposure Indices, 5th ed., American Conference of Governmental Industrial Hygienists Inc., Cincinnati, 1986.

Threshold Limit Values and Biological Exposure Indices for 1997, American Conference of Governmental Industrial Hygienists, Cincinnati, 1997.

Windholz, Martha, Ed., The Merck Index, 11 th ed., Merck and Co., Inc., Rahway, New Jersey, 1989

The information contained herein is offered only as guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Orica will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

End of MSDS



Material Safety Data Sheet

Preparation Date: 07-Nov-2005

Revision Date: 22-Oct-2008

Revision Number: 1

SECTION 1 – PRODUCT AND COMPANY INFORMATION

Supplier(s):

Orica Canada Inc.
Maple Street
Brownsburg, QC

For MSDS Requests: 1-450-533-4201

Orica USA Inc

33101 E Quincy Ave
Watkins, CO 80137-9406

For MSDS Requests: 1-303-268-5000

Product Name:

ElectricCoal™, ElectricMS™, ElectricLP™, Electric Seismic, Electric Instant

Product Code:

20147

Alternate Name(s):

Not available

UN-No:

UN0255 or UN0030 (depending on packaging)

Recommended Use:

Electric detonators and accessory products.

Emergency Telephone Number: FOR CHEMICAL EMERGENCIES (24 HOUR) INVOLVING TRANSPORTATION, SPILL, LEAK, RELEASE, FIRE OR ACCIDENTS: **IN CANADA CALL:** ORICA CANADA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT **1-877-561-3636**. **IN US CALL:** CHEMTREC **1-800-424-9300**. **IN THE U.S.** FOR LOST, STOLEN OR MISPLACED EXPLOSIVES CALL: BATF **1-800-800-3855**. FORM ATF F5400.0 MUST BE COMPLETED AND LOCAL AUTHORITIES (STATE/MUNICIPAL POLICE, ETC.) MUST BE ADVISED.

SECTION 2 – HAZARD IDENTIFICATION

Emergency Overview:

The following information is the potential hazards associated with the ingredient(s) in this product. It is our belief that, under conditions of normal occupational exposure, this product should pose no such hazards to the user. Main risk is that of explosion by shock, friction, fire or other sources of ignition. Read the entire MSDS for a more thorough evaluation of the hazards.

Appearance:

A metal cylinder with varying length attached plastic coated wires.

Physical State:

Solid

Odor:

None

SECTION 3 – COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name

Pentaerythritol Tetranitrate (PETN)

Barium

Chromium

Barium Chromate

CAS-No

78-11-5

7440-39-3

7440-47-3

10294-40-3

Weight %

1-5

1-5

1-5

1-5

SECTION 4- FIRST AID MEASURES

General Advice:

General: Not applicable; this is a packaged product that will not result in exposure to the contents under normal conditions of use.

In the event of contact, administer first aid appropriate for burns, laceration and bruises. If detonation fumes are inhaled, remove to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Oxygen administration may be beneficial in this situation, but should only be administered by personnel trained in its use. Obtain medical attention IMMEDIATELY.

Eye Contact:

No applicable information.

Skin Contact:

No applicable information.

Inhalation:

In the event those workers are overexposed to fumes and vapour resulting from detonation, remove victim from exposure and provide artificial respiration if not breathing.

Ingestion:

No applicable information.

Notes to Physician:

No applicable information.

SECTION 5 – FIRE-FIGHTING MEASURES

Flammable properties:	Product burns if ignited, with possible transition to detonation. May ignite or explode if heated under confinement.
Suitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Evacuate surrounding areas. When controlling fire before involvement of explosives, fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear. Water may be applied through fixed extinguishing system (sprinklers) as long as people need not be present for the system to operate. Water may be used on small fires.
Unsuitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area to a safe distance. Guard against re-entry. This product is a high explosive with a mass detonation hazard. Thermal decomposition can lead to release of irritating gases and vapors.
Protective equipment and precautions for fire fighters:	As in any fire, wear self-contained breathing apparatus pressure-demand, NIOSH approved (or equivalent) and full protective gear.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods for containment:	No information available.
Methods for cleaning up:	Not required. If detonators are damaged, contact an Orica Canada Inc. or Orica USA Inc. Technical Representative. If detonators are broken, contact product advisor.

SECTION 7 - HANDLING AND STORAGE

Handling:	This product is an explosive and should only be used under the supervision of trained personnel. Protect containers from physical damage. Keep away from incompatible materials, heat, sparks, flames and other ignition sources. Avoid rough handling. Keep upwind of discharging unit. Post detonation: Avoid breathing post detonation residue; avoid getting into eyes or on skin. Utilize recommended exposure controls/protective clothing when working with post detonation residue or the contents of a damaged detonator.
Storage:	Store under moderate temperatures recommended by a technical services representative. Store under dry conditions in a well ventilated magazine that has been approved for either detonator storage or explosive storage. Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, sparks and flames. Keep containers closed. Explosives should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials, combustibles, and sources of heat. Keep away from incompatibles. Meet all legal requirements for shipping and magazing.
Storage temperature:	It is recommended that detonators not be stored or used at temperatures exceeding 70°C (158°F) without approved procedures to address the elevated temperatures.

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Other exposure guidelines:	Recommendations listed in this section indicate the type of equipment that will provide protection against exposure to this product under normal conditions of use. Conditions of use, adequacy of engineering or other control measures, and actual exposure situations will dictate the need for specific protective devices at your workplace.
Engineering Measures:	Full-handling precautions should be taken at all times.
Personal Protective Equipment	
Eye/Face Protection:	Safety glasses with side-shields are recommended to prevent eye contact.
Skin Protection:	Gloves and protective clothing made from cotton should provide adequate protective.
Hygiene Measures:	Handle in accordance with good industrial hygiene and safety practice.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Metal cylinder with varying length of attached plastic coated wires	Odor:	None
Physical State:	Solid	Viscosity:	No information available
pH:	No data available	Melting Point/Range:	PETN melts @ 140°C/ 284 °F
Flammable Limits (upper):	No data available	Flammable Limits (lower):	No data available
Explosion Power:	No data available	Specific Gravity:	Not available
		Oxidizing Properties:	No information available

Vapor Pressure: Not available

Partition Coefficient
(n-octanol/water): No data available

SECTION 10 - STABILITY AND REACTIVITY

Stability: Can explode from impact, heat or friction. If detonators are broken, contact product advisor. PETN explodes at 190 - 210°C (374 - 410°F).

Conditions to avoid: Impact or shock. Static discharge.

Incompatible materials: Acids, Bases.

Hazardous decomposition products: Thermal decomposition products are toxic and may include lead, hydrocarbons, oxides of carbon and nitrogen. To a lesser degree, decomposition products may include oxides of lead, chromium, barium, boron and hydrogen cyanide.

Hazardous Polymerization: None under normal processing.

SECTION 11 - TOXICOLOGICAL INFORMATION

Acute Toxicity

Product information: This product is an article. The following information is the potential hazards associated with the Ingredient(s) in this product. Under conditions of normal occupational exposure, this product should pose no such hazards to the user. Main risk is that of explosion by shock, friction, fire or other sources of ignition.

Subchronic Toxicity (28 days): Organic nitrates act as vasodilators; signs and symptoms of poisoning include headache, dizziness, increased heart rate, postural weakness and hypotension. Dermatitis or "drug rash" of the skin may also be observed.

Chronic toxicity: Contains a substance that is a known carcinogen. May cause cardiac effects.
Carcinogenicity: The table below indicates whether each agency has listed and ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
Barium Chromate	A1	Group 1	X	X

Legend: A1: Confirmed human carcinogen. Group 1: Some evidence of carcinogenicity was noted in humans. X: Acknowledged in NTP and OSHA carcinogen lists.

Mutagenic effects: Substances which should be regarded as being mutagenic to man. Lead.

Reproductive effects: It is our belief that under normal conditions of use, this product should pose no reproductive hazard to the worker. Lead exposure may cause reproductive effects based on studies in laboratory animals and on human epidemiological studies.

Developmental effects: It is our belief that under normal conditions of use, this product should pose no reproductive hazard to the worker. Lead has been shown to cause congenital abnormalities and behavioral deficits in experimental animals in addition to its ability to increase the number of miscarriages, stillbirths and abortions in lead-exposed women.

Target Organ: Eyes, Skin, Cardiovascular system, Immune system.

Other adverse effects: Prolonged or repeated exposure to organic nitrates may develop a tolerance due to chronic dilation of the blood vessels. This tolerance disappears rapidly after a few days away from exposure and withdrawal symptoms consisting of angina and heart attack have been reported in chronically exposed workers. Another type of tolerance loss is the "Monday morning disease", where workers experience headaches, dizziness, postural weakness and other symptoms.

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity effects: Contains no substances known to be hazardous to the environment or not degradable in waste water treatment plants.

SECTION 13 - DISPOSAL CONSIDERATIONS

Waste Disposal Method: Burn under supervision of an expert at a government-approved explosive burning ground or destroy, by detonation in boreholes, in accordance with applicable local, provincial and federal laws. Call upon the services of an Orica Canada Inc. or Orica USA Inc. technical representative.

SECTION 14 - TRANSPORT INFORMATION

DOT Proper Shipping Name:	Detonator, Electric
Hazard Class:	1.4B or 1.1 B (depending on packaging)
UN-No:	UN0255 or UN0030 (depending on packaging)
Packing Group:	II
TDG Proper Shipping Name:	Detonator, Electric
Hazard Class:	1.4B or 1.1 B (depending on packaging)
UN-No:	UN0255 or UN0030 (depending on packaging)
Packing Group:	II

SECTION 15 - REGULATORY INFORMATION

CANADIAN CLASSIFICATION: This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS contains all the information required by the CPR

WHMIS hazard class: This product is an explosive and is not regulated by WHMIS.

USA CLASSIFICATION:

SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements, Barium Chromate (10294-40-3), Barium (7440-39-3), & Chromium (7440-47-3).

SARA 311/312 Hazardous Categorization

Acute Health Hazard:	No
Chronic Health Hazard:	No
Fire Hazard:	No
Reactive Hazard:	Yes
Sudden Release of Pressure Hazard:	No

Ozone Protection and 40 CFR 42: No reportable quantities of ozone depleting agents.

Other Regulations/Legislations which apply to this product: Massachusetts Right-to-Know, Pennsylvania Right-to-Know, New Jersey Right-to-Know, Rhode Island Right-to-Know.

TSCA: Complies

DSL: Complies

NDSL: Complies

SECTION 16 - OTHER INFORMATION

Prepared By: Safety, Health & Environment
303-268-5000

Preparation Date: 07-Nov-2005

Revision Date: 22-Oct-2008

The information contained herein is offered as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Orica will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

End of MSDS



Material Safety Data Sheet

Preparation Date: 19-Jul-2007

Revision Date: 22-Oct-2008

Revision Number: 1

SECTION 1 – PRODUCT AND COMPANY INFORMATION

Supplier(s):

Orica Canada Inc.
Maple Street
Brownsburg, QC
For MSDS Requests: 1-450-533-4201

Orica USA Inc
33101 E Quincy Ave
Watkins, CO 80137-9406
For MSDS Requests: 1-303-268-5000

Product Name:

Exel™ Detonator Assemblies Non-Electric

Product Code:

20080

Alternate Name(s):

Exel™ Constadet™, Exel™ Handidet™, Exel™ Handidet™ LP, Exel™ XE MS, Exel™ LP (W), Exel™ MS (W), Exel™ XT, & Exel™ T&D

UN-No:

UN0360 or UN 0361 (Depending on packaging)

Recommended Use:

Non-Electric detonators and accessory products.

Emergency Telephone Number: FOR CHEMICAL EMERGENCIES (24 HOUR) INVOLVING TRANSPORTATION, SPILL, LEAK, RELEASE, FIRE OR ACCIDENTS: **IN CANADA CALL: ORICA CANADA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-877-561-3636. IN US CALL: CHEMTREC 1-800-424-9300. IN THE U.S. FOR LOST, STOLEN OR MISPLACED EXPLOSIVES CALL: BATF 1-800-800-3855.** FORM ATF F5400.0 MUST BE COMPLETED AND LOCAL AUTHORITIES (STATE/MUNICIPAL POLICE, ETC.) MUST BE ADVISED.

SECTION 2 – HAZARD IDENTIFICATION

Emergency Overview:

The following information is the potential hazards associated with the ingredient(s) in this product. It is our belief that, under conditions of normal occupational exposure, this product should pose no such hazards to the user. Main risk is that of explosion by shock, friction, fire or other sources of ignition. Read the entire MSDS for a more thorough evaluation of the hazards.

Appearance:

A signal line (solid core/shock/tube) containing an explosive charge and a detonator.

Physical State:

Solid

Odor:

None

SECTION 3 – COMPOSITION/ INFORMATION ON INGREDIENTS

Chemical Name

CAS-No

Weight %

Pentaerythritol Tetranitrate (PETN)

78-11-5

0-10

Lead Azide

13424-46-9

0-5

Cyclotetramethylenetetranitramine (HMX)

2691-41-0

0.2 – 0.4

Aluminum

7429-90-5

<0.1

Also- may contain a lead sheathed delay element(s); may include a delay composition.

SECTION 4- FIRST AID MEASURES

General Advice:

General: Not applicable; this is a packaged product that will not result in exposure to the contents under normal conditions of use.

In the event of contact, administer first aid appropriate for burns, laceration and bruises. If detonation fumes are inhaled, remove to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Oxygen administration may be beneficial in this situation, but should only be administered by personnel trained in its use. Obtain medical attention IMMEDIATELY.

Eye Contact:

No applicable information.

Skin Contact:

No applicable information.

Inhalation:

In the event those workers are overexposed to fumes and vapour resulting from detonation, remove victim from exposure and provide artificial respiration if not breathing.

Ingestion:

No applicable information.

Notes to Physician:

No applicable information.

20080- Exel™ Detonator Assemblies Non-Electric

SECTION 5 – FIRE-FIGHTING MEASURES

Flammable properties:	High explosive with mass detonation hazard. Expected to be sensitive to mechanical impact. Not expected to be sensitive to static discharge.
Suitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Evacuate surrounding areas. When controlling fire before involvement of explosives, fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear. Water may be applied through fixed extinguishing system (sprinklers) as long as people need not be present for the system to operate. Water may be used on small fires.
Unsuitable extinguishing media:	DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area to a safe distance. Guard against re-entry. This product is a high explosive with a mass detonation hazard. Thermal decomposition can lead to release of irritating gases and vapors.
Protective equipment and precautions for fire fighters:	As in any fire, wear self-contained breathing apparatus pressure-demand, NIOSH approved (or equivalent) and full protective gear.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods for containment:	No information available.
Methods for cleaning up:	Not required. If detonators are damaged, contact an Orica Canada Inc. or Orica USA Inc. technical representative. Deactivating Chemicals: Not required. If detonators are broken, contact product advisor.

SECTION 7 - HANDLING AND STORAGE

Handling:	This product is an explosive and should only be used under the supervision of trained personnel. Protect containers from physical damage. Keep away from incompatible materials, heat, sparks, flames and other ignition sources. Avoid rough handling.
Storage:	Store under moderate temperatures recommended by a technical services representative. Store under dry conditions in a well ventilated magazine that has been approved for either detonator storage or explosive storage. Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, sparks and flames. Keep containers closed. Explosives should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials, combustibles, and sources of heat. Keep away from incompatibles. Meet all legal requirements for shipping and magazinging.
Storage Temperature:	It is recommended that detonators not be stored or used at temperatures exceeding 70 °C (158 °F) without approved procedures to address the elevated temperatures.

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

Other exposure guidelines:	Recommendations listed in this section indicate the type of equipment that will provide protection against exposure to this product under normal conditions of use. Conditions of use, adequacy of engineering or other control measures, and actual exposure situations will dictate the need for specific protective devices at your workplace.
Engineering Measures:	Full-handling precautions should be taken at all times.
Personal Protective Equipment	
Eye/Face Protection:	Safety glasses with side-shields are recommended to prevent eye contact.
Skin Protection:	Gloves and protective clothing made from cotton should provide adequate protective.
Hygiene Measures:	Handle in accordance with good industrial hygiene and safety practice.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	A signal line (solid core/shock/tube) Containing an explosive charge and A detonator.	Odor:	None
Physical State:	Solid	Viscosity:	No Information Available
pH:	No data available	Melting Point/Range:	PETN melts at 140 °C / 284 °F
Flammable Limits (upper):	No data available	Flammable Limits (lower):	No data available

Explosion Power: No data available
Vapor Pressure: Not available
Partition Coefficient (n-octanol/water): No data available

Specific Gravity: Not available
Oxidizing Properties: No information available

SECTION 10 - STABILITY AND REACTIVITY

Stability: Can explode from impact, heat or friction. If detonators are broken, contact product advisor. PETN explodes at 190 - 210 °C (374 - 410 °F).
Conditions to avoid: Impact or shock. Static discharge.
Incompatible materials: Acids. Bases.
Hazardous decomposition products: Thermal decomposition products are toxic and may include lead, hydrocarbons, oxides of carbon and nitrogen. To a lesser degree, decomposition products may include oxides of lead, chromium, barium, boron and hydrogen cyanide.

SECTION 11 - TOXICOLOGICAL INFORMATION

Acute Toxicity

Subchronic Toxicity (28 days): Organic nitrates act as vasodilators; signs and symptoms of poisoning include headache, dizziness, increased heart rate, postural weakness and hypotension. Dermatitis or "drug rash" of the skin may also be observed.

Chronic toxicity: Contains no substance that is a known carcinogen.
Carcinogenicity: The ingredients of this product are not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (occupational Safety and health Administration), and not listed as carcinogens by NTP (National Toxicology Program).

Reproductive effects: It is our belief that under normal conditions of use, this product should pose no reproductive hazard to the worker. Lead exposure may cause reproductive effects based on studies in laboratory animals and on human epidemiological studies.

Developmental effects: It is our belief that under normal conditions of use, this product should pose no reproductive hazard to the worker. Lead has been shown to cause congenital abnormalities and behavioral deficits in experimental animals in addition to its ability to increase the number of miscarriages, stillbirths and abortions in lead-exposed women.

Target Organ: Eyes, Skin, cardiovascular system, Immune system.

Other adverse effects: Prolonged or repeated exposure to organic nitrates may develop a tolerance due to chronic dilation of the blood vessels. This tolerance disappears rapidly after a few days away from exposure and withdrawal symptoms consisting of angina and heart attack have been reported in chronically exposed workers. Another type of tolerance loss is the "Monday morning disease", where workers experience headaches, dizziness, postural weakness and other symptoms.

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity effects: Contains no substances known to be hazardous to the environment or not degradable in waste water treatment plants.

SECTION 13 - DISPOSAL CONSIDERATIONS

Waste Disposal Method: Burn under supervision of an expert at a government-approved explosive burning ground or destroy, by detonation in boreholes, in accordance with applicable local, provincial and federal laws. Call upon the services of an Orica Canada Inc. or Orica USA Inc. technical representative.

SECTION 14 - TRANSPORT INFORMATION

DOT Proper Shipping Name: Detonator assemblies, Non-Electric
Hazard Class: 1.1B or 1.4B (depending on packaging)
UN-No: UN0360 or UN0361 (depending on packaging)
Packing Group: II

TDG Proper Shipping Name: Detonator assemblies, Non-Electric
Hazard Class: 1.1B or 1.4B (depending on packaging)
UN-No: UN0360 or UN0361 (depending on packaging)
Packing Group: II

SECTION 15 - REGULATORY INFORMATION

CANADIAN CLASSIFICATION: This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS contains all the information required by the CPR

WHMIS hazard class: This product is an explosive and is not regulated by WHMIS.

USA CLASSIFICATION:

SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements,

SARA 311/312 Hazardous Categorization

Acute Health Hazard: No

Chronic Health Hazard: No

Fire Hazard: No

Reactive Hazard: Yes

Sudden Release of Pressure Hazard: No

Ozone Protection and 40 CFR 42: No reportable quantities of ozone depleting agents

Other Regulations/Legislations which apply to this product: Massachusetts Right-to-Know, Pennsylvania Right-to-Know, New Jersey Right-to-Know, Rhode Island Right-to-Know.

TSCA: Complies

DSL: Complies

NDSL: Complies

SECTION 16 - OTHER INFORMATION

Prepared By: Safety, Health & Environment
303-268-5000

Preparation Date: 19-Jul-2007

Revision Date: 22-Oct-2008

The information contained herein is offered as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Orica will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

End of MSDS



Material Safety Data Sheet

Preparation Date: 22-Mar-2006

Revision Date: 28-Oct-2008

Revision Number: 1

SECTION 1 – PRODUCT AND COMPANY IDENTIFICATION

Supplier(s):

Orica Canada Inc.
Maple Street
Brownsburg, QC
For MSDS Requests: 450-533-4201

Orica USA Inc.
33101 E. Quincy Avenue
Watkins, CO 80137-9406
For MSDS Requests: 1 303-268-5000

Product Name: POWERDITCH™ 1000, POWERPRO™, POWERFRAC™, GELDYNE™, COALITE™ 8SU, DYNASHEAR™, GEL COALITE™ Z, & XACTEX™
Product Code: 40053
Alternate Name(s): Not available
UN-No: UN0081
Recommended Use: A detonator-sensitive gelatin explosive.

Emergency Telephone Number: FOR CHEMICAL EMERGENCIES (24 HOUR) INVOLVING TRANSPORTATION, SPILL, LEAK, RELEASE, FIRE OR ACCIDENTS: **IN CANADA CALL:** THE ORICA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-877-561-3636. **IN THE U.S. CALL: CHEMTREC 1-800-424-9300. IN THE U.S.:** FOR LOST, STOLEN, OR MISPLACED EXPLOSIVES CALL: BATF 1-800-800-3855. FORM ATF F 5400.0 MUST BE COMPLETED AND LOCAL AUTHORITIES (STATE/MUNICIPAL POLICE, ETC.) MUST BE ADVISED.

SECTION 2 – HAZARD IDENTIFICATION

Emergency Overview:

Risk of explosion by shock, fire or other sources of ignition. Very toxic if swallowed. Irritating to eyes, respiratory system and skin. Oxidizing agent.

Appearance:
Light pink

Physical State:
Semi-Solid

Odor:
Characteristic

SECTION 3 – COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No	Weight %
Ammonium Nitrate	6484-52-2	0-75
Sodium Nitrate	7631-99-4	0-50
Ethylene glycol, Dinitrate	628-96-6	8-76
Sulphur	7704-34-9	0-4
Nitroglycerin	55-63-0	1-20
Nitrocellulose	9004-70-0	0-6

SECTION 4 – FIRST AID MEASURES

General Advice: In case of accident or if you feel unwell, seek medical advice IMMEDIATELY (show the product label where possible).

Eye Contact: Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Immediate medical attention is required.

Skin Contact: Wash off immediately with soap and plenty of water, removing all contaminated clothes and shoes. If skin irritation persists, call a physician.

Inhalation: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical advice IMMEDIATELY.

Ingestion: Immediate medical attention is required. Do not induce vomiting. Clean mouth with water and afterwards drink plenty of water. If spontaneous vomiting occurs, have victim lean forward with head positioned to avoid breathing in of vomitus, rinse mouth and administer more water. Never give anything by mouth to and unconscious person.

Notes to physician: Symptomatic. Administer oxygen if there are signs of cyanosis. If clinical condition deteriorates, administer 10cc Methylene Blue intravenously. It is unlikely for this to be required with methemoglobin level of less than 40%.

SECTION 5 – FIRE-FIGHTING MEASURES

Flammable properties: Not itself combustible but assists fire in burning materials. The product does not flash. Explosive power: 337 kJ/100 g.

Suitable extinguishing media: DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Evacuate surrounding areas to a predetermined safe location no less than 2500 feet (800 meters) in all directions. When controlling fire before involvement of explosives, fire-fighters should wear positive pressure self-containing breathing apparatus (SCBA) and full turnout gear. Water may be applied through fixed extinguishing system (sprinklers) as long as people need not be present for the system to operate.

Unsuitable extinguishing media: DO NOT FIGHT FIRES INVOLVING EXPLOSIVES. Attempts to smother a fire involving this product will be ineffective as it is its own oxygen source. Smother this product could lead to decomposition and explosion. This product is more sensitive to detonation if contaminated with organic or oxidisable material or if heated while confined. Unless the mass of product on fire is flooded with water, re-ignition is possible.

Specific hazards arising from the chemical: This product is a high explosive with mass detonation hazard. DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area to a safe distance. Guard against re-entry. Thermal decomposition can lead to release of irritating gases and vapors.

Protective equipment and precautions for firefighters: As in any fire, wear self-contained breathing apparatus pressure-demand, NIOSH approved (or equivalent) and full protective gear.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Methods for containment: Contain or absorb leaking putty with sand or earth or other suitable substance.

Methods for cleaning up: Avoid the use of metal tools containing iron and/or copper. Be careful to avoid shock, friction, and contact with grit. Collect product for recovery or disposal. For release to land, contain discharge by constructing dykes or applying inert absorbent; for release to water, utilize damming and/or water diversion to minimize the spread of contamination. Collect contaminated soil and water, and absorbent for proper disposal. Notify applicable government authority if release is reportable or could adversely affect the environment.

SECTION 7 – HANDLING AND STORAGE

Handling: This product is an explosive and should only be used under the supervision of trained personnel. The use of coveralls is recommended. Use good industrial hygiene and housekeeping practices. Keep away from open flames, hot surfaces and sources of ignition.

Storage: Store under moderate temperatures recommended by a technical services representative. Store under dry conditions in a well ventilated magazine that has been approved for either detonator storage or explosive storage. Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, spark and flames. Keep containers closed. Explosives should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials; combustibles, and sources of heat. Keep away from incompatibles. Ideal storage temperature is 10-27°C (50-80°F). Do not expose sealed containers to temperatures above 40°C (104°F).

SECTION 8 – EXPOSURE CONTROLS/PERSONAL PROTECTION

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Sodium Nitrate	10 mg/cu m (nuisance dust)	NA	
Ethylene glycol, Dinitrate	TWA: 0.05 ppm Skin	Ceiling: 0.2 ppm Ceiling: 1 mg/ m ³ Skin	
Nitroglycerin	(TWA skin) 0.46 mg/ cu m	Ceiling: 0.2 ppm Ceiling: 2 mg/ m ³ Skin	

Other exposure guidelines: Ammonium Nitrate: ORICA Guideline 5 mg/m³ (internal TWA)

Engineering Measures: No information available.

Personal Protective Equipment

Eye/Face Protection: Face-shield. Tightly fitting safety goggles.

Skin Protection: User should verify impermeability under normal conditions of use prior to general use. Impervious gloves. Nitrile Rubber.

Respiratory Protection: In case of insufficient ventilation wear suitable respiratory equipment. A NIOSH-approved respirator, if required.

Hygiene Measures: Handle in accordance with good industrial hygiene and safety practice. Recommendations listed in this section indicate the type of equipment, which will provide protection against over exposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Light pink	Odor:	Characteristic
Physical State:	Semi-Solid	Viscosity:	No information available
pH:	7	Flash Point:	> 100 °C
Autoignition Temperature:	-222°C (liquid NG) >=100>=212	Boiling Point/Range:	Not available
Melting Point/Range:	Not available	Flammable Limits (Upper):	Not applicable
Flammable Limits (Lower):	Not applicable	Explosion Power:	No data available
Specific Gravity:	085- 1.48 g/cc	Water Solubility:	In soluble in water
Other Solubility:	Slightly soluble in standard organic solvents	Vapor Pressure:	Not applicable
Oxidizing Properties:	Oxidizer	Partition Coefficient (n-octanol/water):	No data available

SECTION 10 – STABILITY AND REACTIVITY

Stability: Stable under normal conditions. Decomposition Temperature: Ammonium Nitrate will spontaneously decompose at 210 °C (410 °F). NG explodes at 222 °C (431.6 °F)

Conditions to avoid: Keep away from open flames, hot surfaces and sources of ignition.

Incompatible materials: Avoid oxidizable materials, metal powder, bronze & copper alloys, fuels (e.g. lubricants, machine oils), fluorocarbon lubricants, acids, corrosive liquids, chlorate, sulphur, sodium nitrite, charcoal, coke and other finely divided combustibles. Strong oxidizing and reducing agents.

Hazardous decomposition products: The following toxic decomposition products may be released. At temperatures above 210 °C, decomposition may be explosive, especially if confined. Nitrogen oxides (NOx). Carbon oxide. Hydrocarbons.

Hazardous Polymerization: None under normal processing. Hazardous polymerization does not occur. Explosive material under shock conditions.

SECTION 11 – TOXICOLOGICAL INFORMATION

Acute Toxicity

Product Information: Irritating to eyes. May cause skin irritation. Harmful if swallowed.

Chemical name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Ammonium Nitrate	2217 mg/kg Rat	3000 mg/kg Rabbit	88.8 mg/L Rat 4 h
Sodium Nitrate	1267-4300 mg/kg Rat		
Ethylene glycol, Dinitrate	460 mg/ kg Rat 540 mg/ kg Mouse		
Nitroglycerin	105 mg/ kg Rat 115 mg/ kg Mouse	280 mg/ kg Rabbit	
Nitrocellulose	5 g/ kg Mouse 5 g/ kg Rat		

Subchronic Toxicity (28 Days): Sodium Nitrate; Ammonium Nitrate: Ingestion may cause methemoglobinemia. Initial manifestation of methemoglobinemia is cyanosis, characterized by navy lips, tongue and mucous membranes, with skin color being slate grey. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia. If ingested, nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include methemoglobinemia, nausea, dizziness, increased heart rate, hypotension, fainting and, possibly shock.

Chronic Toxicity: May cause methemoglobinemia.
Carcinogenicity: The ingredients of this product are not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by T\NTP (National Toxicology Program).
Mutagenic effects: There is no evidence of mutagenic potential.
Irritation: Irritating to eyes. May cause irritation of respiratory tract. May cause skin irritation in susceptible persons.
Reproductive effects: No information is available and no adverse reproductive effects are anticipated.
Developmental effects: No information is available and no adverse developmental effects are anticipated.
Target Organ: Eyes, skin, respiratory system, blood, liver urinary tract, & gastrointestinal tract (GI).
Other Adverse Effects: Prolonged or repeated exposure to organic nitrates may develop a tolerance due to chronic dilation of the blood vessels. This tolerance disappears rapidly after a few days away from exposure and withdrawal symptoms consisting of angina and heart attack have been reported in chronically exposed workers. Another type of tolerance loss is the "Monday morning disease", where workers experience headaches, dizziness, postural weakness and other symptoms.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity effects: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment

Chemical Name	Freshwater Algae Data	Freshwater Fish Species Data	Microtox Data	Water Flea Data	log Pow
Sodium Nitrate					-3.8

Persistence/Degradability: Nitroglycerin is water-insoluble and remains explosive.
Mobility in Environmental media: Dissolves slowly in water.

SECTION 13 – DISPOSAL CONSIDERATIONS

Waste Disposal Method: Burn under supervision of an expert at an explosive burning ground or destroy by detonation in boreholes, in accordance with applicable local, provincial and federal regulations. Call upon the services of an Orica Technical Representative.
US EPA Waste Number: No data available on product.

Chemical Name	RCRA	RCRA- Basis for listing	RCRA- D Series Wastes	RCRA- U Series Wastes
Nitroglycerin –55-63-0	Waste number P081			

SECTION 14 – TRANSPORT INFORMATION

DOT Proper Shipping Name: Explosive Blasting Type A
Hazard Class: 1.1D
UN-No: UN0081
Packing group: II
TDG Proper Shipping Name: Explosive Blasting Type A
Hazard Class: 1.1D
UN-No: UN0081
Packing group: II

Transportation Emergency Telephone Number: 1-877-561-3636 or CHEMTREC: 1-800-424-9300

SECTION 15 – REGULATORY INFORMATION

CANADIAN CLASSIFICATION: This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS contains all the information required by the CPR

WHMIS hazard class: This product is an explosive and is not regulated by WHMIS.
USA CLASSIFICATION:

SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements, Ammonium Nitrate (6484-52-2), Sodium Nitrate (7631-99-4), Nitroglycerin (55-63-0), Nitrocellulose (9004-70-0), Sulphur (7704-34-9), & Ethylene Glycol, Dinitrate (628-96-6)

SARA 311/312 Hazardous Categorization

Acute Health Hazard: Yes
Chronic Health Hazard: Yes
Fire Hazard: Yes
Reactive Hazard: Yes
Sudden Release of Pressure Hazard: No

Ozone Protection and 40 CFR 42: No reportable quantities of ozone depleting agents

Other Regulations/Legislations which apply to this product: New Jersey Right-to-Know, Pennsylvania Right-to-Know, Massachusetts Right-to-Know, Rhode Island Right-to-Know, Florida, New Jersey Special Health Hazard Substance List, Minnesota Hazardous Substance List, California Director's List of Hazardous Substances, California Proposition 65.

TSCA: Complies

DSL: Complies

NDSL: Complies

The components in the product are on the following international inventory lists:

Chemical Name	TSCA	DSL	NDSL	ENCS	EINECS	ELINCS	CHINA	KECL	PICCS	AICS
Ammonium Nitrate	X	X	-	X	X	-	X	X	X	X
Sodium Nitrate	X	X	-	X	X	X	X	X	X	X
Ethylene Glycol, Dinitrate	X	X	-	-	X	-	-	X	-	X
Sulphur	X	X	-	X	X	X	X	X	X	X
Nitroglycerin	X	X	-	X	X	-	-	X	X	X
Nitrocellulose	X	X	-	X	-	-	X	X	X	X

Legend: X – Listed

SECTION 16 – OTHER INFORMATION

Prepared by: Safety Health & Environment
303-268-5000

Preparation Date: 22-Mar-2006
Revision Date: 28-Oct-2008

The information contained herein is offered only as guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and Orica will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

End of MSDS

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: XD-3 EXTRA ENGINE OIL 0W-30
Product Description: Synthetic Base Stocks and Additives
MSDS Number: 8044
Intended Use: Engine oil

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulphur Oxides, Oxides of carbon, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: 210C (410F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist

before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid contact with used product. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

Storage

Do not store in open or unlabelled containers.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Substance Name	Form	Limit/Standard			Note	Source
Phosphorus		TWA	0.1 mg/m ³			ACGIH

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid
Form: clear
Colour: Amber
Odour: Characteristic
Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.844
Flash Point [Method]: 210C (410F) [ASTM D-92]
Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0
Autoignition Temperature: N/D
Boiling Point / Range: > 316C (600F)
Vapour Density (Air = 1): > 2 at 101 kPa
Vapour Pressure: < 0.013 kPa (0.1 mm Hg) at 20°C
Evaporation Rate (N-Butyl Acetate = 1): < 0.1
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): N/D
Solubility in Water: Negligible
Viscosity: [N/D at 40°C] | 11 cSt (11 mm²/sec) at 100C
Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: N/A
Pour Point: -48°C (-54°F)

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 5000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 5000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Diesel engine oils: Not carcinogenic in animals tests. Used and unused diesel engine oils did not produce any carcinogenic effects in chronic mouse skin painting studies. Oils that are used in gasoline engines may become hazardous and display the following properties: Carcinogenic in animal tests. Caused mutations in vitro. Possible allergen and photoallergen. Contains polycyclic aromatic compounds (PAC) from combustion products of gasoline and/or thermal degradation products.

Contains:

Synthetic base oils: Not expected to cause significant health effects under conditions of normal use, based on laboratory studies with the same or similar materials. Not mutagenic or genotoxic. Not sensitising in test animals and humans.

Additional information is available by request.

CMR Status: None.

Chemical Name	CAS Number	List Citations
Phosphorus	7723-14-0	4

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12	ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

SECTION 13	DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14	TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4

3 = TSCA 5e

5 = TSCA 12b

2 = TSCA 5a2

4 = TSCA 6

6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 06: Notification Procedures - Header was modified.

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Color was modified.

Section 09: Boiling Point C(F) was modified.

Section 08: Hand Protection was modified.

Section 07: Handling and Storage-Storage was modified.

Section 11: Dermal Lethality Test Data was modified.

Section 11: Oral Lethality Test Data was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Relative Density - Header was modified.

Section 09: Flash Point C(F) was modified.

Section 09 Viscosity was modified.

Section 09: Relative Density was modified.

Section 15: List Citation Table - Header was modified.

Section 08: Exposure Limits Table was added.
Section 11: Chemical Name - Header was added.
Section 11: CAS Number - Header was added.
Section 11: List Citation - Header was added.
Section 11: Tox List Cited Table was added.
Composition: No components was added.
Section 08: OEL Table - Substance Name Column - Header was added.
Section 08: OEL Table - Form Column - Header was added.
Section 08: OEL Table - Limit Column - Header was added.
Section 08: OEL Table - Notation Column - Header was added.
Section 08: OEL Table - Source Column - Header was added.
Section 13: Regulatory Disposal Information - Header was added.
Section 13: Regulatory Disposal Information - Header was deleted.
Composition: No components was deleted.
Section 15: Canadian List Citations Table was deleted.
Section 15: Chemical Name - Header was deleted.
Section 15: CAS Number - Header was deleted.
Section 15: List Citations -Header was deleted.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006929 (1002607)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: XD-3 EXTRA ENGINE OIL 10W
Product Description: Base Oil and Additives
MSDS Number: 8046
Intended Use: Engine oil

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulphur Oxides, Oxides of carbon, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: 230°C (446°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid contact with used product. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly effect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: brown

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.876

Flash Point [Method]: 230°C (446°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: N/D

Vapour Density (Air = 1): N/D

Vapour Pressure: [N/D at 20°C] | < 1 kPa (7.5 mm Hg) at 38°C

Evaporation Rate (N-Butyl Acetate = 1): < 1

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 6.5 cSt (6.5 mm²/sec) at 100°C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -36°C (-33°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10

STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Diesel engine oils: Not carcinogenic in animals tests. Used and unused diesel engine oils did not produce any carcinogenic effects in chronic mouse skin painting studies. Oils that are used in gasoline engines may become hazardous and display the following properties: Carcinogenic in animal tests. Caused mutations in vitro. Possible allergen and photoallergen. Contains polycyclic aromatic compounds (PAC) from combustion products of gasoline and/or thermal degradation products.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status:

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning (where applicable): Empty containers may retain residue and can be dangerous. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION 14 TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4

3 = TSCA 5e

5 = TSCA 12b

2 = TSCA 5a2

4 = TSCA 6

6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

No revision information is available.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006930 (1012777)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: XD-3 EXTRA ENGINE OIL 15W-40
Product Description: Base Oil and Additives
MSDS Number: 8043
Intended Use: Engine oil

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5	FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulphur Oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: 215C (419F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: 330°C (626°F)

SECTION 6	ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist

before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid contact with used product. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: dark brown

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.87

Flash Point [Method]: 215C (419F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: 330°C (626°F)

Boiling Point / Range: 310C (590F) - 600C (1112F)

Vapour Density (Air = 1): N/D

VAPOUR PRESSURE: [N/D at 20°C] | < 1 kPa (7.5 mm Hg) at 38C

Evaporation Rate (N-Butyl Acetate = 1): < 0.1

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 15.4 cSt (15.4 mm²/sec) at 100C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -27°C (-17°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

<u>Route of Exposure</u>	<u>Conclusion / Remarks</u>
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Diesel engine oils: Not carcinogenic in animals tests. Used and unused diesel engine oils did not produce any carcinogenic effects in chronic mouse skin painting studies. Oils that are used in gasoline engines may become hazardous and display the following properties: Carcinogenic in animal tests. Caused mutations in vitro. Possible allergen and photoallergen. Contains polycyclic aromatic compounds (PAC) from combustion products of gasoline and/or thermal degradation products.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12	ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Expected to be harmful to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13	DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

Regulatory Disposal Information

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14	TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

National Chemical Inventory Listing: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 06: Notification Procedures - Header was modified.

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Boiling Point C(F) was modified.

Section 08: Hand Protection was modified.

Section 09: Vapour Pressure was modified.

Section 09: Vapour Pressure - Header was modified.

Section 05: Hazardous Combustion Products was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Relative Density - Header was modified.

Section 09: Flash Point C(F) was modified.

Section 09 Viscosity was modified.

Section 15: National Chemical Inventory Listing - Header was modified.

Section 09: Relative Density was modified.
Section 15: List Citation Table - Header was modified.
Section 12: Ecological Information - Acute Aquatic Toxicity was added.
Section 12: Ecological Information - Acute Aquatic Toxicity was added.
Section 11: Chronic Tox - Component - WHMIS was added.
Section 11: Chronic Tox - Component - Header was added.
Section 11: Other Health Effects Header was added.
Composition: No components was added.
Section 13: Regulatory Disposal Information - Header was added.
Section 13: Regulatory Disposal Information - Header was deleted.
Section 11: Other Health Effects Header was deleted.
Composition: No components was deleted.
Section 11: Chronic Tox - Component was deleted.
Section 11: Chronic Tox - Component - Header was deleted.
Section 12: Ecological Information - Acute Aquatic Toxicity was deleted.
Section 12: Ecological Information - Acute Aquatic Toxicity was deleted.
Section 15: Canadian List Citations Table was deleted.
Section 15: Chemical Name - Header was deleted.
Section 15: CAS Number - Header was deleted.
Section 15: List Citations -Header was deleted.
Section 09: Form - Header was deleted.
Section 09: Physical State was deleted.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006927 (1004630)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety



MATERIAL SAFETY DATA SHEET

Date Prepared: November 08, 2003
Supersedes: January 25, 2001
MSDS Number: 8407

1. PRODUCT INFORMATION

Product Identifier: OBRA 30W

Application and Use:
Lubricating grease

Product Description:

A grease, a mixture of lubricating oil, soap and additives.

REGULATORY CLASSIFICATION

WHMIS:
Not a controlled product

CEPA: CANADIAN ENVIRONMENTAL PROTECTION ACT
All components of this product are either on the Domestic
Substances List (DSL) or are exempt.

TDG INFORMATION (RAIL/ROAD):
Not Regulated in Canada.

Please be aware that other regulations may apply.

TELEPHONE NUMBERS

Emergency 24 hr. (519) 339-2145
Technical Info. (800) 268-3183

MANUFACTURER/SUPPLIER:

IMPERIAL OIL
Products Division
240 4th Avenue S.W.
Calgary, Alberta
T2P 3M9

2. REGULATED COMPONENTS

The following components are defined in accordance with sub-paragraph 13(a) (i) to (iv) or paragraph 14(a) of the Hazardous Products Act:

NAME	%	CAS #
Not applicable		

3. TYPICAL PHYSICAL & CHEMICAL PROPERTIES

Physical State: Liquid
Specific gravity: not available
Viscosity: 30.40 cSt at 100 deg C
Vapour Density: not available
Boiling Point: not available
Evaporation rate: <1 (1= n-butylacetate)
Solubility in water: negligible
Freezing/Pour Point: 90 deg C DROP
Odour Threshold: not available
Vapour Pressure: <1 kPa at 38 deg C
Density: 0.94 g/cc at 15 deg C
Appearance/odour: White granules or prills, slight ammonia odor.

4. HEALTH HAZARD INFORMATION

NATURE OF HAZARD

INHALATION:

Negligible hazard at normal temperatures (up to 38 deg C).
Elevated temperatures or mechanical action may form vapours, mists or fumes which may be irritating to the eyes, nose, throat and lungs.
Avoid breathing vapours or mists.

EYE CONTACT:

Slightly irritating, but will not injure eye tissue.

SKIN CONTACT:

Low toxicity.
Frequent or prolonged contact may irritate the skin.
High pressure greasing equipment is capable of injecting grease under the skin which may have severe health consequences.

INGESTION:

Low toxicity.

ACUTE TOXICITY DATA:

Based on animal testing data from similar materials and products, the acute toxicity of this product is expected to be:

Oral : LD50 > 5000 mg/kg (Rat)
Dermal : LD50 > 3160 mg/kg (Rabbit)
Inhalation : LC50 > 5000 mg/m3 (Rat)

OCCUPATIONAL EXPOSURE LIMIT:

ACGIH recommends:

For oil mists, 5 mg/m3.

Local regulated limits may vary.

5. FIRST AID MEASURES

INHALATION:

In case of adverse exposure to vapours, mists and/or fumes formed at elevated temperature, or by mechanical action, immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

EYE CONTACT:

Flush eyes with large amounts of water until irritation subsides. If irritation persists, get medical attention.

SKIN CONTACT:

Flush with large amounts of water. Use soap if available. Remove severely contaminated clothing (including shoes) and launder before reuse. If irritation persists, seek medical attention. Consult a physician immediately if the material is injected under the skin from the misuse of high pressure greasing equipment.

INGESTION:

If swallowed, DO NOT induce vomiting. Keep at rest. Get prompt medical attention.

6. PREVENTIVE AND CORRECTIVE MEASURES

PERSONAL PROTECTION:

The selection of personal protective equipment varies, depending upon conditions of use. In open systems where contact is likely, wear safety goggles, chemical-resistant overalls, and chemically impervious gloves. Where only incidental contact is likely, wear safety glasses with side shields. No other special precautions are necessary provided skin/eye

contact is avoided.

Where concentrations in air may exceed the occupational exposure limits given in Section 4 and where engineering, work practices or other means of exposure reduction are not adequate, approved respirators may be necessary to prevent overexposure by inhalation.

ENGINEERING CONTROLS:

The use of local exhaust ventilation is recommended to control emissions near the source. Laboratory samples should be handled in a fumehood. Provide mechanical ventilation of confined spaces.

HANDLING, STORAGE AND SHIPPING:

Keep containers closed. Handle and open containers with care. Store in a cool, well ventilated place away from incompatible materials. In keeping with good personal hygiene practices, wash hands thoroughly after handling the material. Store and load at normal (up to 38 deg C) temperature and at atmospheric pressure. Empty containers may contain product residue. Do not pressurize cut, heat, or weld empty containers. Do not reuse empty containers without commercial cleaning or reconditioning.

LAND SPILL:

Eliminate source of ignition. Keep public away. Prevent additional discharge of material, if possible to do so without hazard. Prevent spills from entering sewers, watercourses or low areas. Contain spilled liquid with sand or earth. Allow material to solidify and scrape up. Place material in suitable containers for recycle or disposal. Consult an expert on disposal of recovered material. Ensure disposal in compliance with government requirements and ensure conformity to local disposal regulations. Notify the appropriate authorities immediately. Take all additional action necessary to prevent and remedy the adverse effects of the spill.

WATER SPILL:

Remove from surface by skimming or with suitable absorbents. If allowed by local authorities and environmental agencies, sinking and/or suitable dispersants may be used in unconfined waters. Consult an expert on disposal of recovered material. Ensure disposal in compliance with government requirements and ensure conformity to local disposal regulations. Notify the appropriate authorities immediately. Take all additional action necessary to prevent and remedy the adverse effects of the spill.

7. FIRE AND EXPLOSION HAZARD

Flashpoint and method: 220 deg C COC ASTM D92

Autoignition: NA Flammable Limits: LEL: NA UEL: NA

GENERAL HAZARDS:

Low Hazard; liquids may burn upon heating to temperatures at or above the flash point.

Toxic gases will form upon combustion.

FIRE FIGHTING:

Use water spray to cool fire exposed surfaces and to protect personnel. Shut off fuel to fire.

Use foam, dry chemical or water spray to extinguish fire.

Respiratory and eye protection required for fire fighting personnel.

A self-contained breathing apparatus (SCBA) should be used for all indoor fires and any significant outdoor fires. For small outdoor fires, which may easily be extinguished with a portable fire extinguisher, use of an SCBA may not be required.

HAZARDOUS COMBUSTION PRODUCTS:

Smoke, carbon monoxide, carbon dioxide under thermal decomposition.

8. REACTIVITY DATA

STABILITY:

This product is stable. Hazardous polymerization will not occur.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:

Strong oxidizing agents

HAZARDOUS DECOMPOSITION:

none

9. NOTES

All components of this product are listed on the U.S. TSCA inventory.

.

REVISION SUMMARY:

Since 25 January 2001, this MSDS has been revised in Section(s):

3, 6, 7

10. PREPARATION

Date Prepared: November 08, 2003
Prepared by: Lubricants & Specialties
IMPERIAL OIL
Products Division
240 4th Avenue S.W.
Calgary, Alberta
T2P 3M9
(800) 268-3183

CAUTION: " The information contained herein relates only to this product or material and may not be valid when used in combination with any other product or material or in any process. If the product is not to be used for a purpose or under conditions which are normal or reasonably foreseeable, this information cannot be relied upon as complete or applicable. For greater certainty, uses other than those described in Section 1 must be reviewed with the supplier. The information contained herein is based on the information available at the indicated date of preparation. This MSDS is for the use of Imperial Oil customers and their employees and agents only. Any further distribution of this MSDS by Imperial Oil customers is prohibited without the written consent of Imperial Oil."

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: ESSO GEAR OIL GX 75W-80W
Product Description: Base Oil and Additives
MSDS Number: 8063
Intended Use: Gear oil

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5**FIRE FIGHTING MEASURES****EXTINGUISHING MEDIA**

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Sulphur Oxides, Aldehydes, Smoke, Fume, Oxides of carbon, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: 160C (320F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6**ACCIDENTAL RELEASE MEASURES****NOTIFICATION PROCEDURES**

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly affect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: yellow

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.856

Flash Point [Method]: 160C (320F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: 230C (446F) - 535C (995F)

Vapour Density (Air = 1): N/D

Vapour Pressure: [N/D at 20°C] | < 1 kPa (7.5 mm Hg) at 38C

Evaporation Rate (N-Butyl Acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 7.8 cSt (7.8 mm²/sec) at 100C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -39°C (-38°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: Data available.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Repeated and/or prolonged exposure may cause irritation to the skin, eyes, or respiratory tract.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status:

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes: Not Applicable

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006955 (1014030)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: ESSO GEAR OIL GX 80W-90
Product Description: Base Oil and Additives
MSDS Number: 8064
Intended Use: Gear oil

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Incomplete combustion products, Oxides of carbon, Sulphur Oxides, Smoke, Fume, Aldehydes

FLAMMABILITY PROPERTIES

Flash Point [Method]: 210°C (410°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly effect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Form: N/D

Colour: dark brown

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.885

Flash Point [Method]: 210°C (410°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: N/D

Vapour Density (Air = 1): > 2 at 101 kPa

Vapour Pressure: < 0.013 kPa (0.1 mm Hg) at 20°C

Evaporation Rate (N-Butyl Acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 15 cSt (15 mm²/sec) at 100°C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -24°C (-11°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: Data available.	Elevated temperatures or mechanical action may form vapours, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Repeated and/or prolonged exposure may cause irritation to the skin, eyes, or respiratory tract.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning (where applicable): Empty containers may retain residue and can be dangerous. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION 14 TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

No revision information is available.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006956 (547465)

Copyright 2002 Imperial Oil Limited, All rights reserved

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: AROX EP 100
Product Description: Base Oil and Additives
MSDS Number: 8296
Intended Use: Lubricant

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

This product may be used in certain applications where misting can occur. Excessive exposure to liquids and mists may cause skin and eye irritation. In addition, excessive exposure to mists may cause respiratory irritation and damage and aggravate pre-existing emphysema or asthma. Low order of toxicity. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek

immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Pressurised mists may form a flammable mixture.

Hazardous Combustion Products: Smoke, Fume, Sulphur Oxides, Aldehydes, Oxides of carbon, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: 230C (446F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid breathing mists or vapour. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

Particulate air-purifying respirator approved for dust or oil mist is recommended.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly effect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended. Chemical-type goggles should be worn during misting operations.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: Amber

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density: 0.89

Flash Point [Method]: 230C (446F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: > 316C (600F)

Vapour Density (Air = 1): N/D

Vapour Pressure: [N/D at 20°C] | < 1 kPa (7.5 mm Hg) at 38C

Evaporation Rate (N-Butyl Acetate = 1): < 1

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): N/D

Solubility in Water: Negligible

Viscosity: 100 cSt (100 mm²/sec) at 40°C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: N/A
Pour Point: -6°C (21°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Elevated temperatures or mechanical action may form vapours, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Oil Mist (highly refined oils): Animals exposed to high concentrations of mist developed oil retention, inflammation, and oil granulomas in the respiratory tract. Oils exposed to high temperatures, cracking conditions, or mixing with tramp / used oils may introduce polycyclic aromatic compounds or microbial contaminants that could result in cancer or severe respiratory hazards.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12

ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13

DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning (where applicable): Empty containers may retain residue and can be dangerous. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

SECTION 14

TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Color was modified.

Section 09: Boiling Point C(F) was modified.

Section 09: Vapour Pressure was modified.

Section 03: Health Hazards was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Flash Point C(F) was modified.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate

and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5007243 (1012879)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety



MATERIAL SAFETY DATA SHEET

Date Prepared: August 28, 2003
Supersedes: May 24, 2000
MSDS Number: 8388

1. PRODUCT INFORMATION

Product Identifier: ARGON EP 1 GREASE

Application and Use:
Lubricating grease

Product Description:

A grease, a mixture of lubricating oil, soap and additives.

REGULATORY CLASSIFICATION

WHMIS:
Not a controlled product

CEPA: CANADIAN ENVIRONMENTAL PROTECTION ACT
All components of this product are either on the Domestic
Substances List (DSL) or are exempt.

TDG INFORMATION (RAIL/ROAD):
Not Regulated in Canada.

Please be aware that other regulations may apply.

TELEPHONE NUMBERS

Emergency 24 hr. (519) 339-2145
Technical Info. (800) 268-3183

MANUFACTURER/SUPPLIER:

IMPERIAL OIL
Products Division
240 4th Avenue S.W.
Calgary, Alberta
T2P 3M9

2. REGULATED COMPONENTS

The following components are defined in accordance with sub-paragraph 13(a) (i) to (iv) or paragraph 14(a) of the Hazardous Products Act:

NAME	%	CAS #
Not applicable		

3. TYPICAL PHYSICAL & CHEMICAL PROPERTIES

Physical State: Liquid
 Specific gravity: 0.920 at 15.6 deg C/15.6 deg C
 Viscosity: 175.00 cSt at 40 deg C
 Vapour Density: not available
 Boiling Point: not available
 Evaporation rate: < 0.01 (1= n-butylacetate)
 Solubility in water: negligible
 Freezing/Pour Point: 130 deg C DROP
 Odour Threshold: not available
 Vapour Pressure: <0.01 kPa at 20 deg C
 Appearance/odour: Brown paste, petroleum odour

4. HEALTH HAZARD INFORMATION

NATURE OF HAZARD

INHALATION:

Negligible hazard at normal temperatures (up to 38 deg C).
 Elevated temperatures or mechanical action may form vapours, mists or fumes which may be irritating to the eyes, nose, throat and lungs.
 Avoid breathing vapours or mists.

EYE CONTACT:

Slightly irritating, but will not injure eye tissue.

SKIN CONTACT:

Low toxicity.
 Frequent or prolonged contact may irritate the skin.
 High pressure greasing equipment is capable of injecting grease under the skin which may have severe health consequences.

INGESTION:

Low toxicity.

ACUTE TOXICITY DATA:

Based on animal testing data from similar materials and products,

the acute toxicity of this product is expected to be:

Oral : LD50 > 5000 mg/kg (Rat)
Dermal : LD50 > 3160 mg/kg (Rabbit)
Inhalation : LC50 > 5000 mg/m3 (Rat)

OCCUPATIONAL EXPOSURE LIMIT:

ACGIH recommends:

For oil mists, 5 mg/m3.

Local regulated limits may vary.

5. FIRST AID MEASURES

INHALATION:

In case of adverse exposure to vapours, mists and/or fumes formed at elevated temperature, or by mechanical action, immediately remove the affected victim from exposure. Administer artificial respiration if breathing has stopped. Keep at rest. Call for prompt medical attention.

EYE CONTACT:

Flush eyes with large amounts of water until irritation subsides. If irritation persists, get medical attention.

SKIN CONTACT:

Flush with large amounts of water. Use soap if available.
Remove severely contaminated clothing (including shoes) and launder before reuse.
If irritation persists, seek medical attention.
Consult a physician immediately if the material is injected under the skin from the misuse of high pressure greasing equipment.

INGESTION:

If swallowed, DO NOT induce vomiting. Keep at rest. Get prompt medical attention.

6. PREVENTIVE AND CORRECTIVE MEASURES

PERSONAL PROTECTION:

The selection of personal protective equipment varies, depending upon conditions of use.
In open systems where contact is likely, wear safety goggles, chemical-resistant overalls, and chemically impervious gloves.
Where only incidental contact is likely, wear safety glasses with side shields. No other special precautions are necessary provided skin/eye contact is avoided.

Where concentrations in air may exceed the occupational exposure limits given in Section 4 and where engineering, work practices or other means of exposure reduction are not adequate, approved respirators may be necessary to prevent overexposure by inhalation.

ENGINEERING CONTROLS:

The use of local exhaust ventilation is recommended to control emissions near the source. Laboratory samples should be handled in a fumehood. Provide mechanical ventilation of confined spaces.

HANDLING, STORAGE AND SHIPPING:

Keep containers closed. Handle and open containers with care. Store in a cool, well ventilated place away from incompatible materials. In keeping with good personal hygiene practices, wash hands thoroughly after handling the material. Do not handle or store near an open flame, sources of heat, or sources of ignition. Empty containers may contain product residue. Do not pressurize cut, heat, or weld empty containers. Do not reuse empty containers without commercial cleaning or reconditioning.

LAND SPILL:

Eliminate source of ignition. Keep public away. Prevent additional discharge of material, if possible to do so without hazard. Prevent spills from entering sewers, watercourses or low areas. Contain spilled liquid with sand or earth. Allow material to solidify and scrape up. Place material in suitable containers for recycle or disposal. If liquid is too viscous for pumping, scrape up. Consult an expert on disposal of recovered material. Ensure disposal in compliance with government requirements and ensure conformity to local disposal regulations. Notify the appropriate authorities immediately. Take all additional action necessary to prevent and remedy the adverse effects of the spill.

WATER SPILL:

Remove from surface by skimming or with suitable absorbents. If allowed by local authorities and environmental agencies, sinking and/or suitable dispersants may be used in unconfined waters. Consult an expert on disposal of recovered material. Ensure disposal in compliance with government requirements and ensure conformity to local disposal regulations. Notify the appropriate authorities immediately. Take all additional action necessary to prevent and remedy the adverse effects of the spill.

7. FIRE AND EXPLOSION HAZARD

Flashpoint and method: 180 deg C COC ASTM D92, BASEOIL

Autoignition: NA Flammable Limits: LEL: NA UEL: NA

GENERAL HAZARDS:

Low Hazard; liquids may burn upon heating to temperatures at or above the flash point.

Toxic gases will form upon combustion.

FIRE FIGHTING:

Use water spray to cool fire exposed surfaces and to protect personnel. Shut off fuel to fire.

Use foam, dry chemical or water spray to extinguish fire.

Respiratory and eye protection required for fire fighting personnel.

A self-contained breathing apparatus (SCBA) should be used for all indoor fires and any significant outdoor fires. For small outdoor fires, which may easily be extinguished with a portable fire extinguisher, use of an SCBA may not be required.

HAZARDOUS COMBUSTION PRODUCTS:

Fumes, smoke, carbon monoxide, sulfur oxides, nitrogen oxides, phosphorus oxides, aldehydes and other decomposition products, in the case of incomplete combustion

Various metal oxides

8. REACTIVITY DATA

STABILITY:

This product is stable. Hazardous polymerization will not occur.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:

Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, etc., as this presents a serious explosion hazard.

HAZARDOUS DECOMPOSITION:

none

9. NOTES

All components of this product are listed on the U.S. TSCA inventory.

.

REVISION SUMMARY:

Since 24 May 2000, this MSDS has been revised in Section(s):

3, 6, 7

10. PREPARATION

Date Prepared: August 28, 2003
Prepared by: Lubricants & Specialties
IMPERIAL OIL
Products Division
240 4th Avenue S.W.
Calgary, Alberta
T2P 3M9
(800) 268-3183

CAUTION: " The information contained herein relates only to this product or material and may not be valid when used in combination with any other product or material or in any process. If the product is not to be used for a purpose or under conditions which are normal or reasonably foreseeable, this information cannot be relied upon as complete or applicable. For greater certainty, uses other than those described in Section 1 must be reviewed with the supplier. The information contained herein is based on the information available at the indicated date of preparation. This MSDS is for the use of Imperial Oil customers and their employees and agents only. Any further distribution of this MSDS by Imperial Oil customers is prohibited without the written consent of Imperial Oil."

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: UNIREX EP 2
Product Description: Base Oil and Additives
MSDS Number: 8382
Intended Use: Grease

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Under normal conditions of intended use, this material is not expected to be an inhalation hazard.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the

body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Hazardous Combustion Products: Aldehydes, Oxides of carbon, Smoke, Fume, Sulphur Oxides, Incomplete combustion products

FLAMMABILITY PROPERTIES

Flash Point [Method]: >200C (392F) [EST. FOR OIL, ASTM D-92 (COC)]

Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Allow spilled material to solidify and shovel it up into a suitable container for recycle or disposal. Scrape up spilled material with shovels into a suitable container for recycle or disposal.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Skim from surface

Water spill and land spill recommendations are based on the most likely spill scenario for this material;

however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7	HANDLING AND STORAGE

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is not a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8	EXPOSURE CONTROLS / PERSONAL PROTECTION

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No protection is ordinarily required under normal conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Solid

Form: semi-fluid

Colour: dark green

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density: 0.89

Flash Point [Method]: >200C (392F) [EST. FOR OIL, ASTM D-92 (COC)]

Flammable Limits (Approximate volume % in air): LEL: N/D UEL: N/D

Autoignition Temperature: N/D

Boiling Point / Range: N/D

Vapour Density (Air = 1): N/D

Vapour Pressure: < 0.01 kPa (0.08 mm Hg) at 20°C

Evaporation Rate (N-Butyl Acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: 220 cSt (220 mm²/sec) at 40°C | 18.5 cSt (18.5 mm²/sec) at 100C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: >260°C (500°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

Note: Most physical properties above are for the oil component in the material.

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on assessment of the components.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.

CHRONIC/OTHER EFFECTS

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Expected to be harmful to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13	DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Suitable routes of disposal are supervised incineration, preferentially with energy recovery, or appropriate recycling methods in accordance with applicable regulations and material characteristics at the time of disposal.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14	TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15 REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: TSCA, EINECS, DSL

The Following Ingredients are Cited on the Lists Below:

Chemical Name	CAS Number	List Citations
DIPHENYLAMINE	122-39-4	1
ZINC DIALKYL DITHIOPHOSPHATE	68457-79-4	6

--REGULATORY LISTS SEARCHED--

1 = TSCA 4	3 = TSCA 5e	5 = TSCA 12b
2 = TSCA 5a2	4 = TSCA 6	6 = NPRI

SECTION 16 OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 06: Notification Procedures - Header was modified.

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 08: Hand Protection was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Flash Point C(F) was modified.

Section 09 Viscosity was modified.

Section 15: National Chemical Inventory Listing was modified.

Section 15: Canadian List Citations Table was modified.

Section 11: Chronic Tox - Component - WHMIS was added.

Section 11: Chronic Tox - Component - Header was added.

Section 11: Other Health Effects Header was added.

Composition: No components was added.

Section 13: Regulatory Disposal Information - Header was added.

Section 13: Regulatory Disposal Information - Header was deleted.

Section 11: Other Health Effects Header was deleted.

Composition: No components was deleted.

Section 15: Special Cases - Header was deleted.

Section 15: Special Cases Table was deleted.
Section 15: Inventory - Header was deleted.
Section 15: Status - Header was deleted.
Section 11: Chronic Tox - Component was deleted.
Section 11: Chronic Tox - Component - Header was deleted.
Section 11: Chemical Name - Header was deleted.
Section 11: CAS Number - Header was deleted.
Section 11: List Citation - Header was deleted.
Section 11: Tox List Cited Table was deleted.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5007334 (1005633)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: ESSO HD ANTIFREEZE 60/40 PREMIX
Product Description: Glycol
MSDS Number: 8514
Intended Use: Antifreeze/coolant

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

Name	CAS#	Concentration*	Acute Toxicity
Ethylene Glycol	107-21-1	55 - 65%	Dermal Lethality: LD50 9.53 g/kg (Rabbit); Inhalation Lethality: LC50 4300 ppm (Rat); Oral Lethality: LD50 4.70 g/kg (Rat)

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

SECTION 3 HAZARDS IDENTIFICATION

This material is considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

HEALTH EFFECTS

May cause harm to the unborn child. Ingestion of ethylene glycol may result in nausea, vomiting, abdominal cramps, blindness, liver damage, irritation, reproductive effects, nerve damage, convulsions, edema of the lung, cardiopulmonary effects (metabolic acidosis), pneumonia and kidney failure which could result in death. The single lethal dose for humans is about 100 ml. Inhalation of high levels of vapour or mists for prolonged periods of time may also result in toxic effects. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

Target Organs: Kidney | Reproductive system |

NFPA Hazard ID:	Health: 1	Flammability: 0	Reactivity: 0
HMIS Hazard ID:	Health: 2*	Flammability: 0	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

Seek immediate medical attention.

NOTE TO PHYSICIAN

This product contains ethylene and/or diethylene glycol which, if ingested, is metabolised to toxic metabolites by the enzyme alcohol dehydrogenase, for which ethanol and 4-methylpyrazole {US drug name Fomepizole, trade name Antizol} are antagonists. Administration of oral or intravenous ethanol or intravenous 4-methylpyrazole may arrest further metabolism of this material and thereby ameliorate the toxicity. Use of ethanol or 4-methylpyrazole does not affect toxic metabolites that are already present and is not a substitute for haemodialysis.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, alcohol-resistant foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water or standard foam

FIRE FIGHTING

Fire Fighting Instructions: Material will not burn. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply.

Hazardous Combustion Products: Incomplete combustion products, Oxides of carbon, Smoke, Fume, Aldehydes

FLAMMABILITY PROPERTIES

Flash Point [Method]: N/A

Flammable Limits (Approximate volume % in air): LEL: N/A UEL: N/A

Autoignition Temperature: N/D

SECTION 6

ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Do not touch or walk through spilled material. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Consult an expert. Warn other shipping. Material will sink. Remove material, as much as possible, using mechanical equipment.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Remove debris in path of spill and remove contaminated debris from shoreline and water surface. Dispose of according to local regulations. Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7

HANDLING AND STORAGE

HANDLING

Avoid breathing mists or vapour. Avoid contact with skin. Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is not a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8

EXPOSURE CONTROLS / PERSONAL PROTECTION

Substance Name	Form	Limit/Standard			Note	Source
Ethylene Glycol	Aerosol.	Ceiling	100 mg/m3			ACGIH

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No protection is ordinarily required under normal conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Work conditions can greatly affect glove durability; inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

If prolonged or repeated contact is likely, chemical-resistant gloves are recommended. If contact with forearms is likely, wear gauntlet-style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

If prolonged or repeated contact is likely, chemical, and oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Form: clear

Colour: green

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 16 C): 1.07 - 1.08
Flash Point [Method]: N/A
Flammable Limits (Approximate volume % in air): LEL: N/A UEL: N/A
Autoignition Temperature: N/D
Boiling Point / Range: 132C (270F)
Vapour Density (Air = 1): 2.1 at 101 kPa
Vapour Pressure: 0.008 kPa (0.06 mm Hg) at 20°C
Evaporation Rate (N-Butyl Acetate = 1): 0.01
pH: 9 - 11
Log Pow (n-Octanol/Water Partition Coefficient): < 2
Solubility in Water: Complete
Viscosity: [N/D at 40°C]
Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: N/D
Pour Point: -52°C (-62°F)

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers, Acids, Alkalies

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: Data available.	Negligible hazard at ambient/normal handling temperatures. Based on test data for structurally similar materials.
INGESTION	
Toxicity (Human): LDLo 100 ml	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on test data for structurally similar materials.
Eye	

Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS**Contains:**

ETHYLENE GLYCOL (EG): Repeated high oral exposure has caused kidney damage, neurological effects, degeneration of the liver and changes in blood chemistry and circulating blood cells in laboratory animals. Repeated overexposure has the potential to cause similar toxic effects in humans. EG causes developmental and reproductive effects at high dose levels in laboratory animals. The relevance of these findings to humans is uncertain. However, as a precaution, avoid exposure during pregnancy.

Additional information is available by request.

CMR Status: None.

Chemical Name	CAS Number	List Citations
Ethylene Glycol	107-21-1	4

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Material -- Expected to remain in water or migrate through soil.

PERSISTENCE AND DEGRADABILITY**Biodegradation:**

Material -- Expected to be readily biodegradable.

Atmospheric Oxidation:

Material -- Expected to degrade rapidly in air

BIOACCUMULATION POTENTIAL

Material -- Potential to bioaccumulate is low.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Even though this product is readily biodegradable, it must not be indiscriminately discarded into the

environment. Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14

TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT)

Proper Shipping Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, LIQUID, N.O.S. (Ethylene Glycol)

Hazard Class & Division: 9

ID Number: 3082

Packing Group: III

ERG Number: 171

Label(s): 9

Transport Document Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, LIQUID, N.O.S., 9, UN3082, PG III, RQ (ETHYLENE GLYCOL)

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15

REGULATORY INFORMATION

WHMIS Classification: Class D, Division 2, Subdivision A: Very Toxic Material

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

NATIONAL CHEMICAL INVENTORY LISTING: DSL, TSCA

The Following Ingredients are Cited on the Lists Below: None.

--REGULATORY LISTS SEARCHED--

1 = TSCA 4

3 = TSCA 5e

5 = TSCA 12b

2 = TSCA 5a2

4 = TSCA 6

6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Boiling Point C(F) was modified.

Section 08: Hand Protection was modified.

Section 11: Oral Lethality Test Data was modified.

Section 06: Accidental Release-Spill Management-Land was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Relative Density - Header was modified.

Hazard Identification: Health Hazards was modified.

Hazard Identification: Emergency Overview Target Organs was modified.

Section 16: Health Hazards was modified.

Section 16: Target Organs was modified.

Section 16: Land Spill was modified.

Section 16: Water Spill was modified.

Section 16: Fire Fighting Media - Header was added.

Section 16: Fire Fighting Media - Header was added.

Section 16: Precautions was added.

Section 16: Precautions - Header was added.

Section 11: Chronic Tox - Component - WHMIS was added.

Section 11: Chronic Tox - Component - Header was added.

Section 11: Other Health Effects Header was added.

Section 11: Other Health Effects Header was deleted.

Section 11: Chronic Tox - Component was deleted.

Section 11: Chronic Tox - Component - Header was deleted.

Precautionary Label Text:

WHMIS Classification: Class D, Division 2, Subdivision A: Very Toxic Material

HEALTH HAZARDS

Danger of serious damage to health by prolonged exposure. May cause harm to the unborn child.

Target Organs: Kidney | Reproductive system |

PRECAUTIONS

Avoid breathing mists or vapour. Avoid contact with skin.

FIRST AID

INHALATION: Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

Eye: Flush thoroughly with water. If irritation occurs, get medical assistance.

Oral: Seek immediate medical attention.

Skin: Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

FIRE FIGHTING MEDIA

Use water fog, alcohol-resistant foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

SPILL/LEAK

Land Spill: Stop leak if you can do so without risk. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Recover by pumping or with suitable absorbent. Do not touch or walk through spilled material.

Water Spill: Stop leak if you can do so without risk. Report spills as required to appropriate authorities. Material will sink. This product emulsifies, disperses or is miscible in water. Consult an expert.

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5007472 (1011905)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: HYDRAUL 56
Product Description: Base Oil and Additives
MSDS Number: 8058
Intended Use: Hydraulic fluid

COMPANY IDENTIFICATION

Supplier: Imperial Oil Products Division
240 4th Avenue
Calgary, ALBERTA. T2P 3M9 Canada
24 Hour Environmental / Health Emergency Telephone 519-339-2145
Transportation Emergency Phone Number 519-339-2145
Product Technical Information 1-800-268-3183
Supplier General Contact 1-800-567-3776

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines see Section 15.

HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

Note: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight streams of water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent run-off from fire control or dilution from entering streams, sewers or drinking water supply. Fire-fighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Pressurised mists may form a flammable mixture.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Oxides of carbon, Incomplete combustion products, Sulphur Oxides

FLAMMABILITY PROPERTIES

Flash Point [Method]: 220C (428F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: 330°C (626°F)

SECTION 6 ACCIDENTAL RELEASE MEASURES

Notification Procedures

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do so without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do so without risk. Confine the spill immediately with booms. Warn other

shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dyke far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

Personal Protection

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate,

gas/vapour warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practise good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Colour: Amber

Odour: Characteristic

Odour Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.885

Flash Point [Method]: 220C (428F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: 330°C (626°F)

Boiling Point / Range: > 322C (612F)

Vapour Density (Air = 1): > 2 at 101 kPa

Vapour Pressure: < 0.013 kPa (0.1 mm Hg) at 20°C

Evaporation Rate (N-Butyl Acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: [N/D at 40°C] | 9.9 cSt (9.9 mm²/sec) at 100C

Oxidizing properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A
Pour Point: -36°C (-33°F)
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10	STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11	TOXICOLOGICAL INFORMATION

Acute Toxicity

Route of Exposure	Conclusion / Remarks
INHALATION	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
INGESTION	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on assessment of the components.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.

CHRONIC/OTHER EFFECTS

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitising in test animals.

Additional information is available by request.

CMR Status: None.

--REGULATORY LISTS SEARCHED--

1 = IARC 1
2 = IARC 2A

3 = IARC 2B
4 = ACGIH ALL

5 = ACGIH A1
6 = ACGIH A2

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (TDG) : Not Regulated for Land Transport

LAND (DOT) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION

WHMIS Classification: Not controlled

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the (M)SDS contains all the information required by the Controlled Products Regulations.

CEPA: All components of this material are either on the Canadian Domestic Substances List (DSL), exempt, or have been notified under CEPA.

National Chemical Inventory Listing: DSL, TSCA

The Following Ingredients are Cited on the Lists Below:

Chemical Name	CAS Number	List Citations
ZINC C1-C14 ALKYLDITHIOPHOSPHATE	68649-42-3	6

--REGULATORY LISTS SEARCHED--

1 = TSCA 4
2 = TSCA 5a2

3 = TSCA 5e
4 = TSCA 6

5 = TSCA 12b
6 = NPRI

SECTION 16	OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 05: Fire Fighting Measures - Fire Fighting Instruction was modified.

Section 06: Notification Procedures - Header was modified.

Section 13: Empty Container Warning was modified.

Section 09: Phys/Chem Properties Note was modified.

Section 09: Boiling Point C(F) was modified.

Section 08: Personal Protection - Header was modified.

Section 08: Hand Protection was modified.

Section 05: Hazardous Combustion Products was modified.

Section 06: Accidental Release- Spill Management- Water was modified.

Section 09: Relative Density - Header was modified.

Section 09: Flash Point C(F) was modified.

Section 09 Viscosity was modified.

Section 15: National Chemical Inventory Listing - Header was modified.

Section 09: Relative Density was modified.

Section 16: MSN,MAT ID was modified.

Section 15: List Citation Table - Header was modified.

Section 15: Canadian List Citations Table was added.

Section 15: Chemical Name - Header was added.

Section 15: CAS Number - Header was added.
Section 15: List Citations -Header was added.
Section 11: Chronic Tox - Component - WHMIS was added.
Section 11: Chronic Tox - Component - Header was added.
Section 11: Other Health Effects Header was added.
Composition: No components was added.
Section 11: Other Health Effects Header was deleted.
Composition: No components was deleted.
Section 11: Chronic Tox - Component was deleted.
Section 11: Chronic Tox - Component - Header was deleted.
Section 09: Form - Header was deleted.
Section 09: Physical State was deleted.

WHMIS Classification: Not controlled

The information and recommendations contained herein are, to the best of Imperial Oil's knowledge and belief, accurate and reliable as of the date issued. Imperial Oil assumes no responsibility for accuracy of information unless the document is the most current available from an official Imperial Oil distribution system. The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use. If buyer repackages this product, legal counsel should be consulted to insure proper health, safety and other necessary information is included on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted.

DGN: 5006949 (1012312)

Copyright 2002 Imperial Oil Limited, All rights reserved

Prepared By: Imperial Oil Limited, IH and Product Safety

**MATERIAL SAFETY DATA**

MSDS No: 01787
CAS No: 013360-78-6
Date: 03/13/2001
Supersedes: 10/14/1997

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **AEROPHINE® 3418A Promoter**

SYNONYMS: Sodium diisobutylidithiophosphinate, 50% aqueous solution

CHEMICAL FAMILY: Dithiophosphinate

MOLECULAR FORMULA: C₈H₁₈PS₂.Na

MOLECULAR WGT: 232

CYTEC INDUSTRIES INC., FIVE GARRET MOUNTAIN PLAZA, WEST PATERSON, NEW JERSEY 07424, USA

For Product Information call 1-800/652-6013. Outside the USA and Canada call 1-973/357-3193.

EMERGENCY PHONE: For emergency involving spill, leak, fire, exposure or accident call CHEMTREC: 1-800/424-9300. Outside the USA and Canada call 1-703/527-3887.

2. COMPOSITION/INFORMATION ON INGREDIENTS**OSHA REGULATED COMPONENTS**

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
Sodium diisobutyl-di thiophosphinate	013360-78-6	50-52	not established	

3. HAZARDS IDENTIFICATION**EMERGENCY OVERVIEW**

APPEARANCE AND ODOR: Colorless to light yellow mobile liquid; odorless

STATEMENTS OF HAZARD:

WARNING! CAUSES EYE IRRITATION
MAY CAUSE SKIN IRRITATION

POTENTIAL HEALTH EFFECTS**EFFECTS OF OVEREXPOSURE:**

The acute oral (rat) and acute dermal (rabbit) LD₅₀ values for this material are 3.35 g/kg and greater than 5.0 g/kg, respectively. Mild skin and moderate eye irritation were produced during primary irritation studies in rabbits. Skin irritation was increased after repeated exposures in rabbit studies.

4. FIRST AID MEASURES

If quantities greater than 15 cc are swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth or induce vomiting in an unconscious person.

In case of skin contact, immediately wash affected areas with soap and plenty of water. Remove contaminated clothing and shoes. Obtain medical attention. Destroy or thoroughly clean shoes before reuse. Do not reuse contaminated clothing without laundering.

In case of eye contact, immediately irrigate with plenty of water for 15 minutes. Obtain medical attention if irritation persists or if otherwise necessary.

Material is not expected to be harmful if inhaled. If inhaled, remove to fresh air.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: >200 F; 93 C

METHOD: Pensky-Martens Closed Cup

FLAMMABLE LIMITS

(% BY VOL): Not applicable

AUTOIGNITION TEMP: 819 F; 437 C

DECOMPOSITION TEMP: >662 F; 350C

EXTINGUISHING MEDIA AND FIRE FIGHTING INSTRUCTIONS

Use water spray, carbon dioxide or dry chemical to extinguish fires. Use water to keep containers cool.

Wear self-contained, positive pressure breathing apparatus and full fire-fighting protective clothing. See Section 8 (Exposure Controls/Personal Protection) for special protective clothing.

6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Where exposure level is not known, wear NIOSH approved, positive pressure, self-contained respirator. Where exposure level is known, wear NIOSH approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Section 8 (Exposure Controls/Personal Protection), wear impervious boots. Cover spills with some inert absorbent material; sweep up and place in a waste disposal container. Flush area with water.

7. HANDLING AND STORAGE

Avoid contact with eyes, skin, and clothing. Wash thoroughly after handling.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Where this material is not used in a closed system, good enclosure and local exhaust ventilation should be provided to control exposure. Food, beverages, and tobacco products should not be carried, stored, or consumed where this material is in use. Before eating, drinking, or smoking, wash face and hands with soap and water. Avoid skin contact. Protective clothing such as impervious gloves, apron, workpants, long sleeve work shirt, or disposable coveralls are recommended to prevent skin contact. For operations where eye or face contact can occur, wear eye protection such as chemical splash proof goggles or face shield. Eyewash equipment and safety shower should be provided in areas of potential exposure. For operations where inhalation exposure can occur, a NIOSH approved respirator recommended by an industrial hygienist may be necessary. A full facepiece respirator also provides eye and face protection.

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR: Colorless to light yellow mobile liquid; odorless

BOILING POINT: 223 F; 106 C

MELTING POINT: 23-32 F; -5-0 C; (crystallization point)

VAPOR PRESSURE: 17.5 mm Hg @ 20 C; (value for water)

SPECIFIC GRAVITY: 1.14 @ 24 C

VAPOR DENSITY: Not applicable

% VOLATILE (BY WT): ~50; (water)

pH: Slightly alkaline

SATURATION IN AIR (% BY VOL): Not applicable

EVAPORATION RATE: Not applicable

SOLUBILITY IN WATER: Complete

10. STABILITY AND REACTIVITY

STABILITY: Stable

CONDITIONS TO AVOID: None known

POLYMERIZATION: Will Not Occur

CONDITIONS TO AVOID: None known

INCOMPATIBLE MATERIALS: Strong mineral acids and strong oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: oxides of carbon; oxides of phosphorus; oxides of sulfur (includes sulfur di and tri oxides)

11. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3. HAZARDS IDENTIFICATION. Toxicological information on the OSHA regulated components of this product is as follows:

Sodium diisobutyldithiophosphinate causes moderate eye and mild skin irritation.

12. ECOLOGICAL INFORMATION

Algae (*Selenastrum capricornutum*), 96 hr EbC50 = 35.1 mg/L; 96 hr ErC50 = 115 mg/L

LC50

BLUEGILL, 96 HOUR: 375 mg/L

DAPHNIA, 48 HOUR: 149 mg/L

BOD

28 Day: 78.8 %

OCTANOL/H₂O PARTITION COEF.: Not applicable

13. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the Cytec product, as supplied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA "listed hazardous waste" or has any of the four RCRA "hazardous waste characteristics." Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA "listed hazardous waste"; information contained in Section 15 of this MSDS is not intended to indicate if the product is a "listed hazardous waste." RCRA Hazardous Waste Characteristics: There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, see Section 5 of this MSDS (flash point). For Corrosivity, see Sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations are subject to change. State and local requirements, which may differ from or be more stringent than the federal regulations, may also apply to the classification of the material if it is to be disposed. Cytec encourages the recycle, recovery and reuse of materials, where permitted, as an alternate to disposal as a waste. Cytec recommends that organic materials classified as RCRA hazardous wastes be disposed of by thermal treatment or incineration at EPA approved facilities. Cytec has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

14. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

D.O.T. SHIPPING INFORMATION		IMO SHIPPING INFORMATION
SHIPPING NAME:	NOT APPLICABLE/NOT REGULATED	NOT APPLICABLE/NOT REGULATED
HAZARD CLASS/ PACKING GROUP:	Not Applicable	Not Applicable
UN NUMBER:	Not Applicable	Not Applicable
IMDG PAGE:	Not Applicable	Not Applicable
D.O.T. HAZARDOUS SUBSTANCES:	(PRODUCT REPORTABLE QUANTITY) Not Applicable	Not Applicable
TRANSPORT LABEL REQUIRED:	None Required	None Required
ICAO/IATA		TRANSPORT CANADA
SHIPPING NAME:	NOT APPLICABLE/NOT REGULATED	NOT APPLICABLE/NOT REGULATED
HAZARD CLASS:	Not Applicable	Not Applicable
SUBSIDIARY CLASS:	Not Applicable	Not Applicable
UN / ID NUMBER:	Not Applicable	Not Applicable
PACKING GROUP:	Not Applicable	Not Applicable
TRANSPORT LABEL REQUIRED:	None Required	None Required
PACKING INSTR:	PASSENGER Not Applicable CARGO Not Applicable	Not Applicable
MAX NET QTY:	PASSENGER Not Applicable CARGO Not Applicable	Not Applicable

ADDITIONAL TRANSPORT INFORMATION

TECHNICAL NAME (N.O.S.): Not Applicable

15. REGULATORY INFORMATION

INVENTORY INFORMATION

US TSCA: All components of this product are included on the TSCA Inventory in compliance with the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq.

CANADA DSL: Components of this product have been reported to Environment Canada in accordance with subsection 25 of the Canadian Environmental Protection Act and are included on the Domestic Substances List.

EEC EINECS: All components of this product are included in the European Inventory of Existing Chemical Substances (EINECS) in compliance with Council Directive 67/548/EEC and its amendments.

**OTHER
ENVIRONMENTAL
INFORMATION**

The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

COMPONENT	CAS. NO.	%	TPQ(lbs)	RQ(lbs)	S313	TSCA 12B

This product does not contain any components regulated under these sections of the EPA

PRODUCT CLASSIFICATION UNDER SECTION 311 OF SARA				
ACUTE (Y)	CHRONIC (N)	FIRE (N)	REACTIVE (N)	PRESSURE (N)

16. OTHER INFORMATION**NFPA HAZARD RATING (National Fire Protection Association)**

Fire	1	0	Reactivity	—
Health	2	0	Special	

FIRE: Materials that must be preheated before ignition can occur.
HEALTH: Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.
REACTIVITY: Materials that in themselves are normally stable, even under fire exposure conditions.

REASON FOR ISSUE:

Revised Section 15

Randy Deskin, Ph.D., DABT

This information is given without any warranty or representation. We do not assume any legal responsibility for same, nor do we give permission, inducement, or recommendation to practice any patented invention without a license. It is offered solely for your consideration, investigation and verification. Before using any product, read its label.

**OLD BRIDGE CHEMICALS, INC.
OLD WATERWORKS ROAD
OLD BRIDGE, NJ 08857**

Telephone: 732-727-2225

Facsimile: 732-727-2653

info@oldbridgechem.com

www.oldbridgechem.com

MATERIAL SAFETY DATA SHEET

October 25, 2006

Page 1 of 6

Product Name: COPPER SULFATE CRYSTALS

Manufacturer: Old Bridge Chemicals, Inc.
P.O. Box 194
Old Bridge, New Jersey 08857

Telephone: (732) 727-2225
Emergency Telephone: (800) 275-3924
24-hour Emergency Telephone: (800) 424-9300 Chemtrec

HAZARD CLASSIFICATION: NFPA: Health-3 / Fire-0 / Reactivity-0
HMIS: Health-3 / Fire-0 / Reactivity-0

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200).

SECTION I. MATERIAL IDENTIFICATION

Common Name: Copper Sulfate
Synonyms: Blue Vitrol, Bluestone, Cupric Sulfate
Molecular Formula: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
EPA Reg. Number: 46923-4
EPA Signal Word: **DANGER**
CAS Number: 7758-99-8
SIC Number: 28199 C 29

SECTION II. COMPOSITION/INFORMATION ON INGREDIENTS

Exposure Limits: ACGIH TLV TWA: 1.0 mg/m³ (as copper dust/mist)
OSHA PEL TWA: 1.0 mg/m³ (as copper dust/mist)

SECTION III. HAZARD INFORMATION

Emergency overview: Odorless blue crystals. Can cause irreversible eye damage and severe skin irritation. Harmful if swallowed or absorbed through the skin. Avoid

breathing dust or mist. Avoid contact with the skin, eyes or clothes. May cause skin sensitization in certain individuals.

Swallowing:	Toxic orally in accordance with FHSLA regulations. Acute oral LD50 (male rats) = 472 mg/Kg. Can cause irritation to the digestive tract and abdominal pain.
Skin :	Slight skin irritant. Excessive exposure may cause skin irritation. Repeated exposure may cause allergic dermatitis. May cause irritation or burns on wet skin.
Eyes:	Can cause severe eye irritation and may result in irreversible eye damage.
Inhalation:	Inhalation of dust may cause irritation to the mucous membranes and upper respiratory tract
Carcinogenicity:	None as per NTP, OSHA, and IARC.

SECTION IV. FIRST AID PROCEDURES

Ingestion:	Give large amounts of milk, egg white, gelatin solution, or if they are not available, large quantities of water. Do not induce vomiting or give anything to an unconscious person. Avoid alcohol. Call Poison Control Center or a physician.
Skin:	Wash thoroughly with soap and water. Remove and wash contaminated clothing before reuse.
Eyes:	Immediately flush eyes with plenty of water for 15 minutes. Hold eyelids apart during irrigation. Call a physician.
Inhalation:	Remove person to fresh air. If not breathing, administer artificial respiration. Get medical attention.
Carcinogenicity:	None.

SECTION V. FIRE AND EXPLOSION DATA

Flash Point:	Not applicable.
Flammable Limits:	Not flammable. If heated above 400° C it can decompose to emit toxic fumes of oxide and sulfur.
Auto Ignition Temperature:	Not determined.
Extinguishing Media:	Copper Sulfate does not burn nor will it support combustion. If stored with other combustible products use water, CO ₂ or dry chemical.
Special Fire Fighting Instructions:	If dry heated above 600° C, SO ₂ is evolved. If water is used it will solubilize the Copper Sulfate and care should be taken to keep such water out of streams or other water bodies.
Fire Fighting Equipment:	Wear self-contained breathing apparatus.

Fire and Explosion Hazards: None.

SECTION VI. ACCIDENTAL RELEASE MEASURES

Use clean-up measures that avoid dust generation. Wear NIOSH or MSHA approved respirator if dust will be generated. Cover spill with absorbent material such as seeping compound or lime. Sweep up and put into an appropriate container for proper disposal in an approved method. Prevent accidental entry of solution into streams or other bodies of water. Shovel spills into plastic bags and seal with tape.

SECTION VII. HANDLING AND STORAGE

Signal Word:

DANGER

Handling Information:

Avoid breathing dust or mist. Sweep up crystals. Eye wash stations should be available in work areas. Users should wash hands before eating, drinking, smoking or using the toilet. Remove PPE immediately after handling this product. Wash outside of gloves before removing. Wash and change into clean clothing as soon as possible. Store in closed containers in a cool, dry, well-ventilated area away from heat sources and reducing agents. Store in original containers. Keep away from galvanized pipe, aluminum and nylon. Place damaged containers in plastic bags.

Storage Information:

SECTION VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ventilation:

TWA = 1 mg/l. for Copper Sulfate. When TWA exceeds this limit in the workplace, provide appropriate ventilation.

Respiratory Protection:

Wear an approved respirator for dusts or mists: MSHA/NIOSH approved number prefix TC-21C, or a NIOSH approved respirator with any R, P or HE filter. Alternatively, provide respiratory protection equipment in accordance with Paragraph 1910.134 of Title 29 of the Code of Federal Regulations.

Eye Protection:

Use safety glasses with side shields or goggles.

Skin Protection:

Applicators and other handlers should wear long-sleeved shirts and long pants, waterproof gloves, shoes plus socks and protective eyewear. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with product's concentrate. Do not reuse them. Keep and wash PPE separately from other laundry.

SECTION IX. PHYSICAL DATA

Physical State:

Blue crystals or powder

Boiling Point:

NA

Melting Point:	Decomposition above 110°C with $-4\text{H}_2\text{O}$
Vapor Density:	NA
Specific Gravity:	2.284
Solubility in H_2O :	22.37% @ 0°C 117.95% @ 100°C
Solubility in Other Solvents:	Soluble in methanol, glycerol and slightly soluble in ethanol.
Molecular Weight:	249.68
Appearance:	Transparent blue crystals
Odor:	Odorless

SECTION X. REACTIVITY DATA

Stability:	Stable
Conditions to Avoid:	Product is highly soluble, but does not react with water.
Incompatibility:	Solutions are mildly corrosive to steel. Store solutions in plastic or rubber or 304, 347 or 316 stainless steel. Iron and moisture should be avoided. Store in a dry area. Incompatible with aluminum powder, acetylene gas, hydroxylamine, magnesium and moisture. Contact with magnesium can generate dangerous levels of hydrogen gas. With exposure to air it will oxidize and turn whitish.
Hazardous Decomposition Products:	None at normal production temperatures and pressures. If dry heated above 600°C toxic sulfur may evolve.
Polymerization:	Will not occur.

SECTION XI. TOXICOLOGICAL INFORMATION

Inhalation:	$\text{LC}_{50} > 2.95 \text{ mg/L}$ (rat) Inhalation of dust can result in irritation of nasal mucous membranes and sometimes of the pharynx, on occasion ulceration with perforation of the nasal septum.
Skin:	$\text{LD}_{50} > 8.0 \text{ g/kg}$ (rabbit)
Ingestion:	$\text{LD}_{50} > 472.5 \text{ mg/kg}$ (rat)
Primary Eye Irritation:	Corrosive, irreversible eye damage.
Primary Skin Irritation:	No skin irritation.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsions may be needed. Wilson's disease can be aggravated by excessive exposure. Symptoms include nausea, vomiting, epigastria pain, diarrhea, dizziness, jaundice, and general debility.

SECTION XII. ENVIRONMENTAL AND DISPOSAL INFORMATION

Aquatic LC_{50} :	Daphnia magna 0.182 mg/L.

	Rainbow Trout 0.17 mg/L. Blue Gill 1.5 mg/L.
Spills and Leaks:	All values are expressed as Copper Sulfate Pentahydrate. Test water was soft. Period 24 hours. Comply with Federal, State and local regulations on reporting spills. Do not wash away crystals or powder. Recover dry if possible. If product is in a confined solution, react with soda ash to form an insoluble Copper Carbonate solid that can be scooped up.
Waste Disposal:	Do not reuse container. Comply with Federal, State and local environmental control regulations. Sweep up crystals, powder or insoluble Copper Carbonate and dispose of in an approved landfill.
Environmental Effects:	May be dangerous if it enters the public water systems. Follow local regulation. Toxic to fish and plants. Fish toxicity critical concentration is 235 mg/l. and plant toxicity is 25 mg/l.

SECTION XIII. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another. It is the buyer's responsibility to ensure that its activities comply with Federal, State, and local laws.

SARA 313 Information; This product contains the following substance subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372: COPPER COMPOUND > 1.0%

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following category:

ACUTE HEALTH HAZARD

OSHA: This product is considered hazardous under the OSHA Hazardous Communication Standard (29 CFR 1910.1200).

TSCA: Listed on the Chemical Inventory

CERCLA Hazardous Substances: RQ is not assigned to the broad class of copper compounds.

RCRA: When discarding this material as supplied, it does not meet RCRA characteristic definition of ignitability, corrosiveness, reactivity, and is not listed in 40CFR 261.33.

This product contains Copper Sulfate and is subject to the reporting requirements of Section 13 of the Emergency Planning and Community-Right-to-Know-Act of 1986 (40CFR372).

SECTION XIV. SHIPPING INFORMATION

DOT Shipping Name RQ, Environmentally Hazardous Substance, Solid, NOS, (CUPRIC SULFATE), 9, UN3077, PGIII, ERG 171

Reportable Quantity (RQ): 10 pounds (4.54 kg)

Not hazardous when shipping less than 10 pounds

Note: Marine pollutant

SECTION XV. MISCELLANEOUS INFORMATION

This is an NSF Certified Product to ANSI/NSF 60. Maximum use in potable water is not to exceed 2 mg. per liter.

SECTION XVI. MSDS PREPARATION INFORMATION

Prepared By: Joel L. Goldschmidt
Vice President



**MATERIAL SAFETY DATASHEET
BULLETIN DE SÉCURITÉ DU PRODUIT**

IN CASE OF EMERGENCY / EN CAS D'URGENCE: SARNIA (519)339-3711 - FORT SASKATCHEWAN (780)998-8282 - VARENNES (450)652-1000

PREPARATION INFORMATION / RENSEIGNEMENTS SUR LA PRÉPARATION:

Prepared for use in Canada by: / Pour utilisation au Canada, préparé par:
EH&S Product Regulatory Management Department
Dow Chemical Canada Inc. P.O. Box 1012, Sarnia, Ontario N7T 7K7 (800) 363-3500 EXT.2241

M A T E R I A L S A F E T Y D A T A S H E E T

1. CHEMICAL PRODUCT & COMPANY IDENTIFICATION

Page: 1

IN CASE OF EMERGENCY: Fort Saskatchewan, Alberta: (780) 998-8282
Sarnia, Ontario: (519) 339-3711
Varenes, Quebec: (450) 652-1000

Product: DOWFROTH* 250 FLOTATION FROTHER

Product Code: 23586

Effective Date: 01/15/99 Date Printed: 07/17/00 MSD: 002010

Dow Chemical Canada Inc.
P.O. Box 1012, Sarnia, Ontario N7T 7K7

Prepared for use in Canada by the EH&S Product Regulatory
Management Department; Phone: (800) 363-3500 EXT. 2241

2. COMPOSITION/INFORMATION ON INGREDIENTS

Propylene oxide methanol adduct	CAS# 037286-64-9	99%
Potassium hydroxide	CAS# 001310-58-3	1%

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

*
* Yellow to dark brown liquid. Low odor. Causes eye burns.
*

POTENTIAL HEALTH EFFECTS (See Section 11 for toxicological data.)

(Continued on page 2)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 2

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

EYE: Due to the pH of the material, it is assumed that exposure may cause severe irritation with corneal injury which may result in permanent impairment of vision, even blindness.

SKIN: Short single exposure not likely to cause significant skin irritation. Prolonged or repeated exposure may cause moderate skin irritation. May cause more severe response if confined to skin or skin is abraded (scratched or cut). Prolonged or repeated exposure to very large amounts of component(s) in this mixture may cause narcosis (drowsiness).

INGESTION: Single dose oral toxicity is considered to be low. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; swallowing amounts larger than that may cause injury. Observations in animals include tremors and convulsions.

INHALATION: At room temperature, vapors are minimal due to physical properties; a single exposure is not likely to be hazardous. If material is heated or mist is produced, concentrations may be attained that are sufficient to cause respiratory irritation and other effects. Signs and symptoms of excessive exposure may be anesthetic or narcotic effects.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Signs and symptoms of excessive exposure may be anesthetic or narcotic effects.

TERATOLOGY (BIRTH DEFECTS): Contains component(s) which did not cause birth defects in laboratory animals.

4. FIRST AID

(Continued on page 3)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 3

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

EYE: Wash eyes immediately and continuously for 30 minutes. Seek medical attention immediately. Wash eyes enroute if possible.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

NOTE TO PHYSICIAN: Eye irrigation may be necessary for an extended period of time to remove as much caustic as possible. Duration of irrigation and treatment is at the discretion of medical personnel. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: 300F, 149C

METHOD USED: Setaflash

AUTOIGNITION TEMPERATURE: Not determined.

FLAMMABILITY LIMITS

LFL: Not determined.

UFL: Not determined.

(Continued on page 4)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 4

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

HAZARDOUS COMBUSTION PRODUCTS: Under fire conditions polymers decompose. The smoke may contain polymer fragments of varying compositions in addition to unidentified toxic and/or irritating compounds. Hazardous combustion products may include and are not limited to: carbon monoxide and carbon dioxide.

OTHER FLAMMABILITY INFORMATION: Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Spills of these organic liquids on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion.

EXTINGUISHING MEDIA: Water fog or fine spray, carbon dioxide, dry chemical, foam. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effectively. Do not use direct water stream. Will spread fire.

MEDIA TO BE AVOIDED: Do not use direct water stream.

FIRE FIGHTING INSTRUCTIONS: Keep people away. Isolate fire area and deny unnecessary entry. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage. Burning liquids may be extinguished by dilution with water. Do not use direct water stream. May spread fire.

PROTECTIVE EQUIPMENT FOR FIRE FIGHTERS: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

6. ACCIDENTAL RELEASE MEASURES (See Section 15 for Regulatory Information)

(Continued on page 5)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 5

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

PROTECT PEOPLE: Clear non-emergency personnel from area.

PROTECT THE ENVIRONMENT: Contain liquid to prevent contamination of soil, surface water or ground water.

CLEANUP: Soak up with suitable, non-reactive absorbent material. Collect into suitable containers for disposal.

7. HANDLING AND STORAGE

HANDLING: Avoid contact with vapors from head space of containers.

STORAGE: To avoid uncontrolled emissions vent vapor from container to storage tank.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guideline.

PERSONAL PROTECTIVE EQUIPMENT

EYE/FACE PROTECTION: Use chemical goggles. Eye wash fountain should be located in immediate work area.

SKIN PROTECTION: When prolonged or frequently repeated contact could occur, use protective clothing impervious to this material. Selection of specific items such as faceshield,

(Continued on page 6)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 6

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

gloves, boots, apron, or full-body suit will depend on operation. If hands are cut or scratched, use gloves impervious to this material even for brief exposures.

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. For most conditions, no respiratory protection should be needed; however, if material is heated or sprayed, use an approved air-purifying respirator.

EXPOSURE GUIDELINE(S): Dipropylene glycol methyl ether: ACGIH TLV and OSHA PEL are 100 ppm TWA, 150 ppm STEL.

Potassium hydroxide: ACGIH TLV and OSHA PEL are 2 mg/m³ Ceiling.

PELs are in accord with those recommended by OSHA, as in the 1989 revision of PELs.

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Yellow to dark brown liquid.
ODOR: Not available.
VAPOR PRESSURE: <0.01 mmHg @ 20C
VAPOR DENSITY: Low
BOILING POINT: 473F, 245C
SOLUBILITY IN WATER: Completely miscible.
SPECIFIC GRAVITY: 0.98 25/25

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable under recommended storage conditions.
See Storage Section.

(Continued on page 7)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 7

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

CONDITIONS TO AVOID: None known.

INCOMPATIBILITY WITH OTHER MATERIALS: Avoid contact with
oxidizing materials.

HAZARDOUS DECOMPOSITION PRODUCTS: None known.

HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL INFORMATION (See Section 3 for Potential Health Effects. For detailed toxicological data, write or call the address or non-emergency number shown in Section 1)

SKIN: The dermal LD50 has not been determined.

INGESTION: The oral LD50 for rats is between 1260 - 2520 mg/kg.

MUTAGENICITY: In vitro mutagenicity studies were negative for component(s) tested.

12. ECOLOGICAL INFORMATION (For detailed Ecological data, write or call the address or non-emergency number shown in Section 1)

ENVIRONMENTAL FATE

MOVEMENT & PARTITIONING: Log octanol/water partition coefficient (log Pow) is estimated to be low. Based largely or completely on information for similar material.

DEGRADATION & PERSISTENCE: 20-Day biochemical oxygen demand

(Continued on page 8)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 8

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

(BOD20) is 0.18 p/p. Biodegradation under aerobic static laboratory conditions is low (BOD20 or BOD28/ThOD between 2.5 and 10%)

ECOTOXICITY: Acute LC50 for fathead minnow (*Pimephales promelas*) is > 100 mg/L. Material is practically non-toxic to fish on an acute basis (LC50 greater than 100 mg/L).

13. DISPOSAL CONSIDERATIONS (See Section 15 for Regulatory Information)

DISPOSAL: DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator or other thermal destruction device.

As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 517-832-1556 for further details.

14. TRANSPORT INFORMATION

(Continued on page 9)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 9

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

DEPARTMENT OF TRANSPORTATION (D.O.T.): For DOT regulatory information, if required, consult transportation regulations, product shipping papers, or your Dow representative.

CANADIAN TDG INFORMATION: For TDG regulatory information, if required, consult transportation regulations, product shipping papers, or your Dow representative.

15. REGULATORY INFORMATION (Not meant to be all-inclusive--selected regulations represented)

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

CANADIAN REGULATIONS

=====

WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information System (WHMIS) Classification for this product is:

- E - corrosive to metal or skin
 Refer elsewhere in the MSDS for specific warnings and safe handling information. Refer to the employer's workplace education program.

(Continued on page 10)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 10

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

REGULATORY INFORMATION (CONTINUED)

- - - - -
CPR STATEMENT: This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

- - - - -
HAZARDOUS PRODUCTS ACT INFORMATION: This product contains the following ingredients which are Controlled Products and/or on the Ingredient Disclosure List (Canadian HPA section 13 and 14):

COMPONENTS:	CAS #	AMOUNT(%w/w)
Polypropylene glycol methyl ether	CAS# 037286-64-9	98%
Potassium hydroxide	CAS# 001310-58-3	1%

U.S. REGULATIONS

=====

SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard

(Continued on page 11)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 11

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

REGULATORY INFORMATION (CONTINUED)

TOXIC SUBSTANCES CONTROL ACT (TSCA):

All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
POTASSIUM HYDROXIDE	001310-58-3	NJ1 NJ3 PA1 PA3
DIPROPYLENE GLYCOL METHYL ETHER	034590-94-8	NJ3 PA1

NJ1=New Jersey Special Health Hazard Substance (present at greater than or equal to 0.1%).

NJ3=New Jersey Workplace Hazardous Substance (present at greater than or equal to 1.0%).

PA1=Pennsylvania Hazardous Substance (present at greater than or equal to 1.0%).

PA3=Pennsylvania Environmental Hazardous Substance (present at greater than or equal to 1.0%).

STATE RIGHT-TO-KNOW: This product is not known to contain any

(Continued on page 12)

* OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

M A T E R I A L S A F E T Y D A T A S H E E T

Product: DOWFROTH* 250 FLOTATION FROTHER
Product Code: 23586

Page: 12

Effective Date: 01/15/99

Date Printed: 07/17/00

MSD: 002010

REGULATORY INFORMATION (CONTINUED)

substances subject to the disclosure requirements of

New Jersey
Pennsylvania

OSHA HAZARD COMMUNICATION STANDARD:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

16. OTHER INFORMATION

MSDS STATUS: Revised Sections 3, 4, 8, 11, 12, 13, 15.
Canadian regulatory information revised.

(R) Indicates a Trademark of The Dow Chemical Company
The Information Herein Is Given In Good Faith, But No Warranty,
Express Or Implied, Is Made. Consult The Dow Chemical Company
For Further Information.

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

EMERGENCY OVERVIEW

DANGER!

**EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT
- EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF
SWALLOWED - ASPIRATION HAZARD**



NFPA 704 (Section 16)

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Jan-04)

Amerada Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs):

COMPANY CONTACT (business hours):

MSDS Internet Website

CHEMTREC (800)424-9300

Corporate Safety (732)750-6000

www.hess.com/about/envIRON.html

SYNONYMS: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS * (rev. Jan-04)

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Gasoline (86290-81-5)	100
Benzene (71-43-2)	0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
n-Butane (106-97-8)	< 10
Ethyl Alcohol (Ethanol) (64-17-5)	0 - 10
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Tertiary-amyl methyl ether (TAME) (994-05-8)	0 to 17.2
Toluene (108-88-3)	1 - 25
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

AMERADAHESSE CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

3. HAZARDS IDENTIFICATION (rev. Dec-97)

EYES

Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY

Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Dec-97)

EYES

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

AMERADAHESSE CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

5. FIRE FIGHTING MEASURES (rev. Dec-97)

FLAMMABLE PROPERTIES:

FLASH POINT: -45 °F (-43°C)
AUTOIGNITION TEMPERATURE: highly variable; > 530 °F (>280 °C)
OSHA/NFPA FLAMMABILITY CLASS: 1A (flammable liquid)
LOWER EXPLOSIVE LIMIT (%): 1.4%
UPPER EXPLOSIVE LIMIT (%): 7.6%

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and/or in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 "Low Expansion Foam - 1994 Edition."

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Dec-97)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Dec-97)

HANDLING PRECAUTIONS

*****USE ONLY AS A MOTOR FUEL*****

*****DO NOT SIPHON BY MOUTH*****

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Jan-04)

EXPOSURE LIMITS

Component (CAS No.)	Source	TWA (ppm)	STEL (ppm)	Exposure Limits	Note
Gasoline (86290-81-5)	ACGIH	300	500	A3	
Benzene (71-43-2)	OSHA	1	5	Carcinogen	
	ACGIH	0.5	2.5	A1, skin	
	USCG	1	5		
n-Butane (106-97-8)	ACGIH	800	--	2003 NOIC: 1000 ppm (TWA) Aliphatic Hydrocarbon Gases Alkane (C1-C4)	
Ethyl Alcohol (ethanol) (64-17-5)	OSHA	1000	--		
	ACGIH	1000	--	A4	
Ethyl benzene (100-41-4)	OSHA	100	--		
	ACGIH	100	125	A3	

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

Component (CAS No.)	Source	TWA (ppm)	STEL (ppm)	Exposure Limits	Note
n-Hexane (110-54-3)	OSHA	500	--		
	ACGIH	50	--	skin	
Methyl-tertiary butyl ether [MTBE] (1634-04-4)	ACGIH	50		A3	
Tertiary-amyl methyl ether [TAME] (994-05-8)				None established	
Toluene (108-88-3)	OSHA	200		Ceiling: 300 ppm; Peak: 500 ppm (10 min.)	
	ACGIH	50	--	A4 (skin)	
1,2,4- Trimethylbenzene (95-63-6)	ACGIH	25	--		
Xylene, mixed isomers (1330-20-7)	OSHA	100	--		
	ACGIH	100	150	A4	

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I. DuPont Tychem®, products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Jan-04)

APPEARANCE

A translucent, straw-colored or light yellow liquid

ODOR

A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

ODOR THRESHOLD

	<u>Odor Detection</u>	<u>Odor Recognition</u>
Non-oxygenated gasoline:	0.5 - 0.6 ppm	0.8 - 1.1 ppm
Gasoline with 15% MTBE:	0.2 - 0.3 ppm	0.4 - 0.7 ppm
Gasoline with 15% TAME:	0.1 ppm	0.2 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	85 to 437 °F (39 to 200 °C)
VAPOR PRESSURE:	6.4 - 15 RVP @ 100 °F (38 °C) (275-475 mm Hg @ 68 °F (20 °C)
VAPOR DENSITY (air = 1):	AP 3 to 4
SPECIFIC GRAVITY (H ₂ O = 1):	0.70 – 0.78
EVAPORATION RATE:	10-11 (n-butyl acetate = 1)
PERCENT VOLATILES:	100 %

AMERAD HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

SOLUBILITY (H₂O): Non-oxygenated gasoline - negligible (< 0.1% @ 77 °F). Gasoline with 15% MTBE - slight (0.1 - 3% @ 77 °F); ethanol is readily soluble in water

10. STABILITY and REACTIVITY (rev. Dec-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

INCOMPATIBLE MATERIALS

Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Dec-97)

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 5 ml/kg

Acute Oral LD50 (rat): 18.75 ml/kg

Primary dermal irritation (rabbits): slightly irritating

Draize eye irritation (rabbits): non-irritating

Guinea pig sensitization: negative

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION (rev. Jan-04)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leach into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS (rev. Dec-97)

Consult federal, state and local waste regulations to determine appropriate disposal options.

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

14. TRANSPORTATION INFORMATION (rev. Jan-04)

DOT PROPER SHIPPING NAME: Gasoline
 DOT HAZARD CLASS and PACKING GROUP: 3, PG II
 DOT IDENTIFICATION NUMBER: UN 1203
 DOT SHIPPING LABEL: FLAMMABLE LIQUID

PLACARD:



15. REGULATORY INFORMATION (rev. Jan-04)

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

<u>ACUTE HEALTH</u>	<u>CHRONIC HEALTH</u>	<u>FIRE</u>	<u>SUDDEN RELEASE OF PRESSURE</u>	<u>REACTIVE</u>
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 to 15

US EPA guidance documents (www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following deminimis levels of toxic chemicals subject to Section 313 reporting:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION - Parts per million (ppm) by weight
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i) perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades

MSDS No. 9950

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 2 (Flammable Liquid)

Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION (rev. Jan-04)

NFPA® HAZARD RATING

HEALTH:	1	Slight
FIRE:	3	Serious
REACTIVITY:	0	Minimal

HMIS® HAZARD RATING

HEALTH:	1 *	Slight
FIRE:	3	Serious
REACTIVITY:	0	Minimal

* CHRONIC

SUPERSEDES MSDS DATED: 12/30/97

ABBREVIATIONS:

AP = Approximately < = Less than > = Greater than
 N/A = Not Applicable N/D = Not Determined ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists	NTP	National Toxicology Program
AIHA	American Industrial Hygiene Association	OPA	Oil Pollution Act of 1990
ANSI	American National Standards Institute (212)642-4900	OSHA	U.S. Occupational Safety & Health Administration
API	American Petroleum Institute (202)682-8000	PEL	Permissible Exposure Limit (OSHA)
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act	RCRA	Resource Conservation and Recovery Act
DOT	U.S. Department of Transportation [General Info: (800)467-4922]	REL	Recommended Exposure Limit (NIOSH)
EPA	U.S. Environmental Protection Agency	SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
HMIS	Hazardous Materials Information System	SCBA	Self-Contained Breathing Apparatus
IARC	International Agency For Research On Cancer	SPCC	Spill Prevention, Control, and Countermeasures
MSHA	Mine Safety and Health Administration	STEL	Short-Term Exposure Limit (generally 15 minutes)
NFPA	National Fire Protection Association (617)770-3000	TLV	Threshold Limit Value (ACGIH)
NIOSH	National Institute of Occupational Safety and Health	TSCA	Toxic Substances Control Act
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)	TWA	Time Weighted Average (8 hr.)
		WEEL	Workplace Environmental Exposure Level (AIHA)
		WHMIS	Workplace Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Material Safety Data Sheet

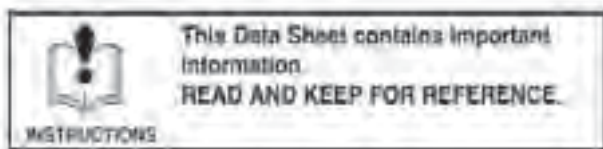


First choice when
quality counts.

308166

Rev. D

Updated: 5/02



IMPORTANT: Read this MSDS before handling or disposing of this product and pass this information on to employees, customers, and users of this product.

Emergency Overview

Physical State Liquid.
Color Clear to light amber. **Odor** Mild petroleum odor.

WARNING!

Oil injected into the skin from high-pressure leaks in hydraulic systems can cause severe injury.

Most damage occurs during the first few hours.

Seek medical attention immediately.

Surgical removal of oil may be necessary.

Spills may create a slipping hazard.

Hazard Rankings

	HMIS	NFPA
Health Hazard	1	0
Fire Hazard	1	1
Reactivity	0	0

* = Chronic Health Hazard

Protective Equipment

Minimum Requirements
See Section 8 for Details



1.0 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Hydraulic Fluid

Chemical Name: Industrial Oils

Graco Inc.

P.O. Box 1441

60 11th Ave. NE

Minneapolis, MN 55440-1441

Part Number(s): 218-797

Use: Hydraulic Fluid used in PT2500 electric driver hydraulic pump.

Emergency Information

Health Emergency (RMPC): (303)- 623-5716

Chemical Spills (Chemtrec): (800)- 424-9300

2.0 COMPOSITION / INFORMATION ON INGREDIENTS

Component %	CAS#	% by Weight
1)Distillates, petroleum, solvent-refined light paraffinic	64741-89-5	30 – 50
2)Distillates, petroleum, solvent-refined heavy paraffinic	64741-89-5	40 – 60
3) Proprietary Ingredients	Proprietary Mixture	0 – 2
4) Zinc alkyldithiophosphate	68649-42-3	0 - 1

For exposure data, see 8.0, Exposure Controls / Personal Protection.

3.0 HAZARDS IDENTIFICATION

Emergency Overview: **Physical State:** Liquid **Odor:** Mild petroleum odor **Color:** Clear to light amber

Potential Health Effects:

Eye Contact	This product can cause transient mild eye irritation with short-term contact with liquid sprays or mists
Skin Contact	This material can cause mild skin irritation from prolonged or repeated skin contact. Injection under the skin can cause inflammation, swelling and mild central nervous system depression. Injection of pressurized hydrocarbons can cause severe, permanent tissue damage. Initial symptoms may be minor. Injection of petroleum hydrocarbons requires immediate medical attention.
Inhalation	At elevated temperatures or in enclosed spaces, product mist or vapors may irritate the mucous membranes of the nose, the throat, bronchi, and lungs
Ingestion	If swallowed, large volumes of material can cause generalized depression, headache, drowsiness, nausea, vomiting and diarrhea. Smaller doses can cause a laxative effect. If aspirated into the lungs, liquid can cause lung damage.
Chronic Health Effects Summary	Contains a petroleum-based mineral oil. Prolonged or repeated skin contact can cause mild irritation and inflammation characterized by drying, cracking, (dermatitis) or oil acne. Repeated or prolonged inhalation of petroleum-based mineral oil mists at concentrations above applicable workplace exposure levels can cause respiratory irritation or other pulmonary effects.
Conditions Aggravated by Exposure	Medical conditions aggravated by exposure to this material may include pre-existing skin disorders.
Target Organs	This material may cause damage to the following organs: skin.
Carcinogenic Potential	This product does not contain any components at concentrations above 0.1% which are considered carcinogenic by OSHA, IARC or NTP.

OSHA Hazard Classification is indicated by an "X" in the box adjacent to the hazard title. If no "X" is present, the product does not exhibit the hazard as defined in the OSHA Hazard Communication Standard (29 CFR 1910.1200).

OSHA Health Hazard Classification			OSHA Physical Hazard Classification		
Irritant	☐	Toxic	☐	Combustible	☐
Sensitizer	☐	Highly Toxic	☐	Explosive	☐
Corrosive	☐	Carcinogenic	☐	Pyrophoric	☐
			Flammable	☐	Water-reactive
			Compressed Gas	☐	Unstable
			Organic Peroxide	☐	☐

4.0 FIRST AID MEASURES

Take proper precautions to ensure your own health and safety before attempting rescue or providing first aid. For more specific information, refer to Exposure Controls and Personal Protection in Section 8 of this MSDS.

Eye	Check for and remove contact lenses. Flush eyes with cool, clean, low-pressure water while occasionally lifting and lowering eyelids. Seek medical attention if excessive tearing, redness, or pain persists.
Skin	Remove contaminated shoes and clothing. Wipe off excess material. Wash exposed skin with mild soap and water. Seek medical attention if tissue appears damaged or if pain or irritation persists. Thoroughly clean contaminated clothing before reuse. Discard contaminated leather goods. If material is injected under the skin, seek medical attention immediately.
Inhalation	Move victim to fresh air. If victim is not breathing, immediately begin rescue breathing. If breathing is difficult, 100 percent humidified oxygen should be administered by a qualified individual. Seek medical attention immediately. Keep the affected individual warm and at rest.
Ingestion	Do not induce vomiting unless directed to by a physician. Do not give anything to drink unless directed to by a physician. Never give anything by mouth to a person who is not fully conscious. Seek medical attention immediately.
Notes to Physician	In the event of injection in underlying tissue, immediate treatment should include extensive incision, debridement and saline irrigation. Inadequate treatment can result in ischemia and gangrene. Early symptoms may be minimal.

. **NOTES:** NA = Not Applicable;

NE = Not Established;

UN = Unavailable

5.0 FIREFIGHTING MEASURES

Flashpoint	OPEN CUP: 212°C (414°F) (Cleveland.).
UFL	No Data
LFL	No Data
Autoignition Temperature	Not Available
Flammability Classification	NFPA Class-IIIB combustible material. Slightly combustible!
Extinguishing Media	Use dry chemical, foam, Carbon Dioxide or water fog
Special Properties	This material can burn but will not readily ignite. This material will release vapors when heated above the flash point temperature that can ignite when exposed to a source of ignition. In enclosed spaces, heated vapor can ignite with explosive force. Mists or sprays may burn at temperatures below the flash point.
Firefighting Equipment	Firefighters must use full bunker gear including NIOSH-approved positive pressure self-contained breathing apparatus to protect against potential hazardous combustion or decomposition products and oxygen deficiencies.
Hazardous Combustion Products	Carbon dioxide, carbon monoxide, smoke, fumes, unburned hydrocarbons and trace oxides of sulfur, phosphorus, zinc and/or nitrogen.

6.0 ACCIDENTAL RELEASE MEASURES

Take proper precautions to ensure your own health and safety before attempting spill control or clean-up. For more specific information, refer to the Emergency Overview on Page 1, Exposure Controls and Personal Protection in Section 8 and Disposal Considerations in Section 13 of this MSDS.

Do not touch damaged containers or spilled material unless wearing appropriate protective equipment. Slipping hazard; do not walk through spilled material. Stop leak if you can do so without risk. For small spills, absorb or cover with dry earth, sand, or other inert non-combustible absorbent material and place into waste containers for later disposal. Contain large spills to maximize product recovery or disposal. Prevent entry into waterways or sewers. In urban area, cleanup spill as soon as possible. In natural environments, seek cleanup advice from specialists to minimize physical habitat damage. This material will float on water. Absorbent pads and similar materials can be used. Comply with all laws and regulations.

7.0 HANDLING AND STORAGE

Handling	Avoid water contamination and extreme temperatures to minimize product degradation. Empty containers may contain product residues that can ignite with explosive force. Do not pressurize, cut, weld, braze solder, drill, grind or expose containers to flames, sparks, heat or other potential ignition sources. Consult appropriate federal, state and local authorities before reusing, reconditioning, reclaiming, recycling or disposing of empty containers and/or waste residues of this product
Storage	Keep container closed. Do not store with strong oxidizing agents. Do not store at temperatures above 120° F or in direct sunlight for extended periods of time. Consult appropriate federal, state and local authorities before reusing, reconditioning, reclaiming, recycling or disposing of empty containers or waste residues of this product.

8.0 EXPOSURE CONTROLS / PERSONAL PROTECTION

Eye	Safety glasses equipped with side shields should be adequate protection under most conditions of use. Wear goggles and/or face shield if splashing or spraying is anticipated. Wear goggles and face shield if material is heated above 125°F (51°C). Have suitable eye wash water available	
Personal Protective Equipment	Personal protective equipment should be selected based upon the conditions under which this material is used. A hazard assessment of the work area for PPE requirements should be conducted by a qualified professional pursuant to OSHA regulations. The following pictograms represent the minimum requirements for personal protective equipment. For certain operations, additional PPE may be required. 	
Hand Protection	Use gloves constructed of chemical resistant materials such as neoprene or heavy nitrile rubber if frequent or prolonged contact is expected. Use heat-protective gloves when handling product at elevated temperatures.	
Body Protection	Use clean and impervious protective clothing (e.g., neoprene or Tyvek ®) if splashing or spraying conditions are present. Protective clothing may include long-sleeve outer garment, apron, or lab coat. If significant contact occurs, remove oil-contaminated clothing as soon as possible and promptly shower. Launder contaminated before reuse or discard. Wear heat protective boots and protective clothing when handling material at elevated temperatures	
Engineering Controls	Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of mists and/or vapors below the recommended exposure limits (see below). An eye wash station and safety shower should be located near the work-station	
Respiratory Protection	Vaporization is not expected at ambient temperatures. Therefore, the need for respiratory protection is not anticipated under normal use conditions and with adequate ventilation. If elevated airborne concentrations above applicable workplace exposure levels are anticipated, a NIOSH-approved organic vapor respirator equipped with a dust/mist prefilter should be used. Protection factors vary depending upon the type of respirator used. Respirators should be used in accordance with OSHA requirements (29 CFR 1910.134).	
General Comments	Use good personal hygiene practices. Wash hands and other exposed skin areas with plenty of mild soap and water before eating, drinking, smoking, use of toilet facilities, or leaving work. DO NOT use gasoline, kerosene, solvents or harsh abrasives as skin cleaners. Since specific exposure standards/control limits have not been established for this product, the "Oil Mist, Mineral" exposure limits shown below are suggested as minimum control guidelines.	
Occupational Exposure Guidelines	Substance 1) Oil Mist, Mineral	Applicable Workplace Exposure Levels ACGIH (United States). TWA: 5 mg/m ³ STEL: 10 mg/m ³ OSHA (United States). TWA: 5 mg/m ³

9.0 CHEMICAL AND PHYSICAL PROPERTIES

Appearance and Odor	Mild petroleum odor
pH	Not Applicable
Vapor Pressure (mm Hg)	<0.001 kPa (<0.01 mmHg) (at 20°C)
Vapor Density (Air = 1)	>1 (Air = 1)
Boiling Point	Not available
Melting Point	Not available
Solubility in Water	Insoluble in cold water.
Specific Gravity (Water = 1)	0.87 (Water = 1)
Physical State	Liquid
Color	Clear to light amber
Viscosity (cST @ 40°C)	33
Volatile Characteristics	Negligible volatility
Additional Properties	Gravity, °API (ASTM D287) = 31.3 @ 60° F Density = 7.42 Lbs/gal. Viscosity (ASTM D2161) = 170 SUS @ 100° F

10.0 STABILITY AND REACTIVITY

Stability	Stable.
Conditions to Avoid	Keep away from extreme heat, sparks, open flame, and strongly oxidizing conditions.
Materials to Avoid	Strong oxidizers.
Hazardous Decomposition	No additional hazardous decomposition products were identified other than the combustion products identified in Section 5 of this MSDS
Hazardous Polymerization	Not expected to occur

11.0 TOXICOLOGICAL INFORMATION

For other health-related information, refer to the Emergency Overview on Page 1 of the Hazards Identification in Section 3 of this MSDS.

Distillates, petroleum, solvent-refined light paraffinic:

ORAL (LD50): Acute: >5000 mg/kg [Rat].

DERMAL (LD50): Acute: >2000 mg/kg [Rabbit].

Distillates, petroleum, solvent-refined heavy paraffinic:

ORAL (LD50): Acute: >5000 mg/kg [Rat].

DERMAL (LD50): Acute: >2000 mg/kg [Rabbit].

Distillates, petroleum, solvent-refined light paraffinic:

Mineral oil mists derived from highly refined oils are reported to have low acute and sub-acute toxicities in animals. Effects from single and short-term repeated exposures to high concentrations of mineral oil mists well above applicable workplace exposure levels include lung inflammatory reaction, lipoid granuloma formation and lipoid pneumonia. In acute and sub-acute studies involving exposures to lower concentrations of mineral oil mists at or near current work place exposure levels produced no significant toxicological effects. In long term studies (up to two years) no carcinogenic effects have been reported in any animal species tested.

Distillates, petroleum, solvent-refined heavy paraffinic:

Mineral oil mists derived from highly refined oils are reported to have low acute and sub-acute toxicities in animals. Effects from single and short-term repeated exposures to high concentrations of mineral oil mists well above applicable workplace exposure levels include lung inflammatory reaction, lipoid granuloma formation and lipoid pneumonia. In acute and sub-acute studies involving exposures to lower concentrations of mineral oil mists at or near current work place exposure levels produced no significant toxicological effects. In long term studies (up to two years) no carcinogenic effects have been reported in any animal species tested.

Hydraulic Oils:

Repeated or prolonged skin contact with certain hydraulic oils can cause mild skin irritation characterized by drying, cracking (dermatitis) or oil acne. Injection under the skin, in muscle or into the blood stream can cause irritation, inflammation, swelling, fever, and systemic effects, including mild central nervous system depression. Injection of pressurized hydrocarbons can cause severe, permanent tissue damage.

12.0 ECOLOGICAL INFORMATION

Ecotoxicity

Analysis for ecological effects has not been conducted on this product. However, if spilled, this product and any contaminated soil or water may be harmful to human, animal, and aquatic life. Also, the coating action associated with petroleum and petroleum products can be harmful or fatal to aquatic life and waterfowl.

Environmental Fate

An environmental fate analysis has not been conducted on this specific product. Plants and animals may experience harmful or fatal effects when coated with petroleum-based products. Petroleum-based (mineral) lube oils will normally float on water. In stagnant or slow-flowing waterways, an oil layer can cover a large surface area. As a result, this oil layer might limit or eliminate natural atmospheric oxygen transport into the water. With time, if not removed, oxygen depletion in the waterway can result in a loss of marine life or create an anaerobic environment. This material contains phosphorus which is a controlled element for disposal in effluent waters in most sections of North America. Phosphorus is known to enhance the formation of algae. Severe algae growth can reduce oxygen content in the water possibly below levels necessary to support marine life.

13.0 DISPOSAL INFORMATION

Hazard characteristic and regulatory waste stream classification can change with product use. Accordingly, it is the responsibility of the user to determine the proper storage, transportation, treatment and/or disposal methodologies for spent materials and residues at the time of disposition.

Conditions of use may cause this material to become a "hazardous waste", as defined by federal or state regulations. It is the responsibility of the user to determine if the material is a "hazardous waste" at the time of disposal. Transportation, treatment, storage, and disposal of waste material must be conducted in accordance with RCRA regulations (see 40 CFR 260 through 40 CFR 271). State and/or local regulations may be more restrictive. Contact the RCRA/Superfund Hotline at (800) 424-9346 or your regional US EPA office for guidance concerning case specific disposal issues. Empty drums and pails retain residue. DO NOT pressurize, cut, weld, braze, solder, drill, grind, or expose this product's empty container to heat, flame, or other ignition sources. DO NOT attempt to clean it. Empty drums and pails should be drained completely, properly bunged or sealed, and promptly sent to a reconditioner.

14.0 TRANSPORTATION INFORMATION

U.S. Dept. of Transportation: Not a US Department of Transportation regulated material.

Hazard Class - Not regulated

Packing Group(s) – Not applicable

UN/NA ID – Not regulated

Reportable Quantity – A Reportable Quantity (RQ) has not been established for this material.

Placards



Emergency Response Guide No. Not applicable

Hazmat STCC No. – Not assigned

MARPOL III Status – Not a DOT “Marine

Pollutant” Per 49 CFR 171.8

15.0 REGULATORY INFORMATION

CERCLA Sections 102A/103 Hazardous Substances (40 CFR Part 302.4)	The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requires notification of the National Response Center concerning release of quantities of "hazardous substances" equal to or greater than the reportable quantities (RQ's) listed in 40 CFR 302.4. As defined by CERCLA, the term "hazardous substance" does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically designated in 40 CFR 302.4. Chemical substances present in this product or refinery stream that may be subject to this statute are: Zinc and Zinc Compounds, Concentration: 0 - 1%
SARA Title III Section 302 Extremely Hazardous Substances (40 CFR Part 355)	The Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III requires facilities subject to Subparts 302 and 304 to submit emergency planning and notification information based on Threshold Planning Quantities (TPQs) and Reportable Quantities (RQs) for "Extremely Hazardous Substances" listed in 40 CFR 302.4 and 40 CFR 355. No components were identified
SARA Title III Section 311/312 Hazardous Categorization (40 CFR Part 370)	The Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III requires facilities subject to this subpart to submit aggregate information on chemicals by "Hazard Category" as defined in 40 CFR 370.2. This material would be classified under the following hazard categories: No SARA 311/312 hazard categories identified.
SARA Title III Sections 313 (40 CFR Part 372)	This product contains the following components in concentrations above de minimis levels that are listed as toxic chemicals in 40 CFR Part 372 pursuant to the requirements of Section 313 of SARA: No components were identified.
U.S. Inventory (TSCA)	This product and/or its components are listed on the Toxic Substances Control Act (TSCA) inventory.
CWA	This material is classified as an oil under Section 311 of the Clean Water Act (CWA) and the Oil Pollution Act of 1990 (OPA). Discharges or spills which produce a visible sheen on waters of the United States, their adjoining shorelines, or into conduits leading to surface waters must be reported to the EPA's National Response Center at (800) 424-8802.
California Proposition 65	This material may contain the following components which are known to the State of California to cause cancer, birth defects or other reproductive harm, and may be subject to the requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5): Toluene: 0.001%
New Jersey Right-to-Know Label	Petroleum Oil (Hydraulic Fluid)
Additional Regulatory Remarks	No additional regulatory remarks

16.0 OTHER INFORMATION

Refer to the top of Page 1 for the HMIS and NFPA Hazard Ratings for this product.

ABBREVIATIONS

AP = Approximately, EQ = Equal, > = Greater Than, < = Less Than, NA = Not Applicable, ND = No Data, NE = Not Established

ACGIH = American Conference of Governmental Industrial Hygienists

IARC = International Agency for Research on Cancer

NIOSH = National Institute of Occupational Safety and Health

NPCA = National Paint and Coating Manufacturers Association

NFPA = National Fire Protection Association

AIHA = American Industrial Hygiene Association

NTP = National Toxicology Program

OSHA = Occupational Safety and Health Administration

HMIS = Hazardous Materials Information System

EPA = Environmental Protection Agency

Prepared By	Graco, Inc.

This Material Safety Data Sheet and the information it contains is offered to you in good faith as accurate. We have reviewed any information contained in this data sheet which we have received from sources outside our company. We believe that information to be correct, but cannot guarantee its accuracy or completeness. Health and safety precautions in this Data Sheet may not be adequate for all individuals and/or situations. It is the users' obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. No statement made in this data sheet shall be construed as a permission or recommendation for the use of any product in a manner that might infringe existing patents. No warranty is made, either express or implied.

NOTES: NA = Not Applicable; NE = Not Established; UN = Unavailable

All written and visual data contained in this document reflects the latest product information available at the time of publication.

Graco reserves the right to make changes at any time without notice.

Sales Offices: Minneapolis, Detroit,

International Offices: Belgium, Korea, Hong Kong, Japan

www.graco.com

PRINTED IN U.S.A.



MATERIAL SAFETY DATA SHEET

Hydrochloric Acid

Section 01 - Chemical And Product And Company Information

Product Identifier Hydrochloric acid, inhibited hydrochloric acid

Product Use Acidizing (activation) of petroleum wells, scale removal, ore reduction, metal cleaning, pH adjustment, industrial acidizing, generation of chlorine dioxide, regeneration of ion exchange resins.

Supplier Name..... ClearTech Industries Inc.
2302 Hanselman Avenue
Saskatoon, SK. Canada
S7L 5Z3

Prepared By..... ClearTech Industries Inc. Technical Department
Phone: (306)664-2522

Preparation Date..... May 5, 2008

24-Hour Emergency Phone..... 306-664-2522



Section 02 - Composition / Information on Ingredients

Hazardous Ingredients..... Hydrochloric Acid 15-40%

CAS Number..... Hydrochloric Acid 7647-01-0

Synonym (s)..... Aqueous hydrogen chloride, muriatic acid



Section 03 - Hazard Identification

- Inhalation**..... Vapour or mist can cause irritation to nose, throat, and upper respiratory tract. Symptoms include: coughing, choking, and bleeding of the nose and gums. Severe exposure can result in pulmonary edema and corrosion of tissues in the nose and throat.
- Skin Contact / Absorption**..... Contact may produce severe irritation or corrosive skin damage, depending upon length of contact and amount of acid. Effects range from dermatitis, photo sensitization, redness, swelling, pain, permanent scarring, to death.
- Eye Contact**..... Low concentrations of vapour or mist can be irritating, causing redness. Concentrated vapour, mist or splashed liquid can cause severe irritation, burns and permanent blindness.
- Ingestion**..... Causes severe burns of the mouth, esophagus, and stomach, with consequent pain, nausea, vomiting, diarrhea, circulatory collapse, and possibly death.
- Exposure Limits**..... ACGIH/PEL= 5ppm (hydrochloric acid)

Section 04 - First Aid Measures

- Inhalation**..... Remove victim to fresh air. Give artificial respiration only if breathing has stopped. If breathing is difficult, give oxygen. Seek immediate medical attention.
- Skin Contact / Absorption**..... Remove contaminated clothing. Wash affected area with lukewarm water for 20-30 minutes. Seek medical attention immediately.
- Eye Contact**..... Flush immediately with lukewarm water for at least 20 minutes. Forcibly hold eyelids apart to ensure complete irrigation of eye tissue. Seek immediate medical attention.
- Ingestion**..... Do not induce vomiting. If vomiting occurs, lean victim forward to prevent breathing in vomitus. Rinse mouth out with water. If the victim can swallow, give 1 cup of water or milk to dilute. If vomiting occurs, rinse the mouth out and give another cup of water. Do not give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention.
- Additional Information**..... Not available



Section 05 - Fire Fighting

- Conditions of Flammability**..... Non-flammable
- Means of Extinction**..... Product does not burn. Where fire is involved, use any fire fighting agent appropriate for surrounding material; use water spray to cool fire-exposed surfaces.
- Flash Point**..... Not applicable
- Auto-ignition Temperature**..... Not applicable
- Upper Flammable Limit** Not applicable
- Lower Flammable Limit**..... Not applicable
- Hazardous Combustible Products**... Hydrogen and chlorine gas formed at temperatures over 1500°C.
- Special Fire Fighting Procedures**..... Wear NIOSH-approved self-contained breathing apparatus and protective clothing.
- Explosion Hazards**..... Normally none, but when in contact with metals explosive hydrogen gas may be evolved.

Section 06 - Accidental Release Measures

- Leak / Spill**..... Wear appropriate personal protective equipment. Ventilate area. Restrict access to area until clean up is complete. Stop or reduce leak if safe to do so. Prevent material from entering sewers.
- Deactivating Materials**..... Soda ash, lime, limestone

Section 07 - Handling and Storage

- Handling Procedures**..... Use proper equipment for lifting and transporting all containers. Use sensible industrial hygiene and housekeeping practices. Wash thoroughly after handling. Avoid all situations that could lead to harmful exposure.
- Storage Requirements**..... Store in a cool, dry, well-ventilated place. Keep container tightly closed, and away from incompatible materials. Store away from incompatible materials such as oxidizing materials, reducing materials and strong bases.



Section 08 - Personal Protection and Exposure Controls

Protective Equipment

- Eyes**..... Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.
- Respiratory**..... At concentrations up to 50 ppm, chemical charge respirator or air-purifying respirator is recommended. Above this level, a self-contained breathing apparatus is required.
- Gloves**..... Impervious gloves of chemically resistant material (rubber or PVC) should be worn at all times. Wash contaminated clothing with soap and water, dry thoroughly before reuse.
- Clothing**..... Body suits, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing with soap and water, dry thoroughly before reuse.
- Footwear**..... Impervious boots of chemically resistant material should be worn at all times.

Engineering Controls

- Ventilation Requirements**..... Mechanical ventilation (dilution or local exhaust), process or personnel enclosure and control of process conditions should be provided. Supply sufficient replacement air to make up for air removed by exhaust systems.
- Other**..... Emergency shower and eyewash should be in close proximity.

Section 09 - Physical and Chemical Properties

- Physical State**..... Liquid
- Odor and Appearance**..... Colourless or slightly yellow, fuming liquid with a pungent odour.
- Odor Threshold**..... Detectable at 1-5ppm
- Specific Gravity (Water=1)**..... 1.16-1.19 (30-35%); 1.08 (15%)
- Vapor Pressure (mm Hg, 20C)**..... 100mm Hg at 20°C (35%)
- Vapor Density (Air=1)**..... 1.268
- Evaporation Rate**..... < 1



Boiling Point..... 90°C (30%), 83°C (31%)

Freeze/Melting Point..... -35°C (35%)

pH..... < 1

Water/Oil Distribution Coefficient.... < 1

Bulk Density..... Not available

% Volatiles by Volume..... 100%

Solubility in Water..... Completely miscible

Molecular Formula..... HCl

Molecular Weight..... 36.46

Section 10 - Stability and Reactivity

Stability..... Stable, heat and contamination could cause decomposition.

Incompatibility..... Incompatible with strong bases, metals, phosphines, acetylides, borides, carbides, silicides, vinyl acetate, formaldehyde, hypochlorites, cyanides, sulphides.

Hazardous Products of Decomposition.. Contact with hypochlorites liberates chlorine gas. May react violently with incompatible substances. May release toxic and/or flammable gases such as hydrogen and phosphine gas. Considerable amounts of heat may be evolved.

Polymerization..... Will not occur.

Section 11 - Toxicological Information

Irritancy..... Severe irritant, corrosive to eyes and skin.

Sensitization..... Not available

Chronic/Acute Effects..... Prolonged exposure can cause erosion and discolouration of teeth and chronic inflammation of nose, throat, and airways. Repeated or prolonged contact to dilute solutions can cause dermatitis.

Synergistic Materials..... Not available



Animal Toxicity Data..... LC₅₀(inhalation,mouse,4 hour)= 757ppm
LD₅₀(oral,rabbit)= 900mg/kg

Carcinogenicity..... Not considered to be carcinogenic by IARC, NTP and ACGIH.

Reproductive Toxicity..... Not available

Teratogenicity..... Not available

Mutagenicity..... Not available

Section 12 - Ecological Information

Fish Toxicity..... Not available

Biodegradability..... When released into the soil, this material is not expected to biodegrade.

Environmental Effects..... Extremely toxic to aquatic life by lowering the pH below 5.5. When released into the soil, this material may leach into groundwater.

Section 13 - Disposal Consideration

Waste Disposal..... Dispose in accordance with all federal, provincial, and/or local regulations including the Canadian Environmental Protection Act.

Section 14 - Transportation Information

TDG Classification

Class..... 8

Group..... II

PIN Number..... UN1789

Other..... Secure containers (full and/or empty) with suitable hold down devices during shipment.

Section 15 - Regulatory Information

WHMIS Classification.....D1, E



NOTE: THE PRODUCT LISTED ON THIS MSDS HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CANADIAN CONTROLLED PRODUCTS REGULATIONS. THIS MSDS CONTAINS ALL INFORMATION REQUIRED BY THOSE REGULATIONS.

NSF Certification.....Product is certified under ANSI/NSF Standard 60 for scale control and pH adjustment at a maximum dosage for the following:

31% hydrochloric acid: 45mg/L

35% hydrochloric acid: 40mg/L

Section 16 - Other Information

Note: The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations.

Attention: Receiver of the chemical goods / MSDS coordinator

As part of our commitment to the Canadian Association of Chemical Distributors (CACD) Responsible Distribution[®] initiative, ClearTech Industries Inc. and its associated companies require, as a condition of sale, that you forward the attached Material Safety Data Sheet(s) to all affected employees, customers, and end-users. ClearTech will send any available supplementary handling, health, and safety information to you at your request.

If you have any questions or concerns please call our customer service or technical service department.

ClearTech Industries Inc. - Locations

Corporate Head Office: 2302 Hanselman Avenue, Saskatoon, SK, S7L 5Z3

Phone: 306-664-2522

Fax: 306-665-6216

www.ClearTech.ca

Location	Address	Postal Code	Phone Number	Fax Number
Richmond, B.C.	12431 Horseshoe Way	V7A 4X6	604-272-4000	604-272-4596
Calgary, AB.	5516E - 40 th St. S.E.	T2C 2A1	403-279-1096	403-236-0989
Edmonton, AB.	11750 - 180 th Street	T5S 1N7	780-452-6000	780-452-4600
Saskatoon, SK.	2302 Hanselman Avenue	S7L 5Z3	306-933-0177	306-933-3282
Regina, SK.	555 Henderson Drive	S42 5X2	306-721-7737	306-721-8611
Winnipeg, MB.	340 Saulteaux Crescent	R3J 3T2	204-987-9777	204-987-9770
Mississauga, ON.	7480 Bath Road	L4T 1L2	905-612-0566	905-612-0575

24 Hour Emergency Number - All Locations - 306-664-2522



SECTION 1 – IDENTIFICATION OF PRODUCT

Product Name: Magnafloc 10

Chemical Family: Copolymer of acrylamide and sodium acrylate

Product Use: Drilling Mud Additive

**Work Place Hazardous Information Systems Data
(WHMIS)**

WHMIS Classification: Not a controlled product
Work Place Hazard: N/A

Transportation Of Dangerous Goods (TDG)

TDG Classification: Not a regulated product
Package Group: N/A
UN Number (PIN): N/A

SECTION 2 – HAZARDOUS INGREDIENTS

No Hazardous Ingredients

SECTION 3 – PHYSICAL DATA

Physical State: White granular solid

Odour And Appearance: Little odour

Odour Threshold: N/A

Vapour Pressure: N/A

Vapour Density: N/A

Evaporation Rate: N/A

Coefficient Of Water To Oil Distribution: N/A

Boiling Point: N/A

Freezing Point: N/A

Melting Point: N/A

pH: N/A

Solubility: Soluble.

Specific Gravity: N/A

Percent Volatile By Volume: N/A



SECTION 4 – FIRE AND EXPLOSION DATA

Conditions Of Flammability: Very low risk.

Flashpoint: N/A

Lower Flammable Limit:

Upper Flammable Limit: N/A

Auto Ignition Temperature: N/A

Means Of Extinction

Dry Chemical, Carbon Dioxide, Foam.

Hazardous Combustion Products

None known

Sensitivity To Impact / Static Discharge

As with most organic powders, flammable dust clouds may be formed; avoid generating dust.
Avoid sources of ignition.

Special Firefighting Procedures

Firefighters must wear appropriate breathing apparatus and clothing. Use of water may cause extreme slipperiness.

SECTION 5 – REACTIVITY DATA

Chemically Stable?: Yes

Conditions Of Chemical Instability

Incompatible With Other Substances?: Yes

Incompatible Substances

Avoid strong oxidizing agents and caustic solutions.

Conditions Of Reactivity

None known

Hazardous Decomposition Products

None known

Hazardous Polymerization: Will not occur



SECTION 6 – TOXICOLOGICAL PROPERTIES

	Skin	Skin Absorption	Eye Contact	Inhalation	Ingestion
Routes Of Entry:	Yes	No	Yes	Yes	Yes
Irritation:	Prolonged exposure may cause irritation, swelling, or dermatitis.		Exposure may cause irritation to eyes or eye lids.	May cause slight irritation of the nose and throat.	May cause nausea and vomiting.

General Irritancy Of Product

N/A

Exposure Limits

N/A

Effects Of Acute Exposure: None known
Effects Of Chronic Exposure: None known
Sensitization To Product: N/A
Carcinogenicity: N/A
Teratogenicity: N/A
Reproductive Toxicity: N/A
Mutagenicity: N/A
Synergistic Products: N/A

SECTION 7 – PREVENTIVE MEASURES

Gloves: See [Clothing]

Respirator: If using in a confined non ventilated space, use of an approved dust mask is advised.

Eye: See [Clothing]

Footwear: See [Clothing]

Clothing: Chemical resistant clothing is recommended including gloves, apron and goggles.

Other:

Engineering Controls

Storage Requirements

Avoid high temperatures, ingestion, dusty conditions, and all sources of ignition.

Special Shipping Information

Leak And Spill Procedures

Wear protective equipment. Recover material into approved containers. Do not allow into water ways. Wash spill site after cleanup.

Magnafloc 10

**Waste Disposal**

All waste should be disposed of according to Federal, Provincial, and Local regulations. Containers should NOT be reused. Containers should be disposed of in accordance with government regulations.

Handling Procedures And Equipment

Avoid inhalation of vapours or mist. Avoid prolonged skin contact. Use with appropriate ventilation.

SECTION 8 – FIRST AID MEASURES / OTHER HAZARDOUS INFORMATION**Specific Measures**

N/A

Skin First Aid

Wash with soap and water. If adverse symptoms develop, seek medical attention.

Eye First Aid

Flush eyes with running water for at least 15 minutes. If adverse symptoms develop, seek medical attention.

Inhalation First Aid

Move victim to fresh air. If breathing has stopped, apply artificial respiration. If breathing is difficult, administer oxygen. Seek immediate medical attention.

Ingestion First Aid

Do not induce vomiting. Give large quantities of water, if conscious. Call a physician.

SECTION 9 – PREPARATION INFORMATION

Prepared By: Safety Department

Phone: (403) 234-7771 **Preparation Date:** October 01, 2006

THE INFORMATION AND SUGGESTIONS CONTAINED HEREIN ARE GIVEN IN GOOD FAITH. NO WARRANTY, EXPRESSED OR IMPLIED, IS MADE.



Copper Sulfate Pentahydrate

Date Prepared: May 17, 2002



NFPA RATING

HEALTH	3
FLAMMABILITY	0
REACTIVITY	0
PROTECTIVE EQUIPMENT	

HMIS RATING

MATERIAL SAFETY DATA SHEET

SECTION I. PRODUCT IDENTIFICATION

Product Name: Copper Sulfate Pentahydrate

Synonyms: Triangle Brand Copper Sulfate; Triangle Brand Copper Sulfate Crystal; Triangle Brand Copper Sulfate Instant Powder; Triangle Brand Copper Sulfate Pentahydrate; Triangle Brand Cupric Sulfate Pentahydrate Technical; Phelps Dodge Copper Sulfate; Phelps Dodge Refining Corporation Triangle Brand Copper Sulfate; Phelps Dodge El Paso Triangle Brand; Cupric Sulfate; Copper Sulfate; Copper Sulfate Pentahydrate; Blue Vitrol; Triangle Brand Cupric Sulphate Pentahydrate Technical; Triangle Brand Copper Sulphate Instant Powder; Triangle Brand Copper Sulphate Crystal

Product Use: Industrial manufacturing, animal feed, algicide, fungicide, herbicide, pesticide or as a fertilizer.

Manufacturer/Vendor Information: PHELPS DODGE REFINING CORP.
P.O Box 20001
El Paso, Texas

Chemtrec 24-Hour Emergency Phone:
In USA or Canada (800)424-9300
Other Information Phone: (915)778-9881

SECTION II. COMPOSITION / INFORMATION ON INGREDIENTS

<u>CAS No.</u>	<u>Chemical Name</u>	<u>Exposure Limits</u>	<u>% by wt.</u>
7758-99-8	Copper sulfate pentahydrate (CuSO ₄ •5H ₂ O), (Cupric sulfate), (Blue Vitriol), (Bluestone)	ACGIH TLV TWA: 1.0 mg/m ³ (as copper dust/mist) OSHA PEL TWA: 1.0 mg/m ³ (as copper dust/mist)	99
	Anhydrous Cupric Sulfate (CAS# 7758-98-7)	Phelps Dodge Triangle Brand Copper Sulfate Copper Sulfate Pentahydrate (CAS 7758-99-8) Contains anhydrous copper sulfate Contains water of crystallization Metallic copper equivalent	=99% =63.3% =35.7% =25.2%

SECTION III. HAZARDS IDENTIFICATION

Emergency Overview: Odorless, transparent blue crystals, granules or powder. Can cause irreversible eye damage and slight skin irritation. Harmful if swallowed. Avoid breathing mist or dust and contact with skin, eyes or clothing.

Route(s) of Entry: Inhalation, eye contact, skin contact and ingestion.

Acute Exposure: Can cause skin, eye and respiratory irritation.

Chronic Exposure: Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis. Prolonged excessive inhalation of mists containing copper sulfate may cause adverse effects on the liver and kidneys.

Carcinogenicity (NTP) (IARC) (OSHA) (ACGIH): Not listed

Eye: Corrosive and may result in irreversible eye damage.

Skin Contact: Can cause slight skin irritation. May cause localized discoloration of the skin. Product specific tests in accordance with USEPA standards do not indicate skin sensitization is likely to occur.

Inhalation: Can result in irritation of the upper respiratory tract and in excessive quantities may cause ulceration and perforation of the nasal septum.

Ingestion: Can result in digestive tract irritation, nausea, vomiting, diarrhea and abdominal pain.

SECTION IV. FIRST AID MEASURES

Eyes: Immediately flush eyes with plenty of water. Hold eye open and rinse slowly and gently for at least 15-20 minutes. Contact physician for treatment advice.

Skin: Wash skin with soap and plenty of water. If irritation persists contact a physician.

SECTION IV. FIRST AID MEASURES (Continued)

Ingestion: Contact a poison control center or physician for treatment advice. Have person sip a glass of water if able to swallow. Do not give anything by mouth to an unconscious person. Do not induce vomiting unless told to do so by the poison control center or physician. If vomiting occurs spontaneously, avoid aspiration.

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get immediate medical attention.

SECTION V. FIRE FIGHTING MEASURES

Flash Pt: Not applicable
Flammable Limits in Air-Lower: Not applicable
Flammable Limits in Air – Upper: Not applicable
Auto Ignition Temperature: Not applicable
Fire Fighting Extinguishing Media: Does not burn or support combustion. Use extinguishing media appropriate for surrounding fire (CO₂, dry chemical or water).
Fire Fighting Equipment: As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.
Fire Fighting Instructions: Evacuate area and fight fire from a safe distance.
Fire and Explosion Hazards: Sealed containers may rupture when heated due to release of water from crystals.
Hazardous Combustion Products: Not applicable
Explosion Data - Mechanical Impact / Static Discharge: Not available
Unusual Hazards: Material is acidic when dissolved in water, contact with magnesium metal may evolve hydrogen gas. Anhydrous cupric sulfate formed on water loss (white color). Anhydrous salt will ignite hydroxylamine, if present.

SECTION VI. ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Use clean-up methods that avoid dust generation (vacuum, wet). Wear a NIOSH approved respirator if dust will be generated in clean-up. Use protective clothing if skin contact is likely. If material is diluted in a water solution, and a spill occurs in a confined area, introduce lime or soda ash to form insoluble copper salts and dispose of by approved method. Prevent accidental entry of solution into streams and other water bodies. Shovel any spills into plastic bags and seal with tape. Copper sulfate solution may deteriorate concrete.

SECTION VII. HANDLING AND STORAGE

Signal Word: Danger.

Handling Information: Avoid breathing dust or solution mist. Sweep up crystals or powder, vacuum is preferred. Eye wash stations should be available in work areas. Users should wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Storage Information: Store in closed containers in a cool, dry, well-ventilated area away from heat sources and reducing agents. Store copper sulfate in stainless steel, fiberglass, polypropylene, PVC's or plastic equipment. Keep away from galvanized pipe and nylon equipment. If container or bag is damaged, place the container or bag in a plastic bag. Use good housekeeping practices to prevent dust accumulation.

SECTION VIII. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use adequate general or local ventilation to keep airborne concentrations below the exposure limits.

Eye Protection: Use protective goggles or a face-shield.

Skin Protection: Use protective clothing to prevent repeated or prolonged skin contact. Applicators and other handlers must wear long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and protective eyewear. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with product's concentrate. Do not reuse them. Keep and wash PPE separately from other laundry.

SECTION VIII. EXPOSURE CONTROLS / PERSONAL PROTECTION (Continued)

Respiratory Protection: A respiratory protection program that meets OSHA 29 CFR 1910.134 requirements must be followed whenever workplace conditions warrant respirator use. For concentrations up to 10 times the exposure limit, use NIOSH approved half- or full-face, air-purifying respirator. For higher concentrations, consult a professional industrial hygienist.

SECTION IX. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Transparent blue crystals, granules or powder.
Melting Point:	Not available
Boiling Point:	-5H ₂ O @ 150 °C (760 mmHg)
Decomposition Temperature:	Decomposition above 110 °C with -4 H ₂ O
Density/Specific Gravity:	2.284 @ 15.6 °C
Odor/Odor Threshold:	Not available
Evaporation rate:	Not applicable
pH:	Not available
Coefficient of water/oil distribution:	Not available
Vapor Pressure:	Not applicable
Vapor Density:	Not applicable
Solubility in Water:	83.1 g/100 cc water @ 30 °C
Molecular Weight:	249.68

SECTION X. STABILITY AND REACTIVITY

Stability: Stable.

Incompatibility: Acetylene gas, aluminum powder, hydroxylamine, magnesium, moist air. Contact with magnesium metal can generate dangerous levels of hydrogen gas.

Conditions under which product is chemically unstable: Not applicable

Hazardous decomposition products: At temperatures >600 °C material decomposes to cupric oxide and sulfur dioxide.

Conditions of reactivity: Not applicable

Hazardous Polymerization: Will not occur.

SECTION XI. TOXICOLOGICAL INFORMATION**Toxicology Tests: (Triangle Brand Copper Sulfate Crystal)****Test : 1**

LD/LC : LD₅₀

Test Type : Acute

Test Route : Dermal

Test Species : Rabbit

Results Amounts : >5050 mg/kg

Test : 3

LD/LC : LC₅₀

Test Type : Acute, 4 hr

Test Route : Inhalation

Test Species : Rats

Results Amounts : >2.95 mg/L

Test : 2

LD/LC : LD₅₀

Test Type : Acute

Test Route : Oral

Test Species : Rat

Results Amounts : 352 mg/kg*

*Results based on toxicity evaluation of this product.

Primary Eye Irritation: Corrosive, irreversible eye damage

Primary Skin Irritation: Slightly irritating.

Skin Sensitization: Product-specific tests in accordance with USEPA standards did not indicate that this product would cause skin sensitization.

Respiratory Tract Sensitization: Not available.

Carcinogenicity: Not listed as a carcinogen by NTP, IARC, OSHA, or ACGIH.

SECTION XI. TOXICOLOGICAL INFORMATION (Continued)

Mutagenicity: A study performed with copper sulphate on mice showed mutagenicity in a chromosomal aberration test; however, the route of exposure (*i.e.*, intraperitoneal) is not likely to be applicable to workplace use of this product.

Reproductive Toxicity: No reproductive effects were shown in a feeding test performed with copper sulphate on rats and mice.

Teratogenicity: Embryotoxicity was not seen at non-maternally toxic doses of copper sulphate in the relevant studies reviewed.

Toxicologically Synergistic Materials: Not available.

Other Chronic Effects: Long term inhalation of copper sulfate containing mists (*i.e.*, Bordeaux mixture) may cause adverse effects to the liver and kidneys. A sub-chronic test performed on rats and mice showed that at high exposure levels in feed (>4000 ppm) cupric sulfate is toxic to the liver and kidneys.

Additional Information: Inhalation of dust and mists of copper salts can result in irritation of nasal mucous membranes, sometimes of the pharynx and, on occasion ulceration with perforation of the nasal septum. Exposure to copper dust causes discoloration of the skin.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsions may be needed. Wilson's disease or G6PD deficiency (individual who absorbs, retains and stores copper) can be aggravated by excessive exposure. Symptoms may include nausea, vomiting, epigastric pain, diarrhea, dizziness, jaundice, and general debility.

SECTION XII. ECOLOGICAL INFORMATION

Subacute dietary LC₅₀: >10,000 ppm (quail and duck).

96 hr acute toxicity LC₅₀: 0.65 ppm (bluegill), 0.056 ppm (trout), 16 ppm (pink shrimp)

48 hr EC₅₀: 54 ppb (eastern oysters)

48 hr LC₅₀: 17 ppm (pink shrimp), 600 ppb (daphnia)

24 hr LC₅₀: 6.9 ppm (blue crab), 600 ppb (daphnia)

Bioaccumulation: Not available

Biodegradability: Not applicable

SECTION XIII. DISPOSAL CONSIDERATIONS

Waste Disposal Method: Waste must be disposed of in accordance with federal, state/provincial and local environmental control regulations. Improper disposal is a violation of law. Do not reuse empty container. If allowed by federal, state/provincial and local authorities, dispose of container in a sanitary landfill or by incineration.

SECTION XIV. TRANSPORT INFORMATION

<u>Proper Shipping Name:</u>	<u>Technical Name (If N.O.S.):</u>	<u>Hazard Class:</u>	<u>ID:</u>	<u>PG:</u>
DOT: <i>Environmentally Hazardous Substance, Solid, n.o.s., (Cupric Sulfate)*</i> Reportable Quantity (RQ) = 10 pounds (4.54 kg).		9	UN3077	III

*Applicable when product is shipped in packaging of 10 pounds or greater.

SECTION XV. REGULATORY INFORMATION**US Federal**

Federal Drinking Water Standards: (*Copper*) EPA 1300µg/L (action level), 1000 µg/L

Clean Water Act: This product contains compounds identified in 40 CFR 116.4.

TSCA: Listed

EPCRA, SARA Title III, Section 313 (40 CFR 372) Chemicals subject to reporting requirements (see Section II for CAS number and percentage in mixture): Section 312 and/or 313 reporting may be required for this product, depending of the amount used and/or stored on site.

CERCLA Hazardous Substances: RQ is not assigned to the broad class of copper compounds.

DOT: RQ 10 pounds (4.54 kg), See Section XIV TRANSPORT INFORMATION

Canada

This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* and the MSDS contains all of the information required by the *Controlled Products Regulations*.

SECTION XVI. OTHER INFORMATION

Prepared By:	Phelps Dodge Corporation Department of Occupational Health and Safety One North Central Avenue Phoenix, AZ 85004 Telephone number (602.366.8398)
Reason for Revision:	Added use statement in Section I. Revised Section III and XI to reflect recent toxicity tests, Updated/revised information in other Sections with addition of Section XII in accordance with WHMIS.

Disclaimer: This information is based on available scientific evidence known to the Phelps Dodge Corporation. The information contained in the MSDS is being disclosed as required pursuant to applicable law. However, Phelps Dodge does not guarantee its accuracy or completeness. Health and safety precautions in this data sheet may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. This information is furnished without warranty, expressed or implicit.

MATERIAL SAFETY DATA SHEET

Date Printed: 07/09/2004

Date Updated: 03/07/2004

Version 1.2

Section 1 - Product and Company Information

Product Name	DEXTRIN
Product Number	260754
Brand	ALDRICH
Company	Sigma-Aldrich
Street Address	3050 Spruce Street
City, State, Zip, Country	SAINT LOUIS MO 63103 US
Technical Phone:	314 771 5765
Emergency Phone:	414 273 3850 Ext. 5996
Fax:	800 325 5052

Section 2 - Composition/Information on Ingredient

Substance Name	CAS #	SARA 313
DEXTRIN	9004-53-9	No
Formula	C6H12O6	
RTECS Number:	HH9450000	

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Caution: Avoid contact and inhalation.

For additional information on toxicity, please refer to Section 11.

Section 4 - First Aid Measures

ORAL EXPOSURE

If swallowed, wash out mouth with water provided person is conscious. Call a physician.

INHALATION EXPOSURE

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.

DERMAL EXPOSURE

In case of contact, immediately wash skin with soap and copious amounts of water.

EYE EXPOSURE

In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes.

Section 5 - Fire Fighting Measures

FLASH POINT

N/A

AUTOIGNITION TEMP

N/A

FLAMMABILITY

N/A

EXTINGUISHING MEDIA

Suitable: Water spray. Carbon dioxide, dry chemical powder, or appropriate foam.

FIREFIGHTING

Protective Equipment: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
Specific Hazard(s): Emits toxic fumes under fire conditions.

Section 6 - Accidental Release Measures

PROCEDURE(S) OF PERSONAL PRECAUTION(S)

Wear respirator, chemical safety goggles, rubber boots, and heavy rubber gloves.

METHODS FOR CLEANING UP

Sweep up, place in a bag and hold for waste disposal. Avoid raising dust. Ventilate area and wash spill site after material pickup is complete.

Section 7 - Handling and Storage

HANDLING

User Exposure: Avoid breathing dust. Avoid contact with eyes, skin, and clothing.

STORAGE

Suitable: Keep container closed. Store in a cool dry place.

SPECIAL REQUIREMENTS

Hygroscopic.

Section 8 - Exposure Controls / PPE

ENGINEERING CONTROLS

Mechanical exhaust required.

PERSONAL PROTECTIVE EQUIPMENT

Respiratory: Government approved respirator.
Hand: Compatible chemical-resistant gloves.
Eye: Chemical safety goggles.

GENERAL HYGIENE MEASURES

Wash thoroughly after handling. Wash contaminated clothing before reuse.

Section 9 - Physical/Chemical Properties

Appearance	Color: Faintly yellow Form: Powder	
Property	Value	At Temperature or Pressure
Molecular Weight	N/A	
pH	N/A	
BP/BP Range	N/A	
MP/MP Range	N/A	

Freezing Point	N/A
Vapor Pressure	N/A
Vapor Density	N/A
Saturated Vapor Conc.	N/A
SG/Density	N/A
Bulk Density	N/A
Odor Threshold	N/A
Volatile%	N/A
VOC Content	N/A
Water Content	N/A
Solvent Content	N/A
Evaporation Rate	N/A
Viscosity	N/A
Surface Tension	N/A
Partition Coefficient	N/A
Decomposition Temp.	N/A
Flash Point	N/A
Explosion Limits	N/A
Flammability	N/A
Autoignition Temp	N/A
Refractive Index	N/A
Optical Rotation	N/A
Miscellaneous Data	N/A
Solubility	N/A

N/A = not available

Section 10 - Stability and Reactivity

STABILITY

Conditions of Instability: Protect from moisture.

Conditions to Avoid: Protect from moisture.

Materials to Avoid: Strong oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS

Hazardous Decomposition Products: Carbon monoxide, Carbon dioxide.

Section 11 - Toxicological Information

ROUTE OF EXPOSURE

Multiple Routes: May be harmful by inhalation, ingestion, or skin absorption. May cause irritation.

SIGNS AND SYMPTOMS OF EXPOSURE

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

TOXICITY DATA

Intravenous
 Mouse
 350 MG(FE)/KG
 LD50

Section 12 - Ecological Information

No data available.

Section 13 - Disposal Considerations

APPROPRIATE METHOD OF DISPOSAL OF SUBSTANCE OR PREPARATION

Dissolve or mix the material with a combustible solvent and burn

in a chemical incinerator equipped with an afterburner and scrubber. Observe all federal, state, and local environmental regulations.

Section 14 - Transport Information

DOT

Proper Shipping Name: None
Non-Hazardous for Transport: This substance is considered to be non-hazardous for transport.

IATA

Non-Hazardous for Air Transport: Non-hazardous for air transport.

Section 15 - Regulatory Information

US CLASSIFICATION AND LABEL TEXT

US Statements: Caution: Avoid contact and inhalation.

UNITED STATES REGULATORY INFORMATION

SARA LISTED: No
TSCA INVENTORY ITEM: Yes

CANADA REGULATORY INFORMATION

WHMIS Classification: This product has been classified in accordance with the hazard criteria of the CPR, and the MSDS contains all the information required by the CPR.
DSL: Yes
NDSL: No

Section 16 - Other Information

DISCLAIMER

For R&D use only. Not for drug, household or other uses.

WARRANTY

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Inc., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale. Copyright 2004 Sigma-Aldrich Co. License granted to make unlimited paper copies for internal use only.

MATERIAL SAFETY DATA SHEET

For Emergency Assistance
Involving Chemicals Call CHEMTREC
(800) 424-9300

WHMIS (Classification)
CLASS B-3: Combustible liquid with
a flash point between 37.8°C
(100°F) and 93.3°C (200°F).
CLASS D-2B: Material causing other
toxic effects (TOXIC).

Section I. Chemical Product Identification

Distributed by:
Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC
V6X 1W5

Product Name	Methyl Isobutyl Carbinol	Code	LA1277
		CAS#	000108112
Synonym	Methyl Amyl Alcohol MIBC 2-Pentanol-4-Methyl		
		DSL	On the DSL list.
Chemical Name	dimethyl-1,3 butanol-1		
		CI#	Not available.
Chemical Family	Not available.		
Chemical Formula	C6H14O		
Material Uses	Industrial applications: Organic solvent		

Section II. Composition and Information on Ingredients

Name	CAS #	% by Weight	LC50/LD50
Methyl Isobutyl Carbinol	000108112	100	ORAL (LD50): Acute: >2590 mg/kg [Rat]. DERMAL (LD50): Acute: >3.5 mL/kg [Rabbit]. VAPOR (LC50): Acute: >2000 ppm 4 hours [Rat].

Section III. Hazards Identification

Potential Acute Very hazardous in case of ingestion. Hazardous in case of
Health Effects skin contact (irritant), of eye contact (irritant), of
inhalation.

Potential	CARCINOGENIC EFFECTS: Not available.
Chronic Health	MUTAGENIC EFFECTS: Not available.
Effects	TERATOGENIC EFFECTS: Not available.
	DEVELOPMENTAL TOXICITY: Not available.
	Repeated exposure to an highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

****Section IV. First Aid Measures****

Eye Contact	IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention.
Skin Contact	Flush affected skin with gently flowing lukewarm water for at least 20 minutes and remove contaminated clothing while rinsing. Wash contaminated skin with mild soap and water for 15 minutes. If irritation occurs and persists, obtain medical attention.
Hazardous Skin Contact	Flush affected skin with gently flowing lukewarm water for at least 20 minutes and remove contaminated clothing while rinsing. Wash contaminated skin with mild soap and water for 15 minutes. If irritation occurs and persists, obtain medical attention.
Inhalation	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Hazardous Inhalation	Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.
Ingestion	Do not induce vomiting. Do not give anything by mouth to an unconscious person. Guard against aspiration into lungs by having the individual turn on to their left side. If vomiting occurs spontaneously keep head below hips to prevent aspiration of liquid into the lungs. Obtain medical attention immediately.
Hazardous Ingestion	Not available.

****Section V. Fire and Explosion Data****

The Product is: Flammable.

Auto-Ignition Temperature	338°C (640.4°F)

Flash Points	CLOSED CUP: 44°C (111.2°F). (TAG) OPEN CUP: 51.7°C (125.1°F) (Cleveland).

Flammable Limits LOWER: 1% UPPER: 5.5%

Products of Combustion	Carbon monoxide and carbon dioxide are produced on combustion.

Fire Hazards in Presence of Various Substances	Flammable in presence of open flames and sparks, of heat, of oxidizing materials.
Explosion Hazards in Presence of Various Substances	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of oxidizing materials.
Fire Fighting Media and Instructions	Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, autoignition or explosion.
Special Remarks on Fire Hazards	Vapour forms a flammable/explosive mixture with air between upper and lower flammable limits. Do not enter confined fire space without adequate protective clothing and an approved positive pressure self-contained breathing apparatus. Containers exposed to intense heat from fires should be cooled with water to prevent vapour pressure buildup which could result in container rupture. Product will float and can be reignited on surface of water. Container areas exposed to direct flame contact should be cooled with large quantities of water as needed to prevent weakening of container structure. Caution - Combustible.
Special Remarks on Explosion Hazards	Not available.

****Section VI. Accidental Release Measures****

Small Spill	Absorb with an inert material and put the spilled material in an appropriate waste disposal.
Large Spill	Issue warning "Combustible". Eliminate all ignition sources. Handling equipment must be grounded. Isolate hazard area and restrict access. Try to work upwind of spill. Avoid direct contact with material. Wear appropriate breathing apparatus (if applicable) and protective clothing. Stop leak only if safe to do so. Dike and contain land spills; contain water spills by booming. Use water fog to knock down vapours; contain runoff. For large spills remove by mechanical means and place in containers. Absorb residue or small spills with absorbent material and remove to non-leaking containers for disposal. Recommended materials: Clay or Sand Flush area with water to remove trace residue. Dispose of recovered material as noted under Disposal Considerations. Notify appropriate environmental agency(ies).

****Section VII. Handling and Storage****

Precautions	Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. DO NOT ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the

label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids. Hot surfaces may be sufficient to ignite liquid even in the absence of sparks or flames. Extinguish pilot lights, cigarettes and turn off other sources of ignition prior to use and until all vapours are gone. Vapours may accumulate and travel to distant ignition sources and flashback. Empty containers may contain hazardous product residues. Do not pressurize drum containers to empty them. Fixed equipment as well as transfer containers and equipment should be grounded to prevent accumulation of static charge. Do not cut, drill, grind, weld or perform similar operations on or near containers. Air-dry contaminated clothing in a well ventilated area before laundering. Launder contaminated clothing prior to reuse. Use good personal hygiene.

Storage	Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Use explosion-proof ventilation to prevent vapour accumulation.

****Section VIII. Exposure Controls/Personal Protection****

Engineering Controls	Make up air should always be supplied to balance air exhausted (either generally or locally). Local ventilation recommended where mechanical ventilation is ineffective in controlling airborne concentrations below the recommended occupational exposure limit. Concentrations in air should be maintained below the recommended threshold limit value if unprotected personnel are involved. For personnel entry into confined spaces (i.e. bulk storage tanks) a proper confined space entry procedure must be followed including ventilation and testing of tank atmosphere. Electrical and mechanical equipment should be explosion-proof. Mechanical ventilation is recommended for all indoor situations to control fugitive emissions. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection	Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes. Impervious gloves (neoprene) should be worn at all times when handling this product. Impervious clothing (apron, coveralls) should also be worn in confined workspaces or where the risk of skin exposure is much higher. Safety showers should be available for emergency use. If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator. Use a NIOSH-approved chemical cartridge respirator with organic vapour cartridges or use a NIOSH-approved supplied-air respirator. For high airborne concentrations, use a NIOSH-approved supplied-air respirator, either self-contained or airline breathing apparatus, operated in positive pressure mode.

Personal Protection in Case of a Large Spill	Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes. Impervious gloves (neoprene) should be worn at all times when handling this product. Impervious clothing (apron, coveralls) should also be worn in confined workspaces or where the risk of skin exposure is much higher. Safety showers should be available for emergency

use. If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator. Use a NIOSH-approved chemical cartridge respirator with organic vapour cartridges or use a NIOSH-approved supplied-air respirator. For high airborne concentrations, use a NIOSH-approved supplied-air respirator, either self-contained or airline breathing apparatus, operated in positive pressure mode.

Exposure Limits TWA: 104 STEL: 167 (mg/m³) from ACGIH (TLV) [United States] SKIN
TWA: 25 STEL: 40 (ppm) from ACGIH (TLV) [United States] SKIN

Consult local authorities for acceptable exposure limits.

Section IX. Physical and Chemical Properties

Physical State and Appearance	Liquid.	Odor	Sweetish. Alcohol like.
		Taste	Not available.
Molecular Weight	102.17 g/mole		
pH (1% soln/water)	Not available.	Color	Colorless.
Boiling Point	130°C - 133°C (266°F - 271.4°F)		
Melting Point	-90°C (-130°F)		
Critical Temperature	Not available.		
Specific Gravity	0.808 (Water = 1)		
Vapor Pressure	>0.4 kPa (@ 20°C)		
Vapor Density	3.5 (Air = 1)		
Volatility	Not available.		
Odor Threshold	Not available.		
Evaporation rate	0.27		
Viscosity	Not available.		
Water/Oil Dist. Coeff.	The product is more soluble in oil; log(oil/water) = 26.9		
Ionicity (in Water)	Not available.		
Dispersion Properties	Not available.		
Solubility	Very slightly soluble in cold water, hot water. Soluble in Other Solvents: Alcohol, Ether, Organic Solvents		

Section X. Stability and Reactivity Data

Stability	The product is stable.
Instability Temperature	Not available.
Conditions of Instability	Do not use with aluminum equipment at temperatures above 49 degrees Celsius. Avoid excessive heat, open flames and all ignition sources.
Incompatibility with various substances	Reactive with oxidizing agents, acids.
Corrosivity	Not available.
Special Remarks on Reactivity	Not available.
Special Remarks on Corrosivity	Not available.
Hazardous Polymerization	Will not occur.

****Section XI. Toxicological Information****

Routes of Entry	Absorbed through skin. Eye contact. Inhalation. Ingestion.
Toxicity to Animals	Acute oral toxicity (LD50): >2590 mg/kg [Rat]. Acute dermal toxicity (LD50): >3.5 mL/kg [Rabbit]. Acute toxicity of the vapor (LC50): >2000 ppm 4 hours [Rat].
Chronic Effects on Humans	CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. Repeated exposure to an highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.
Other Toxic Effects on Humans	Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation.
Special Remarks on Toxicity to Animals	Not available.
Special Remarks on Chronic Effects on Humans	Prolonged and repeated contact with skin can cause defatting and drying of the skin resulting in skin irritation and dermatitis. Prolonged exposure to high vapour concentration can cause headache, dizziness, nausea, blurred vision and central nervous system depression. Pre-existing Conditions: Pre-existing eye, skin and respiratory disorders may be aggravated by exposure to this product.
Special Remarks	Vapours are moderately irritating to the respiratory

on	passages.
Other Toxic	Ingestion of this product may cause headache, dizziness,
Effects on Humans	fatigue and central nervous system depression. Vapours are moderately irritating to the eyes.

****Section XII. Ecological Information****

Ecotoxicity	Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams, or public waterways. Block off drains and ditches. Provincial regulations require and federal regulations may require that environmental and/or other agencies be notified of a spill incident. Spill area must be cleaned and restored to original condition or to the satisfaction of authorities. MIBC is practically non-toxic to aquatic organisms and is expected to be slightly toxic to mammalian wildlife. MIBC may deoxygenate surface waters.

BOD5 and COD	Not available.

Products of Biodegradation	Biodegradable. Not likely to bioaccumulate.

Toxicity of the Products of Biodegradation	Not available.

Special Remarks on the Products of Biodegradation	Not available.

****Section XIII. Disposal Considerations****

Waste Disposal	Waste management priorities (depending on volumes and concentration of waste) are: 1. recycle (reprocess), 2. energy recovery (cement kilns, thermal power generation), 3. incineration, 4. disposal at a licenced waste disposal facility. Do not attempt to combust waste on-site. Incinerate at a licenced waste disposal site with approval of environmental authority.

****Section XIV. Transport Information****

TDG Classification	Class 3: Flammable liquid.

Shipping name	Methyl isobutyl carbinol

PIN	UN2053

Packing Group	III

Special Provisions for Transport	Not regulated under the Transportation of Dangerous Goods Act when transported by road or rail in packagings or containers of 454 L or less (waste excluded).

****Section XV. Other Regulatory Information****

Other Regulations	OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

****Section XVI. Other Information****

References -Manufacturer's Material Safety Data Sheet.

Other Special Not available.
Considerations

Validated by Hardev Bendick on 12/7/2000. Verified by Hardev Bendick.

Tel. number for non-emergency questions concerning MSDS: 1-866-686-4827

Notice to Reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Univar Canada Ltd. expressly disclaims all expressed or implied warranties of merchantability and fitness for a particular purpose with respect to the product provided.**

===== END OF MSDS =====



Material Safety Data Sheet

acc. to OSHA and ANSI

Printing date 02/03/2003

Reviewed on 11/01/2002

• 1 Identification of substance:

○ **Product details:**

○ **Product name:** Potassium ethyl xanthate

○ **Stock number:** A11450

○ **Manufacturer/Supplier:**

Alfa Aesar, A Johnson Matthey Company
Johnson Matthey Catalog Company, Inc.
30 Bond Street
Ward Hill, MA 01835-8099
Emergency Phone: (978) 521-6300
CHEMTREC: (800) 424-9300
Web Site: www.alfa.com

○ **Information Department:** Health, Safety and Environmental Department

○ **Emergency information:**

During normal hours the Health, Safety and Environmental Department. After normal hours call Chemtrec at (800) 424-9300.

• 2 Composition/Data on components:

○ **Chemical characterization:**

Description: (CAS#)

Potassium ethyl xanthate (CAS# 140-89-6): 100%

○ **Identification number(s):**

○ **EINECS Number:** 205-439-3

• 3 Hazards identification

○ **Hazard description:** Xn Harmful

○ **Information pertaining to particular dangers for man and environment**

R 22 Harmful if swallowed.

R 36/37/38 Irritating to eyes, respiratory system and skin.

○ **Classification system**

○ **HMIS ratings (scale 0-4)**

(Hazardous Materials Identification System)

Health (acute effects) = 1

Flammability = 1

Reactivity = 1

- **4 First aid measures**

- **After inhalation**
Supply fresh air. If required, provide artificial respiration. Keep patient warm. Seek immediate medical advice.
- **After skin contact**
Immediately wash with water and soap and rinse thoroughly. Seek immediate medical advice.
- **After eye contact**
Rinse opened eye for several minutes under running water. Then consult a doctor.
- **After swallowing** Seek immediate medical advice.

- **5 Fire fighting measures**

- **Suitable extinguishing agents**
Carbon dioxide, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
- **Special hazards caused by the material, its products of combustion or resulting gases:**
In case of fire, the following can be released:
Carbon monoxide and carbon dioxide
Sulfur oxides (SO_x)
- **Protective equipment:**
Wear self-contained respirator.
Wear fully protective impervious suit.

- **6 Accidental release measures**

- **Person-related safety precautions:**
Wear protective equipment. Keep unprotected persons away.
Ensure adequate ventilation
- **Measures for environmental protection:**
Do not allow material to be released to the environment without proper governmental permits.
- **Measures for cleaning/collecting:**
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
- **Additional information:**
See Section 7 for information on safe handling
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

- **7 Handling and storage**

- **Handling**
- **Information for safe handling:**
Keep container tightly sealed.
Store in cool, dry place in tightly closed containers.
Ensure good ventilation at the workplace.
- **Information about protection against explosions and fires:**
Keep ignition sources away.
- **Storage**
- **Requirements to be met by storerooms and receptacles:**
No special requirements.
- **Information about storage in one common storage facility:**
Store away from oxidizing agents.

- **Further information about storage conditions:**
Keep container tightly sealed.
Store in cool, dry conditions in well sealed containers.

• **8 Exposure controls and personal protection**

- **Additional information about design of technical systems:**
Properly operating chemical fume hood designed for hazardous chemicals and having an average face velocity of at least 100 feet per minute.
- **Components with limit values that require monitoring at the workplace:**
Not required.
- **Additional information:** No data
- **Personal protective equipment**
- **General protective and hygienic measures**
The usual precautionary measures for handling chemicals should be followed.
Keep away from foodstuffs, beverages and feed.
Remove all soiled and contaminated clothing immediately.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.
- **Breathing equipment:**
Use suitable respirator when high concentrations are present.
- **Protection of hands:**
Impervious gloves
Check protective gloves prior to each use for their proper condition.
- **Material of gloves**
The selection of suitable gloves not only depends on the material, but also on quality. Quality will vary from manufacturer to manufacturer.
- **Eye protection:** Safety glasses
- **Body protection:** Protective work clothing.

• **9 Physical and chemical properties:**

○ **General Information**

- **Form:** Powder
- **Color:** Light yellow
- **Odor:** Not determined

	<u>Value/Range</u>	<u>Unit</u>	<u>Method</u>
○ Change in condition			
○ Melting point/Melting range:	213	° C	dec
○ Boiling point/Boiling range:	Not determined		
○ Sublimation temperature / start:	Not determined		
○ Ignition temperature:	Not determined		
○ Decomposition temperature:	Not determined		
○ Danger of explosion: Product does not present an explosion hazard.			
○ Explosion limits:			
○ Lower:	Not determined		
○ Upper:	Not determined		
○ Vapor pressure:	Not determined		

- **Density:** Not determined
- **Solubility in / Miscibility with**
- **Water:** Not determined

• **10 Stability and reactivity**

- **Thermal decomposition / conditions to be avoided:**
Decomposition will not occur if used and stored according to specifications.
- **Materials to be avoided:** Oxidizing agents
- **Dangerous reactions** No dangerous reactions known
- **Dangerous products of decomposition:**
Carbon monoxide and carbon dioxide
Sulfur oxides (SO_x)

• **11 Toxicological information**

- **Acute toxicity:**
LD/LC50 values that are relevant for classification:
Oral: LD50: 308 mg/kg (mus)
LD50: 1700 mg/kg (rat)
- **Primary irritant effect:**
- **on the skin:** Irritant to skin and mucous membranes.
- **on the eye:** Irritating effect.
- **Sensitization:** No sensitizing effects known.
- **Subacute to chronic toxicity:**
- **Subacute to chronic toxicity:**
The Registry of Toxic Effects of Chemical Substances (RTECS) reports the following effects in laboratory animals:
Behavioral - excitement.
Behavioral - muscle contraction or spasticity.
Behavioral - antipsychotic.
Behavioral - somnolence (general depressed activity).
Lungs, Thorax, or Respiration - respiratory depression
Blood - changes in erythrocyte (RBC) count.
Biochemical - Enzyme inhibition, induction, or change in blood or tissue levels - catalases.
Biochemical - Enzyme inhibition, induction, or change in blood or tissue levels - other enzymes.
- **Additional toxicological information:**
To the best of our knowledge the acute and chronic toxicity of this substance is not fully known.
No classification data on carcinogenic properties of this material is available from the EPA, IARC, NTP, OSHA or ACGIH.

• **12 Ecological information:**

- **General notes:**
Do not allow material to be released to the environment without proper governmental permits.

• **13 Disposal considerations**

- **Product:**
- **Recommendation**
Consult state, local or national regulations to ensure proper disposal.
- **Uncleaned packagings:**

- **Recommendation:**
Disposal must be made according to official regulations.

- **14 Transport information**

Not a hazardous material for transportation.

- **DOT regulations:**
- **Hazard class:** None
- **Land transport ADR/RID (cross-border)**
- **ADR/RID class:** None
- **Maritime transport IMDG:**
- **IMDG Class:** None
- **Air transport ICAO-TI and IATA-DGR:**
- **ICAO/IATA Class:** None
- **Transport/Additional information:**
Not dangerous according to the above specifications.

- **15 Regulations**

- **Product related hazard informations:**
- **Hazard symbols:** Xn Harmful
- **Risk phrases:**
22 Harmful if swallowed.
36/37/38 Irritating to eyes, respiratory system and skin.
- **Safety phrases:**
26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
36/37 Wear suitable protective clothing and gloves.
- **National regulations**
All components of this product are listed in the U.S. Environmental Agency Toxic Substances Control Act Chemical substance Inventory.
- **Information about limitation of use:**
For use only by technically qualified individuals.

- **16 Other information:**

Employers should use this information only as a supplement to other information gathered by them, and should make independent judgement of suitability of this information to ensure proper use and protect the health and safety of employees. This information is furnished without warranty, and any use of the product not in conformance with this Material Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

- **Department issuing MSDS:** Health, Safety and Environmental Department.
- **Contact:** Darrell R. Sanders

Technical Service: 1-800-343-7276
Bulk/Specialty Sales: 1-888-343-8025

ALFA AESAR
26 Parkridge Road
Ward Hill, MA 01835
USA
info@alfa.com

Alfa Aesar is an ISO-9002 certified company.

Fine chemicals for research and development from Alfa Aesar, a Johnson Matthey company

VAN WATERS & ROGERS INC., SUBSIDIARY OF UNIVAR
1600 NORTON BLDG. SEATTLE, WA 98104-1564 (408) 435-8700

-----EMERGENCY ASSISTANCE-----

FOR EMERGENCY ASSISTANCE INVOLVING CHEMICALS CALL CHEMTREC (800)424-9300

-----FOR PRODUCT AND SALES INFORMATION-----

CONTACT YOUR LOCAL VAN WATERS & ROGERS BRANCH OFFICE

-----PRODUCT IDENTIFICATION-----

PRODUCT NAME: SODIUM ETHYL XANTHATE CAS NO.: UNASSIGNED
COMMON NAMES/SYNONYMS: AERO(R) 325 VW&R CODE: T1791

FORMULA: ROCS(S) NA OR ROCS(S) K DATE ISSUED: 08/89
HAZARD RATING (MANUFACTURER) SUPERCEDES: 10/87

HEALTH: 1
FIRE: 0
REACTIVITY: 0
SPECIAL: NONE

HAZARD RATING SCALE:
0=MINIMAL 3=SERIOUS
1=SLIGHT 4=SEVERE
2=MODERATE

-----HAZARDOUS INGREDIENTS-----

COMPONENT	CAS NO.	%	EXPOSURE LIMITS, PPM			
			OSHA PEL	ACGIH TLV	OTHER LIMIT	HAZARD
SODIUM ETHYL XANTHATE	UNREPORTED	UNKNOWN	NONE	NONE	NONE	NONE
ETHANOL	64-17-5	0.5-1	1000	1000	NONE	FLAMMABLE

(R) TRADEMARK OF AMERICAN CYANIMID COMPANY.

-----PHYSICAL PROPERTIES-----

BOILING POINT, DEG F: N/A VAPOR PRESSURE, MM HG/20 DEG C: N/A
MELTING POINT, DEG F: 360-493 VAPOR DENSITY (AIR=1): N/A
SPECIFIC GRAVITY (WATER=1): N/A WATER SOLUBILITY, %: APPRECIABLE
APPEARANCE AND ODOR: N/A EVAPORATION RATE (BUTYL ACETATE=1): NIL

-----FIRST AID MEASURES-----

IF INHALED: REMOVE TO FRESH AIR. GIVE ARTIFICIAL RESPIRATION IF NOT BREATHING. GET IMMEDIATE MEDICAL ATTENTION.

IN CASE OF EYE CONTACT: IMMEDIATELY FLUSH EYES WITH LOTS OF RUNNING WATER FOR 15 MINUTES, LIFTING THE UPPER AND LOWER EYELIDS OCCASIONALLY. GET IMMEDIATE MEDICAL ATTENTION.

IN CASE OF SKIN CONTACT: IMMEDIATELY WASH SKIN WITH LOTS OF SOAP AND WATER. REMOVE CONTAMINATED CLOTHING AND SHOES; WASH BEFORE REUSE. GET MEDICAL ATTENTION IF IRRITATION PERSISTS AFTER WASHING.

IF SWALLOWED: IF CONSCIOUS, IMMEDIATELY INDUCE VOMITING BY GIVING 2 GLASSES OF WATER AND STICKING A FINGER DOWN THE THROAT. GET IMMEDIATE

MEDICAL ATTENTION. DO NOT GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS OR CONVULSING PERSON.

-----HEALTH HAZARD INFORMATION-----

PRIMARY ROUTES OF EXPOSURE: INHALATION, SKIN OR EYE CONTACT.

SIGNS AND SYMPTOMS OF EXPOSURE

INHALATION: BREATHING DUST MAY IRRITATE THE NOSE AND THROAT AND CAUSE COUGHING AND CHEST DISCOMFORT.

EYE CONTACT: DUSTS MAY IRRITATE THE EYES.

SKIN CONTACT: PROLONGED OR REPEATED CONTACT WITH THE DUST MAY IRRITATE THE SKIN.

SWALLOWED: NONE CURRENTLY KNOWN.

CHRONIC EFFECTS OF EXPOSURE: NO SPECIFIC INFORMATION AVAILABLE.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: NONE REPORTED.

-----TOXICITY DATA-----

ORAL: NO DATA FOUND.

DERMAL: NO DATA FOUND.

INHALATION: NO DATA FOUND.

CARCINOGENICITY: THIS MATERIAL IS NOT CONSIDERED TO BE A CARCINOGEN BY THE NATIONAL TOXICOLOGY PROGRAM, THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER, OR THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

OTHER DATA: NONE

-----PERSONAL PROTECTION-----

VENTILATION: LOCAL MECHANICAL EXHAUST VENTILATION CAPABLE OF MINIMIZING DUST EMISSIONS AT THE POINT OF USE.

RESPIRATORY PROTECTION: IF USE CONDITIONS GENERATE VAPORS OR MISTS, WEAR A NIOSH-APPROVED RESPIRATOR APPROPRIATE FOR THOSE EMISSION LEVELS. APPROPRIATE RESPIRATORS MAY BE A FULL FACEPIECE OR A HALF MASK AIR-PURIFYING CARTRIDGE RESPIRATOR EQUIPPED FOR ORGANIC VAPORS/MISTS, A SELF-CONTAINED BREATHING APPARATUS IN THE PRESSURE DEMAND MODE, OR A SUPPLIED-AIR RESPIRATOR.

EYE PROTECTION: CHEMICAL GOGGLES. IT IS GENERALLY RECOGNIZED THAT CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH CHEMICALS BECAUSE CONTACT LENSES MAY CONTRIBUTE TO THE SEVERITY OF AN EYE INJURY.

PROTECTIVE CLOTHING: LONG-SLEEVED SHIRT, TROUSERS, SAFETY SHOES, AND GLOVES.

OTHER PROTECTIVE MEASURES: AN EYEWASH AND SAFETY SHOWER SHOULD BE NEARBY AND READY FOR USE.

FLASH POINT, DEG F: N/A FLAMMABLE LIMITS IN AIR, %
METHOD USED: N/A LOWER: N/A UPPER: N/A
EXTINGUISHING MEDIA: USE WATER SPRAY, DRY CHEMICAL, CO2, OR ALCOHOL
FOAM.

UNUSUAL FIRE AND EXPLOSION HAZARDS: NONE.

HAZARDOUS DECOMPOSITION PRODUCTS: CARBON DISULFIDE.

NOTE: EMPTY CONTAINERS CAN HAVE RESIDUES, GASES AND MISTS AND ARE SUBJECT TO PROPER WASTE DISPOSAL, AS ABOVE.

OTHER PRECAUTIONS: CONTAINERS, EVEN THOSE THAT HAVE BEEN EMPTIED, WILL RETAIN PRODUCT RESIDUE AND VAPORS. ALWAYS OBEY HAZARD WARNINGS AND HANDLE EMPTY CONTAINERS AS IF THEY WERE FULL.

-----FOR ADDITIONAL INFORMATION-----

CONTACT MSDS COORDINATOR, VAN WATERS & ROGERS INC.
DURING BUSINESS HOURS, PACIFIC TIME (408)435-8700

-----NOTICE-----

VAN WATERS & ROGERS INC. ("VW&R") EXPRESSLY DISCLAIMS ALL EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WITH RESPECT TO THE PRODUCT OR INFORMATION PROVIDED HEREIN.

ALL INFORMATION APPEARING HEREIN IS BASED UPON DATA OBTAINED FROM THE MANUFACTURER AND/OR RECOGNIZED TECHNICAL SOURCES. WHILE THE INFORMATION IS BELIEVED TO BE ACCURATE, VW&R MAKES NO REPRESENTATIONS AS TO ITS ACCURACY OR SUFFICIENCY. CONDITIONS OF USE ARE BEYOND VW&R'S CONTROL AND THEREFORE USERS ARE RESPONSIBLE TO VERIFY THIS DATA UNDER THEIR OWN OPERATING CONDITIONS TO DETERMINE WHETHER THE PRODUCT IS SUITABLE FOR THEIR PARTICULAR PURPOSES AND THEY ASSUME ALL RISKS OF THEIR USE, HANDLING, AND DISPOSAL OF THE PRODUCT, OR FROM THE PUBLICATION OR USE OF, OR RELIANCE UPON, INFORMATION CONTAINED HEREIN. THIS INFORMATION RELATES ONLY TO THE PRODUCT DESIGNATED HEREIN, AND DOES NOT RELATE TO ITS USE IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY OTHER PROCESS.

-----REVISION-----

08/89: CHANGED HEADING AND CONTACT INFORMATION.



Material Safety Data Sheet

ORFOM ® SIPX (SODIUM ISOPROPYL XANTHATE)

September 30, 2001

MSDS #: 28990

Revision #0

CHEVRON PHILLIPS CHEMICAL COMPANY LP
10001 Six Pines Drive
The Woodlands, TX 77380

PHONE NUMBERS

HEALTH:

Chevron Phillips Emergency
Information Center 866.442.9628
(North America) and
1.832.813.4984(International)

TRANSPORTATION:

North America: CHEMTREC 800.424.9300
or 703.527.3887

ASIA: 1.703.527.3887

EUROPE: BIG .32.14.584545 (phone)
or .32.14.583516 (telefax)

SOUTH AMERICA SOS-Cotec

Inside Brazil: 0800.111.767

Outside Brazil: 55.19.3467.1600

Technical Services: (832) 813-4862

For Additional MSDSs: (800) 852-5530

A. Product Identification

Synonyms: Not Established

Chemical Name: Sodium Isopropyl Xanthate

Chemical Family: Dithiocarbonate

Chemical Formula: C₄H₇OS₂Na

CAS Reg. No.: 140-93-2

Product No.: Not Established

Product and/or Components Entered on EPA's TSCA Inventory: YES

This product is in U.S. commerce, and is listed in the Toxic Substances Control Act (TSCA) Inventory of Chemicals; hence, it may be subject to applicable TSCA provisions and restrictions.

Canadian Inventory Listing Status: DSL

All ingredients are listed in the Domestic Substances List (DSL).

Impurities are exempt in accordance with Section 3 of the Canadian Environmental Protection Act (CEPA).

B. Components

Ingredients	CAS Number	% By Wt.	OSHA PEL	ACGIH TLV
Sodium Isopropyl Xanthate	140-93-2	>84.0	NE	NE
Sodium Hydroxide	1310-73-2	< 3.0	2 mg/m ³	2 mg/m ³ (C)
Water	7732-18-5	Reminder	NE	NE

C. Personal Protection Information

Ventilation: Use adequate ventilation to control exposure below recommended level.

Respiratory Protection: Not generally required unless needed to prevent respiratory irritation.

Eye Protection: Use safety glasses with side shields.

Skin Protection: No special garments required. Avoid unnecessary skin contamination. Use impervious rubber gloves.

NOTE: Personal protection information shown in Section C is based upon general information as to normal uses and conditions. Where special or unusual uses or conditions exist, it is suggested that the expert assistance of an industrial hygienist or other qualified professional be sought.

D. Handling and Storage Precautions

Do not get in eyes, on skin or on clothing. Do not breathe vapors, mist, fume or dust. Wear protective equipment and/or garments described above if exposure conditions warrant. Wash thoroughly after handling. Launder contaminated clothing before reuse. Use only with adequate ventilation.

Store in a closed containers. Store in cool, well-ventilated area away from ignition sources. Protect from moisture and oxidants.

E. Reactivity Data

Stability: Stable
Conditions to Avoid: Acid; ignition sources.

Incompatibility (Materials to Avoid): Oxidants, organic or inorganic acids

Hazardous Polymerization: Will Not Occur

Conditions to Avoid: Not Applicable

Hazardous Decomposition Products: Sulfur oxides and carbon disulfides released on heating.

F. Health Hazard Data

Recommended Exposure Limits:

Control as Particulate Not Otherwise Classified (PNOC) or Regulated:

	OSHA PEL	ACGIH TLV*
Respirable Fraction	5 mg/m ³	3 mg/m ³
Total Dust	15 mg/m ³	10 mg/m ³

* The value is for inhalable (total) particulate matter containing no asbestos and

Acute Effects of Overexposure:

Eye: Irritation possible.

Skin: Mild irritation. Dermatitis may be possible with prolonged contact.

Inhalation: Dust may cause irritation to the nose, throat, and upper respiratory tract.

Ingestion: Low to moderate toxicity possible.

Subchronic and Chronic Effects of Overexposure:

Xanthates can decompose to release carbon disulfide (CAS # 75-15-0) which may cause dizziness, headache, fatigue, nervousness, loss of appetite, psychosis and nerve, heart, kidney or liver changes.

Other Health Effects:

No known applicable information.

Health Hazard Categories:

Animal Human

Animal Human

Known Carcinogen	___	___	Toxic	___	___
Suspect Carcinogen	___	___	Corrosive	___	___
Mutagen	___	___	Irritant	___	___
Teratogen	___	___	Target Organ Toxin	<u>X</u>	<u>X</u>
Allergic Sensitizer	___	___	Specify - Liver, Kidney, Heart &		
Highly Toxic	___	___	Nerve Toxin		

Canadian WHIMS:

CLASS D: POISONOUS AND INFECTIOUS MATERIAL CATEGORIES

1. Materials Causing Immediate and Serious Toxic Effects

- A. Very Toxic _____
 B. Toxic _____

2. Materials Causing Other Toxic Effects

A. Very Toxic

1. Chronic Toxic Effects	_____
2. Teratogen/Embryo Toxin	_____
3. Carcinogen	_____
4. Reproductive Toxin	_____
5. Respiratory Tract Sensitizer	_____
6. Mutagen	_____

B. Toxic

1. Chronic Toxic Effects	<u>X</u>
2. Skin or Eye Irritant	_____
3. Skin Sensitizer	_____
4. Mutagen	_____

Specify: Liver - Toxin; Kidney - Toxin; Heart - Toxin; Nerve - Toxin.

First Aid and Emergency Procedures:

Eye: Flush eyes with running water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention.

Skin: Wash skin with soap and water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention.

Inhalation: Remove from exposure. If breathing is difficult, give oxygen. If breathing ceases, administer artificial respiration followed by oxygen. Seek immediate medical attention.

Ingestion: Give two glasses of water and induce vomiting, only if subject is conscious. Seek medical attention.

G. Physical Data

Appearance: Yellowish Powder or Pellets
Odor: Slight
Boiling Point: Not Applicable
Vapor Pressure: Not Applicable
Vapor Density (Air = 1): Not Applicable
Solubility in Water: Appreciable
Specific Gravity (H₂O = 1): Not Established
Percent Volatile by Volume: 14 maximum
Evaporation Rate (Butyl Acetate = 1): Not Applicable
Viscosity: Not Applicable

H. Fire and Explosion Data

Flash Point (Method Used): Not Applicable (solid or powder)
Flammable Limits (% by Volume in Air): LEL - Not Applicable
UEL - Not Applicable

Fire Extinguishing Media: Dry chemical, foam or carbon dioxide (CO₂)

Special Fire Fighting Procedures: Evacuate area of all unnecessary personnel. Shut off source, if possible. Use NIOSH/MSHA approved self-contained breathing apparatus and other protective equipment and/or garments described in Section C if conditions warrant. Water fog or spray may be used to cool exposed containers and equipment.

Fire and Explosion Hazards: Sulfur oxides and carbon disulfide released upon heating.

I. Spill, Leak and Disposal Procedures

Precautions Required if Material is Released or Spilled:

Evacuate area of all unnecessary personnel. Wear protective equipment and/or garments described in Section C if exposure conditions warrant. Shut off source, if possible and contain spill. Protect from ignition. Keep out of water sources and sewers. Follow normal clean-up procedures for solid spills. Control dust. Avoid breathing dust. Avoid contact with skin and eyes.

Waste Disposal (Insure Conformity with all Applicable Disposal Regulations):
Incinerate or place in permitted waste management facility.

J. DOT Transportation

Shipping Name: Self-heating, solid, organic, n.o.s., (Sodium isopropyl xanthate)
Hazard Class: 4.2
ID Number: UN 3088
Packing Group: II
Marking: Self-heating, solid, organic, n.o.s., (Sodium isopropyl xanthate), UN 3088
Label: Spontaneously combustible
Placard: Spontaneously combustible/3088
Hazardous Substance/RQ: Not Applicable
Shipping Description: Self-heating, solid, organic, n.o.s., (Sodium isopropyl xanthate), 4.2, UN 3088, PG II
Packaging References: 49 CFR 173.212, 173.241

K. RCRA Classification - Unadulterated Product as a Waste

Reactive (D003)

Prior to disposal, consult your environmental contact to determine if the TCLP (Toxicity Characteristic Leaching Procedure, EPA Test Method 1311) is required. Reference 40 CFR Part 261.

L. Protection Required for Work on Contaminated Equipment

Contact immediate supervisor for specific instructions before work is initiated. Wear protective equipment and/or garments described in Section C if exposure conditions warrant. Use NIOSH/MSHA approved respiratory protection, such as air-supplied mask, in confined spaces or other poorly ventilated areas.

M. Hazard Classification

☒ This product meets the following hazard definition(s) as defined by the Occupational Safety and Health Hazard Communication Standard (29 CFR Section 1910.1200):

☐ Combustible Liquid	☐ Flammable Aerosol	☐ Oxidizer
☐ Compressed Gas	☐ Explosive	☐ Pyrophoric
☐ Flammable Gas	☒ Health Hazard (Section F)	☐ Unstable
☐ Flammable Liquid	☐ Organic Peroxide	☐ Water Reactive
☐ Flammable Solid		

— Based on information presently available, this product does not meet any of the hazard definitions of 29 CFR Section 1910.1200.

Canadian WHIMS:

Class D: Poisonous and Infectious Material
Division 2. Materials Causing Other Toxic Effects

N. Additional Comments

SARA 313

This product contains the following chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.
(See Section B).

Sodium Hydroxide
Carbon Disulfide

NFPA 704 Hazard Codes - - - - - Signals

Health	: 1	Least	- 0
Flammability:	0	Slight	- 1
Reactivity	: 0	Moderate	- 2
Special Haz.:	-	High	- 3
		Extreme	- 4

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the ANSI MSDS Standard (Z400.1) by EHS Product Stewardship Group, Chevron Phillips Chemical Company LP, 10001 Six Pines Drive, The Woodlands, TX 77380

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.



Material Safety Data Sheet

<u>PRODUCT IDENTIFICATION</u>	<u>CHEMICAL ABSTRACT NO.</u>	<u>DATE REVISED</u>
CALCIUM OXIDE - Quicklime	CAS No. 1305-78-8	01/03/2006

Section I

<u>MANUFACTURER</u> Cutler-Magner Company Foot of Hill Avenue Superior, WI 54880	<u>24 Hour Emergency Contact Number:</u> (715) 392-5146 Ask for Supervisor On Call	<u>HMIS II SAFETY RATING</u> Health - 3 Flammability - 0 Physical Hazard - 2 Personal Protective Equip - E
	<u>Telephone Number for Information:</u> (800) 232-1302	
	Other Common Names: Pebble Lime, Unslaked Lime Trade Names: Rockport	

Section II – Hazardous Ingredients / Identity Information

Specific Chemical Identity; Common Names	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (Optional)
Calcium Oxide; Lime; Quicklime	5 mg/m ³	2 mg/m ³		
Crystalline Silica (Quartz)	0.1 mg/m ³	0.05 mg/m ³	Respirable	0.1 to 0.3 %

Calcium oxide is not listed on the NTP, IARC, or OSHA lists of carcinogens. Crystalline silica, a component of this product, is listed by IARC and NTP but not by OSHA. In 1997, IARC determined that "crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1). OSHA requires that products containing 0.1% of a known carcinogen must be labeled. NTP states that "silica, crystalline (respirable)" may reasonably be anticipated to be a carcinogen (1991). Cutler-Magner Company recommends using personal protection equipment when handling this product.

Section III – Physical / Chemical Characteristics

Boiling Point (Calcium Oxide)	2850 °C	Specific Gravity (H ₂ O=1)	3.2-3.4
Vapor Pressure (mm Hg)	NA	Melting Point	2570 °C
Vapor Density (Air = 1)	NA	Evaporation Rate	NA
Solubility in Water	Reacts to form calcium hydroxide		
Appearance and Color	White to gray lumps, pebbles, granules, powder; faint earthy odor		

Section IV – Fire and Explosion Hazard Data

Flash Point	NA	Flammable Limits – NA
Extinguishing Method	NA	
Special Fire Fighting Procedures	Reaction with water may produce enough heat to ignite combustible material.	
Unusual Fire and Explosion Hazards	Material is an explosion hazard when wet and confined.	

Section V – Reactivity Data

Stability	Unstable		Conditions to Avoid – NA
	Stable	X	
Incompatibility (Materials to Avoid)		Water, Acid, Interhalogen, Phosphorus (V) Oxide	
Hazardous Decomposition or Byproducts		None	
Hazardous Polymerization	May Occur		Conditions to Avoid – NA
	Will Not Occur	X	

Section VI – Health Hazard Data

Route(s) of Entry	Inhalation? - YES	Absorption Through Skin? – YES	Ingestion (swallowing)? - YES
Health Hazards	Acute	Causes irritation and inflammation to mucous membrane and respiratory passages.	
	Chronic	Long-term exposure can cause irritation, ulceration and perforation of nasal septum.	
Toxicological Information	No LD50 / LC50 have been identified for this product. Quicklime is not listed by MSHA, OSHA, or IARC as a carcinogen, but this product may contain trace amounts of crystalline silica, which has been classified by IARC as (Group 1) carcinogenic to humans when inhaled in the form of quartz or cristobalite.		
Signs and Symptoms of Exposure		Irritation of skin, eyes, and respiratory tract.	
Medical Conditions Generally Aggravated by Exposure		Respiratory disease, skin condition.	
Emergency and First Aid Procedures		Remove to fresh air. Wash dust with soap and water. Flush out eyes with generous amounts of water. Drink plenty of water if swallowed. See Physician.	

Section VII – Precautions for Safe Handling

Steps to Be Taken in Case Material is Released or Spilled	Normal clean-up procedures. Care should be taken to avoid causing dust to become airborne. Vacuum cleaning systems are recommended.		
Waste Disposal Method	Dispose of product in accordance with Federal, State and Local regulations.		
Precautions to Be Taken in Handling	Store away from water and acids.		
Other Precautions	Waste should not be discarded with combustible material where the possibility exists of getting the mixture wet – FIRE HAZARD!		

Section VIII – Control Measures

Respiratory Protection - Dust filter mask is recommended as minimal protection		
Ventilation	Local Exhaust – To maintain TLV and PEL Mechanical – To maintain TLV' and PEL	Special – None Other – None
Protective Gloves – Cloth or leather gloves will protect skin		
Eye Protection – Fitted goggles will reduce eye injury		
Other Protective Clothing – Long sleeve shirts and pants		
Work / Hygienic Practices – Maintain dust exposure limits below TLV and PEL. If not possible – use respiratory protection		

Section IX – Ecological Information

Ecotoxicity: Because of the high pH of this product, in high concentrations it would be expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems.

Environmental Fate: This material shows no bioaccumulation effect or food chain toxicity.

Section X – Regulatory Information

EPA

RCRA Hazardous Waste Classification (40 CFR 261): Not Listed
RCRA Hazardous Waste Number (40 CFR 261.33): Not Listed
ERCLA Hazardous Substance (40 CFR 302.4): Unlisted specific per RCRA,
Sec. 3001; CWA, Sec.311 (b)(4); CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ): Not Listed
SARA 311/312 Codes: Not Listed
SARA Toxic Chemical (40 CFR 372.65): Not Listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not Listed;
Threshold Planning Quantity (TPQ): Not Listed
All chemical ingredients are listed on the USEPA TSCA Inventory List

OSHA / MSHA

Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): 5 mg/M³ TWA-8
MSHA: Not Listed
OSHA Specifically Regulated Substance (29 CFR 1910): Not Listed

Canada

WHIMS Classification: "E" Corrosive Materials (Listed due to corrosive effect of aluminum)
WHIMS Classification: "D2A" Materials Causing Other Toxic Effects
CANADA DSL: Listed

State Regulations

Consult state and local authorities for guidance

Other

HMIS: Health Risk 3, Flammability 0, Reactivity 1, Personal Protection E
NFPA: Health Hazard 3, Fire Hazard 0, Reactivity 1
DOT: For aircraft transport only, Calcium Oxide is classified as Hazard Class 8
– Corrosive, UN 1910, Packing Group 3

The above information is believed to be correct as of the date hereof. However, no warranty of merchantability, fitness for any use, or any other warranty is expressed or is to be implied regarding the accuracy of these data, the results to be obtained from the use of the material, or the hazards connected with such use. Since the information contained herein may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the data hereof may suggest modification of the information, we do not assume responsibility for the results of its use. This information is furnished on the condition that the person(s) receiving it shall make their own determination as to the suitability of the material for their particular purpose and on the condition that they assume the risk of use thereof.

**MATERIAL SAFETY DATA SHEET****Sodium Sulphide****Section 01 - Chemical And Product And Company Information**

Product Identifier Sodium Sulphide

Product Use Depilatory for hides and skins, manufacture of rubber, sulphur dyes, rayon denitrating, paper pulp, ore floatation, metal refining, cotton printing, as chemical intermediate and laboratory reagent.

Supplier Name ClearTech Industries Inc.
2303 Hanselman Avenue
Saskatoon SK S7I 5Z3
Canada

Prepared By ClearTech Industries Inc. Technical Department
Phone: (306)664-2522

Preparation Date 10/25/04

24-Hour Emergency Phone 306-664-2522

**Section 02 - Composition / Information on Ingredients**

Hazardous Ingredients Sodium Sulfide 59-62%

CAS Number Sodium Sulfide 1313-82-2

Synonym (s) Sodium Monosulfide; Sulfur Compounds; Na₂S



Section 03 - Hazard Identification

- Inhalation**..... Hazard is highly toxic (50-100 ppm in air) hydrogen sulfide which may accumulate in confined spaces due to the decomposition of sodium sulfide or from its reaction with acids. Symptoms include painful conjunctivitis, headache, nausea, dizziness, coughing and, in extreme cases, pulmonary edema and possible death.
- Skin Contact / Absorption**..... Contact with skin can produce serious caustic burns with painful inflammation and possible destruction of tissue. May cause irritation, severe burns and corrosion to the skin. This material may be absorbed through the skin producing toxicity typical of hydrogen sulfide poisoning.
- Eye Contact**..... Inflammation, tearing and pain may be expected. Severe contact can cause destruction of tissue. This product has similar effects as alkalies following direct exposure to the eye and can cause lacrimation, sensitivity to light, tearing and irreversible damage, including blindness.
- Ingestion**..... Sodium sulfide is a strong base and can cause severe burns on the mucous membrane. Hydrolysis by gastric fluids releases toxic hydrogen sulfide. The symptoms and effects are similar to those under inhalation, above.
- Exposure Limits**..... No occupational exposure limits have been established by OSHA & ACGIH for this product. The limits for hydrogen sulphide have been established:
- OSHA/TWA: 10ppm
OSHA/STEL: 15ppm
ACGIH/TWA: 10ppm
OSHA/STEL: 15ppm

Section 04 - First Aid Measures

- Inhalation**..... Hydrogen sulfide has a characteristic "rotten egg" odor. Remove victim to fresh air. Give artificial respiration only if breathing has stopped. If breathing is difficult, give oxygen. Seek immediate medical attention.
- Skin Contact / Absorption**..... Remove contaminated clothing. Wash affected area with soap and water. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.
- Eye Contact**..... Flush immediately with water for at least 20 minutes. Forcibly hold eyelids apart to ensure complete irrigation of eye tissue. Seek immediate medical attention as further treatment will be necessary.
- Ingestion**..... Gently wipe or rinse the inside of the mouth with water. Sips of water may be given if person is fully conscious. Never give anything by mouth to an unconscious or convulsing person. Do not induce vomiting. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.



Additional Information..... Contact with acid and excessive heat liberates flammable and poisonous hydrogen sulfide gas.

Section 05 - Fire Fighting

Conditions of Flammability..... Non-flammable

Means of Extinction..... Not available

Flash Point..... Not available

Auto-ignition Temperature..... 260°C

Upper Flammable Limit Not available

Lower Flammable Limit..... Not available

Hazardous Combustible Products... Contact with all acids or excessive heat will liberate poisonous, flammable hydrogen sulfide gas.

Special Fire Fighting Procedures..... Wear NIOSH-approved self-contained breathing apparatus and protective clothing. Fire-fighters must wear NIOSH approved, pressure demand, self-contained breathing apparatus with full face piece for possible exposure to hazardous gases. Hydrogen sulfide vapors are heavier than air and may travel a considerable distance to source of ignition and flash back.

Explosion Hazards..... Not available



Section 06 - Accidental Release Measures

- Leak / Spill**..... Immediately evacuate the area. Remove sources of ignition. Provide maximum ventilation. Unprotected personnel should move upwind of spill. Only personnel equipped with proper respiratory and eye/skin protection should be permitted in the area. Carefully shovel or sweep up spilled material and place into closed containers. Spilled material should be reclaimed if possible. Product must not come in contact with acids. After all visible traces have been removed, thoroughly wet vacuum the area. Do not flush to sewer. At the first sign of a hydrogen sulfide leak, a planned emergency program should be put into operation. Emergency drills should be made periodically. If a hydrogen sulfide leak occurs, all persons must promptly leave the area. A wind sock or other wind direction indicator should be within sight. Move crossways to the wind from the contaminated area. Insure that the entire area is evacuated. Only persons wearing NIOSH approved self-contained breathing apparatus or full facepiece airline respirators with auxiliary SCBA's operated in the pressure/demand mode and eye/skin protection should be permitted in area. Each hydrogen sulfide leak should be dealt with immediately. Lead acetate strips or portable monitoring instruments can be used to locate a hydrogen sulfide leak. If hydrogen sulfide is leaking, the lead acetate paper will turn brown. When working on a leak, employees should take a position so that escaping hydrogen sulfide moves away from them. Supplied air equipment must be working no matter how small the leak.
- Deactivating Materials**..... Not available

Section 07 - Handling and Storage

- Handling Procedures**..... Use proper equipment for lifting and transporting all containers. Use sensible industrial hygiene and housekeeping practices. Wash thoroughly after handling. Avoid all situations that could lead to harmful exposure.
- Storage Requirements**..... Store away from strong oxidizing agents. Do not allow contact with acids and excessive heat. Will liberate poisonous, flammable hydrogen sulfide gas. Do not store in zinc, aluminum or copper containers. Wear respiratory protection whenever exposure to vapor is likely. Wear appropriate personal protective equipment when handling this product. Store in a cool, dry, well-ventilated place. Store only in closed, properly labeled containers. Keep container closed when not in use.

Section 08 - Personal Protection and Exposure Controls

Protective Equipment

- Eyes**..... Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.



- Respiratory**..... If exposure of hydrogen sulfide gas could exceed the exposure limits, use NIOSH approved full face airline and/or self-contained breathing apparatus operated in a positive pressure demand mode. The respiratory use limitations made by NIOSH or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134.
- Gloves**..... Impervious gloves of chemically resistant material (rubber or PVC) should be worn at all times. Wash contaminated clothing with soap and water, dry thoroughly before reuse.
- Clothing**..... Body suits, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing with soap and water, dry thoroughly before reuse.
- Footwear**..... Impervious boots of chemically resistant material should be worn at all times

Engineering Controls

- Ventilation Requirements**..... Mechanical ventilation (dilution or local exhaust), process or personnel enclosure, and control of process conditions. Supply sufficient replacement air to make up for air removed by exhaust systems.
- Other**..... Use local exhaust or general room/dilution ventilation as appropriate to control employee exposures in the work place.

Section 09 - Physical and Chemical Properties

- Physical State**..... Flakes
- Odor and Appearance**..... Slight rotten egg, white to yellow.
- Odor Threshold**..... 1-5 ppm for hydrogen sulfide.
- Specific Gravity (Water=1)**..... 1.858 (flake)
- Vapor Pressure (mm Hg, 20C)**..... Not available
- Vapor Density (Air=1)**..... Not available
- Evaporation Rate**..... Not available
- Boiling Point**..... 174°C
- Freeze/Melting Point**..... 92°C
- pH**..... Strongly alkaline



Water/Oil Distribution Coefficient.... Not available

Bulk Density..... 40 lbs/ft³(flake)

% Volatiles by Volume..... Very low

Solubility in Water..... 15% @ 20°C

Molecular Formula..... Na₂S

Molecular Weight..... 78.04

Section 10 - Stability and Reactivity

Stability..... Stable

Incompatibility..... Avoid contact with strong oxidizing agents and acids. Avoid concentrating solutions, could cause spontaneous ignition. Solutions attack zinc, copper, aluminum and alloys of these metals. Avoid heat, flames, sparks and other sources of ignition.

Hazardous Products of Decomposition.. Oxides of sulfur, oxides of sodium, hydrogen sulfide.

Polymerization..... Will not occur

Section 11 - Toxicological Information

Irritancy..... Strong irritant, corrosive.

Sensitization..... Not available



Chronic/Acute Effects	ACUTE: Irritation of mucous membranes, eyes, and respiratory tract is possible following exposure to the decomposition product, hydrogen sulfide gas, which is potentially lethal. CHRONIC: The effects of long-term, low level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the prevention of all contact with this material to avoid any effects from repetitive acute exposures. Hydrogen sulfide is a toxic and irritant gas whose effects are exerted on the respiratory system, gastrointestinal tract, eyes and central nervous system. Acute effects on the respiratory system, in order of increasing severity, can be a runny nose with anosmia (loss of the sense of smell), tracheobronchitis with pain, cough, pulmonary edema with dyspnea (shortness of breath) , delayed bronchopneumonia, respiratory paralysis and terminal asphyxial convulsion. Acute effects may occur without warning as a result of olfactory fatigue. While the odor of hydrogen sulfide is distinct at 0.3ppm, olfactory fatigue occurs rapidly with continuous inhalation. Gastrointestinal effects can be profuse salivation, nausea, vomiting or diarrhea. Nervous system effects may be giddiness, headache, vomiting, vertigo, amnesia, confusion and unconsciousness. Eye irritation is the most common low exposure effect of hydrogen sulfide and is characterized by irritation of the conjunctiva with photophobia to severe conjunctivitis with keratitis. A possible warning sign of eye exposure is the appearance of halos around light sources and increased sensitivity to light.
Synergistic Materials	Not available
Animal Toxicity Data	LD ₅₀ (Oral, Rat)= 200mg/kg LD ₅₀ (Dermal, Rabbit)= 177.8mg/kg
Carcinogenicity	This product is NOT listed as a carcinogen or suspected carcinogen by NTP, IARC, or OSHA.
Reproductive Toxicity	Not available
Teratogenicity	Not available
Mutagenicity	Not available

Section 12 - Ecological Information

Fish Toxicity	LC50(48 hrs, Bluegill Sunfish)= 61ppm
Biodegradability	Not available
Environmental Effects	This product is highly toxic to aquatic life.



Section 13 - Disposal Consideration

Waste Disposal.....Dispose in accordance with all federal, provincial, and/or local regulations including the Canadian Environmental Protection Act.

Section 14 - Transportation Information

TDG Classification

Class..... 8

Group..... II

PIN Number..... UN 1849

Other..... Secure containers (full and/or empty) with suitable hold down devices during shipment.

Section 15 - Regulatory Information

WHMIS Classification.....E, D1A

NOTE: THE PRODUCT LISTED ON THIS MSDS HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CANADIAN CONTROLLED PRODUCTS REGULATIONS. THIS MSDS CONTAINS ALL INFORMATION REQUIRED BY THOSE REGULATIONS

Section 16 - Other Information

Note: The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations.

ClearTech Industries Inc. - Locations

Corporate Head Office: 2302 Hanselman Avenue, Saskatoon, SK, S7L 5Z3

Phone: 306-664-2522

Fax: 306-665-6216

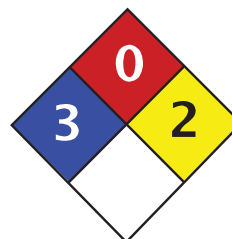
www.ClearTech.ca

Location	Address	Postal Code	Phone Number	Fax Number
Richmond BC	12431 Horseshoe way	V7A 4X6	604-272-4000	604-272-4596
Calgary AB	5516E - 40 th St. S.E.	T2C 2A1	403-279-1096	403-236-0989
Edmonton AB	11750 - 180 th Street	T5S 1N7	780-452-6000	780-452-4600
Saskatoon SK	2302 Hanselman Avenue	S7L 5Z3	306-933-0177	306-933-3282



Regina SK	555 Henderson Drive	S42 5X2	306-721-7737	306-721-8611
Winnipeg MB	340 Saulteaux Crescent	R3J 3T2	204-987-9777	204-987-9770
Mississauga ON	7480 Bath Road	L4T 1L2	905-612-0566	905-612-0575

24 Hour Emergency Number - All Locations - 306-664-2522



Health	3
Fire	0
Reactivity	2
Personal Protection	

Material Safety Data Sheet

Sulfuric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sulfuric acid

Catalog Codes: SLS2539, SLS1741, SLS3166, SLS2371, SLS3793

CAS#: 7664-93-9

RTECS: WS5600000

TSCA: TSCA 8(b) inventory: Sulfuric acid

CI#: Not applicable.

Synonym: Oil of Vitriol; Sulfuric Acid

Chemical Name: Hydrogen sulfate

Chemical Formula: H₂-SO₄

Contact Information:

Sciencelab.com, Inc.

14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**

International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sulfuric acid	7664-93-9	95 - 98

Toxicological Data on Ingredients: Sulfuric acid: ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m 2 hours [Rat]. 320 mg/m 2 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.

MUTAGENIC EFFECTS: Not available.

TERATOGENIC EFFECTS: Not available.

DEVELOPMENTAL TOXICITY: Not available.

The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion:

Products of combustion are not available since material is non-flammable. However, products of decomposition include fumes of oxides of sulfur. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas. Reacts with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.

Fire Hazards in Presence of Various Substances: Combustible materials

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.

Risks of explosion of the product in presence of static discharge: Not available.

Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:

Metal acetylides (Monocesium and Monorubidium), and carbides ignite with concentrated sulfuric acid.

White Phosphorous + boiling Sulfuric acid or its vapor ignites on contact.

May ignite other combustible materials.

May cause fire when sulfuric acid is mixed with Cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithium disilicide, phosphorous (III) oxide, and oxidizing agents such as chlorates, halogens, permanganates.

Special Remarks on Explosion Hazards:

Mixtures of sulfuric acid and any of the following can explode: p-nitrotoluene, pentasilver

trihydroxydiaminophosphate, perchlorates, alcohols with strong hydrogen peroxide, ammonium tetraperoxychromate, mercuric nitrite, potassium chlorate, potassium permanganate with potassium chloride, carbides, nitro compounds, nitrates, carbides, phosphorous, iodides, picrates, fulminates, dienes, alcohols (when heated)

Nitramide decomposes explosively on contact with concentrated sulfuric acid.

1,3,5-Trinitrosohexahydro-1,3,5-triazine + sulfuric acid causes explosive decomposition.

Section 6: Accidental Release Measures

Small Spill:

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:

Corrosive liquid. Poisonous liquid.

Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:

Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:

Hygroscopic. Reacts. violently with water. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:

TWA: 1 STEL: 3 (mg/m³) [Australia] Inhalation

TWA: 1 (mg/m³) from OSHA (PEL) [United States] Inhalation

TWA: 1 STEL: 3 (mg/m³) from ACGIH (TLV) [United States] [1999] Inhalation

TWA: 1 (mg/m³) from NIOSH [United States] Inhalation

TWA: 1 (mg/m³) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Thick oily liquid.)

Odor: Odorless, but has a choking odor when hot.

Taste: Marked acid taste. (Strong.)

Molecular Weight: 98.08 g/mole

Color: Colorless.

pH (1% soln/water): Acidic.

Boiling Point:

270°C (518°F) - 340 deg. C

Decomposes at 340 deg. C

Melting Point: -35°C (-31°F) to 10.36 deg. C (93% to 100% purity)

Critical Temperature: Not available.

Specific Gravity: 1.84 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 3.4 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:

Easily soluble in cold water.

Sulfuric is soluble in water with liberation of much heat.

Soluble in ethyl alcohol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability:

Conditions to Avoid: Incompatible materials, excess heat, combustible material materials, organic materials, exposure to moist air or water, oxidizers, amines, bases.

Always add the acid to water, never the reverse.

Incompatibility with various substances:

Reactive with oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

Corrosivity:

Extremely corrosive in presence of aluminum, of copper, of stainless steel(316).

Highly corrosive in presence of stainless steel(304).

Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Hygroscopic. Strong oxidizer. Reacts violently with water and alcohol especially when water is added to the product.

Incompatible (can react explosively or dangerously) with the following: ACETIC ACID, ACRYLIC ACID, AMMONIUM HYDROXIDE, CRESOL, CUMENE, DICHLOROETHYL ETHER, ETHYLENE CYANOHYDRIN, ETHYLENEIMINE, NITRIC ACID, 2-NITROPROPANE, PROPYLENE OXIDE, SULFOLANE, VINYLIDENE CHLORIDE, DIETHYLENE GLYCOL MONOMETHYL ETHER, ETHYL ACETATE, ETHYLENE CYANOHYDRIN, ETHYLENE GLYCOL MONOETHYL ETHER ACETATE, GLYOXAL, METHYL ETHYL KETONE, dehydrating agents, organic materials, moisture (water), Acetic anhydride, Acetone, cyanohydrin, Acetone+nitric acid, Acetone + potassium dichromate, Acetonitrile, Acrolein, Acrylonitrile, Acrylonitrile+water, Alcohols + hydrogen peroxide, ally compounds such as Allyl alcohol, and Allyl Chloride, 2-Aminoethanol, Ammonium hydroxide, Ammonium triperchromate, Aniline, Bromate + metals, Bromine pentafluoride, n-Butyraldehyde, Carbides, Cesium acetylene carbide, Chlorates, Cyclopentanone oxime, chlorinates, Chlorates + metals, Chlorine trifluoride, Chlorosulfonic acid, 2-cyano-4-nitrobenzenediazonium hydrogen sulfate, Cuprous nitride, p-chloronitrobenzene, 1,5-Dinitronaphthlene + sulfur, Diisobutylene, p-dimethylaminobenzaldehyde, 1,3-Diazidobenzene, Dimethylbenzylcarbinol + hydrogen peroxide, Epichlorohydrin, Ethyl alcohol + hydrogen peroxide, Ethylene diamine, Ethylene glycol and other glycols, , Ethylenimine, Fulminates, hydrogen peroxide, Hydrochloric acid, Hydrofluoric acid, Iodine heptafluoride, Indane + nitric acid, Iron, Isoprene, Lithium silicide, Mercuric nitride, Mesityl oxide, Mercury nitride, Metals (powdered), Nitromethane, Nitric acid + glycerides, p-Nitrotoluene, Pentasilver trihydroxydiaminophosphate, Perchlorates, Perchloric acid, Permanganates + benzene, 1-Phenyl-2-methylpropyl alcohol + hydrogen peroxide, Phosphorus, Phosphorus isocyanate, Picrates, Potassium tert-butoxide, Potassium chlorate, Potassium Permanganate and other permanganates, halogens, amines, Potassium Permanganate + Potassium chloride, Potassium Permanganate + water, Propiolactone (beta)-, Pyridine, Rubidium acetylene carbide, Silver permanganate, Sodium, Sodium carbonate, sodium hydroxide, Steel, styrene monomer, toluene + nitric acid, Vinyl acetate, Thallium (I) azidodithiocarbonate, Zinc chlorate, Zinc iodide, azides, carbonates, cyanides, sulfides, sulfites, alkali hydrides, carboxylic acid anhydrides, nitriles, olefinic organics, aqueous acids, cyclopentadiene, cyano-alcohols, metal acetylides, Hydrogen gas is generated by the action of the acid on most metals (i.e. lead, copper, tin, zinc, aluminum, etc.). Concentrated sulfuric acid oxidizes, dehydrates, or sulfonates most organic compounds.

Special Remarks on Corrosivity:

Non-corrosive to lead and mild steel, but dilute acid attacks most metals.

Attacks many metals releasing hydrogen.

Minor corrosive effect on bronze.

No corrosion data on brass or zinc.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:

WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE.

Acute oral toxicity (LD50): 2140 mg/kg [Rat.].

Acute toxicity of the vapor (LC50): 320 mg/m³ 2 hours [Mouse].

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.

May cause damage to the following organs: kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth.

Other Toxic Effects on Humans:

Extremely hazardous in case of inhalation (lung corrosive).

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: Not available.**Special Remarks on Chronic Effects on Humans:**

Mutagenicity: Cytogenetic Analysis: Hamster, ovary = 4mmol/L

Reproductive effects: May cause adverse reproductive effects based on animal data. Developmental abnormalities (musculoskeletal) in rabbits at a dose of 20 mg/m³ for 7 hrs.(RTECS)

Teratogenecity: neither embryotoxic, fetotoxic, nor teratogenetic in mice or rabbits at inhaled doses producing some maternal toxicity

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects:

Skin: Causes severe skin irritation and burns. Continued contact can cause tissue necrosis.

Eye: Causes severe eye irritation and burns. May cause irreversible eye injury.

Ingestion: Harmful if swallowed. May cause permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the stomach, GI bleeding, edema of the glottis, necrosis and scarring, and sudden circulatory collapse(similar to acute inhalation). It may also cause systemic toxicity with acidosis.

Inhalation: May cause severe irritation of the respiratory tract and mucous membranes with sore throat, coughing, shortness of breath, and delayed lung edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Cause corrosive action on mucous membranes. May affect cardiovascular system (hypotension, depressed cardiac output, bradycardia). Circulatory collapse with clammy skin, weak and rapid pulse, shallow respiration, and scanty urine may follow. Circulatory shock is often the immediate cause of death. May also affect teeth(changes in teeth and supporting structures - erosion, discoloration).

Chronic Potential Health Effects:

Inhalation: Prolonged or repeated inhalation may affect behavior (muscle contraction or spasticity), urinary system (kidney damage), and cardiovascular system, heart (ischemic heart leisons), and respiratory system/lungs(pulmonary edema, lung damage), teeth (dental discoloration, erosion).

Skin: Prolonged or repeated skin contact may cause dermatitis, an allergic skin reaction.

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 49 mg/l 48 hours [bluegill/sunfish].

BOD5 and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Sulfuric acid may be placed in sealed container or absorbed in vermiculite, dry sand, earth, or a similar material. It may also be diluted and neutralized. Be sure to consult with local or regional authorities (waste regulators) prior to any disposal. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Sulfuric acid UNNA: 1830 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information**Federal and State Regulations:**

Illinois toxic substances disclosure to employee act: Sulfuric acid
New York release reporting list: Sulfuric acid
Rhode Island RTK hazardous substances: Sulfuric acid
Pennsylvania RTK: Sulfuric acid
Minnesota: Sulfuric acid
Massachusetts RTK: Sulfuric acid
New Jersey: Sulfuric acid
California Director's List of Hazardous Substances (8 CCR 339): Sulfuric acid
Tennessee RTK: Sulfuric acid
TSCA 8(b) inventory: Sulfuric acid
SARA 302/304/311/312 extremely hazardous substances: Sulfuric acid
SARA 313 toxic chemical notification and release reporting: Sulfuric acid
CERCLA: Hazardous substances.: Sulfuric acid: 1000 lbs. (453.6 kg)

Other Regulations:

OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:**WHMIS (Canada):**

CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS E: Corrosive liquid.

DSCL (EEC):

R35- Causes severe burns.
S2- Keep out of the reach of children.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S30- Never add water to this product.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 2

Personal Protection:**National Fire Protection Association (U.S.A.):****Health:** 3**Flammability:** 0**Reactivity:** 2**Specific hazard:****Protective Equipment:**

Gloves.

Full suit.

Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.

Face shield.

Section 16: Other Information**References:**

- Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec.
- The Sigma-Aldrich Library of Chemical Safety Data, Edition II.
- Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.

Other Special Considerations: Not available.**Created:** 10/09/2005 11:58 PM**Last Updated:** 11/06/2008 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab.com be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.

**MADISON INDUSTRIES, INC.
OLD WATERWORKS ROAD
OLD BRIDGE, NJ 08857**

Telephone: 732-727-2225

Facsimile: 732-727-2653

info@oldbridgechem.com

www.oldbridgechem.com

MATERIAL SAFETY DATA SHEET

October 25, 2006

Page 1 of 4

Common Name: ZINC SULFATE

Manufacturer: Madison Industries, Inc.
P.O. Box 175
Old Bridge, New Jersey 08857

Telephone: 732-727-2225
Emergency Telephone: 800-275-3924
24 Hour Emergency Telephone: 800-424-9300 (Chemtrec)

HAZARDOUS CLSSIFICATION: NFPA: Health-2 / Fire-0 / Reactivity-0
HMIS: Health-2 / Fire-0 / Reactivity-0

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200).

ATTENTION: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

SECTION I. MATERIAL IDENTIFICATION

Common Name:	Zinc Sulfate
Trade Name:	Zinc Sulfate Monohydrate
Molecular Formula:	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$
Molecular Weight:	179
CAS Number:	7446-19-7

SECTION II. HAZARDS

This material or the components of this material are included in the Toxic Chemical Inventory as required in Section 8 (b) of the Toxic Substance Control Act (Public Law 94-469) and is codified in 40 CR 720.

Superfund Amendments & Reauthorization Act - Title III Applicability Section 312 40 CFR 370.40:

Health X Acute
Hazard X Chronic

Section 313 Zinc Compounds 40 CFR 372-85

SECTION III. PHYSICAL DATA

Physical State:	White powder or granules
Boiling Point:	NA
Melting Point:	No data
Crystallization Point:	70°F
Vapor Density:	0 (water = 1)
Specific Gravity:	3.28
Solubility in H ₂ O:	30% at 70°F
Appearance:	White powder or granules
Evaporation Rate:	NA

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point:	Not flammable.
Extinguishing Media:	Dry chemical, Carbon Dioxide or Foam. Water may be ineffective, but water spray or fog may be used as a cooling agent.
Fire and Explosion Hazards:	May release toxic Oxides of Zinc and Sulfur in a fire.

SECTION V. REACTIVITY DATA

Stability:	Stable at normal temperatures and pressures.
Thermal Decomposition:	May release toxic and hazardous Oxides of Zinc and Sulfur.
Polymerization:	Will not occur.

SECTION VI. HEALTH AND HAZARD INFORMATION

Route of Entry:	Ingestion or inhalation.
Target Organs:	Respiratory system, eyes and skin.
Acute Exposure:	May cause skin irritation. May cause eye irritation, possible corneal burn. May cause gastrointestinal disturbance. May cause irritation to nose and throat.
Chronic Exposure:	May cause skin dermatitis. May cause eye conjunctivitis. No known ingestion reaction anticipated. May cause inhalation reflex bronchial constriction.

SECTION VII. FIRST AID PROCEDURES

Swallowing:	If person is conscious induce vomiting. Call Poison Control Center or a physician. Do not give anything by mouth to an unconscious person.
Skin:	Immediately wash skin with soap and plenty of water. Remove contaminated clothing and shoes. Call a physician. Wash contaminated clothing before reuse.
Eyes:	Immediately flush eyes with plenty of water for 15 minutes. Hold eyelids apart during irrigation. Call a physician.
Inhalation:	Immediately remove person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped administer artificial respiration. Keep person warm and calm. Call a physician.
Carcinogenicity:	None

SECTION VIII. HANDLING PRECAUTIONS

Personal Protective Equipment:	Respirators - If exposure cannot be maintained at or below established OSHA guidelines, respiratory protection must be provided in accordance with 29 CFR 1910.134 requirements. Skin Protection - Wear appropriate protective clothing and chemical resistant gloves as needed to prevent skin contact. Consult manufacturer to determine appropriate type of gloves or clothing for your particular application. Clean contaminated clothing and protective equipment before reuse. Wash thoroughly after handling material. Eye Protection - Wear splash proof or dust proof safety goggles wherever there is a potential for eye contact.
Ventilation:	Provide local exhaust or process enclosing ventilation to maintain exposures below OSHA guidelines 29 CFR 1910.1000 subpart 7.

SECTION IX. SPILL OR LEAK PROCEDURES

Spills or Leaks:	Comply with Federal, State and Local regulations on reporting spills. Flush with plenty of water to an approved chemical sewer.
Waste Disposal:	Comply with Federal, State and Local regulations. Zinc Sulfate can be carefully reacted with Sodium Carbonate to form an insoluble Zinc Carbonate solid that can be scooped up and sent to a disposal contractor.

SECTION X. SPECIAL PRECAUTIONS

Storage:	Heated storage is necessary to prevent crystallization. Keep containers closed.
Other Precautions:	Do not take internally.

SECTION XI. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate. However, no warranty, expressed or implied, is given. Regulatory requirements are subject to change and may differ from one location to another. It is the buyer's responsibility to ensure that its activities comply with Federal, State and local laws.

U.S. REGULATIONS: SARA 313 Information; this product contains the following substance subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372: **Zinc Compound 40.5%**

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following category:

AN IMMEDIATE HEALTH HAZARD

SECTION XII. SHIPPING INFORMATION

QUANTITIES OF 1000 POUNDS OR MORE: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, NOS, (Zinc Sulfate) 9, UN3082, PGIII, RQ, ERG 171

QUANTITIES OF LESS THAN 1000 POUNDS: NON-HAZARDOUS AND NON-REGULATED IN THAT PACKAGE

SECTION XIII. MSDS PREPARATION INFORMATION

Prepared by: Joel L. Goldschmidt
Vice President

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Section 1 - Product and Company Identification

Synonyms: Ultra-low sulphur diesel, diesel oil, fuel distillate, hydrodesulfurized kerosene

Chemical Name: Kerosine, petroleum, hydrodesulfurized

Chemical Family: Kerosene

Material Use: Fuel for home heating; also for marine and on-road diesel engines

Chemical Formula: Not available; complex mixture

NOVA Chemicals
P.O. Box 2518 Station M
Calgary, Alberta, Canada T2P 5C8

Product Information: 1-412-490-4063

MSDS Information Email:

msdsemail@novachem.com

EMERGENCY Telephone Numbers:

North America (Canada and US):

1-800-581-6882, 1-403-314-8787 (NOVA Chemicals) (24 hours)

1-800-424-9300 (CHEMTREC-USA) (24 hours)

1-513-996-8668 (Canuloc-Canada) (24 hours)

Mexico and South America: +44 208 762 8322 (NCEC) (24 hours)

General Comments

This product is a complex mixture of aliphatic, olefinic, naphthenic and aromatic hydrocarbons having a variable boiling range of 150°C to 370°C (320°F to 698°F).

Section 2 - Hazards Identification

HMIS Ratings: Health: 1 • Fire: 2 • Physical Hazard: 0 • Personal Protection: chemical goggles, gloves, respirator

*Human Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe * = Chronic hazard*

NFPA Ratings: Health: 1 • Fire: 2 • Reactivity: 0

Human Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

Emergency Overview

WARNING! COMBUSTIBLE Product is an amber oily liquid with a kerosene-like odor. This product burns readily when heated to high temperatures, giving off combustible and toxic vapors. This product is harmful and possibly fatal if swallowed. Small amounts of this product, if aspirated into the lungs, may cause mild to severe injury. This product is irritating to the eyes and skin. Ingestion or excessive inhalation of this product may result in headache, sleepiness, dizziness, nausea, loss of coordination, and in extreme conditions coma and possibly death. Contains trace components that may cause cancer. Avoid contact. Pre-existing medical conditions may be aggravated by exposure. Prevent entry into ditches, sewers, and waterways.

Potential Health Effects: Eyes

This product is irritating to the eyes. Pre-existing medical conditions are aggravated by exposure.

Potential Health Effects: Skin

Prolonged and/or repeated skin contact with this product may cause irritation, blistering and severe dermatitis. Product may be partially absorbed through intact skin. Prolonged or repeated contact with this product may cause allergic-like skin reactions and over time may possibly cause skin cancer. Pre-existing medical conditions are aggravated by exposure.

Potential Health Effects: Ingestion

This product is harmful or fatal if swallowed. Ingestion causes gastrointestinal irritation, nausea, vomiting, and cramping; depression of the central nervous system. May also cause central nervous system effects including headache, sleepiness, dizziness, nausea, loss of coordination, and in extreme conditions coma and possibly death. Ingestion may cause kidney and liver damage and blood disorders. Small amounts of this product, if aspirated into the lungs, may cause mild to severe pulmonary injury.

Potential Health Effects: Inhalation

This product may be harmful by inhalation. Pre-existing medical conditions are aggravated by exposure. Excessive inhalation of this material may result in heartbeat irregularities and central nervous system effects including headache, sleepiness, dizziness, nausea, loss of coordination, and in extreme conditions respiratory failure, coma and possibly death. Small amounts of this product, if aspirated into the lungs, may cause mild to severe pulmonary injury.

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Section 3 - Composition / Information on Ingredients

CAS #	Component	Percent by Wt.
54742-81-0	Keros 16, petroleu(m), hydrosulfurized	≥99.5
7704-34-9	Sulfur	0-0.005

Additional Information

This product is considered to be hazardous under 29 CFR 1910.1200 (Hazard Communication)

This material is a controlled product under Canadian WHMIS regulations.

This material is regulated as a hazardous material/dangerous goods for transportation.

See Section 8 for applicable exposure limits. See Section 11 for application toxicity data.

Section 4 - First Aid Measures

First Aid: Eyes

Remove contact lenses, if it can be done safely. Immediately flush eyes with water for at least 15 minutes while holding eyelids open. Seek medical attention if symptoms develop or persist.

First Aid: Skin

For skin contact, wash immediately with soap and water for at least 15 minutes. Seek medical attention if symptoms develop or persist. Completely decontaminate clothing, shoes and other protective equipment before reuse or discard.

First Aid: Inhalation

Move affected individual to non-contaminated air. Loosen tight clothing such as a collar, tie, belt or waistband to facilitate breathing. Seek immediate medical attention if the individual is not breathing, is unconscious or if any other symptoms persist. **WARNING:** Contact through mouth-to-mouth resuscitation may pose a secondary risk to the rescuer. Avoid mouth-to-mouth contact by using a mouth shield or guard to perform artificial respiration.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Loosen tight clothing such as a collar, tie, belt or waistband. Seek immediate medical attention. Small amounts which accidentally enter the mouth should be rinsed out until taste is gone.

First Aid: Notes to Physician

For more detailed medical emergency support information call 1-800-561-8882 or 1-403-314-8767 (24 hours, NOVA Chemicals Emergency Response). Ensure thorough eye and skin decontamination. Treat unconsciousness, nausea, hypotension, seizures and cardiac arrhythmias in the conventional manner. Aspiration of this product during induced emesis can result in lung injury. If evacuation of stomach contents is considered necessary, use the method least likely to cause aspiration, such as gastric lavage after protecting the airway. Observe hospitalized patients for delayed chemical pneumonia, acute tubular necrosis, encephalopathy and dysrhythmias. Monitor for urinary phenol within 72 hours of acute exposure.

Section 5 - Fire Fighting Measures

See Section 9, Physical Properties for flammability limits, flash point and autoignition information.

General Fire Hazards

Fire and container explosion hazards are serious when this product is exposed to heat, flame or oxidizing materials. Empty containers when heated may pose a fire risk. Vapors are heavier than air and may travel along the ground to some distant source of ignition and flash back. Consider need for immediate emergency isolation and evacuation.

Explosion Hazards

Vapors may form explosive mixture with air. Keep containers away from source of heat, fire or oxidizing materials.

Hazardous Combustion Products

Upon decomposition, this product emits carbon monoxide, carbon dioxide, low molecular weight hydrocarbons, acidic gases, nitrogen oxides, sulfur oxides, and other toxic contaminants.

Extinguishing Media

Dry chemical, foam, carbon dioxide, and water fog. Water may be an ineffective extinguishing medium and increase spread of flames. Use water spray to cool fire-exposed containers and to protect personnel. Monitor water run-off for flammability, and prevent from entering drains and sewers, or other confined or underground spaces.

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Fire Fighting Equipment/Instructions

Reference 2004 Emergency Response Guidebook, Guide No. 128 for additional details and instructions. Position upwind. Keep unnecessary personnel away. Move containers from fire area if you can do so without risk. Fight fire from maximum distance or use unmanned holders or monitor nozzles. Immediately withdraw in case of fire and tank venting or heat discoloration of a tank. If container, rail car or tank truck is involved in a fire, isolate for 800 meters (1/2 mile) in all directions, also consider initial evacuation for 800 meters (1/2 mile) in all directions. Fire fighters should wear full-face, self-contained breathing apparatus and thermal protective clothing. Avoid inhaling any smoke and combustion products. Remove and clean or destroy any contaminated clothing. Cool containers with water spray until well after the fire is out. Control runoff waters to prevent entry into sewers, drains, underground or confined spaces and waterways.

Section 6 - Accidental Release Measures

Evacuation Procedures

Isolate area. Keep unnecessary personnel away. Alert stand-by emergency and fire fighting personnel. Monitor surrounding area for build-up of flammable air concentrations.

Spills

Small spill or leak area should be isolated immediately for at least 50 meters (164 feet) in all directions. Eliminate ignition sources. Large spills, isolate and consider downwind evacuation for 300 meters (984 feet). Keep upwind and out of low areas. Stop discharge if safe to do so. Contain discharge by booming on water or diking on ground. Remove liquid material with non-sparking approved pumps, skimmers or vacuum equipment. Absorb with DRY earth, sand or other non-combustible material. Soil remediation may be required. Prevent entry into sewers, drains, underground or confined spaces, water intakes and waterways.

Special Procedures

Contact local police/emergency services and appropriate emergency telephone numbers provided in Section 1. Ensure that statutory and regulatory reporting requirements in the applicable jurisdiction are met. Wear appropriate protective equipment and clothing during cleanup. Individuals without appropriate protective equipment should be excluded from area of spill until cleanup has been completed.

See Section 8 for recommended Personal Protective Equipment and see Section 13 for waste disposal considerations.

Section 7 - Handling and Storage

Handling Procedures

Keep locked up or secured. Handle in fully grounded, properly designed and approved equipment systems that are suitable for flammable liquids. Use with adequate ventilation. Do not ingest or inhale. Keep away from heat and ignition sources. No smoking or open flames permitted in storage, use or handling areas. Dissipate static electricity during transfer by grounding and bonding containers and equipment. An anti-static agent may be added to storage tanks to reduce static charge build-up during loading. Take special precautions when cold cutting or breaking into lines, or when cleaning and disposing of empty containers. Do not breathe gas, fumes, vapor or spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately. Avoid contact with skin and eyes. Keep away from incompatible materials such as oxidizing agents. After handling, always wash hands thoroughly with soap and water.

Storage Procedures

Storage area should be clearly identified, well-illuminated, clear of obstruction and accessible only to trained and authorized personnel. Adequate security must be provided so that unauthorized personnel do not have access to product. Store in grounded, properly designed and approved vessels and away from incompatible materials. Store and use away from heat, sparks, open flame or any other ignition source. An anti-static agent may be added to storage tanks to reduce static charge build-up during loading. Keep absorbents for leaks and spills readily available. Store according to applicable regulations. Have appropriate extinguishing capability in storage area (e.g. sprinkler system, portable fire extinguishers) and flammable gas detectors. Inspect vents during winter conditions for vapor ice build-up.

See Section 8, Exposure Controls/Personal Protection for appropriate Personal Protective Equipment. See Section 10 for information on incompatibilities.

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Section 8 - Exposure Controls / Personal Protection

Exposure Guidelines

A: General Product Information

Refer to published exposure limits - use effective control measures and PPE to maintain worker exposure to concentrations that are below these limits. Ensure that eyewash stations and safety showers are proximal to work locations.

B: Component Exposure Limits

ACGIH, OSHA, NIOSH, EPA, Alberta, and Ontario exposure limit lists have been checked for major components listed with CAS registry numbers. Other exposure limits may apply. Check with proper authorities.

Kerosine, petroleum, hydrosulfurized (54742-81-0)

ACGIH 200 mg/m³ TWA (as total hydrocarbon vapor) (application restricted to conditions in which there are negligible aerosol exposures)

Skin - potential significant contribution to overall exposure by the cutaneous route

Ontario 200 mg/m³ TWAEV (as total hydrocarbon vapor) (application restricted to conditions in which there are negligible aerosol exposures)

Absorption through skin, eyes, or mucous membranes

Sulfur (7704-34-9)

Alberta 10 mg/m³ TWA

ENGINEERING CONTROLS

Engineering methods to reduce hazardous exposure are preferred controls. Methods include mechanical ventilation (dilution and local exhaust) process or personal enclosure, remote and automated operation, control of process conditions, leak detection and repair systems, and other process modifications. Ensure all exhaust ventilation systems are discharged to outdoors away from air intakes and ignition sources. Supply sufficient replacement air to make up for air removed by exhaust systems. Administrative (procedure) controls and use of personal protective equipment may also be required.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment: Eyes/Face

Wear safety glasses; chemical goggles are recommended if splashing is possible, or to prevent eye irritation from vapors.

Personal Protective Equipment: Skin/Hands/Foot

Use impervious gloves. Wear chemical-resistant safety footwear with good traction to prevent slipping. Work clothing that sufficiently prevents skin contact should be worn, such as coveralls and long sleeves. Fire resistant (i.e., Nomex) or natural fiber clothing (i.e., cotton or wool) is recommended. Synthetic clothing can generate static electricity and is not recommended where flammable vapor releases may occur.

Personal Protective Equipment: Respiratory

If engineering controls and ventilation is not sufficient to prevent buildup of aerosols or vapors, appropriate NIOSH/MSHA approved air-purifying respirators or self-contained breathing apparatus (SCBA) appropriate for exposure potential should be used. Air supplied breathing apparatus must be used when oxygen concentrations are low or if airborne concentrations exceed the limits of the air-purifying respirators.

Personal Protective Equipment: General

Personal protective equipment (PPE) should not be considered a long-term solution to exposure control. Employer programs to properly select, fit, maintain, and train employees to use equipment must accompany PPE. Consult a competent industrial hygiene resource, the PPE manufacturer's recommendation, and/or applicable regulations to determine hazard potential and ensure adequate protection.

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Section 9 - Physical & Chemical Properties

Physical State and Appearance:	Oil, liquid	Color:	Amber
Odor:	Kerosene-like; can be detected at low ppm levels	pH:	Not available
Vapor Pressure:	1.50 mm Hg at 20°C (68°F)	Vapor Density @ 0°C (Air=1):	8
Boiling Point:	Range: 160°C-370°C (320°F-698°F)	Melting Point:	Not applicable
Solubility (H ₂ O):	Insoluble	Specific Gravity (Water=1):	0.85
Freezing Point:	Range: -35°C -0°C (-32°F - 32°F)	Dispersion Properties:	Not available
Evaporation Rate (Ethyl Ether):	300	Viscosity:	Range: 1.30 -4.10 cSt at 40°C (104°F)
Percent Volatile:	100%	Auto Ignition:	267°C (504°F)
Flash Point:	24°C (75°F)	Flash Point Method:	Pensky-Martens
Upper Flammable Limit (UFL):	Not available	Lower Flammable Limit (LFL):	Not available
Flammability Classification:	Combustible		

Section 10 - Stability & Reactivity Information

Chemical Stability

This product is stable under normal use conditions for shock, vibration, pressure, or temperature.

Instability

Not applicable

Chemical Stability: Conditions to Avoid

Keep away from heat, sparks, or open flame

Incompatibility

May react with oxidizing agents. Slightly reactive with metals. Heated vapors or mists may form explosive mixture with air.

Hazardous Polymerization

Not likely to occur

Corrosivity

Not considered to be corrosive.

Hazardous Decomposition

Upon decomposition, this product emits carbon monoxide, carbon dioxide, low molecular weight hydrocarbons, acidic gases, nitrogen oxides, sulfur oxides, and other toxic contaminants.

Section 11 - Toxicological Information

A: Acute Toxicity - General Product Information

Similar fuel oil mixtures have been tested under the EPA's High Production Volume (HPV) program for the Kerosenes/Jet Fuel Category. Kerosene is not considered acutely toxic. Animal tests have produced moderate to severe skin irritation and eye irritation. Eye irritation generally resolved within one to 7 days. Kerosenes did not produce sensitization when tested in guinea pigs. Sulfur component may cause sensitization.

B: Acute Toxicity - LD50/LC50

Kerosene, petroleum, hydrosulfurized (64742-81-0)

Inhalation LC50 Rat >5.2 mg/L/4H, Oral LD50 Rat >5000 mg/kg, Dermal LD50 Rabbit >2000 mg/kg

Sulfur (7704-34-9)

Inhalation LC50 Rat >0.23 mg/L/4H, Oral LD50 Rat >3000 mg/kg, Dermal LD50 Rabbit >2000 mg/kg

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

C: Chronic Toxicity - General Product Information

Similar fuel/oil mixtures have been tested under the EPA's High Production Volume (HPV) program for the Kerosenes/Jet Fuel Category. Chronic skin exposure causes dermatitis and slight to moderate skin irritation in rabbits. Some animal studies have indicated damage to the heart and spleen. No tests have shown evidence of mutagenicity or teratogenicity. In carcinogenicity tests, kerosene was not an initiator but did show evidence of tumor promoting activity.

D: Chronic Toxicity - Carcinogenic Effects

ACGIH, EPA, IARC, OSHA, and NTP carcinogen lists have been checked for selected similar materials or those components with CAS registry numbers.

Kerosene, petroleum, hydrosulfurized (64742-81-0)

ACGIH: A3 - Confirmed animal carcinogen with unknown relevance to humans (as total hydrocarbon vapor)

IARC: Monograph 45, 1989 (revised to Jet Fuel); Group 3 (not classifiable)

Section 12 - Ecological Information

Ecotoxicity

A: General Product Information

Similar fuel/oil mixtures have been tested under the EPA's High Production Volume (HPV) program for the Kerosenes/Jet Fuel Category. Product is largely insoluble in water. Under ambient conditions, this product absorbs quickly in soil. Kerosene shows moderate toxicity to aquatic organisms.

B: Component Analysis - Ecotoxicity - Aquatic/Terrestrial Toxicity

Kerosene, petroleum, hydrosulfurized (64742-81-0)

96 Hr LC50 *Pimephales promelas*: 45 mg/L (flow-through) 96 Hr LC50 *Lepomis macrochirus*: 1740 mg/L (static)

96 Hr LC50 *Dendroica heteropoda*: 4720 mg/L

Sulfur (7704-34-9)

96 Hr LC50 *Brachydan rerio*: 868 mg/L (static)

Environmental Fate/Mobility

Kerosene is not subject to hydrolysis. Partitioning to water is <10% at equilibrium, while partitioning to sediment is 2% and to biota (fish) is 0.1%.

Persistence/Degradability

This material is considered biodegradable. Some components biodegrade quickly while other higher molecular weight components will degrade more slowly. Atmospheric half-lives of 0.2 to 1.5 days have been calculated for representative C9 and C18 hydrocarbon components of kerosenes.

Bioaccumulation/Accumulation

Lower molecular-weight, normal hydrocarbons are most readily biodegraded but tend to partition to air rather than water while more complex, higher molecular weight polynuclear aromatics and substituted aromatics tend to sorb to soil or sediment both processes limit bioavailability and can slow biodegradation. The hydrocarbons in kerosenes are generally not inhibitory to microbial activity though changes in microbial community composition may occur in spill or impacted areas due to the proliferation of species that can biodegrade the compounds.

Section 13 - Disposal Considerations

U.S./Canadian Waste Number & Descriptions

A: General Product Information

This product may be known to be a hazardous waste according to US and Canadian regulations. The use, handling or processing of this product may alter this product. Contact federal, provincial/state and local authorities in order to generate or ship a waste material associated with this product to ensure materials are handled appropriately and meet all criteria for disposal of hazardous waste. **DO NOT ATTEMPT TO DISPOSE OF BY UNCONTROLLED IGNITION.** Since emptied containers retain product residue, follow safe handling label warnings even after container is emptied.

See Section 7: Handling and Storage and Section 8: Exposure Controls/Personal Protection for additional handling information that may be applicable for safe handling and the protection of employees.

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Waste generator is advised to carefully consider hazardous properties and control measures needed for other materials that may be found in the waste.

B: Component Waste Numbers

No EPA Waste Numbers are applicable for this product's components.

Section 14 - Transportation Information

US DOT Information

Shipping Name: DIESEL FUEL

UN/NA #: NA1093 Hazard Class: 3 Packing Group: III

Required Label(s): None

Additional Info.: 2004 Emergency Guidebook, Guide #128

This classification applies to US domestic shipments only.

This product meets the conditions of 49 CFR 173.120 (b)(2) and may be reclassified as a combustible liquid for shipments within the U.S.

Canadian TDG Information

Shipping Name: DIESEL FUEL

UN #: UN1202 Hazard Class: 3 Packing Group: III

Required Label(s): FLAMMABLE LIQUID

Additional Info.: 2004 Emergency Guidebook, Guide #128

International Air Transport Association (IATA) and ICAO Information

Shipping Name: DIESEL FUEL

UN #: UN1202 Hazard Class: 3 Packing Group: III

Required Label(s): FLAMMABLE LIQUID

International Maritime Dangerous Goods (IMDG) Code

Shipping Name: DIESEL FUEL

UN #: UN1202 Hazard Class: 3 Packing Group: III

Required Label(s): FLAMMABLE LIQUID

Additional Info.: EmS Code: F-E, S-E

Marine Pollutant: No

Section 15 - Regulatory Information

A: International Regulations

Component Analysis - International Inventory Status

Component	CAS #	US - TSCA	CANADA - DSL	EU - EINECS
Kerosene, petroleum, hydrosulfurized	64742-81-0	Yes	Yes	Yes
Sulfur	7704-34-9	Yes	Yes	Yes

B: USA Federal & State Regulations

Ongoing occupational hygiene, medical surveillance programs, or site emission or spill reporting may be required by Federal or State regulations. Check for applicable regulations.

USA OSHA Hazard Communication Class

This product/material is considered hazardous under 29 CFR 1910.1200 (Hazard Communication). HCS Classes:

HCS CLASS: Combustible liquid having a flash point between 37.8°C (100°F) and 93.3°C (200°F).

HCS CLASS: Irritating substance

HCS CLASS: Target organ effects.

USA Right-to-Know - Federal

None of this product's components are listed under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), or CERCLA (40 CFR 302.4).

USA Right-to-Know - State

The following components appear on one or more of the following state hazardous substances lists. Some components (including those present only in trace quantities, and therefore not listed in this document) may be included on the Right-To-Know lists of other U.S. states. The reader is therefore cautioned to contact his or her

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

NOVA Chemicals' representative or NOVA Chemicals' Product Integrity group for further U.S. State Right-To-Know information.

Component _____
Sulfur _____

CAS
7704-34-9

NJ
Yes

PA
Yes

C: Canadian Regulations - Federal and Provincial

WHMIS Ingredient Disclosure List (IDL)

No components are listed in the WHMIS Ingredient Disclosure List (IDL)

WHMIS Classification

Workplace Hazardous Materials Information System (WHMIS): This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and the MSDS contains all the information required by the CPR.

WHMIS CLASS B3 Combustible liquid with a flash point between 37.8°C (100°F) and 93.3°C (200°F).

WHMIS CLASS O2A Material causing other toxic effects, very toxic material

WHMIS CLASS O2B: Material causing other toxic effects, toxic material

Other Regulations

Ongoing occupational hygiene, medical surveillance programs or site emission or spill reporting may be required by Federal or Provincial regulations. Check for applicable regulations

Section 16 - Other Information

Label Information

WARNING COMBUSTIBLE Product is an amber oily liquid with a kerosene-like odor. This product burns readily when heated to high temperatures, giving off combustible and toxic vapors. This product is harmful and possibly fatal if swallowed. Small amounts of this product, if aspirated into the lungs, may cause mild to severe injury. This product is irritating to the eyes and skin. Ingestion or excessive inhalation of this product may result in headache, sleepiness, dizziness, nausea, loss of coordination, and in extreme conditions coma and possibly death. Contains trace components that may cause cancer. Avoid contact. Pre-existing medical conditions are aggravated by exposure. Prevent entry into ditches, sewers, and waterways.

FIRST AID:
SKIN: For skin contact, wash immediately with soap and water for at least 15 minutes. Seek medical attention if symptoms develop or persist. Completely decontaminate clothing, shoes and other protective equipment before reuse or discard.
EYES: Remove contact lenses, if it can be done safely. Immediately flush eyes with water for at least 15 minutes, while holding eyelids open. Seek medical attention if symptoms develop or persist.

INHALATION: Move affected individual to non-contaminated air. Loosen tight clothing such as a collar, tie, belt or waistband to facilitate breathing. Seek immediate medical attention if the individual is not breathing, is unconscious or if any other symptoms persist. **WARNING:** Contact through mouth-to-mouth resuscitation may pose a secondary risk to the rescuer. Avoid mouth-to-mouth contact by using a mouth shield or guard to perform artificial respiration.

INGESTION: DO NOT INDUCE VOMITING. Loosen tight clothing such as a collar, tie, belt or waistband. Seek immediate medical attention. Small amounts which accidentally enter the mouth should be rinsed out until taste is gone.

IN CASE OF A LARGE SPILL: Consider downwind evacuation for 300 meters (984 feet). Stop discharge if safe to do so. Eliminate ignition sources. Keep upwind and out of low areas. Isolate, contain, and attempt to recover. Absorb with DRY earth, sand or other non-combustible material. Remove material with non-sparking approved pumps, skimmers or vacuum equipment. Soil remediation may be required. Prevent entry into sewers, ditches, underground or confined spaces, water intakes and waterways.

References

Available on request.

Special Considerations

The International Agency for Research on Cancer (IARC) has categorized diesel exhaust as carcinogenic to humans (Class 2A).

Diesel exhaust particulates

NTP Reasonably Anticipated to be a Human Carcinogen (related to Diesel exhaust particulates)

IARC Monograph 46, 1989 (related to Diesel engine exhaust) (Group 2A (probably carcinogenic to humans))

For additional information on equipment bonding and grounding, refer to the American Petroleum Institute (API) Recommended Practice 2003, "Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents" or National Fire Protection Association (NFPA) 77, "Recommended Practice on Static Electricity".

Material Safety Data Sheet

Material Name: **Low Sulfur Diesel-S15**

MSDS ID: NOVA-0034

Key/Legend

ACGIH = American Conference of Governmental Industrial Hygienists; B.P.V. = Boiling Liquid-Expanding Vapor Explosion; BOD = Biochemical Oxygen Demand; CAS = Chemical Abstracts Service; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; CFR = Control Products Regulations; DOT = Department of Transportation; DSL = Durable Substances List; EINECS = European Inventory of Existing Commercial Substances; EPA = Environmental Protection Agency; EU = European Union; FDA = Food and Drug Administration; IARC = International Agency for Research on Cancer; ILI = Ingredient Disclosure List; K_{ow} = Octanol/water partition coefficient; LEL = Lower Explosive Limit; NIOSH = National Institute for Occupational Safety and Health; NJTGH = New Jersey Trade Secret Registry; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; RCRA = Resource Conservation and Recovery Act; SARA = Subacute Amendments and Reauthorization Act; TGS = Transportation of Dangerous Goods; TSCA = Toxic Substances Control Act

MSDS Prepared by: NOVA Chemicals

MSDS Information Phone Number: 1-412-490-4063

Other Information

Notice to Reader

ALTHOUGH THE INFORMATION CONTAINED IN THIS DOCUMENT IS PRESENTED IN GOOD FAITH, BASED ON AVAILABLE INFORMATION BELIEVED TO BE RELIABLE AT THE TIME OF PREPARATION OF THIS DOCUMENT, NOVA CHEMICALS MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT TO THE INFORMATION OR THE PRODUCT/MATERIALS DESCRIBED HEREIN, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES AND CONDITIONS (INCLUDING ALL WARRANTIES AND CONDITIONS OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE). NO FREEDOM FROM INFRINGEMENT OF ANY PATENT OWNED BY NOVA CHEMICALS OR OTHERS IS TO BE INFERRED. THIS INFORMATION IS SUBJECT TO CHANGE WITHOUT NOTICE. PLEASE CONTACT NOVA CHEMICALS FOR THE MOST CURRENT VERSION OF THIS MSDS. NOVA CHEMICALS DOES NOT ASSUME RESPONSIBILITY FOR MSDS OBTAINED FROM THIRD PARTY SOURCES.

UNLESS SPECIFICALLY AGREED OTHERWISE, NOVA CHEMICALS DOES NOT TAKE RESPONSIBILITY FOR USE, TRANSPORTATION, STORAGE, HANDLING OR DISPOSAL OF THE PRODUCTS DESCRIBED HEREIN.



NOVA Chemicals*

is a registered trademark of NOVA Brands Ltd.; authorized use/utilisation autorisée.

This is the end of MSDS # NOVA-0034



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX G
ALEXCO RESOURCE CORP
EMERGENCY RESPONSE PLAN
UPDATED DECEMBER 2008**

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



ALEXCO

Managing Risk – Unlocking Value

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



This controlled document will be regularly updated to reflect revisions.

- Updated Emergency Management Response Plan (EMRP) documents will be bound and distributed to all authorized personnel.
- All Keno Hill Project personnel must have EMRP training and know where to gain access to the document in the event of an emergency.

Authorized Distribution / Location List:

Alexco Resource Corp. - Keno Hill Property:

Administration Office
Bellekeno East Shifters Office
Care & Maintenance Shop
First Aid Room
General Managers Workspace
Kitchen Medical Station
Mine Rescue Shed – Bellekeno East
Safety Coordinators Office

Alexco Resource Corp. - :

Access Consulting Group Whitehorse Office
Alexco Resource Corp. Vancouver Office
Alexco Resource Corp. Whitehorse Office

Community:

Mayo Nursing Station

Government:

Occupational Health & Safety - YWCHSB

Primary Partners On-site Contractors:

First Nation Na-Cho Nyak Dun – Mayo
Procon Mining and Tunneling Corporate Office

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



CONTENTS:

1.0 PURPOSE.....	5
2.0 DEFINITIONS	5
• 2.1 “SERIOUS INCIDENT”	5
• 2.2 “SERIOUS INJURY” AND “SERIOUS ACCIDENT” UNDER OH&S ACT.....	6
3.0 INITIAL RESPONSE TO SERIOUS INCIDENT - KENO HILL MINES	8
4.0 FOLLOW-UP TO SERIOUS INCIDENT.....	9
5.0 RESPONSIBILITY MATRIX.....	10
6.0 CONTACTS FOR SITE PERSONNEL.....	11
7.0 EXTERNAL RESOURCE CONTACTS.....	12
8.0 UNDERGROUND EMERGENCY ACTION PLAN	13
• 8.1 REPORTING THE EMERGENCY.....	14
• 8.2 FIRE	15
• 8.3 EMERGENCY WARNING RESPONSE	16
• 8.4 MEDICAL PERSONNEL	17
• 8.5 REFUGE CHAMBER BARACADING.....	18
• 8.6 MINE VENTILATION CONTROLS	20
• 8.7 MINE OUTAGE PLAN.....	20
9.0 MINE RESCUE	22
10.0 REPORTABLE SPILL QUANTITIES	23
11.0 SPILL RESPONSE EQUIPMENT RESOURCE LIST.....	25
12.0 MISSING PERSONS ACTION PLAN.....	26
13.0 EMERGENCY EQUIPMENT AND EQUIPMENT LOCATIONS.....	27
14.0 EMERGENCY FIRST AID PATIENT ASSESSMENT MODEL.....	28

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.0 CONTACTS - KENO HILL.....	29
• 15.1 KENO HILL PROJECT	29
• 15.2 KENO HILL PROJECT – DEPARTMENT MANAGERS	30
• 15.3 FIRST AID, HEALTH & SAFETY DEPARTMENT	30
• 15.4 ALTERNATE KENO HILL PROJECT – DEPARTMENT MANAGERS.....	31
• 15.5 REPORTING FOR “SERIOUS” INCIDENTS, INJURIES, OR ACCIDENTS	32
• 15.6 RADIO COMMUNICATION	32
• 15.7 EMERGENCY MEDIVAC TRANSPORTATION	33
• 15.8 KENO HILL MINE RESCUE	34
• 15.9 COOPERATIVE KENO HILL MINE RESCUE	34
• 15.10 TERRITORIAL AND FEDERAL CONTACT NUMBERS	35

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



1.0 PURPOSE

This guide sets out the response protocol in the event of a “Serious Incident” as defined in the following section.

It is intended for use as a quick reference handbook for managers and supervisors. Incident reporting and investigating is also outlined.

In an emergency situation it is imperative that due diligence is exercised as well as discretion. The priorities are the protection of **LIFE, LIMB and PROPERTY** – in that order.

2.0 DEFINITIONS

2.1 “SERIOUS INCIDENT”

A “**Serious Incident**” is defined as any occurrence meeting one or more of the following criteria:

1. Any “serious injury” or “serious accident” as defined in OH&S 33(1) (see Section 2.2),
2. Any incident requiring first aid or rescue response to the scene,
3. Any fire requiring discharge of a fire extinguisher,
4. Any release of mill process solution outside of containment,
5. Any release of a hazardous product where there is potential for that product to enter a waterway,
6. Any hazardous product spill of reportable volume, as defined in Section 11.0.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



2.2 **“SERIOUS INJURY” AND “SERIOUS ACCIDENT” UNDER OH&S ACT**

(Excerpt from Occupational Health & Safety Act)

33. (1) In this section,

“Serious Injury” means:

- a) an injury that results in death,
- b) fracture of a major bone, including the skull, the spine, the pelvis, or the thighbone,
- c) amputation other than of a finger or toe,
- d) loss of sight of an eye,
- e) internal bleeding,
- f) full thickness (third degree) burns,
- g) dysfunction that results from concussion, electrical contact, lack of oxygen, or poisoning, or
- h) an injury that results in paralysis (permanent loss of function);

“Serious Accident” means:

- (a) an uncontrolled explosion,
- (b) failure of a safety device on a hoist, hoist mechanism, or hoist rope,
- (c) collapse or upset of a crane
- (d) collapse or failure of a load-bearing component of a building or structure regardless of whether the building or structure is complete or under construction,
- (e) collapse or failure of a temporary support structure,

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



- (f) an inrush of water in an underground working,
- (g) fire or explosion in an underground working,
- (h) collapse or cave-in, of a trench, excavation wall, underground working, or stockpile,
- (i) accidental release of a controlled product,
- (j) brake failure on mobile equipment that causes a runaway,
- (k) any accident that likely would have caused serious injury but for safety precautions, rescue measures, or chance. (As amended by SY 1988, c.22, s. 5; SY 1989, c. 19, s.6)

Reprinted from "Occupational Health and Safety with Mine Safety Regulations."
Yukon Workers' Compensation Health and Safety Board. Department of Justice, Government of the Yukon. 1992

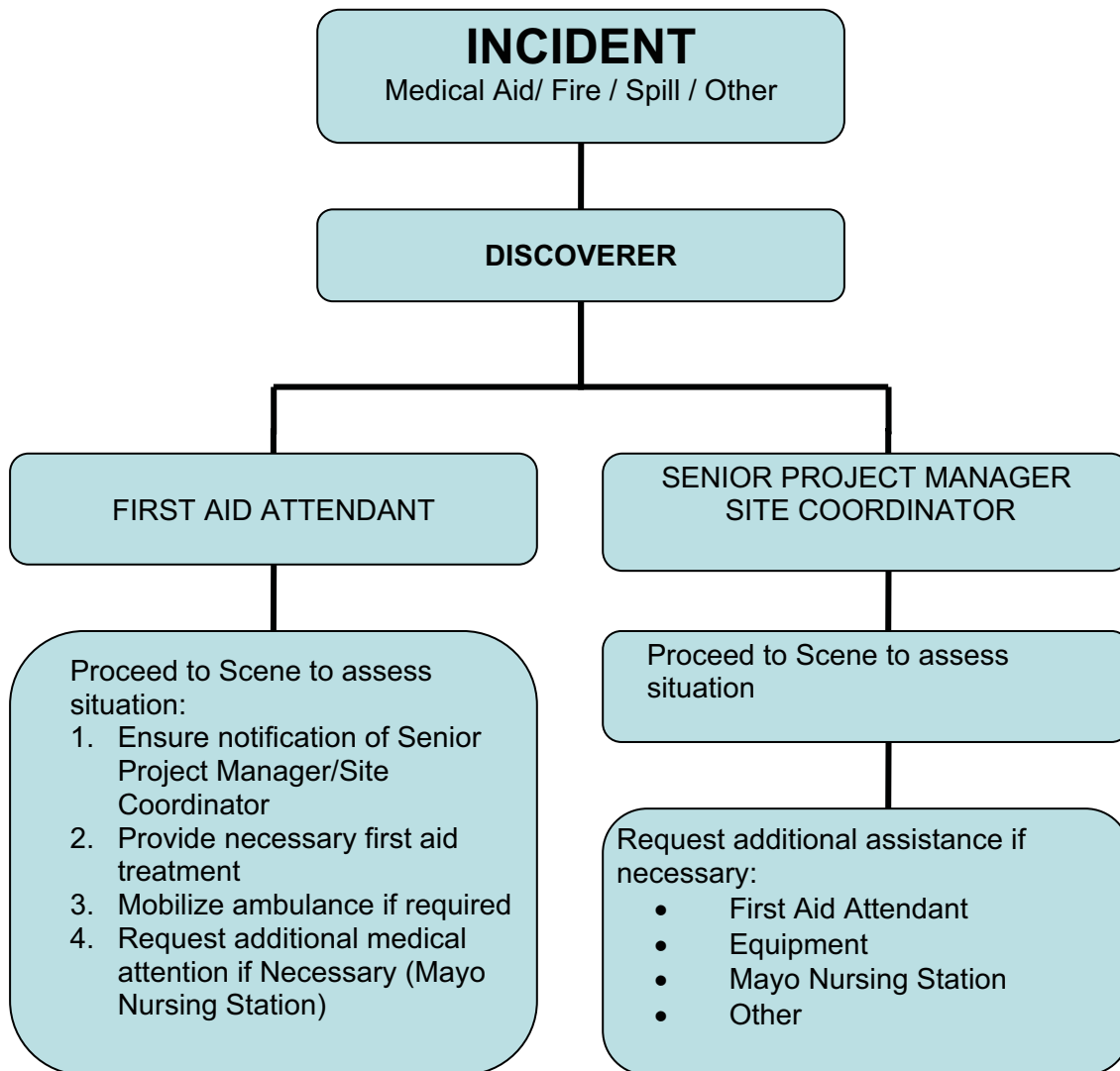
Keno Hill Project

EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



3.0 INITIAL RESPONSE TO SERIOUS INCIDENT - KENO HILL PROJECT

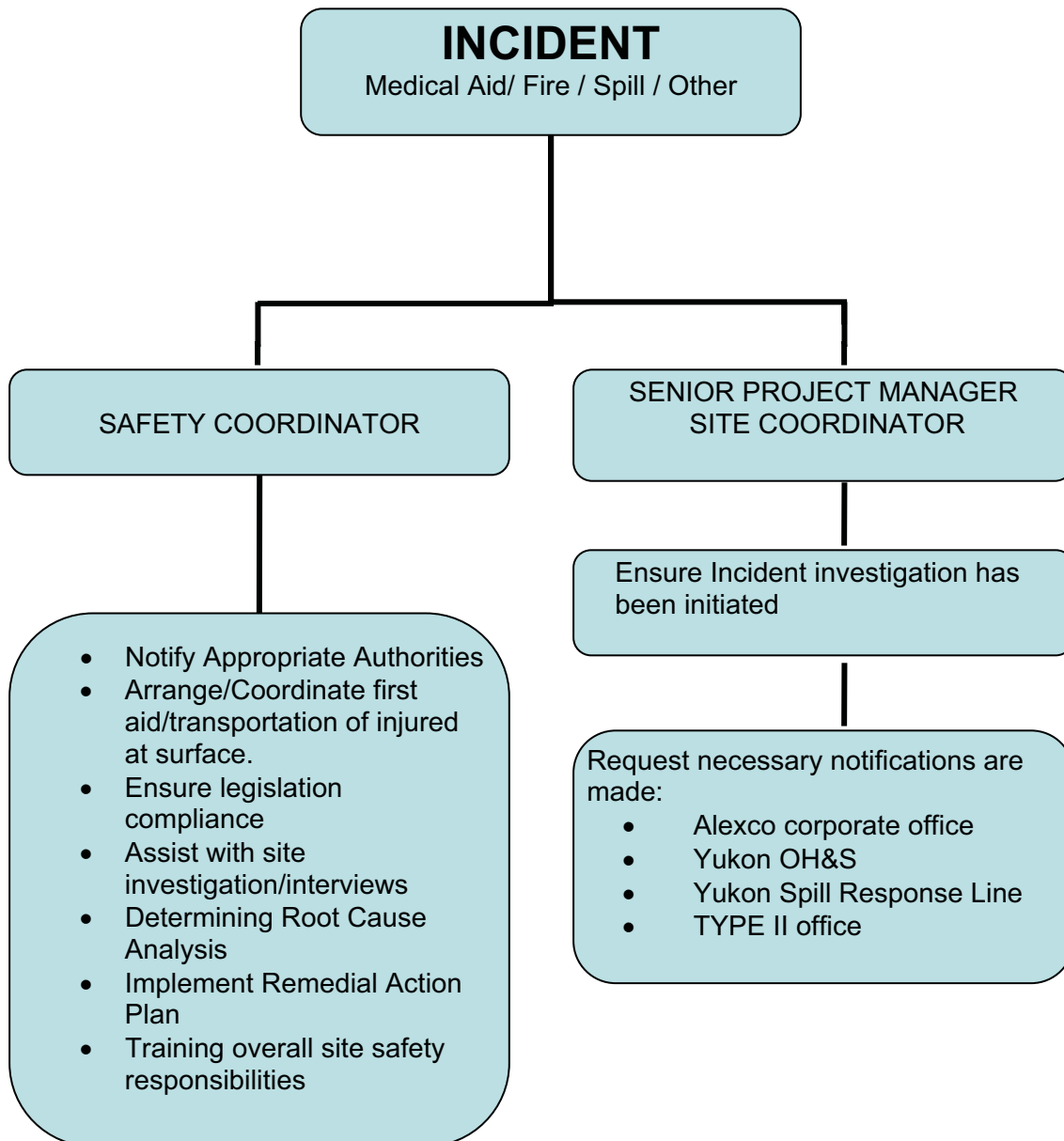


Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



4.0 FOLLOW UP TO SERIOUS INCIDENT - KENO HILL PROJECT



Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



5.0 SERIOUS INCIDENT RESPONSIBILITY MATRIX

POSITION	RESPONSIBILITIES
Area Supervisor Site Coordinator	• Coordinate initial response • E.R.T. and specialized resources mobilization & consultation • Attend and coordinate response for all incidents involving “serious injury” and “serious accident”, as defined in Sec. 33, OHS Act • Initial scene control • Responsible for investigation – determine contributing causes and take immediate proactive action • Request additional external resources as necessary • Coordinate recovery and investigative activity • Notify Senior Project Manager • Ensure all government reporting has been completed • Organize and conduct post-incident debriefings • Prepare Incident Report and make recommendations
First Aid Attendant	• Ensure area supervisor has been notified of incident • Provide first aid treatment if necessary • Mobilize ambulance to scene, if required • Stand by to assist as required by scene coordinator
Senior Project Manager	• Designate on-call senior personnel during weekends • Receive briefings on incident details • Provide direction as required • Notify regulatory agencies, government and Alexco corporate office of incident • Review Incident Reports • Attend at all incidents involving “serious injury” and “serious accident”, as defined in Sec. 33, OHS Act • Verify compliance with standards and government regulatory requirements • Forward necessary reports to regulatory agencies • Fire Chief – assume responsibility for fire investigation
Safety Coordinator	

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



6.0 SERIOUS INCIDENT CONTACTS FOR SITE PERSONNEL

Position	Contact Personnel	Office Contact Number	Radio	Home Contact Number
District Manager	Jim Muntzert	867-995-3113	CH 3	719-689-2575
Operations General Manager	Tim Hall	867-995-3113	CH 3	907-790-2245
Safety Coordinator	Colleen Geddes	867-995-3113	CH 3	867-667-6155
VP Exploration	Stan Dodd	867-995-3113	CH 3	604-980-6119
Project / Construction Manager	Peter Johnson	867-995-3113	CH 3	867-993-5911
Site Services Manager	Sam Wallingham	867-995-3113	CH 3	867-456-2796
Remediation Manager	Kael Hanak	867-995-3113	CH 3	867-393-2741
Chief Operating Officer	Brad Thrall	604-633-4888		604-250-6501
Chief Executive Officer	Clynt Nauman	604-633-4888		604-250-3293
Access Consulting Group	Dan Cornett	867-668-6463		867-668-7964
Procon Mining (Elsa)	Anson Smith	867-995-3113 604-637-5997 (Bellekeno)	CH 3	
Procon Mining (Vancouver)	Brad Skeeles	604-296-3365		778-837-4407

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



7.0 EXTERNAL RESOURCE CONTACTS

With the exception of medical aid incidents, external resources will be authorized only by the Senior Project Manager on site or his designate, or those with higher level of responsibility.

Assistance Required For:	Agency Contact	Contact Number
Ambulance / Air Medivac	Mayo Nursing Station	867-996-4444
Poisonous Substance Ingestion	Poison Control Centre	867-633-8477
Fire (building) / Rescue Assistance	Mayo Fire Department	867-996-2222
Forest Fire		888-798-FIRE
Spill	Yukon Spill Report Line	867-667-7244
Spill Fax		867-393-6266
Wildlife Management	YTG Ren. Res. - Mayo	867-996-2162
Crime – Related Incidents	RCMP – Mayo	867-996-5555
Fatality	Coroner or RCMP	867-996-5555
Mine Rescue YT OH&S	Mine Inspector	867-334-2002
Procon Mining and Tunneling Ltd	Brad Skeeles	604-291-8292

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.0 UNDERGROUND EMERGENCY ACTION PLAN

In an emergency situation it is imperative that due diligence is exercised as well as discretion. The priorities are the protection of **LIFE, LIMB and PROPERTY** – in that order

Please see **Section 2. of this E.M.R.P document** for further definition of a SERIOUS reportable incident / accident. All SERIOUS reportable incidents / accidents require notification of the YT OH&S Mine Inspector as defined in the Occupation Health and Safety Act – Mine Safety Regulations

“Underground Emergency” means:

- a) “Serious” Incident
- b) Serious Injury
- c) Uncontrolled fire
- d) Unexpected fall
- e) Unexpected explosion
- f) Any condition that can negatively affect:
 - life,
 - health
 - the environment.

“Mass Casualty Incident Emergency” – Underground means:

Any underground emergency which could affect 5 or more people.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.1 REPORTING THE EMERGENCY:

Where an EMERGENCY exists that may affect mine personnel, evacuation procedures must be initiated.

Underground Emergency -

Any person discovering an emergency shall:

1. Request or initiate mine evacuation.
2. Notify personnel of the emergency using a mine phone or radio in your area (leaky feeder).
3. When mine radio or phone is not readily available for use as emergency notification:
 - a) Proceed to the mine portal.
 - b) Open the stench warning control box located on the compressed airline
 - c) Turn the cylinder "on".
 - d) Remain at the box until the cylinder is empty.
 - e) Proceed to Bellekeno Mine Office Dry and report the nature of the emergency to response personnel.
 - f) Report in, brass out and standby for further instruction.
 - g) In addition to the compressed airline stench a stench bottle will be located at the main fan intake at both Bellekeno East Portal and Bellekeno 625 level. The fan must be on and response personnel must open the stench bottle and release the gas into the main fan air intake.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.2 IN CASE OF FIRE:

Where a FIRE exists that may affect other personnel working in the area, evacuation procedures must be initiated:

Evacuation Procedures

1. Warn all personnel in the immediate area (voice, radio, phone) to evacuate to a safe location.
2. Initiate the Stench Warning System.
3. Where the fire is small, use nearby fire extinguishers to extinguish it, provided it is safe to do so.
4. If down wind of the fire, don your self rescuer (either the W65 or the SCSR's) and proceed to either a refuge station or fresh air base.
5. Do not expose yourself to unnecessary risk and keep a clear area of retreat behind you.
6. If the fire is too big, do not hesitate, leave the area immediately and evacuate to the designated assembly area or seek refuge.

Mass Casualty Incident Emergency - Underground

In the event of an emergency which could harm more than 5 employees, request that the underground stench warning system be initiated immediately:

This includes:

- All fires
- Fall of ground
- Inundation of water
- Unplanned explosion
- Gas
- Electrical

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.3 EMERGENCY WARNING RESPONSE:

Upon being notified of a mine emergency evacuation either by radio, phone or stench warning:

1. Stop work immediately,
2. Note the time you received the warning
3. Calmly proceed out of the mine using the safest route possible.
4. DO NOT RUSH UNNECESSARILY – EXCESSIVE SPEEDS USED TO LEAVE THE MINE CAN RESULT IN INCIDENT OR INJURY.

Once out of the mine,

1. Proceed immediately to the Bellekeno Mine Office Dry,
2. Report in to the Check out Coordinator and “Brass Out”.
3. Remain in the Mine Office Dry for further instructions.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.4 MEDICAL PERSONNEL:

Underground Emergency – System of response

1. Initiate emergency response notification procedures as directed by Area Supervisor or Site Coordinator.
2. Upon completion of the emergency response notification procedure:
 - a) Complete the EMERGENCY DATA SHEET.
 - b) Establish MEDICAL ROOM as the COMMUNICATION CENTER.
 - c) Keep all Communication Equipment on Standby.
 - d) Direct operations personnel to COMMUNICATION CENTER.
 - e) Confirm Incident Coordinator (IC) response has been initiated.
 - f) Complete the EMERGENCY DATA SHEET by obtaining the following information:
 - Name of person reporting the emergency
 - Nature and severity of injuries and/or incident
 - Assistance required
 - Location of emergency
 - Number of people involved

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.5 REFUGE CHAMBER BARRICADING

For use when the nature of an emergency (such as fire, smoke, fall of ground) prevents your safe exit from the mine.

Nature of the refuge chamber

An air lock is provided to keep smoke and gases out of the inner chamber. There is a charged air line between the doors that can be used to blow smoke and gases out of the air lock before opening the inner door and possibly admitting bad air into the chamber.

When the refuge chamber is required:

1. DO NOT HESITATE. DON YOUR SELF-RESCUER IF SMOKE OR FIRE IS ENCOUNTERED.
2. RETREAT DIRECTLY TO THE NEAREST REFUGE CHAMBER AND BARRICADE YOURSELF IN.
3. Review the barricading procedures posted inside the refuge chamber.
4. Once inside, if smoke and gases leak in around the door frame, use the foam sealant provided to seal the door frame.
5. There is a compressed air line in the inner chamber. Open the air valve a $\frac{1}{4}$ turn to ensure a supply of breathing air and create a slight positive pressure to keep smoke and gases out.
6. Each chamber has a CO₂ exhaust valve located on an outer wall 2 feet above the floor. Find it and open it when using compressed or bottled air. This will prevent the chamber from over-pressurizing and allows carbon dioxide from your exhaled breath to escape. Carbon dioxide is much heavier than air; that is why the valve is low on the wall.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



7. If the compressed air line loses pressure, the compressed air bottles can be used to provide a source of breathing air. Turn the compressed air line off. If fire caused the failure, air could be withdrawn out of the chamber through the air line.
8. Turn on all 4 compressed air bottles. Turn the regulator knob and adjust the outlet pressure to 25 – 30 psi. Adequate breathing air and slight positive pressure will be provided.
9. Check the mine phone for operation and call outside the mine. Report the following information:
 10. Your name and name of others in refuge.
 11. Refuge Chamber location.
 12. Outside conditions.
 13. That you are safe in refuge.
 14. Remain in the refuge as long as you are safe, even if communication is cut off.
 15. Do not be tempted to wander about the mine seeking safe passage out.
 16. Remain in the refuge until you are rescued by mine rescue personnel.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



8.6 MAIN VENTILATION CONTROLS IN CASE OF FIRE

In the event of an underground fire, efforts will be undertaken to ensure ventilation to the mine is maintained.

Operation of the main ventilation fans in Bellekeno East Decline and/or Bellekeno 625 level will be guarded and monitored to ensure continuous operation of the fans at all times.

The effects of the alteration to the main ventilation fans shall be clearly understood before the changes are made.

During a mine fire:

- There will be no alteration to the operation of the main fans without the authorization of the Area Supervisor or Site Coordinator.

8.7 MINE VENTILATION OUTAGE ACTION PLAN

In the event of fan failure due to a malfunction, accident, power failure, or other such unplanned or unscheduled event, this action plan applies to all underground employees and contractors whose work areas are affected by the temporary interruption of the operation of the main, booster, or auxiliary fans in the mine.

Main Ventilation Interruption Procedure:

Less Than 2 Hours:

1. Diesel mobile equipment, mucking operations, will cease in all active production and development headings supplied by mechanical ventilation until the main ventilation system is restored. ... OR ... The active heading is continually monitored for air quality and is maintained in compliance with the applicable standards.
2. All other work relevant (scaling, cleanup, maintenance, etc) to the active heading may continue per normal operations provided the air quality remains in compliance with the applicable standards.
3. Diesel mobile equipment for access to, or egress from, the mine will continue per normal mine operations provided air quality remains within compliance of the standards. **If the ventilation is forced the diesel equipment must be shut down until ventilation is re-established.**

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



Two Hours or More:

1. Air quality testing will be performed by Supervision in all active headings affected by the ventilation interruption. Where air quality is not within compliance of the standards for mine ventilation, all personnel shall be withdrawn from the active heading affected.
2. Ventilation to the affected active headings shall be restored to normal and the air quality in the affected active workings shall be tested by Supervision to ensure the air quality meets the requirements of the standards prior to the return to work in the area.
3. Prolonged ventilation interruption will require air quality testing in the affected active workings at least every four hours until ventilation has been restored.
4. In areas where air quality prevents continued testing, normal ventilation shall be restored for a minimum of two hours before persons enter the area to test air quality ... OR ... Suitable self contained breathing apparatus and procedures consistent with YT WCB OHS Regulations will be followed by competent persons to perform air quality testing the effected area.
5. Diesel mobile equipment for access to, or egress from, the mine on the main haulage ways will continue per normal mine operations provided air quality remains within compliance of the standards.
 - a. **This is contingent on the mine having flow through exhaust. If the ventilation is forced the diesel equipment must be shut down and the mine evacuated until ventilation is re-established.**

Mine Quality Air Standards		
OXYGEN	Minimum 19%	Normal air is 21%
CARBON MONOXIDE	Permissible limit 35 PPM	
NITROGEN DIOXIDE	Permissible limit 3 PPM	

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



SULFUR DIOXIDE	Permissible limit 2 PPM	

9.0 MINE RESCUE

The contractor (Procon Mining and Tunneling) and Alexco Resource Corp. will have a trained mine rescue team available for mine emergencies.

If the mine rescue team is required, a back-up team has to be readily available. Due to Alexco's size of operation, sufficient responders may not be available onsite. Alexco has in place cooperative agreements with the Cantung Mine in the Yukon, BHP Ekati Mine in the NWT and other divisions of Procon Mining and Tunneling.

If the incident requires Mine Rescue response the YT OH&S Mine Inspector, Cantung and Ekati must be notified immediately, advised of the situation and to respond immediately pending available resources.

Agency	Contact Personnel	Office Contact Number	Home Contact Number
YT OH&S Mine Inspector	Ossie Venasse	867-334-2002	1-800-661-0443 (toll free)
Procon Mining and Tunneling	Brad Skeeles	604-291-8292	778-837-4407
Cantung Mine	Mark Goebel or Mike Daley	604-759-0913 X225	safety@skymessage.com .
BHP Ekati Mine (NWT)	Rob MacLean or Richard Weishaupt	867-880-2201	867-880-2154

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



10.0 REPORTABLE SPILL QUANTITIES

Should a spill of reportable quantity occur, under federal and territorial regulations, we are required to *immediately* notify the 24-hour Yukon Spill Report line: telephone number 867-667-7244.

For the purposes of the water use license:

1. Any quantity of spill is reportable.
2. The Senior Project Manager, Site Coordinator or Manager On-Call are responsible for reporting spills.
3. Reportable spills require an Incident Investigation Report to be completed.

This guide will assist in determining what volume of product requires reporting to regulatory agencies.

If a spill is deemed to be of reportable quantity, the area supervisor will immediately notify the Site Coordinator or Senior Project Manager who will in turn ensure that spill reporting is completed by designated personnel.

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



Reportable spill quantities

HAZARD Class	TYPICAL PRODUCTS ON SITE	REPORTABLE QUANTITY
Explosives (1)	ANFO	Any amount spilled outside of blast pattern
Flammable Gases (2.1)	- Propane - Acetylene	>100 Liters
Non-Flammable Gases (2.2)	Halon	>100 Liters
Poisonous Gases (2.3)		Any Amount
Non-poisonous Gases (2.3)		>100 Liters
Corrosive Gases (2.4)		Any Amount
Non-corrosive Gases (2.2)		>100 Liters
Flammable Liquids (3.)	- Diesel - Gasoline - Glycol - Hydraulic &/or Engine Oil	>200 Liters
Flammable Solids (4.)		>25 kg
Spontaneous Combustibles (4.)		>25 kg
Dangerous When Wet (4.)		>25 kg
Oxidizers (5.1)	- Sodium Hydroxide / Caustic Soda - Lime Solution - Sodium Nitrate - Calcium Hypochlorite - Ammonium Nitrate	>50 kg or 50 Liters
Corrosive Materials (8.)	Hydrochloric / Muriatic /	>5 kg or 5 Liters
Miscellaneous Dangerous Goods (9.1)		>50 kg
Dangerous Waste (9.3)	Waste Oil	>5 kg or 5 Liters

The Bellekeno MLU operating permit dictates that all spill swill be reported.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



11.0 SPILL RESPONSE EQUIPMENT RESOURCE LIST

	Location	Contact
Spill Response Kit	• Bellekeno East Fuel Tank • Bellekeno East Shop • Bellekeno 625 adit	Site Coordinator
Oil- Absorbent Pads	• In Spill Kits	Site Coordinator
Oil- Absorbent Booms	• In Spill Kits	Site Coordinator

Any contaminated soils will be removed to the land treatment facility in Mayo or a suitable permitted facility within the Keno Project area.

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



12.0 MISSING PERSONS ACTION PLAN

Potential exists where persons may become lost on the property. Such incidents can occur under the following circumstance:

- Alexco or Contractor personnel engaged in surface exploration or any other activities (i.e. care and maintenance) are overdue and can not be located or contacted.

Upon notification that Alexco personnel, or Contractors are unaccounted for on the property you should:

1. Immediately advise the Area Supervisor and Senior Project Manager or Site Coordinator who will:
 - Assess and determine the level of response required.
 - Gather all available information about the missing persons including last known location.
 - Advise the RCMP of the circumstances and request further assistance
 - Designate Keno Hill Project employees to stand-by and assist the RCMP in search efforts as directed
2. Stand-by to provide further information and assistance as required.

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



13.0 EMERGENCY EQUIPMENT AND EQUIPMENT LOCATIONS

EMERGENCY EQUIPMENT	LOCATION	USE IS AUTHORIZED BY:
Ambulance 4x4 Suburban with Stretchers	Elsa Town site Fire hall	Sr .Project Manager / Site Coord. First Aid Attendant
(MMTU) Mobile Medical Treatment Unit 4 x 4 Truck with Stretchers	Bellekeno Mine Site	Sr .Project Manager / Site Coord. First Aid Attendant
AED Automatic External Defibrillator Use when CPR is required	Admin 1 st Aid Room Black and Neon ZOLL – AED Bellekeno East 1 st Aid Room	Sr .Project Manager / Site Coord. First Aid Attendant
Oxygen Airway Adjuncts (OPA)	MMTV 1 st Aid Jump Kit Admin 1 st Aid Room Bellekeno East 1 st Aid Room	Sr .Project Manager / Site Coord. First Aid Attendant
Spinal Precautions Spine Boards & Head Blocks Stiff Collars Spyder Straps KED – Vehicle extrication device	Ambulance MMTV Admin 1 st Aid Room Bellekeno East 1 st Aid Room	Sr .Project Manager / Site Coord. First Aid Attendant
Splints Vacuum Splints – Extremity breaks	Admin 1 st Aid Room Bellekeno E. 1 st Aid Room	Sr .Project Manager / Site Coord. First Aid Attendant
Wound Management Burn Dressings Sterile Water Bandages & Dressings	Ambulance MMTV Admin 1 st Aid Room 1 st Aid Jump Kit Bellekeno East 1 st Aid Room	Sr .Project Manager / Site Coord. First Aid Attendant
EPI Pens Anaphylactic Shock / Allergies	Ambulance MMTV Admin 1 st Aid Room 1 st Aid Jump Kit Bellekeno E. 1 st Aid	Sr .Project Manager / Site Coord. First Aid Attendant

27 of 36

PRINTED COPIES ARE UNCONTROLLED

W:\ACG_ACTIVE\KENO HILL MINE\ALEXCO\BELLEKENO\BK Mine Permitting\Project
Proposal\Appendices\Emer Resp Plan NEW from Tim\EMP Version D 041208.doc

Keno Hill Project

EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



	Room	

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



14.0 EMERGENCY FIRST AID PATIENT ASSESSMENT MODEL

THE ROLE OF THE FIRST PERSON AT THE SCENE

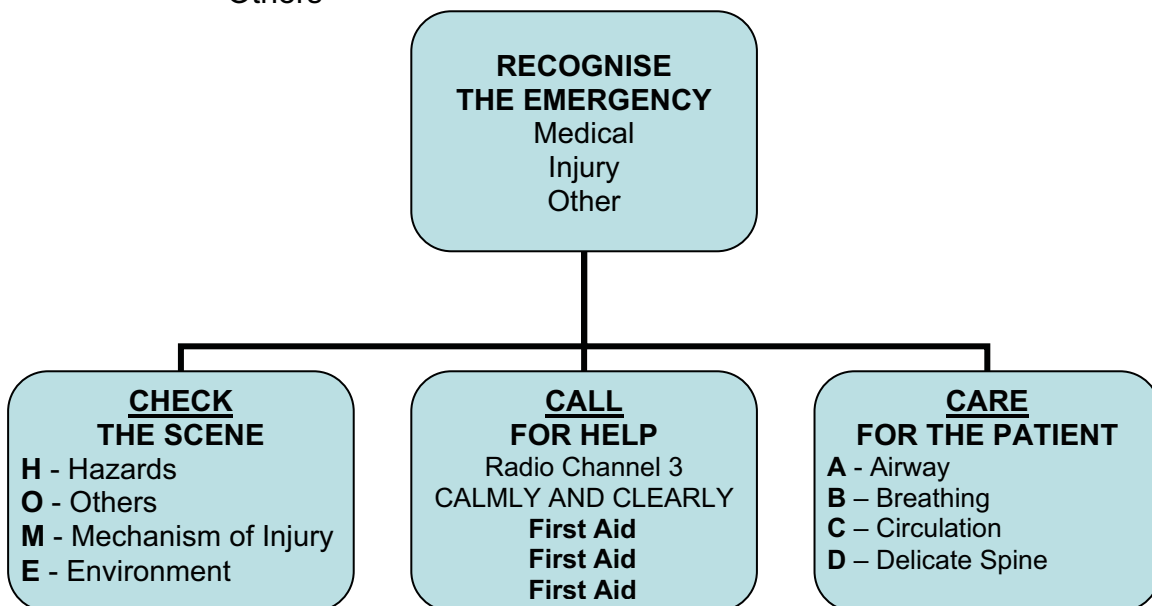
1. **CHECK** - Recognize the emergency
2. **CALL** – Activate medical services / first aid to attend the scene
3. **CARE** - Act according to your skills, knowledge and comfort level

A “**medical emergency**” is an illness or condition that needs immediate medical attention. For example:

- Anaphylactic shock
- Diabetic emergency
- Heart attack
- Others

An “**injury**” is damage to the body caused by external force. For example this damage can cause

- Broken bones
- Burns
- Wounds
- Others



Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.0 EMERGENCY CONTACT INFORMATION

*As this **MERP document** is updated, only revised pages will be replaced.*

15.1 Keno Hill Project

Name	Office	Home (other)	Cell
Jim Muntzert District Manager	867-995-3113	719-689-2575	719-332-4700
Tim Hall Operations General Manager	867-995-3113	907-790-2245	907-723-8974
Colleen Geddes Safety Coordinator	867-995-3113	867-667-6155	867-332-8384
Peter Johnson Project/Construction Manager	867-995-3113	867-993-5911	N/A
Sam Wallingham Site Services Manager	867-995-3113	867-456-2796	N/A
Kael Hanak Remediation Manager	867-995-3113	867-393-2741	N/A
Andrea Mansell Administration	867-995-3113	867-993-5911	N/A
Stan Dodd VP Exploration	867-995-3113	360-647-1375	360-319-1882
Bellekeno Shifters Office	1-604-637-5669		
Anson Smith Procon Mining	867-995-3113		306-382-9748

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



In the event of a “SERIOUS” Incident, injury or accident you must notify:

1. Keno Hill Project Department Manager or Alternate
2. Member of the First Aid, Health and Safety Department

15.2 Keno Hill Project Department/Area Managers

Name	Office	Home (other)	Cell
Jim Muntzert District Manager	867-995-3113	719-689-2575	
Tim Hall Operations General Manager	867-995-3113	907-790-2245	907-723-8974
Colleen Geddes Safety Coordinator	867-995-3113	867-667-6155	867-332-8384
Stan Dodd VP Exploration	867-995-3113	360-647-1375	360-319-1882
Peter Johnson Project/Construction Manager	867-995-3113	867-993-5911	
Sam Wallingham Site Services Manager	867-995-3113	867-456-2796	
Kael Hanak Remediation Manager	867-995-3113	867-393-2741	N/A
Andrea Mansell Administration	867-995-3113	867-993-5911	
Anson Smith Procon Mining	867-995-3113		

15.3 First Aid, Health & Safety Department

Name	Office	Home (other)	Qualification
Jennifer Dobbie First Aid & Safety	867-995-3113	867-332-5363	OFA 3, 1 st Responder
Sandra Carlick First Aid & Safety	867-995-3113	250-771-5678	OFA 31 st Responder
Harlan Schilling First Aid & Safety	867-995-3113	867-334-4559	EMR 1 st Responder

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



Andrea Mansell First Aid / Administration	867-995-3113	867-993-5911	EMR, Red Cross 1 st Aid Instructor

15.4 Alternate Keno Hill Department Managers

Name	Office	Home (other)	Cell
Grant Ewing / Les Keim Care and Maintenance	867-995-3113	867-332-1329 GE 867-993-5878 LK	
Rob McIntyre Access Consulting	867-668-6463	867-633-5844	867-334-6002
Dan Cornett Access Consulting	867-668-6463	867-668-7964	867-334-5104
Brad Thrall, COO Alexco Resource Corp	604-633-4888		604-250-6501
Clynt Nauman, CEO Alexco Resource Corp	604-633-4888		604-250-3293
David Whittle, CFO Alexco Resource Corp	604-633-4888		

ALEXCO RESOURCE CORP.

Keno Hill Project
PO Box #7
Elsa, Yukon Territory
Y0B 1J0

Tel: 867-995-3113

Fax: 604-995-2600

ALEXCO RESOURCE CORP.

Corporate Administrative Office
Suite 1150 - 200 Granville Street
Vancouver, BC
V6C 1S4

Tel: 604-633-4888

Fax: 604-633-4887

ALEXCO RESOURCE CORP.

#3 Calcite Business Centre
151 Industrial Road
Whitehorse, YT
Y1A 2V3

Tel: 867-633-4881

Fax: 867-633-4882

Keno Hill Project
EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.5 Reporting for “Serious” incidents, injuries, or accidents

Agency	Name	Home (other)	Other
YT OH&S Mine Inspector	Ossie Venasse	867-334-2002	1-800-661-0443 (toll free)
Chief Operating Officer Alexco Resource Corp	Brad Thrall	604-633-4888	604-250-6501
Chief Executive Officer Alexco Resource Corp	Clynt Nauman	604-633-4888	604-250-3293
Chief Financial Officer Alexco Resource Corp	David Whittle	604-633-4888	

15.6 Radio Communications

Channel	Area
Channel 3	Keno Hill Project – First Aid
Channel 4	LAD 1

Summon First Aid by:

Ensuring the radio turned on and on Channel 3

Keying the mic. to capture the channel

Clearly and calmly say: First Aid ...First Aid ...First Aid

Wait for a response from the attendant

State your name

State your location

State the nature of the assistance required

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.7 Emergency MEDIVAC Transportation

Name	Office	
ALCAN Air Fixed Wing	867-668-2107	Whitehorse Dispatch
Trans North Helicopters Helicopter	867-996-2355 867-335-2355	Mayo Dispatch Kel Huston - Pilot
Trans North Helicopters Helicopter	867-668-2177	Whitehorse Dispatch
Mayo Nursing Station Ground Ambulance	867-996-4444	Mayo Nursing Station Dispatch
Mayo RCMP Alternate Emergency	867-996-5555	Mayo / Whitehorse Station Dispatch

Important information to convey to MEDIVAC dispatch

1. Number of patients
2. Location of patients
3. Patient assessment provided by First Aid Attendant including:
 - Level of consciousness
 - Vitals – ABC's
 - Treatments provided (if any)
 - Spinal precautions (if any)
4. Weather or driving conditions
5. Coordinates for helicopter

HELICOPTER LANDING PADS -

Sites have windsocks for directional reference

Safety personnel will ensure the landing site is clear, lighted and free of traffic

<u>Elsa town site:</u>	Latitude	63. 54 North
	Longitude	135.29 West
Landing is at the shop / transport area		
<u>Bellekeno East Mine:</u>	Latitude	63. 54 North
	Longitude	135.15 West
Landing is at the helicopter pad located up hill of the portal at the waste rock site.		

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.8 Keno Hill Mine Rescue

Name	Agency
Training Aug 21, 2008	
Daniel Robertson	PROCON
Batache Gagnon	PROCON
Tyler Chase	PROCON
Joe Volf	PROCON
Andre Whitt	PROCON
Jennifer Dobbie	ALEXCO
Grant Ewing	ALEXCO
Travis Murphy	ALEXCO
Florian Zech	ALEXCO

15.9 Co-operative Mine Rescue (CMR) Assistance

Agency	Name	Home (other)	Other
YT OH&S Mine Inspector	Ossie Venasse	867-334-2002	1-800-661-0443 (toll free)
Procon Mining and Tunneling	Brad Skeeles	604-291-8292	778-837-4407
Cantung Mine	Mark Goebel or Mike Daley	604-759-0913 X225	safety@skymessa ge.com
BHP Ekati Mine (NWT)	Rob MacLean or Richard Weishaupt	867-880-2201	867-880-2154

Keno Hill Project EMERGENCY RESPONSE PLAN

Effective: December 4, 2008
Projected Revision: March 20, 2009



15.10 Territorial and Federal contact numbers

Name	Office	
Mayo Ambulance	867-996-4444	Mayo (Volunteer Responders)
Mayo Fire & Rescue	867-996-2222	Mayo (Volunteer Responders)
RCMP	867-996-5555	Mayo
Whitehorse Regional Hospital	867-393-8700	Emergency
Whitehorse Regional Hospital	867-393-8700	Admissions
Yukon Corner	867-667-5317	Whitehorse
Yukon Dept. of Conservation	867-667-5317	Whitehorse
Yukon Dept. of Fish & Game	867-393-6722	Whitehorse
Yukon Energy	867-996-2387	Mayo
Yukon Energy	1-800-676-2843	After hours Whitehorse
Yukon Occupational Health & Safety	867-334-2002 tel 867-393-6279 fax	YOH&S Ossie Venasse (Mine Inspector)



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX H
UNITED KENO HILLS MINES LIMITED
SITE CHARACTERIZATION REPORT
CHAPTERS 3, 6 AND 8**

May 2006

Prepared by: Access Mining Consultants Ltd.

3. Regional Setting

This chapter provides a description of the regional setting for the Galena Hill - Keno Hill area; bedrock geology, soils, wildlife, vegetation, climate, hydrology, and aquatic resources. The regional setting descriptions are not intended to provide baseline environmental conditions for the area prior to mining. The area had nearly a century of mining activities. The collection of data to describe baseline environmental conditions was not even a consideration during early mining development; as such, very little baseline data has been documented.

It should also be recognized that over the course of time the local ecosystem has changed, and in some areas adjusted or even adapted to reflect the current mining activities in the area. This has complicated the establishment of “baseline” conditions necessary to measure and assess the impacts that have occurred. The regional setting for the area is therefore based on the present environmental conditions.

3.1 General Description of Area

The UKHM mine site lies within the Yukon Plateau, just south of the rugged Wernecke Mountains. The terrain consists of concordant, rolling, upland areas separated by wide valleys. Alpine mountain peaks extend above the uplands locally. Valley bottoms and slopes are have dense boreal forest cover but the upland commonly extends above tree line and is tundra covered.

Geologically, the area is part of the Selwyn Basin and is characterized by late pre-Cambrian through Mississippian marine clastic meta-sedimentary rocks intruded by mid-Cretaceous granitic plutons. The meta-sediments are complexly deformed and thrust imbricated. Silver bearing veins are found along late brittle faults that cut the deformed package. The camp is at the western extent of the Cordilleran ice sheet thus a complex assemblage of glacial and peri-glacial landforms and deposits are present. Valley bottoms are broad and overburden covered, commonly boggy and contain thick peat deposits. Permafrost is widespread though discontinuous, and is always a consideration for development.

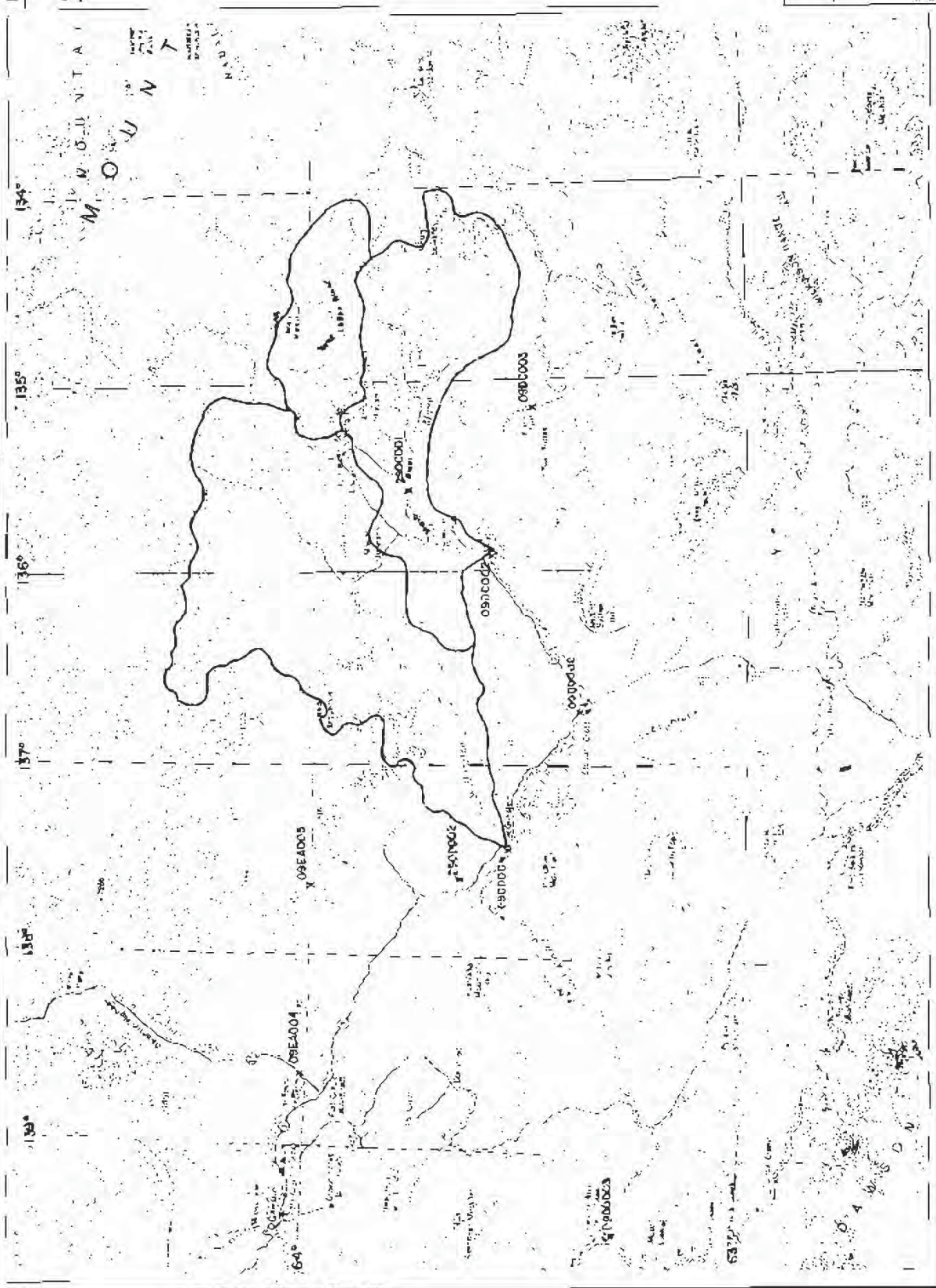
The mine site is wholly contained within the catchment of the Stewart River. Figure 3-1 shows the location of the mine site in relation to this river and to other major rivers and lakes in the region. As can be seen, the area occupied by the mine development is somewhat unique in terms of drainage patterns. Drainage from the UKHM mine site enters the Stewart River at not one, but three different points. This is because the site straddles the drainage divides of three different tributaries of the Stewart River. Listed in the downstream order in which they enter the Stewart River, these tributaries are the Keno Ladue River, the Mayo River, and the McQuesten River.

The location in the interior of Yukon, south of the Wernecke mountains, results in the area being semi-arid but subject to occasional heavy rainstorms. Snow cover is light and blankets the area from October to May. Temperature extremes are characteristic of the area. Winters are long, cold and dark. Summers are mild to cool, often rainy and grey but occasionally interrupted by hot, dry, clear spells. Stream flows generally peak in May with the spring snow melt but heavy flows also occur in summer and fall during thunderstorms. Long daylight hours in summer are conducive to lush plant growth but the short growing season limits the overall growth rate and size of most vegetation.

The area has experienced a long history of occupation and development thus its original wilderness character has changed considerably. Road access and consequent hunting pressure has diminished wildlife populations but the habitat remains generally healthy and productive. Hardrock mining has caused an influx of population but in itself has not caused a great deal of habitat destruction. Placer mining has profoundly changed some valley bottoms causing significant changes to stream beds and creating new and commonly productive wildlife habitat. Logging, partly to support mining operations, has been carried out on a small scale in many valleys but large scale mechanized logging has not occurred and re-growth is progressing well. Fish populations have declined due to a combination of off shore harvest and local habitat degradation, both chemical and physical, from hardrock and placer mining respectively as well as other undertakings. The effects of local activities on habitat do not appear to be either irreversible or necessarily long term since, based on water quality and benthic invertebrate studies as well as observations of extensive re-vegetation, there has been considerable self healing in the time frame of the area developments.

LEGEND

1. Dotted line: Section boundary
 2. Solid line: Section boundary
 3. Dashed line: Section boundary



UNITED KENO HILL
 MINES LIMITED

REGIONAL LOCATION MAP

1. Dotted line: Section boundary
 2. Solid line: Section boundary
 3. Dashed line: Section boundary

The following sections provide further detail on the bedrock and surficial geology, physiography, soils, vegetation, wildlife, climate, hydrology and aquatic resources of the area. Land use patterns are discussed in Chapter 5 and an extensive discussion of water quality is included in Chapter 6. Because of the importance of potential chemical impacts on water quality and resultant impacts on the aquatic environment and fishery, these subjects are most extensively covered.

3.2 Bedrock Geology

The Keno Hill - Galena Hill area is underlain by mid-Paleozoic meta-sedimentary rocks overthrust by late pre-Cambrian meta-sedimentary rocks. The rocks of the district, for many years, have been divided into a three formations, the "lower schist", the "central quartzite" and the "upper schist". Most of the ore deposits occur in the "central quartzite". These three formations were considered to represent a conformable sequence of meta-sedimentary strata. This subdivision remains a useful one; it corresponds to UKHM's usage and will be used in this document. It should be noted, however, that more detailed work since the 1960's has shown the situation to be much more complicated. Recent mapping in the area (Figure 3-2) has continued a long standing tradition of re-interpretation of the stratigraphy and structure of the district as summarized in Roots and Murphy (1992).

The "lower schist" is now correlated by Roots and Murphy (1992) with the Devonian and Mississippian Earn Group and includes carbonaceous phyllite, siliceous carbonaceous meta-siltstone and rare calcareous greywacke. Intercalated with the meta-sedimentary rocks are waxy green, locally quartz and feldspar porphyritic, felsic, meta-volcanic phyllite, particularly abundant in the top 100 m. The "central quartzite" is now referred to by Roots and Murphy (1992) as the Keno Hill Quartzite. It is thought to be of Mississippian age and consists of finely to coarsely foliated, lineated, light to dark grey, vitreous quartzite; interlayered are carbonaceous phyllite, chloritic phyllite and rare limestone. Intrusive into both these units are foliation concordant meta-diorite bodies (actinolite-chlorite-plagioclase bearing, fine to coarse grained greenstone) thought to be of mid-Triassic age. The "upper schist" is now thought to be an imbricated and/or isoclinally folded zone comprising intercalated rocks of late pre-Cambrian Hyland Group and Keno Hill Quartzite (Roots and Murphy, 1992). The structurally overlying Hyland

Group (grit unit) is thrust over the above Paleozoic sequence on the Robert Service Thrust. The Hyland Group is a meta-sedimentary sequence consisting of medium brown, foliated and lineated phyllite and psammite (a sandstone); quartz and feldspar pebble psammite; with lesser calc-phyllite, marble and carbonaceous phyllite. The meta-sedimentary rocks are intruded by dykes and sills of fine grained, locally porphyritic, locally altered, aplite and granite. These dykes and sills are neither common nor large. They are most abundant in the north flank of Keno Hill.

Irrespective of stratigraphic formations or regional map units only a few major rock types are commonly encountered in the area of the old mine workings. These are:

- schists and phyllites with variable carbon content;
- chloritic phyllites or schists;
- quartzites and phyllitic quartzites;
- sericite-quartz phyllites; and,
- greenstones.

Boyle (1962) produced a classic study of the geology and geochemistry of the Keno Hill - Galena Hill district. Boyle's description of the major rock types of the district remains one of the best published and is quoted below to provide details on each of the major lithologies as well as their chemistry.

Argillites, Phyllites, Slates, and Schists

Of this group of rocks, schists are the most abundant, followed by phyllites and argillites; slates have a limited local occurrence.

The argillites occur in beds ranging in thickness from a few inches to 10 feet or more and are generally interbedded with the various types of schists, phyllites and quartzites. All varieties of argillite exhibit a poorly developed cleavage approximately parallel with the bedding. In many occurrences they are crumpled, fractured, or crushed and contain numerous carbonate and quartz stringers.

In hand specimens most argillites are grey, but some are dense black and contain much carbonaceous matter and pyrite.

In thin sections the grey argillites are seen to contain white mica (sericite) and/or brown mica (biotite), microcrystalline quartz and leucoxene, chlorite, isotropic colloidal material, and pyrite. Some contain a little carbonate. Accessory minerals are tourmaline, zircon, and rutile. The texture is commonly banded, with layers containing essentially sericite, leucoxene,

and a little quartz alternating with layers containing quartz, carbonate, and subordinate sericite and/or biotite. In most sections the small irregular masses of pyrite are strung out along particular bands.

The black argillites are composed mainly of layers of carbonaceous material containing much fine-grained pyrite and minor amounts of carbonate minerals, quartz, and sericite. These generally alternate with layers containing quartz, sericite, carbonate minerals, some carbonaceous material, and a little pyrite.

Mineralogically, the phyllites are essentially the same as the argillites. They are, however, a little coarser grained and exhibit a silky sheen on cleavage surfaces. Most are greyish or buff; some are black and contain much carbonaceous material and pyrite. In the field many of the phyllites are warped, dragged, or crushed, and such rocks generally contain numerous stringers of quartz and carbonate. Boudins of quartz may also occur in these rocks but are rarely as abundant as in the schists.

The slates generally occur in highly disturbed zones, particularly on the noses of small folds. In most occurrences the slaty cleavage is not well developed. Mineralogically, the slates are similar to the argillites and phyllites.

There is little evidence of residual clastic grains in any of the argillites, slates, and phyllites. Most of these rocks are also remarkably devoid of original sedimentary features such as grain gradation, crossbedding, concretions, etc. Some argillites and phyllites, however, exhibit a fine bedding lamination.

The varieties of schist found in the area include graphitic schists, quartz-sericite schist, and chlorite schist. All are highly foliated and locally exhibit wrinkle lineations, many small drag folds, and innumerable crenulations. Most contain an abundance of stringers irregular masses, and bulbous lenses (boudins) of white quartz in small fractures, between schist layers, in dragged and crenulated zones, and along bedding planes.

The graphitic schists weather easily to a crumbly mass of small black schistose fragments and hence only rarely form good outcrops. In drill-cores and underground exposures they occur in beds ranging from a fraction of an inch to a few feet in thickness and are everywhere intercalated with phyllites, slates, or thin- and thick-bedded quartzites. In hand specimens they are black or greyish black, and exhibit well-developed schist planes that possess a dull to bright sheen when wet.

Under the microscope the principal mineral constituents are dense opaque carbonaceous matter (graphite), quartz, sericite, carbonate minerals, feldspar, chlorite, isotropic colloidal material, and numerous microcrystals of pyrite. The accessory minerals, where identifiable, are tourmaline, rutile, and zircon. The texture is schistose with interlaced laminae, strands, and wisps of graphite and sericite enclosing elongated micro-lenses or in the wavy and crumpled zones of the graphite laminae. In some sections

microcrystalline pyrite is strung out along the graphitic laminae. Micro-boudins of quartz, many containing a cube of pyrite, are common in nearly all sections.

The quartz-sericite schists also weather easily and form few prominent outcrops. All occurrences exhibit a marked schistosity and where dragged, crenulated, or crushed contain numerous stringers, masses, and boudins of white quartz. In hand specimens they are greenish or mottled greenish yellow, and have a silvery lustre when wet.

In thin sections the quartz-sericite schists are seen to consist essentially of quartz and sericite with subordinate amounts of carbonate minerals and leucoxene. The leucoxene consists of a felted aggregate of rutile needles and is invariably concentrated in swirling masses in the laminae of sericite. The main accessories are apatite, zircon, and tourmaline, and a few pyrite metacrysts are also present in most sections. The texture is schistose with laminae, shreds, and wisps of sericite and leucoxene enclosing irregular elongated lenses and bands composed principally of quartz with some shreds of sericite and a few cubes of pyrite.

Quartzites

Quartzites occur throughout the sedimentary sequence, but tend to be concentrated in well-defined bands in the various formations. Both thick- and thin-bedded varieties are present. The thick-bedded variety comprises beds ranging from 3 to 25 feet in thickness; thin-bedded varieties occur in beds from an inch to a foot or more thick. Both varieties are interbedded with assemblages of schist, argillite, and phyllite. All thick-bedded quartzites are well jointed and yield large blocks during weathering and frost action. The thin-bedded varieties are generally contorted, warped, and locally drag-folded. Stringers, irregular veinlets, and small lenses of quartz are abundant in both varieties.

In hand specimens the fresh quartzites are white to grey to black, and have a gneissoid to schistose appearance. Some are very fine grained and resemble recrystallized cherts. On weathered surfaces most of the quartzites are buff, but others are grey or white.

Thin sections show that the quartzites consist essentially of quartz, with minor amounts of white mica (sericite) and, locally, carbonate minerals. Calcareous varieties contain up to 30 percent carbonate minerals. The black quartzites contain much carbonaceous material. Accessory minerals in all varieties include irregular patches and specks of leucoxene, tourmaline, zircon, apatite, and pyrite. The pyrite occurs mainly as cubes, distorted cubes, and crystal groups.

Most of the quartzites are fine grained, the cherty variety being very fine grained. Typical specimens have a gneissoid to schistose mosaic texture with the quartz grains showing a pronounced elongation. Most of the sericite flakes and wisps and the carbonaceous material occur at the border of the quartz grains, and both exhibit parallelism. Some varieties of white quartzite are banded, with relatively pure quartz laminae

alternating with laminae of quartz and sericite or quartz, sericite, and carbonate minerals.

Some of the quartzites exhibit crossbedding, bedding laminations, and other original depositional features, and a few show faint overgrowths of silica on the quartz grains. These were undoubtedly originally fine-grained orthoquartzites. Other quartzites, especially the nearly pure white cherty varieties as well as some fine grained grey varieties, exhibit no observable original clastic features but have a banding similar to certain recrystallized cherts.

Greenstones

The greenstones are schistose, greyish green to dark green rocks that occur in conformable elongated lenses and sills, principally in the schistose formations and to a lesser extent in the quartzite formations. The greenstones weather differentially compared with the schists and quartzites and form prominent precipices and knobs. In most occurrences they are jointed and present a slabby appearance. In some bodies narrow shear zones, joints, and irregular fractures contain small lenses and masses of quartz, epidote, and calcite.

In thin sections the greenstones present considerable variety both in mineral composition and texture. All are highly altered, and it is rare to find bodies with any original minerals. Remnants of original textures are, however, preserved in most bodies.

The principal minerals now present in the greenstones are hornblende, actinolite, saussurite (zoisite, epidote, albite, sericite, carbonate), plagioclase (oligoclase to andesine), chlorite, stilpnomelane, biotite, white mica (sericite), leucoxene, and carbonate minerals. Quartz, potash feldspar, illite, magnetite, limonite, and apatite are common minor constituents, and pyrite is present in some bodies. All these minerals are not necessarily found in any one greenstone mass.

The texture of most of the larger greenstone bodies is diabasic with amphibole in various degrees of alteration as large lath-like crystals. In a few sections pyroxene (augite?) is present. Most of the feldspars are so highly saussuritized that their precise original composition is impossible to decipher. Originally magnetite and ilmenite crystals are rimmed or pervaded by leucoxene and limonite. Apatite occurs in small euhedral crystals. Chlorite is generally present, commonly in considerable amounts, and biotite, sericite, quartz, and carbonate minerals are found in some bodies. Some of the quartz may be primary, but most appears to have originated from alteration processes.

Smaller greenstone bodies and the borders of the large lenses have a schistose texture. In these the amphibole, saussurite, carbonates, and other minerals are fine grained, highly intergrown, and drawn out into bands, streaks, and elongated lenses and trains.

A few greenstones bodies have pseudo-porphyrific texture due to the presence of large, irregular, commonly somewhat angular, masses of leucoxene and/or saussurite set in a fine-grained, felted groundmass of amphibole, feldspar, chlorite, carbonates, and saussurite.

Geochemistry

Boyle (1965) provides some whole rock major and trace element analyses for composite samples of various rocks of the district. These are summarized in Table 3-1 (major elements) and Table 3-2 (minor and trace elements).

The phyllites and schists show a fairly uniform composition throughout the district. The composition is consistent with siliceous marine shales. Sulphur, carbon and CO₂ are all fairly high compared to the other rock types as would be expected from rock descriptions. These constituents are also high compared to average shales or schists. CaO, FeO, Fe₂O₃, K₂O, Na₂O, and MgO are lower than average shales. The phyllites and schists contain elevated concentrations of several metals such as Pb, Zn, Cu, As, Sb, Mo and Ba. Gleeson and Boyle (1980) also note Ni, Sn, F and U are enriched in the phyllites compared to other lithologies. Table 3-3 summarizes their findings. Barium enrichment is not unusual for Devonian-Mississippian marine shales of central Yukon nor is the elevated metal carbon and sulphur content. These rocks are an important feature influencing background metal and sulphate contents of stream waters.

The analytical data for quartz-sericite schist are ambiguous. These rocks are thought to be felsic metavolcanics however the available major element whole rock analysis provide little support for this hypothesis. Trace elements show slight enrichments in Zn, Cu, Ba and Mo. The limited trace element data of Kwong et al. (1992), Table 3-4, particularly high Ti, Ni, Co and Cu, imply an affinity to greenstone rather than felsic rocks. The quartz-sericite schists are low in carbon and contain fairly low sulphur.

Table 3-1 (After Boyle 1955)
Major Elements in Rocks of Keno Hill - Galena District

Sample from (Hill)	Sourdough	Keno	Galena	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Keno	Galena	Sourdough	Galena
Sample Number	A-464	A-619	A-697	A-692	A-621	A-631	A-698	A-622	A-620	A-694	A-695											
Constituent	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
SiO ₂	66.9	65.7	63.6	80.8	49.7	46.3	88.9	88.2	66.9	97.4	75.8	81.5										
Al ₂ O ₃	18.7	12.2	15.5	7.5	15.3	13.8	1.5	2.1	8.4	0.6	1.9	1.1										
Fe ₂ O ₃	2.1	1.4	1.7	0.8	2.6	0.8	0.2	0.3	0.8	0.0	0.4	0.2										
FeO	1.70 ¹	1.93 ¹	2.44 ¹	2.33	8.07	10.12	1.05	1.10	1.72	0.34	0.46	0.74										
CaO	1.3	2.3	2.4	1.4	9.3	12.9	3.2	1.5	7.7	0.9	10.3	7.4										
MgO	1.7	1.1	1.5	1.2	6.3	4.5	0.0	1.1	0.8	0.0	0.9	0.3										
Na ₂ O	0.2	1.1	0.7	0.3	2.2	1.7	0.2	0.4	1.1	0.1	0.1	0.0										
K ₂ O	2.7	2.3	2.7	1.3	0.2	0.2	0.2	0.3	1.6	0.1	0.3	0.2										
H ₂ O (total)	2.7	3.49	2.8	1.91	2.9	4.05	0.71	0.55	0.9	0.15	0.44	0.32										
TiO ₂	0.9	0.7	0.8	0.4	1.7	1.7	0.2	0.2	0.5	0.1	0.2	0.1										
P ₂ O ₅	0.2	0.4	0.4	0	0.2	0.2	0.1	0.1	0.2	0.0	0.2	0.1										
MnO	0.3	0.2	0.0	0	0	0.1	0.1	0.10	0.1	0	0	0										
CO ₂	2.25	4.65	2.1	0.51	0.31	2.58	2.94	2.94	7.97	0	8.42	7.24										
S	0.72	0.56	1.2	0.21	0.03	0.14	0.1	0.17	0.52	0.0	0.25	0										
C	1.37	1	1.3	-	-	-	-	0.09	0.29	-	-	-										
Total	101.8	99	99.1	98.7	98.8	99.1	99.4	98.7	99.5	99.7	99.7	99.2										
Less O=S	0.3	0.2	0.5	0.1	0	0.1	0	0.1	0.2	0	0.1	0										
Total	101.5	98.8	98.6	98.6	98.8	99	99.4	98.6	99.3	99.7	99.6	99.2										
Powder Density	2.755	2.736	2.8	2.717	3.03	2.875	2.688	2.690	2.726	2.684	2.701	2.670										

¹Values uncertain because of the presence of large amounts of carbon

A-464 Graphitic schist and phyllite - composite sample.

A-619 Graphitic schist, phyllite, argillite, and slate - composite sample A-622 Composite of all samples and thick- and thin-bedded quartzite

A-697 Graphitic schist, argillite, phyllite, and slate - composite sample A-620 Composite of medium- and thick-bedded gray quartzite

A-692 Quartz-Banded schist - composite sample A-694 Composite of thin-bedded quartzite and phyllite

A-621 Composite sample greenstone lenses A-463 Composite of white cherty quartzite

A-691 composite sample greenstone lenses A-695 Composite of calcareous quartzite

Table 3-2 (After Boyle, 1955)
Minor and Trace Elements in Rocks of Keno Hill-Galena Hill District

All values in parts per million

No. of Composite Samples	Greenstones		Graphitic argillites, schists, and pyrites		Quartz- sericite schist		Thick- and thin-bedded grey quartz		Siliceous White quartzites		Calcareous quartzites	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
Pb	2-10	5	5-38	15	5-25	7	2-20	7	2-15	6	5-6	3
Zn	30-160	73	25-120	62	65-180	90.5	5-85	30	5-3	10	15-50	27
Ca	<2	<2	0-2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ag	0.10-1.50	0.32	0.17-1.60	0.50	0.12-1.1	0.44	0.13-1.30	0.31	0.17-0.37	25	0.24-0.54	0.36
Cu	30-200	102	10-180	31	10-90	46	2-60	12	5-33	14	5-8	7
Ga	2-50	20	5-54	18.3	5.2-35	18	0-17	4	5-14	5	<5	<5
In	<0.5	<0.5	<0.5	<0.5	<0.5-0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mo	<5	<5	5-52	8	5-22	10	0-25	5	<5	<5	<5-11	<5
Sn	2-10	3	2-15	4	5-6.3	5	<5	<5	<5	<5	<5	<5
W	<4	<4	<4-14	<4	<4	<4	<4	<4	<4	<4	<4	<4
Bi	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ba	100-3000	475	100-15000	2240	1000-15000	3200	100	310	100-500	200	100-1000	400
Sr	50-500	130	100-2000	495	100-1000	300	1000	<100	<100	<100	<100	<100
Cl	50-800	164	50-900	235	100-500	<100	<100	<100	<100	<100	<100	<100
Ti	0000-15000	12000	4000-5500	4800	2500-3000	2500	100-800	1300	400-800	600	600-1200	900
Mn	500-1000	775	620-2300	1500	500-1500	1000	600-3000	775	200-400	300	100-300	200
As	2-25	6	2-75	18.5	2-15	6	2-35	7.8	1-15	5	3-10	7
Sb	<10-150	1	10-75	3.1	1-15	1	10-80	15	<1-1	<1	<10-10	<1
S	300-1400	850	5500-11800	8200	1000-5200	2100	1000-5200	2635	<10-10	200	100-2500	1200

**Table 1-1 (After Gleason and Boyle, 1980)
Range and Median Values of Trace Elements
in Rocks of the Keno Hill District**

	Rock Type		Quartzite	Phyllite	Greenstone	Limestone
	No. of Samples		85	76	44	14
Cl	R ¹		2 - 400	2 - 180	2 - 2800	2 - 400
	M ²		2	4	60	20
Pb	R		2.5 - 350	2.5 - 1800	2.5 - 65	2.5 - 35
	M		2.5	2.5	2.5	2.5
Zn	R		5 - 800	5 - 360	5 - 460	5 - 230
	M		20	80	110	10
Ni	R		2.5 - 120	2.5 - 95	2.5 - 145	2.5 - 55
	M		2.5	20	70	2.5
Co	R		2.5 - 20	2.5 - 55	2.5 - 60	2.5 - 15
	M		2.5	2.5	10	2.5
As	R		1 - 80	1 - 70	1 - 44	1 - 6
	M		-	1	1	1
Sb	R		0.5 - 30	0.5 - 20	0.5 - 3.0	0.5 - 3.0
	M		0.5	0.5	0.5	0.5
Mo	R		0.5 - 9	0.5 - 20	0.5 - 3	0.5 - 6
	M		0.5	0.5	0.5	0.5
W	R		2	2	2	2
	M		2	2	2	2
U	R		0.1 - 6.7	0.8 - 13.5	0.4 - 4.6	0.3 - 4.2
	M		1.5	2.5	2	-
Sn	R		ND - 10	ND - 24	ND - 1	ND - 5
	M		4	5	ND	ND
Ag	R		ND - 7.6	ND - 1.2	ND - 1.2	ND - 0.3
	M		ND	ND	ND	ND
F	R		ND - 1825	ND - 1500	70 - 1110	115 - 1135
	M		180	550	320	300
Ba	R		80 - 9461	277 - 14345	82 - 9674	32 - 1383
	M		350	1200	400	70

Notes: 1 - R = Range of values (ppm)
2 - M = Median values (ppm)
3 - ND = detectable for: Sn < 1 ppm
Ag < 0.1 ppm
F < 20 ppm

The quartzites are, as expected, rich in SiO_2 , low in Al_2O_3 and most of the metals relative to the phyllites and schists. Analytical data for variants of the quartzites such as thin-bedded or phyllite quartzite and calcareous quartzite show elevated Al_2O_3 and CaO respectively as would be expected. Trace elements in the quartzites are generally low although elevated Pb and Zn are noted near the veins.

Greenstones show compositions not inconsistent with altered mafic igneous rocks. This mafic affinity is particularly displayed in elevated levels of Ti, Ni, Co and Cu.

3.2.1 Structure

All rocks of the district are very complexly deformed; their outcrops are dominated by a low angle (dipping 15° to 35°) foliation related to strong isoclinal folding and thrust faulting. The region includes three thrust sheets of regional significance. The "central quartzite" and "lower schist" are part of the middle thrust sheet. As noted above, the "upper schist" may be an imbricated zone at the base of the upper sheet. The foliation is generally parallel to lithologic contacts and thrust boundaries. Country rock units in the district trend east-west and dip 20 to 30 degrees south. The meta-sedimentary sequence forms the south flank of the northeast trending, open, McQuesten anticline which gently warps the entire deformed and thrust imbricated sequence.

Approximately parallel to the axis of the McQuesten anticline are a series of faults striking northeast and dipping steeply southeast, these faults show left-lateral apparent offset and have displacements of up to 150 m. This fault system is the locus of most mineralization in the district and its members are referred to locally as the "vein faults" (Watson, 1985). The vein faults are offset by two additional fault sets which are less mineralized or un-mineralized. The first of these is known as the "cross faults" and strike northwest, dipping 40 to 60 degrees southwest; these faults are typically normal and exhibit right lateral apparent displacements of 1 m. to 600 m. The second set are referred to as the "bedding plane faults" which are foliation parallel faults, apparently showing thrust displacement on the order of 1 to 30 m.

Both the cross faults and bedding plane faults appear to show post ore movement and several ore zones are displaced by them. Vein faults also show limited evidence of post-ore movement. Faults, especially the three sets of late faults, are of great importance to

ore formation and groundwater flow thus also oxidation of the lodes and contaminant migration. As discussed below, of the major underground workings, several are hydraulically connected via the fault zones.

3.2.2 Ore Deposits

The ore in the Keno Hill - Galena Hill camp occurs in irregular shoots within vein systems developed along the vein faults. Vein development is related to the competence of the country rock thus the best veins are found where at least one wall is in brittle rocks like quartzite or greenstone. Where the fault passes into soft phyllites or schists it is poorly mineralized or may not be visible at all. The veins are commonly less than a metre wide but in some areas may be up to several tens of metres wide. Mineralogy in the veins of the district is complex and varied, oxidation and supergene enrichment adds further complexity. A summary of the minerals of the district compiled by the staff of UKHM is provided in Technical Appendix I. The following quotation from Watson (1986) provides a good overview on vein morphology and mineralogy.

In excess of 65 ore deposits and prospects have been identified within the district. These deposits are contained within vein faults with a combined total strike length in excess of 160 kilometres (100 miles). All the economically mineable silver lodes located to date have been contained within an area 26 kilometres (16 miles) long by 1.6 to 6.4 kilometres (1 to 4 miles) wide.

The principal lode deposits occur within the Central Quartzite in areas where brittle failure of the competent quartzite has allowed open areas conducive to ore deposition. Where the vein faults pass into schistose units they generally become narrow and normally contain little or no ore. Ore zones are also known to occur in the Lower Schist where a competent unit, such as a greenstone lens, forms one or both of the walls of the vein fault. Most ore zones (ore shoots) in this area have had their shape and size boundaries defined on a greater than 515 g/t Ag (15 oz/ton Ag) basis.

Principal ore minerals are argentiferous galena, freibergite (argentiferous tetrahedrite - "grey copper"), and pyrargyrite ("ruby silver"). Polybasite, stephanite, argentite and native silver occur locally in minor amounts. The principal gangue mineral is siderite.

Vein faults can take the form of 'simple' veins, breccia zones and sheeted zones.

'Simple' veins consist of a gangue of siderite, often with some quartz. Mineralization consists of discontinuous bands and lenses of silver-bearing

sulphides. Some brecciation is always present with fragments of country rock included in the vein.

Breccia zones consist of generally angular rock fragments (quartzite, phyllite, greenstone) in a matrix of siderite, often with some quartz. In some areas the breccia fragments have been rounded or ground into a clay or sandy gouge. Breccia fragments normally account for 20 to 50 percent of the vein but may exceed 90 percent in places.

Sheeted zones consist of rectilinear slabs of quartzite or greenstone separated by narrow (1-10 cm; 0.5-4 inch) breccia or gouge filled fractures. The breccia fragments and rectilinear slabs are cemented by siderite, sulphides and some quartz within the ore shoots. The fractures are barren or contain only a few carbonate minerals outside of ore shoots. Vein faults may grade from breccia to sheeted zones.

Several vein fault systems consist of two or more distinct, parallel to sub-parallel, vein faults. The inter-vein material between these vein faults in some locations consists of country rock shot with narrow mineralized fractures. In areas where the density of the mineralized fractures is sufficient this inter-vein material may produce ore.

Vein faults are often made up of a series of slips or fault planes. Slickensides are common on wall rock, siderite and sphalerite along these fault planes.

The transition from an ore shoot to a barren section of vein fault often exhibits no changes in vein appearance other than a decrease in silver-bearing minerals.

Ore shoots range from 0.3 to 30 meters (1 to 100 feet) in thickness. Strike length and dip extension of individual ore shoots range from 30 to 355 meters (100 to 1,110 feet). Several ore shoots commonly occur in a single vein fault.

Ten deposits in the Keno Hill - Galena Hill area have had documented silver production in excess of 31.1 million grams (1,000,000 ounces), 8 more deposits have produced from 3.1 to 31.1 million grams (100,000 to 1,000,000 ounces) and a further 7 have produced in excess of 311,000 grams (10,000 ounces).

The largest single producer is the Hector-Calumet Mine which has produced 2,383,543 tonnes (2,627,406 tons) of ore with an average grade of 1,237 g/t Ag (36.09 oz/ton Ag).

Two stages of vein mineralization are distinguished in the area. The first stage deposited quartz, pyrite, some arsenopyrite, trace gold and some sulphosalts in the vein faults. Following movement on the vein faults, a second stage of mineralization deposited siderite, galena, sphalerite, pyrite, freibergite, and pyrargyrite. Most of the economically mineable ore deposits to date have been stage two types. Supergene enrichment has

occurred but is not believed to have been an important ore forming process. The oxidation zone extends from a few meters to 150 meters (10 - 500 feet) below surface. Within this zone, minerals such as limonite, pyrolusite, cerussite, and anglesite are common. Native silver, argentite and jarosite may occur locally.

Ore zones, within vein faults in the Central Quartzite, appear to be spatially associated with some or all of the following features: a) adjacent to and in the footwall of cross faults; b) the junction of two or more veins; c) cymoid loops; d) areas where the vein fault changes dip; e) directly beneath the contact with the Upper Schist. The ore deposits are believed to be of hydrothermal origin and the listed features have produced areas of lower pressure and temperature within the vein faults, conducive to ore deposition.

The origins of the Keno Hill - Galena Hill mineralized vein faults are still a subject of much debate. K-Ar dating has returned an age of 90 Ma for the mineralized vein faults (Sinclair et al, 1980). Granitic intrusions occur to the north and south district and are of similar age to the vein mineralization. It is assumed that these granitic intrusions, or a buried intrusion below the district, acted as a heat pump for the hydrothermal systems. The temperature of formation of the deposits has not been clearly determined.

All deposits known to date have been located in a near surface environment. This may be due in part to exploration techniques which have been directed towards shallow lying deposits. One current theory is that deeper, buried deposits may be present but have yet to be found.

Most deposits mined to date have been mined to a depth of 90 to 150 meters (300 to 500 feet) below surface. A notable exception has been the Hector-Calumet Mine which was mined to a depth of 366 meters (1,200 feet) below surface. Part of the apparent depth limitation is man-made, with contributing factors such as the topographic location of adits and the pre-determined depth of shafts. Several mines appear to have ore zones continuing below the lowermost level of the mine.

Metal zonation has been difficult to establish. There appears to be a trend towards a regional lateral zonation of silver and gold. Silver is predominant within the central lode deposits of the district. Gold has never been an important economic constituent within these lodes. Outside the central core are several gold and gold-silver lodes such as those on Mt. Hinton and in the Dublin Gulch area. Most of these are hosted by quartz rich veins. Even within the central core, elevated gold values have been noted at the extremities, in the Husky S.W. and Silver King vein systems, the Moth vein and some of the Keno Hill vein systems. The significance of this zonation, if any, has yet to be determined.

Vertical zonation within individual deposits is also a matter of some debate. An overriding theory in this area, developed in the 1920's, maintains that all deposits bottom out in zinc. This has been a self fulfilling theory in some mines with decisions made to bottom a mine based on elevated zinc values

rather than on a lack of silver values. The depth of oxidation, when compared to the depth of the workings in many mines, may be significant. Zinc depletion within this oxidation zone may be a contributing factor to the apparent zonation which indicates a significant increase in zinc with depth.

There does not appear to be any well defined trace element zonation within or around individual ore shoots. A workable exploration technique utilizing trace elements has yet to be developed.

Alteration haloes surrounding vein faults are usually not distinct. Alteration with the sedimentary sequences may take the form of a minor pyritization, some small chemical changes and irregular carbonate leaching. The leached zone may extend up to 4.6 meters (15 feet) away from the vein zone. Other alteration rarely extends more than 15 meters (50 feet) from the vein fault.

A fracture zone, consisting of small stringers of siderite with sulphides, is common in all types of country rock, for distances up to 7.6 meters (25 feet) away from the main vein fault.

Alteration haloes are distinct but narrow where the vein faults cut greenstone. The alteration zone commonly extends only a few centimetres (inches) away from the vein fault. It consists of a carbonate + sericite zone adjacent to the vein fault grading to a carbonate + chlorite zone grading to unaltered greenstone.

Lynch (1986) has investigated the zoning of vein mineralogy in the district and noted potentially important regularities in the distribution of phases such as calcite, siderite, pyrrhotite and arsenopyrite that may have environmental significance. The following excerpt from Lynch provide a good overview of zoning within the district.

The principal hypogene minerals in the deposits are siderite quartz, pyrite, galena, and sphalerite with lesser to minor freibergite, pyrargyrite (ruby silver), arsenopyrite, chalcopyrite, pyrrhotite, jamesonite, boulangerite, polybasite, stephanite, calcite, and barite among others. The dominant minerals are generally medium to coarse grained and massive. Some veins are variably banded (Boyle, 1965), or can change in mineralogy along strike from quartz-rich to carbonate and/or sulphide rich fractions. Mineralized faults are sharp planar veins up to 50 cm wide or may be extensive stockwork, sheeted vein, and breccia zones greater than 15 metres in width. Systems such as the Hector-Calumet and the Sadie-Ladue veins are each continuous along strike for over two kilometres.

On a detained scale paragenetic and textural relationships can be complicated and variable, showing considerable overlap and repetition. Such complications are possibly due to advancing and retreating hydrothermal fronts, as well as by continued movement and brecciation along the faults during mineralization. However, on a broader scale zoning

patterns defined by specific vein minerals become clear. Three veining stages are often recognized. The earliest is principally a quartz veinlet stockwork and lesser pyrite and arsenopyrite and occasional feldspar. Minor boulangerite, some galena and sphalerite are reported by Boyle (1965). Boyle stresses that arsenopyrite is a typical mineral of this stage of Keno Hill but is absent or present in only small amounts of the veins of Galena Hill. The second stage consists of carbonate-sulphide-sulphosalt veins crosscutting the early quartz stockworks; this includes the bulk of the ore material. A third stage of veining and vug encrustations consists of quartz and pyrite and has a sparse distribution.

Alteration of host rocks is generally weak, however, pyrite disseminated through the wallrock along the veins is common and is accompanied by silicification/recrystallization. Bleaching of the dark graphitic host to lighter colours is also seen, especially in sections of the quartz-pyrite rich Husky S.W. deposit. The greenstones in contact with the veins are variably sericitized and chloritized.

The deposits at the western end of the district, such as the Husky, Husky S.W., Elsa, and Silver King Mines, as well as the Lucky Queen Mine in the east, are distinguished by the presence of pyrargyrite. It occurs as fine grained stringers in association with typical hypogene minerals such quartz, siderite, and pyrite. It was not firmly established in the past whether pyrargyrite is of a supergene or hypogene origin, however the occurrence of pyrargyrite in deep exposures of the Husky Mine apparently untouched by surface processes, such as rust staining, indicates a likely hypogene nature.

Along the eastern flank of Galena Hill, deep vein exposures at low altitudes contain pyrrhotite. It is typically fine grained and a minor component; however, in the Flame and Moth as well as the Duncan Creek veins it is present in considerable quantity. Arsenopyrite within these carbonate-quartz-pyrrhotite veins is another indicator for this zone. Chalcopyrite and sphalerite appear to be more abundant here as well.

Calcite is in the deep veins of the valley between Galena and Keno Hills but also extends east onto Keno Hill and beyond. Along the eastern side of Galena Hill, calcite, siderite, arsenopyrite and pyrrhotite bearing veins reach up to 900 metres in altitude, whereas siderite veining without calcite, arsenopyrite or pyrrhotite, extends upwards above 1300 metres altitude. The trio calcite, arsenopyrite and pyrrhotite appear to be markers for relatively deeper vein exposures.

At the eastern end of the district, the Keno, Homestake, and Mt. Hinton deposits are characterized by jamesonite-boulangerite. They are associated with abundant quartz, arsenopyrite, pyrite, and light reddish-brown sphalerite. Carbonate is typically absent from these portions of the veins, though they appear to extend laterally into siderite and/or calcite rich fractions. Jamesonite is characteristic of splay faults extending off of the principal vein faults in the Keno deposit (Boyle, 1965).

Wall rock alteration, as noted, is not strongly developed in the country rocks around the vein systems. Boyle (1965) notes a definite base metal enrichment in the wall rocks of some veins and Lynch (1986), in the above quotation, describes a weak pyritization of the wall rocks of several vein systems. This limited dispersion of metal and sulphur from the veins is of environmental significance since underground development has tended to be within, or close to, the vein faults thus adit dumps tend to be dominated by more sulphide rich lithologies. Open pit dumps, on the other hand, include rocks further from the vein and would be expected to contain material with a lower sulphide and base metal content, more akin to the regional rock units.

The amount, form and distribution of pyrite in the veins is of importance in understanding the acid generation potential. Available evidence suggests that pyrite is widespread but does not amount to more than a few percent of most veins. Pyrite grain size is variable but much is described as medium to coarse grained. Most of the pyrite has already been destroyed in the oxidized portion of the veins. These relationships suggest that the potential for acid generation exists but is limited. Widespread distribution of carbonate and its abundance relative to pyrite further limits potential for acid generation since pH is not likely to reach levels that will be conducive to bacteriological catalysis of the oxidation reactions. Hydrolysis of ferric iron from weathering of siderite will create some acidity but this is limited. Further consideration of acid generation potential is provided in Chapter 7 along with test data collected during this study.

3.2.3 Physiography and Surficial Geology

The district lies within the northeastern part of the Yukon Plateau (Bostock, 1948), and the terrain is mountainous with elevations ranging from 1,848 metres (Summit of Keno Hill) to 610 metres (McQuesten River valley). The area has been profoundly influenced by the latest glaciation but shows more subtle evidence of an earlier event as well.

The lower slopes of Galena Hill show clear evidence of ice marginal deposits such as kame terraces related to the glacial lobes occupying the major valley. Ice moved south down the McQuesten Valley and a lobe extending up Christal Creek to a terminus near Keno City. This lobe diverted Lightning Creek into Duncan Creek from its original course into Christal Creek. The terminus of the south McQuesten lobe is north of Mt. Haldane. There were local alpine glaciers in the higher eastern part of the area, in addition to the

large ice sheet in the major valleys, but they appear not to have coalesced with the larger sheets. The retreat of the Cordilleran ice sheet has had a major impact on the south McQuesten valley. Till blankets much of the valley and glacio-fluvial deposits are widespread. Glacio-lacustrine deposits formed in ice marginal lakes occur in the deeper part of the valley. Large meltwater streams have left huge meander scars which divert those of the underfit present day south McQuesten River. Boyle (1965) provides the following additional description of the physiography and glacial deposits in the area.

Galena Hill trends northeast between Duncan Creek and the McQuesten River valley. It has an elevation of 4,740 feet, a moderately steep southwestern slope, and steeper north, northwestern, and southeastern slopes. The terrain above 4,300 feet is relatively flat and rolling, and marked by several level grassy meadows. The north, northwestern, and southeastern slopes of the hill are crossed by several streams that have cut steep gulches into the rock strata. The principal streams responsible for these gulches are Galena, Flat, Brefalt, and Sandy Creeks and Porcupine Gulch on the northwestern slope and Hinton and Fisher Creeks on the eastern and southeastern slopes.

Keno Hill and Sourdough Hill are adjacent hills separated by Lightning Creek. Keno Hill trends northeast and lies between the Keno Ladue-McQuesten River valley and Allen, Faith, Lightning, and Christal Creeks. The hill has relatively gentle southern and southeastern slopes and a precipitous northern slope, marked by two cirques, Faro Gulch and Silver Basin Gulch. The terrain above 4,500 feet is relatively flat and rolling with five prominent rocky knolls known as Keno, Minto, Monument (the highest point on Keno Hill, elevation 6,065 feet), Caribou, and Beauvette. On the slopes of the hill several streams follow steep gulches in the rock strata, the principal ones being Gambler, Faro, McKay, and Silver Basin on the northern slope, Faith, Hope, and Charity on the northeastern and southern slopes, and Erickson on the western slope.

Sourdough Hill (Pl. VI) lies southwest of Keno Hill and trends north between Thunder, Lightning, and Duncan Creeks. The part of the hill described in this report is on the northern and northwestern slopes, which are gentle up to 4,200 feet and from there rise abruptly to a steep rocky hogsback that trends southwest for some 6,000 feet.

Extensive rock outcrops are uncommon on Galena, Keno, and Sourdough Hills, and with the exception of the gulches and cirques where relatively good geological sections are present, detailed mapping can only be done by observing float. Below an elevation of 4,400 feet rock outcrops are sparse, and the slopes are covered with till, soil, rock debris, much, and muskeg, in which conifers, birch, aspen, Arctic black-birch, and other vegetation grow abundantly. Above this elevation the soil is thin, outcrops are more numerous, the ground is covered with local rock float, the terrain

is treeless, and the vegetation is limited to alpine species and grassy meadows.

The lower slopes of the hills were severely glaciated during Pleistocene time by ice-sheets that spread, from the east, over the entire area. Glacial till, gravel, and other debris lie in a series of benches on the slopes of the hills and floor the valleys. The deposits are generally 5 to 20 feet thick, but in some areas as on the southern slope of Keno Hill facing Lightning Creek and north of Christal Lake, they are 30 to 50 feet thick or more.

The Keno Hill-Galena Hill area is in the region of permanently frozen ground. Wernecke (1932) has given an interesting account of the permafrost conditions, and the present investigation has added further data. The permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden, amount of vegetative cover, and presence of flowing underground and surface water. At high elevations and on slopes with a northern exposure it is generally present. Thus, on Keno Hill, the mine workings on the top of the hill and on the northern slope encountered permafrost some 400 feet below the surface. On the northern slopes of Sourdough Hill and Galena Hill a similar situation prevails, and frost and ice lenses have been encountered at depths of 250 feet or more in the mine workings. On the lower southern slope of Keno Hill, however, the workings of the Onek and Mount Keno mines show little evidence of permafrost. In places where surface and underground water are flowing the permafrost has been thawed out and frostfree windows and strips are present. These provide access and egress for waters that are oxidizing the lodes.

The effects of frost action, soil creep, and slope wash are marked on the hills, particularly at the higher elevations. Frost action is responsible for features such as stone rings and stripes, and produces a general 'boiling action' that brings rock float, mineralized float, and soil from deeper layers to the surface, thus facilitating the mapping of both the underlying bedrock and the tracing of vein faults. On steep slopes, however, frost action and land creep have transported float downhill places, 100 feet or more, making the accurate mapping of contacts and vein faults difficult.

Glacial Deposits

The glacial deposits of the area were laid down during the advance and retreat of at least two ice-sheets that spread over the area from the east. The evidence for the first glaciation is rather meagre and is restricted to the presence of erratics above an elevation of 4,000 feet on Keno and Galena Hills and to an old till in the upper part of Dublin Gulch. The most distinctive deposits are those of the last glaciation.

These deposits floor the principal valleys and form benches on the lower slopes of the hills. They vary in thickness from a few feet to 50 feet or more and are composed mainly of till, glacio-fluvial deposits, glacio-lacustrine gravel, sand and silt, and layers of peat.

The tills, rarely more than a few feet thick, are absent in places. They are grey or greenish buff and consist of a heterogeneous mixture of fine sand, clay, small particles of schist, quartzite, and greenstone, and variously sized stones and boulders. Carbonate, mostly in the cementing materials, is present in some tills.

The clay and sand fractions are composed principally of irregular grains and broken fragments of quartz, feldspar, mica minerals, and hornblende. Heavy mineral accessories as determined by X-ray are magnetite, ilmenite, rutile, sphene, leucoxene, zircon, staurolite, garnet, monazite, epidote, tourmaline, pyrite, and red and black jasper pebbles. The till minerals are generally angular and abraded, and look fresh with little visible evidence of chemical decomposition. Most tills give a neutral or slightly alkaline reaction (pH 7-7.5).

Most of the rock pebbles and fragments and the heavy minerals in the tills are probably derived locally. Some minerals such as garnet and staurolite and the jasper pebbles may, however, have travelled considerable distances, because these minerals are not plentiful in the rocks underlying Keno and Galena Hills.

Lenses of gravel and sand are common in some tills, and thin peat layers are present locally. The gravel and sand lenses generally contain the same mineral assemblage as the tills. The peat layers are composed essentially of brownish and brownish black decomposed plant remains and much brownish material (humus). A small amount of mineral matter, consisting of quartz, feldspar, mica flakes, and a suite of heavy accessory minerals similar to that in the tills, is present throughout the peat.

The glacio-fluvial deposits are as much as 50 feet or more thick and include poorly sorted gravels and sand deposits which occur in kames, eskers, and glacial benches. Most of the pebbles and stones are relatively well rounded to subangular and consists of quartzite, schist, greenstone, diorite, and granite, all mainly derived locally. The fine sandy fractions contain the same mineral assemblage as the tills.

The glacio-lacustrine deposits range from a few feet to tens of feet in thickness. In places they are stratified, in others they consist of unsorted, washed gravels containing sand lenses. The gravels contain well-rounded pebbles, stones, and subangular schist fragments of local derivation. The mineral constitution of the sand lenses and fine fractions of the gravels is similar to that of the other glacial deposits described above.

3.3 Soils

Soils were not studied as part of this work programme, however, the following description of soil is excerpted from Boyle's (1965) work:

Soil development has been affected by four principal factors: the variability of parent materials, the marked relief of the country, the climatic and

vegetative forces under which the soil developed, and the presence of permafrost.

In the Keno Hill-Galena Hill area both bedrocks and glacial materials have served as parents for soil. The marked relief has had the effect of producing deeper soils in the valleys and on the lower slopes of the hills. The difference in the exposure of the hillsides has been responsible for the occurrence of greatly different soils within short distances. South-facing slopes are generally less densely wooded and freer from permafrost than north-facing slopes. On the former the soils are somewhat better developed; the latter are covered in most places by deposits of muck, peat, and half-bog soils.

Except for a few localized areas, the soils are not strongly weathered or deeply leached. They also exhibit a poor profile development, particularly those underlain by permafrost.

The soils in the area can be conveniently classified into two general types: (1) residual, and (2) muck peat, and half-bog.

The residual soils were formed principally from the weathering of the various types of bedrocks, or as is evident in some places, particularly in the vicinity of Dublin Gulch, from the decomposition of a till that predates the last glaciation.

The thickness of the residual soils varies, depending on the slope of the hills. On the tops of the hills they are rarely more than 3 feet thick and in places are entirely absent; lower down on the slopes the soils, thickened by slope wash and land creep, may exceed 10 feet. In most areas they are highly disturbed by solifluction and frost-boiling, and their profile development is either immature or non-existent. In places the following generalized profile is present from the surface downward:

HORIZON	DESCRIPTION
Surface A ₀₀	Trees, Shrubs, grass, moss, loose leaves, etc.
A ₀	Undecomposed, partly matter organic layer consisting of roots, moss, woody fragments, humus, etc. - 3 to 6 inches thick - unfrozen during summer.
A ₁	Organic layer consisting of decomposed roots, moss, woody fragments, humus, clay, sand, etc. - 3 to 6 inches thick - generally unfrozen during summer. This layer is thin or absent in places.
B + C	Residual soil - 1 foot to 10 feet thick. Frozen except locally. The soil overlying quartzite and greenstone is light reddish and yellow brown and contains much fine sand, clay, and small amounts of humus. Because of frost action angular blocks of quartzite and greenstone are generally admixed with the soil in all areas. The principal mineral constituents are quartz, feldspar, micas, clay minerals, hornblende, and limonite. The common heavy minerals are zircon, rutile, sphene, ilmenite, magnetite, epidote, monazite, tourmaline, and garnet. The soils overlying greenstones carry much sphene and leucoxene and small amounts of chromite. In the vicinity of the siderite-galena-sphalerite and pyrite-arsenopyrite lodes cerussite, beudantite, scorodite, native gold, oxidized galena cubes, goethite and limonite particles, and oxidized pyrite nodules appear in the heavy fractions. Over parts of the Dublin Gulch granodiorite mass and in the vicinity of some skarn zones the soils are weathered residuum carry scheelite. The soil overlying schists is grey or black, depending upon the type of schist. Over graphitic schists the soil is black and contains much graphitic material. Small fragments and plates of schist are universally present. The principal mineral constituents are quartz, feldspar, micas, clay minerals, graphite, and limonite. The common heavy minerals are similar to those overlying quartzite. Near the cassiterite veins north of Dublin Gulch the soils overlying schists and quartzites carry small amounts of cassiterite and tourmaline.
Bedrock D	Quartzite, phyllite, greenstone, and schist.

Most residual soils are moderately well drained on the lower slopes of the hills, but poorly drained on the tops of the hills, where the upper layers of the soil are water-saturated all summer. The pH of most residual soils varies from 5.2 to 6.5.

The muck, peat, and half-bog soils are largely developed on the north slopes of the hills and on low-lying poorly drained ground. In most occurrences the profiles show the following sequence from the surface downwards:

HORIZON	DESCRIPTION
Surface A ₀₀	Trees, grasses, low shrubs, mosses, loose leaves, etc.
A ₀	Slightly compressed undecomposed organic matter consisting of woody fragments, roots, mosses, leaves, and minor amounts of mineral matter; 3 to 6 inches thick; unfrozen during summer.
A ₁	Muck composed of dark brown to black decomposed organic matter and humus with a slight admixture of clay, sand, etc.; 6 to 10 inches thick; generally permanently frozen below top few inches.
B + C (Residual Soils)	Residual soil or till, gravel, and sand; generally frozen; thickness varies.
D (Glacial Materials)	Thickness varies
Bedrock D	Quartzite, phyllite, greenstone, and schist.

The muck, peat, and half bog soils are very poorly drained and are water-saturated all summer. Their pH varies from 6.0 to 7.0.

3.4 Vegetation

The Elsa-Keno Hill area is located within the Mayo Lake-Ross River Ecoregion (Oswald and Senyk, 1977). The region is characterized by discontinuous widespread permafrost, with much of the area poorly drained and underlain by perennially frozen ground. Many valleys include peatlands, palsas, fens and meadows of sedge tussocks. Upper slopes may be covered with scree material, with treeline occurring at 1350 to 1500 meters.

The predominant tree cover in the area consists of white spruce (*Picea glauca*), black spruce (*Picea mariana*) and willows (*Salix spp.*). Less commonly occurring trees are trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white birch (*Betula papyrifera*). Alpine fir (*Abies lasiocarpa*) is common at higher elevations and alder (*Alnus crispa*) occurs along creek banks and in disturbed areas. Isolated pockets of lodgepole pine (*Pinus contorta*) can also be found.

Most south-facing slopes are covered with white spruce along with aspen, balsam poplar and willows, while north-facing slopes are underlain by permafrost and covered with stunted black spruce. Much of the drier south-facing slopes has been burned at some point during the past century (Green, 1971).

The shrub layer on the north facing slopes and peatbog areas consists of dwarf birch (*Betula glandulosa*), willows (*Salix spp.*), shrubby cinquefoil (*Potentilla fruticosa*), crowberry (*Empetrum nigrum*), cloudberry (*Rubus chamaemorus*) and dwarf raspberry (*Rubus acaulis*), as well as ericaceous shrubs such as Labrador tea (*Ledum decumbens*), bearberry (*Arctostaphylos rubra*), blueberry (*Vaccinium uliginosum*), cranberry (*Vaccinium vitis-idaea*) and bog cranberry (*Oxycoccus microcarpus*). The drier south-facing slopes have a shrub layer which includes rose (*Rosa acicularis*), twinflower (*Linnaea borealis*), and gooseberry (*Ribes oxycanthoides*).

Alpine areas support a variety of plant communities. The low ground vegetation mainly consists of mat forming plants such as moss campion (*Silene acaulis*) and ericaceous shrubs such as heather (*Cassiope spp.*). A variety of alpine flowering forb species are also found. Dry areas, particularly well-drained rocky alpine sites, have extensive lichen development.

Wetland species are mostly graminoids, including sedges such as *Carex aquatilis* and *Carex lugens*, cotton-grass sedges (*Eriophorum augustifolium*, *Eriophorum russeolum* and *Eriophorum vaginatum*), and grasses such as reed-bentgrass (*Calamagrostis canadensis*). Forb species such as Sudeten lousewort (*Pedicularis sudetica*), wintergreen (*Pyrola spp.*) and coltsfoot (*Petasites spp.*) are also scattered throughout wetland areas.

Aquatic plants commonly found in the area include water-milfoil (*Myriophyllum exalbescent*), pondweed (*Potamogeton richardsonii*), mare's-tail (*Hippuris vulgaris*) and bur-reed (*Sparganium spp.*).

Common horsetail (*Equisetum arvense*) is the predominant species of vegetation occurring on the unsubmerged portion of the Elsa tailings impoundment. Squirrel-tail grass (*Hordeum jubatum*) is found in large patches in the higher, drier areas. Hairgrass (*Deschampsia caespitosa*) and willows (*Salix spp.*) are scattered throughout. Sedge (*Carex aquatilis*) is the predominant plant in the wetter tailings and shallow water, along with occasional occurrences of willow, water horsetail (*Equisetum arvense*) and sloughgrass (*Beckmannia syzigachne*).

Metal levels in local wetland plant species were investigated as part of the Galkeno 900 pilot wetlands testwork. Samples for metal analyses were collected from wetland plant tissue and sediments to determine the extent of metal uptake by plants. Test results indicate that sediments contain considerable quantities of metals, while plant tissue metal levels remain near reported values for non-enriched sites. A complete discussion of metals uptake by plants is found in Appendix II, Table 3.

3.5 Wildlife

The Elsa-Keno Hill area supports a variety of wildlife including ungulates, fur-bearers, small mammals, upland game birds and waterfowl.

This area is included in the range of the Mayo woodland caribou herd, although only anecdotal information on the herd is available. Little is known about the caribou population in the area, as no recent inventories have been carried out. Caribou are occasionally harvested in the area.

Aerial moose surveys in the Mayo area in 1988 and 1993 included the area between the Mayo-Elsa-Keno highway and the South McQuesten River. The estimated density in 1993 was 119 moose/1000 km² compared to a density of 104 moose/1000 km² in 1988. The estimated average density for the entire Yukon is 127 moose/1000 km² (Ward, 1993). The resident non-native harvest in the survey area (game management zones 2-

58, 4-01, and 4-04) averages about 11 moose per year. The area is not currently hunted by non-residents. No accurate record for the native harvest of moose is available.

The Elsa-Keno area no longer supports thin-horn sheep. A small population had existed on Keno Hill, but was hunted out during the 1920's (Carey, 1992). There has been some discussion regarding the re-introduction of sheep to Keno Hill, but some believe that the habitat has been too much altered by mining development and access roads to make sheep re-establishment viable.

The South McQuesten River area is known as good quality fur-bearer habitat, although fur harvest records for traplines in the area are not currently available. The most commonly harvested fur-bearers are marten, wolverine and lynx. A total of 5 registered traplines occur wholly or partly in the Galena - Keno Hill area.

Other small mammals common to the area include muskrat, beaver, ground squirrel, red squirrel, varying hare, fox, mink, weasel, vole and shrew. Less common are porcupine, river otter and chipmunk. Alpine areas have local populations of hoary marmot and pika. Large carnivores include black bear, grizzly bear and timber wolf.

Information on waterfowl populations is restricted to casual observations. No systematic surveys have been carried out. There are reports of Canada geese nesting on wetlands in the area, and large numbers of Canada, snow and white-fronted geese have been seen to use the area during spring and fall migrations. Loons, grebes and diving ducks have been seen on larger water bodies such as McQuesten Lake and dabbling ducks have been observed in the wetlands.

Game birds common to the area include spruce grouse and ptarmigan. Less common are ruffed grouse, blue grouse and sharp-tailed grouse.

The health of the local wildlife populations near the Galena - Keno Hills area has not been studied. Within the last two years local people have expressed concern over the health of local wildlife which are routinely consumed. Government programs have attempted to address this issue by collecting wildlife muscle, kidney, and liver tissue; particularly for caribou and moose, and analyzing these tissues for metal and organo

chlorine levels. To date, a limited number of moose (2 samples) and caribou samples have been specifically collected from the South McQuesten River area. Although a detailed comparison is not possible, metal levels from the moose tissue were not atypical of other animal results in the territory. A detailed summary of all wildlife test results by local communities is being compiled (M. Palmer, M. Gamberg, 1996) Y.T.G. Renewable Resources routinely accepts wildlife tissue samples for metal analyses. It is expected that a database of metal levels in local wildlife species will develop as additional data is compiled.

3.6 Climate

3.6.1 General

This section presents an assessment of two climatic variables which were required to develop an overall water balance for the UKHM mine site (as described in Section 8.2). The two variables are average precipitation and average evaporation. These two variables were considered the key parameters in developing the water balance for the UKHM site.

3.6.2 Available Data

The climate records from a total of eleven climate stations were assembled to assist in characterizing the climate of the UKHM mine site. Details of these stations are presented in Table 3-5. The table also identifies the type of climatic information each station provided for the study.

Table 3-5 Details of Regional Climate Stations

Station Name ³	Latitude		Longitude		Elevation (m.a.s.l.)	Period of Record	Mean Annual Precipitation (mm)	Information Applicable To This Study
	Deg.	Min.	Deg.	Min.				
AES¹								
Boundary/ Mile 34 Boundary Road	64	14	140	21	1038	1967 - 1978	576	Precipitation
Cinton Creek	64	28	140	44	576	1984 - 1978	370	Precipitation
Dawson	64	3	139	26	320	1897 - 1979	306	Precipitation/ Humidity/ Temperature
Dawson Airport	64	3	139	8	369	1976 - 1985	340	Precipitation/ Humidity/ Temperature
Elisa	63	55	135	29	814	1948 - 1866, 1974 - 1989	413	Precipitation
Pelly Ranch/ Fort Salkirk	62	49	137	22	454	1954 - 1995	286	Precipitation/ Bright Sunshine
Keno Hill	63	56	136	12	1472	1974 - 1982	590	Precipitation
Kondiker Dempster	64	27	138	13	960	1965 - 1985	468	Precipitation
Mayo Airport/ Mayo/ Mayo Landing	63	37	135	52	504	1924 - 1995	306	Precipitation/ Humidity/ Temperature
Snag Airport	62	22	140	24	587	1943 - 1986	339	Humidity/ Temperature
DIAND²								
Fat Creek	63	55	135	30	730 (approx.)	1992 - 1994 (summers only)	Not available	Humidity/ Temperature

Notes: 1. Environment Canada, Atmospheric Environment Service

2. Department of Indian Affairs and Northern Development, Fire Management Program

3. For some stations, more than one name is presented. Where this happens, the first name given is the current official designation of the station. Other names represent past designations of the station. Name changes appear to have most often been triggered by the slight relocation of the station.

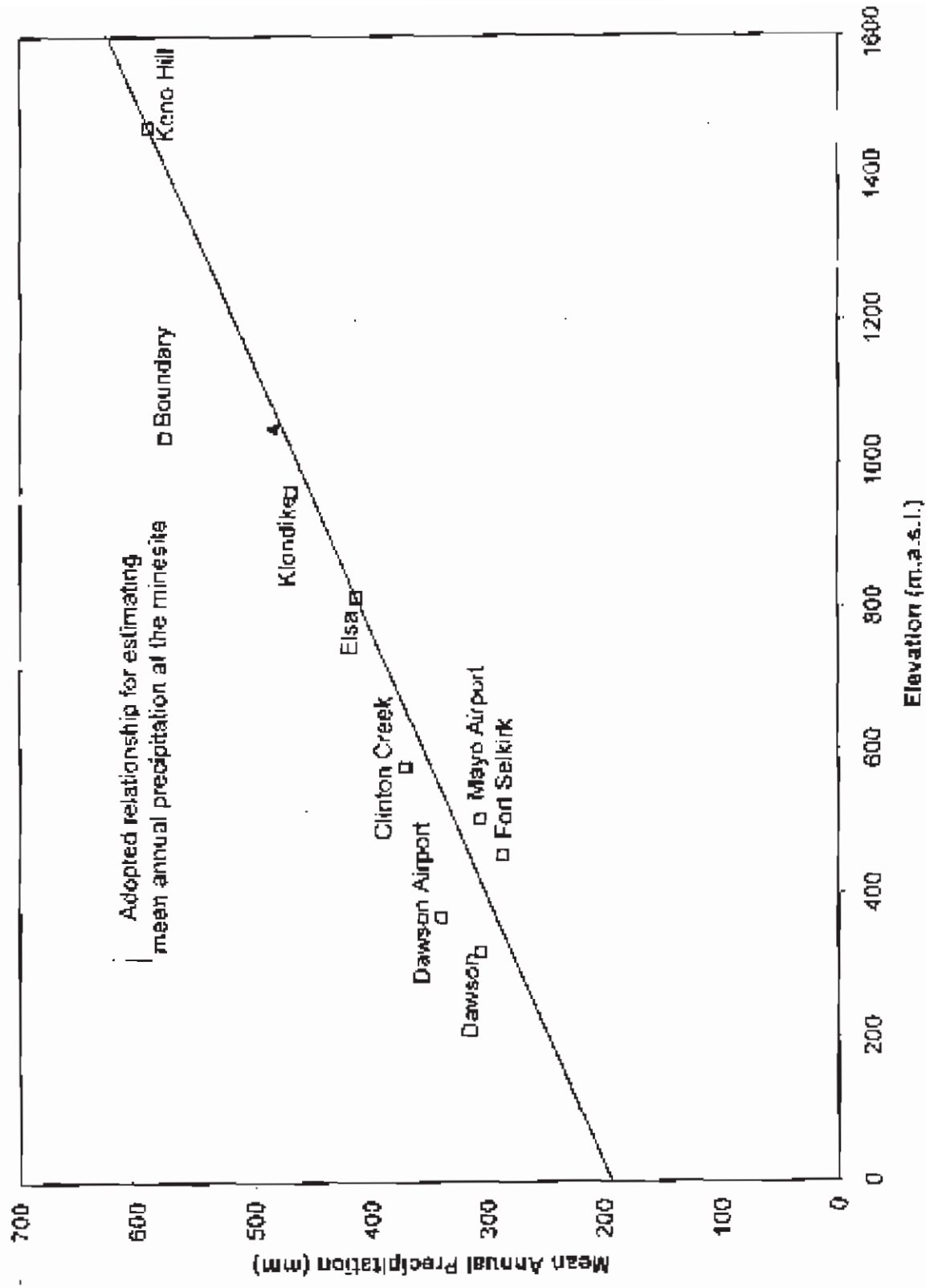
The region around the UKHM mine site is well served by a reasonably dense network of climate monitoring stations, a most unusual situation for a mine site located in the sparsely populated regions of northern Canada. Of particular noteworthiness is the fact that at least three climate stations have been operated within the boundaries of the mine site. Two of these stations were maintained by the Atmospheric Environment Service (AES) and were located at the Elsa townsite and on the southern flank of Keno Hill. The third station was operated on a seasonal basis by DIAND at a site in the Flat Creek catchment near the Elsa townsite. In addition to these mine site stations, the AES operate a principal climatological station at the Mayo Airport, located some 40 km southwest of Elsa. The data from the Mayo Airport can be combined with that of two discontinued stations in the near vicinity of the airport (i.e. Mayo Landing and Mayo) to construct a long-term climate record spanning 72 years.

Another source of information, but not included in Table 3-5, is climate data collected at the Dublin Gulch property, a proposed heap-leach gold operation located approximately 21 km northwest of Elsa. These data have not been used in the present study but may be incorporated into future analyses related to the water licence application.

3.6.3 Precipitation

Mean annual precipitation (MAP) within a mountainous region typically increases with increasing elevation. The region around the UKHM mine site is no exception to this rule as illustrated by the graph of MAP versus elevation shown on Figure 3-3. The data points on this graph were obtained from the information assembled in Table 3-5 for the regional AES climate stations.

Figure 3-3 Mean Annual Precipitation as a Function of Elevation



The UKHM mine site is in an area of significant relief. Accordingly, MAP can be expected to vary considerably within the boundaries of the mine site. In order to quantify this variation, an empirical relationship was derived between MAP and elevation using the data from the two AES stations which were operated on the mine property, namely the Elsa and Keno Hill stations. These are suitable stations for deriving the relationship since their elevations are widely separated (i.e. 814 m versus 1472 m). Assuming a linear relationship between MAP and elevation, a line was fitted to the data of these two mine site stations (see Figure 3-3). The slope of this line indicates that MAP increases by an average of 27 mm for every 100 m of ascent, a value not too dissimilar from that observed in other regions of the Yukon interior.

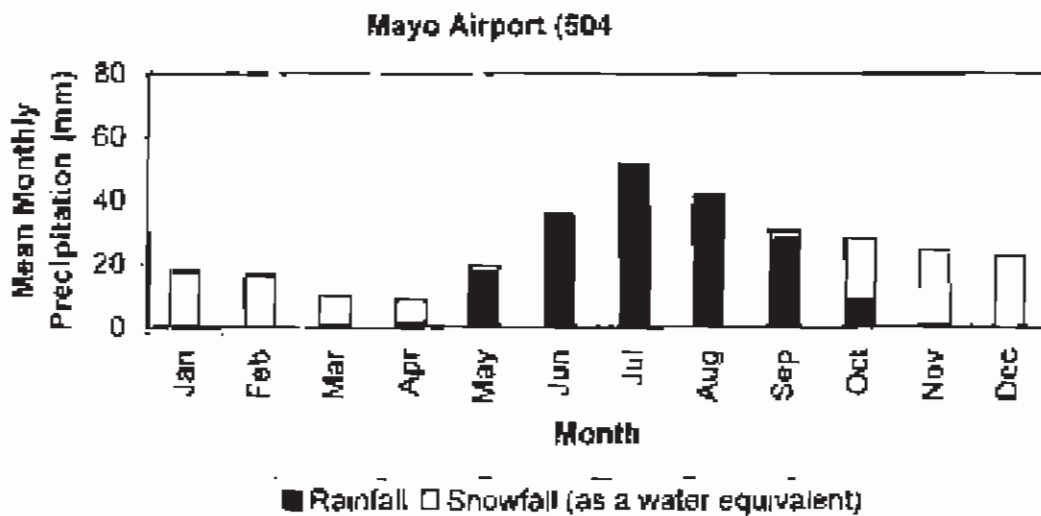
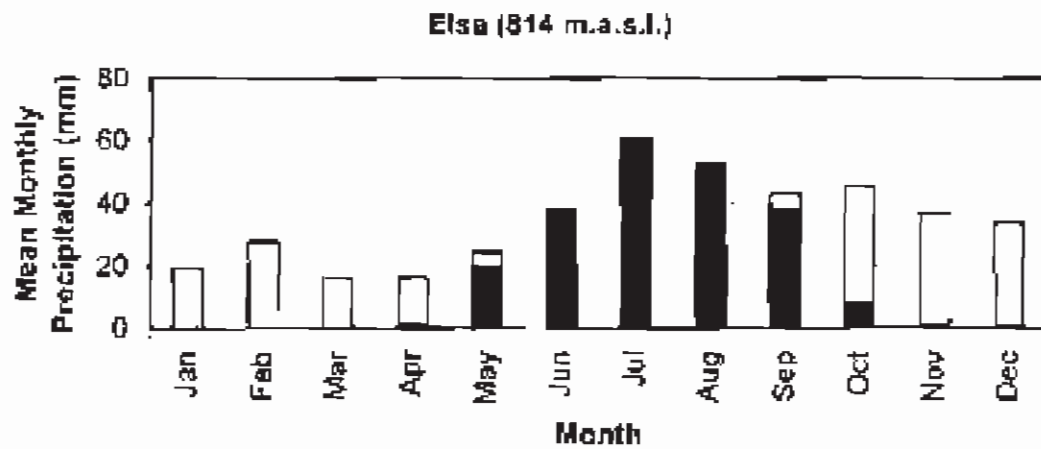
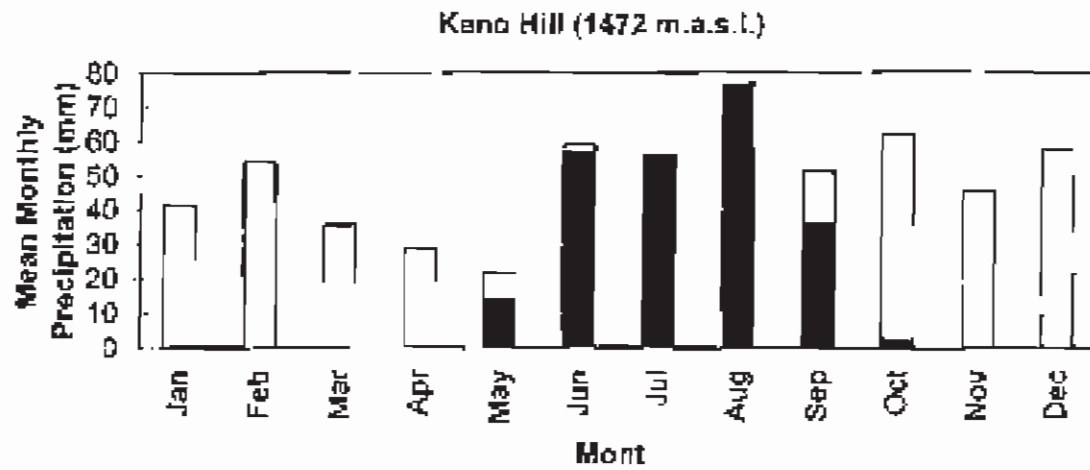
The curve fitted exclusively to the Elsa and Keno Hill data seems to also explain much of the variation in MAP observed at the other regional AES climate stations. The scatter about the line drawn on Figure 3-3 can largely be attributed to a mild drying trend as one moves from the northwest to the southeast across the region. This drying trend is made apparent by noting where the individual climate stations are located in relation to the mine site. All stations plotting above the line are located north and west of the UKHM site. In contrast, the two stations plotting below the line are found south of the mine site.

The adopted empirical relationship shown on Figure 3-3 should be viewed as providing only approximate estimates of MAP for ungauged points within the mine site. Although elevation is the principal control, precipitation also varies according to other variables such as slope and aspect which are not explicitly accounted for in the empirical relationship.

Figure 3-4 was prepared to illustrate the seasonal distribution of precipitation at the mine site. As with MAP, the seasonal distribution is influenced by elevation. To demonstrate this influence, the seasonal distributions for Mayo Airport (504 m), Elsa (814 m), and Keno Hill (1472 m) have been plotted on Figure 3-4. The following observations can be drawn from examining these distributions:

- precipitation is common throughout the year;
- the wettest period is normally the summer months of July and August;

FIGURE 3-4 Mean Monthly Precipitation



- the driest month of the year is typically April;
- the proportion of total precipitation which falls as rain decreases as elevation increases (60% of total precipitation at Mayo Airport, 53% at Elsa, and 41% at Keno Hill); and,
- the precipitation gradient during winter is steeper than that during summer (which suggests orographic effects are more pronounced during snowfall than during rainfall).

Evaporation

Two rates of evaporation are of interest, namely lake evaporation and evapotranspiration. The former refers to evaporation from a free-water surface while the latter refers to evaporation from a land surface including transpiration from plants. Both rates were estimated from meteorological data using a computer program known as WREVAP which was developed by Environment Canada's National Hydrology Research Institute (Morton, 1985).

The meteorological inputs to the WREVAP model comprise humidity, temperature, and sunshine duration. In order to obtain valid estimates of evaporation, the model must be provided with accurate measurements of the first two climatic variables. Model results are less sensitive to the accuracy of the third input requirement, i.e., sunshine duration. Thus, the use of sunshine duration records from another nearby climate station provides adequate accuracy. With this in mind, a search was made for climate stations which met the following two criteria:

- the station experiences a comparable climate to the mine site; and,
- as a minimum, the station monitors both humidity and air temperature.

Using these criteria, a total of four climate stations were selected for the evaporation modelling, one located at the mine site itself (Flat Creek) and three located in the general region (Dawson, Dawson Airport, and Mayo Airport). At none of these locations was sunshine duration monitored. To obtain this additional information, reference was made to the closest climate station equipped to measure sunshine duration (viz, Pelly Ranch or, as it was formerly known, Fort Selkirk).

Figure 3-5 displays the results of applying the WREVAP model to the meteorological conditions at each of the four climate stations. The top graph shows estimates of mean monthly evapotranspiration while the bottom graph shows the monthly distribution of lake evaporation. As can be observed, all four stations experience similar rates of both lake evaporation and actual evapotranspiration. Based on this similarity, the average of the evaporation rates at the four stations was selected to represent the conditions at the mine site. The average annual lake evaporation is about 460 mm while the estimated actual evapotranspiration is about 200 mm per annum, or 43% of lake evaporation.

3.7 Hydrology

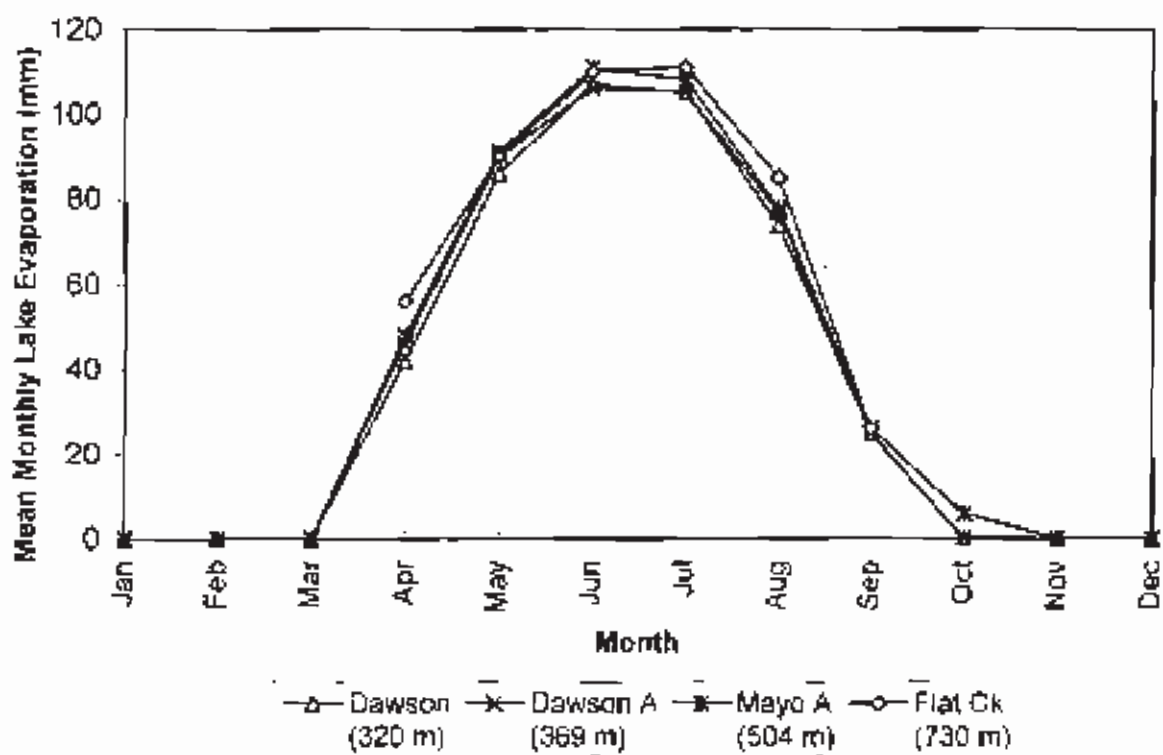
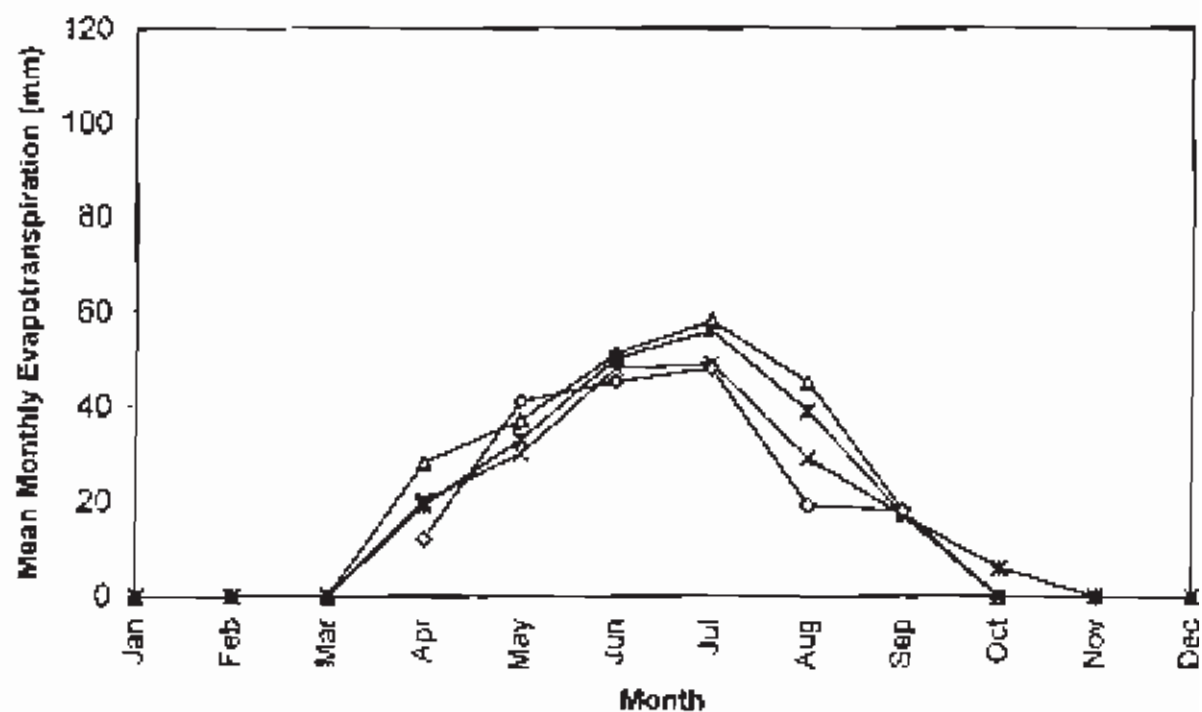
3.7.1 General

This section describes an analysis undertaken to estimate the average flows at key locations on the mine site streams. This information was required to construct an overall site water balance and chemical load balances for the UKHM mine site.

3.7.2 Available Data

The hydrology of the mine site streams was characterized using a mix of both site-specific and regional data. The site-specific data can be categorized into two groups. The first group encompasses a series of spot flow measurements made at the mine site water quality stations by UKHM personnel, government agencies, and consultants. The second group is data collected at five streamflow gauging stations established on mine site streams during 1994 and 1995 by Laberge Environmental Services. One of these stations is automatically monitored using a pressure transducer and data logger. The other four stations are equipped with staff gauges and must be manually read. The data collected to date at the five gauging stations are presented in Technical Appendix III. Maps showing the gauge locations and the catchment boundaries are shown in Figures 3-6 and 3-7.

Figure 3-5 Mean Monthly Evaporation Data



The site-specific data on their own are inadequate to fully characterize the hydrology of the mine site streams. This is because the spot flow measurements collected at the water quality monitoring stations are sparse and generally do not cover all seasons. Also, the streamflow records at the five mine site gauging stations are still of short length and, in the case of the manual gauges, are also intermittent.

In the absence of long-term and complete records of streamflow for the mine site streams, resort was made to data collected at the hydrometric networks of the Water Survey of Canada (WSC) and the Water Resources Division of DIAND. The streamflow gauges operated by the WSC are typically sited on streams with large catchments (say greater than 500 km²) and are monitored on a year-round basis. In contrast, the DIAND gauges are normally located on streams with small catchments and are operated seasonally during the period of open water. The networks of both government agencies were examined to identify regional gauging stations which could be useful in characterizing the average flows of the mine site streams. A total of fifteen stations were selected for this purpose, fourteen operated by the WSC and one operated by DIAND. Table 3-6 provides details of these stations, including period of record, catchment area, catchment median elevation, and mean annual runoff (MAR). Median elevation is a physical characteristic of the catchment and is defined as the contour which divides the catchment exactly into halves. The mean annual runoff for each regional gauge is expressed in two types of units, namely a long-term average flow rate and a depth. The latter unit may be interpreted as the depth to which the average annual runoff volume would spread uniformly over the total catchment area.

All of the selected WSC stations gauge unregulated flows, or flows which have been minimally influenced by human activity. The flows measured at the DIAND station, on the other hand, are characterized as being partially regulated owing to the placer mining activity upstream of the gauge.

The data collected by the WSC and DIAND were used to characterize the mine site hydrology using a technique known as regional analysis. Essentially, this involved deriving empirical relationships between the measured streamflow of the regional

Table 3-6 Details of Regional Streamflow Gauging Stations

Streamflow Gauging Station		Period of Record	Catchment Area (km ²)	Catchment Median Elevation (m.a.s.l.)	Mean Annual Runoff	
ID No.	Name				(m ³ /s)	(mm)
WATER SURVEY OF CANADA						
10MA003	Blackstone River near Chapman Lake Anstrip	1984 - 1994	1130	1400	9.14	256
10MB004	Bonnet Plume River above Gillespie Creek	1981 - 1994	3760	1390	53.2	447
09DA001	Hess River above Emerald Creek	1976 - 1994	4840	1400	80	522
09EB003	Indian River above the mouth	1982 - 1994	2220	770	6.31	90
09EA003	Klondike River above Bonanza Creek	1965 - 1994	7800	1040	63.1	255
09EA005	Little South Klondike River below Ross Creek	1983 - 1994	860	1190	7.07	269
09BB002	MacMillan River near the mouth	1984 - 1994	13800	1130	150	343
09DD004	McQuesten River near the mouth	1979 - 1994	4760 ¹	1030	36.9	245
09EA004	North Klondike River near the mouth	1974 - 1994	1100	1290	13.1	376
09BB001	South MacMillan River at km 407 Canal Road	1974 - 1994	997	1470	20.2	639
09DC003	Stewart River above Fraser Falls	1980 - 1994	30600	1240	383	395
09DC002	Stewart River at Mayo	1949 - 1979	31600	1230	370	370
09DD002	Stewart River at Stewart Crossing	1961 - 1973	35000	1210	415	374
09DD003	Stewart River at the mouth	1963 - 1994	51000	1090	469	290
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT						
29DC001	Duncan Creek at Mayo Lake Road	1979 - 1982	228	1200	1.8	250 ²

Notes:

1. Publications of the Water Survey of Canada show an incorrect catchment area for this station of 2870 km².
2. This station was operated on a seasonal basis and has a record with 7 complete months of streamflow data. These data were correlated with the observed flows at neighbouring streamflow gauging stations operated by the Water Survey of Canada. This correlation indicated Duncan Creek has a long-term average flow of approximately 1.8 m³/s at the DIAND gauging site.

29/10/98 940.0
C-10.2

stations and the physical characteristics of the catchments which generated the streamflow. These empirical relationships then formed the basis for estimating flows at ungauged mine site streams (or, as was often the case with the UKHM mine site, streams with limited flow measurements).

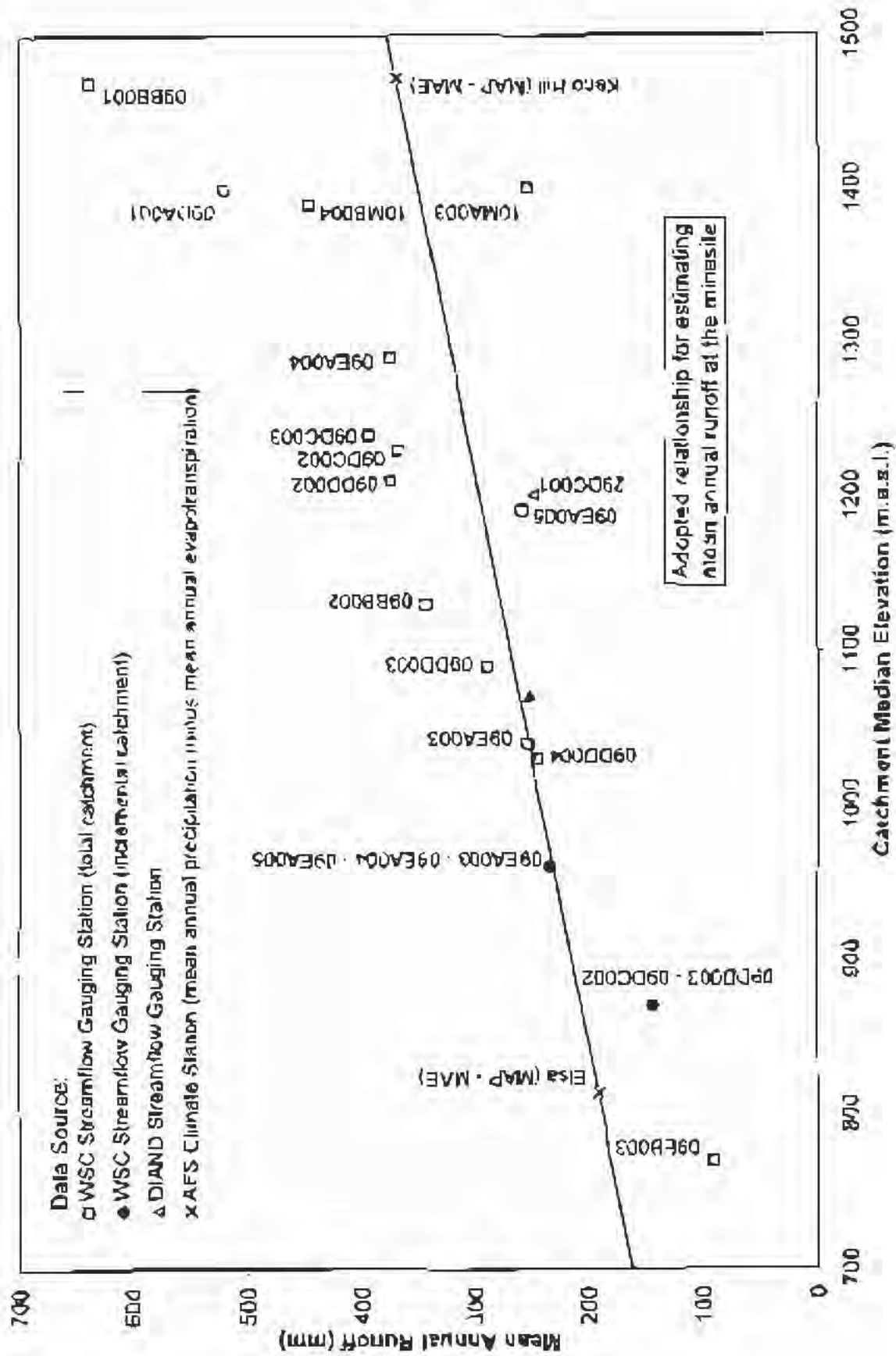
The subsections below describe the steps undertaken to apply the regional analysis to the mine site streams. Missing from these subsections is a discussion of how the site-specific data were used to validate flow estimates made by the regional analysis. In general, the measured flows at the mine site were found to closely match the estimated flows derived by regional analysis.

3.7.3 Mean Annual Runoff

As noted in Section 3.6.3, elevation generally accounts for a large proportion of the variation in mean annual precipitation within a mountainous region. It follows, therefore, that mean annual runoff (MAR) would also be a function of elevation. Figure 3-8 shows how this observation was used to estimate the average flows of the mine site streams. The vertical axis of this figure displays values of MAR expressed as equivalent depths of water. The horizontal axis, on the other hand, shows values of median elevation, which is the variable adopted to characterize the elevation characteristics of the regional and mine site catchments. The following sources of data were assembled to derive a relationship between these two variables for the study area:

- fifteen pairs of MAR and median elevation data provided by the WSC and DIAND stations listed in Table 3-6;
- two pairs of MAR and median elevation values provided by two incremental catchments monitored by the WSC (as explained below); and,
- two point estimates of unit runoff based on the climatic data presented in Section 3.5 (as also explained below).

Figure 3-8 Mean Annual Runoff as a Function of Elevation



Some preparatory work was required to assemble the first source of data. In all but one case, the MAR for the regional station was simply extracted from the agency's published streamflow records. For the one exceptional case, the gauging station was operated on a seasonal basis and, accordingly, a correlation had to be conducted to infill missing data so that the MAR could be estimated. Median elevations for all the stations were measured from topographic maps using a planimeter.

The second source of data is essentially a subset of the first. Where more than one streamflow gauge was located on a stream, it was possible to provide a set of MAR and median elevation values for the intervening catchment area between the gauges. For example, the runoff generated by the lower Stewart River watershed was quantified by subtracting the flows measured at Station 09DC002 from those at Station 09DD003. The median elevation of this incremental catchment was measured by examining only the area which lies between these two gauging stations.

The third source of information made use of climatic data to derive indirect estimates of runoff. Essentially, this was done by subtracting an estimate of average annual evapotranspiration from the average annual precipitation measured at each of the Elsa and Keno Hill climate stations. For example, the Keno Hill station has a MAP of 590 mm and an estimated average annual evapotranspiration of 200 mm. Subtraction of the evapotranspiration rate from the MAP suggests that the area in the immediate vicinity of the Keno Hill station generates an average of 390 mm of runoff per year.

Once all the data were assembled and processed, a curve was fitted to the data to develop a relationship which was believed to represent the conditions at the mine site. Fitting this curve was a somewhat subjective exercise, involving a comparison between the physical characteristics of the WSC and DIAND catchments with those of the mine site catchments. In addition, emphasis was placed on the point estimates of unit runoff derived from the climatic data. In the end, a straight line running through the two estimates provided by the climatic data was adopted to represent the conditions at the mine site. It is of interest to note that this line intersects the data point provided by the WSC station on the McQuesten River, which is of course the catchment which contains the mine site.

The relationship on Figure 3-8 was used to estimate the average flows on the mine site streams using the following four-step algorithm:

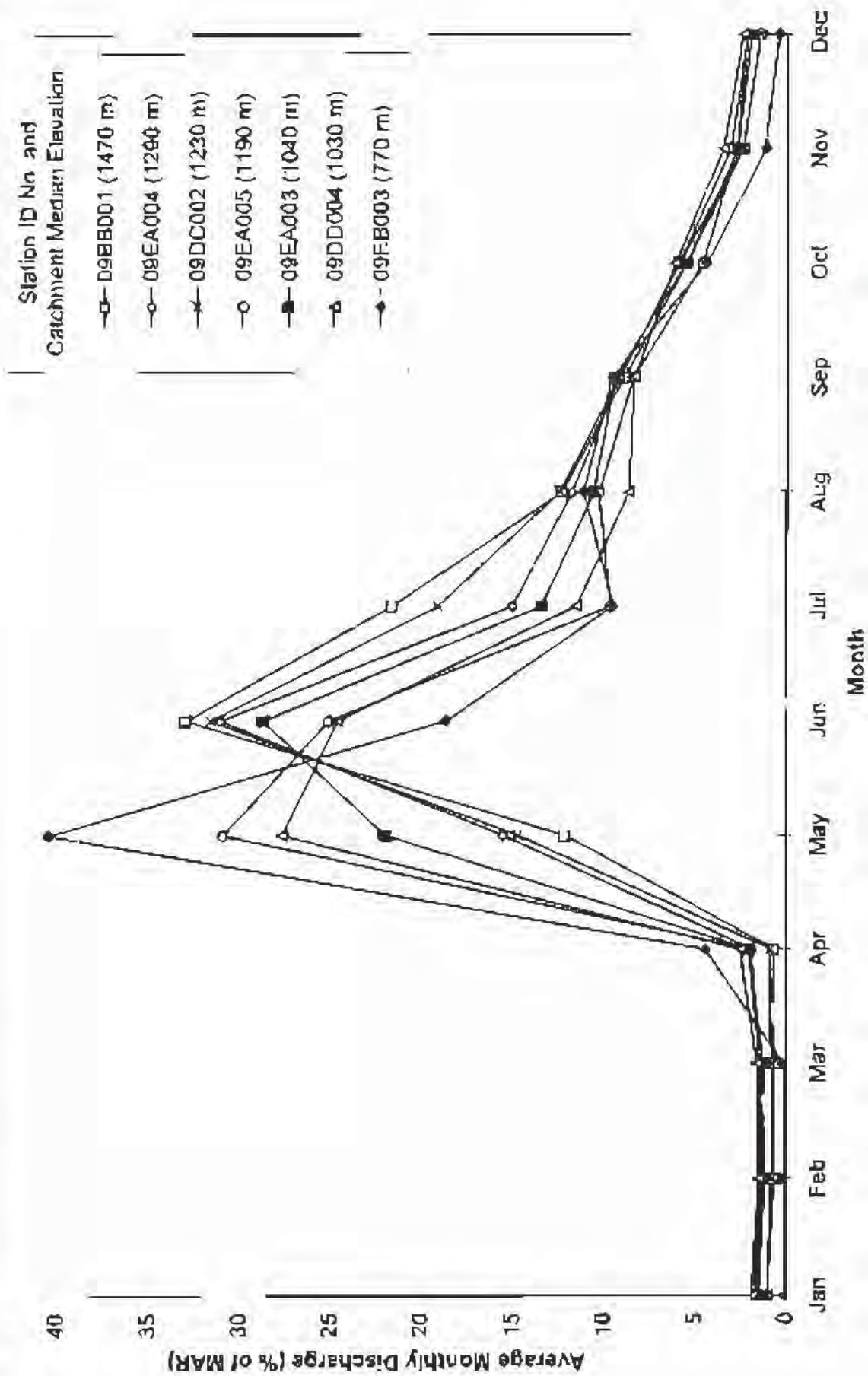
- a point of interest was defined and its catchment boundary outlined on a topographic map;
- using a planimeter, both the catchment area and catchment median elevation were measured;
- the curve on Figure 3-8 was entered at the appropriate value of median elevation and the corresponding unit MAR value was read from the graph's vertical axis; and,
- the product of unit MAR and measured catchment area was calculated to estimate the long-term average annual runoff volume for the point of interest.

3.7.4 Seasonal Runoff Distribution

The runoff pattern at the mine site was estimated by examining the average monthly hydrographs of regional gauging stations. Figure 3-9 graphically presents the monthly distributions, expressed as percentages of MAR, of seven regional stations. These stations were selected to illustrate the distributions from catchments with a broad range of physical characteristics. All distributions are characterized by high spring flows during snowmelt and low winter flows during prolonged freezing conditions. Examination of the distributions indicates median elevation is a reasonably good predictor of the shape of a stream's average monthly hydrograph. Two trends with median elevation are apparent. Firstly, the occurrence of the peak monthly flow is correlated with median elevation. As expected, low elevation catchments generally experience earlier peaks than high elevation catchments. Secondly, the relative magnitude of the winter base flow appears related to elevation. The relative magnitude of the base flow seems to increase as the median elevation increases from about 700 m to 1200 m. Above approximately 1200 m, the trend reverses.

Figure 3-8 Monthly Discharge (MAR)

45



A comparison between the physical characteristics of the mine site catchments and those of the WSC catchments indicated the McQuesten River (Station No. 09DD004) likely best represents the streamflow distributions of most of the mine site drainages. For some of the higher elevation catchments, such as Lightning Creek, the distribution for the North Klondike River may be more suitable.

3.8 Aquatic Resources

3.8.1 Benthic Invertebrates

The following sections summarize the benthic investigations in the Elsa area. The detailed report on the biological monitoring survey conducted at UKHM in 1994 is provided in Technical Appendix IV.

3.8.1.1 Review of Benthic Community Monitoring

According to licence number Y2S3-2014 effective August 1, 1980 to July 31, 1985 and licence number Y1N85-02RI effective September 26, 1985 to September 25, 1990, benthic fauna sampling was to be conducted by UKHM on an annual basis at four specified locations. These locations were:

- at Elsa Valley tailings decant (2DD-S1);
- Flat Creek upstream from South McQuesten River (2DD-S9);
- South McQuesten River upstream from Flat Creek; and,
- South McQuesten River downstream from Flat Creek (2DD-S11).

UKHM hired various consultants to carry out this program from 1986 to 1990 inclusive, but no mine sponsored invertebrate sampling was conducted from 1980 to 1985 (Northern Biomes Limited, 1986; Northern Biomes Limited, 1987; Leverton and Associates, 1988; Burns 1989; and Burns 1990). Environmental Protection Services carried out biological monitoring at these and other sites in the Elsa area, in 1975, 1985 and 1990 (Environmental Protection Services, 1978; Davidge & MacKenzie Grieve, 1989; and Environmental Protection Services, 1995). UKHM contracted Laberge Environmental Services (LES) in 1994 to carry out a biological monitoring program in the Elsa area.

All of the relevant benthic data from these surveys have been summarized and are presented in Table 3-7. The sampling method, using artificial substrate samplers, was consistent throughout these studies. When assessing benthic communities, usually abundance (total population), diversity (total number of taxonomic groups found at each site) and the composition of the community, are examined. For example, a healthy community found in clean waters would be comprised of many different types of organisms, many individuals would be present, and there would be representation of pollution sensitive species.

Invertebrate abundance has fluctuated over the years and this variance can be attributed to many natural factors such as climate, stream flow, life cycles of various organisms, timing of sampling, as well as the chemistry of the water. Diptera have generally been the dominant organisms throughout the years at all of the stations although species composition within the order Diptera was different between years.

The site on the South McQuesten River upstream of Christal Creek has been sampled for benthic invertebrates on four separate occasions (1975, 1985, 1990 and 1994). This location represents a true background site. The site on the South McQuesten River upstream of Flat Creek is not considered a background site for Flat Creek as this site is impacted further upstream by the Christal Creek drainage. Populations have decreased on the South McQuesten River upstream of Flat Creek from the upper South McQuesten site except for sampling done in 1975. The site on the South McQuesten downstream of Flat Creek is the old licence station 2DD-S11, which is located approximately 100 metres downstream of the confluence with Flat Creek. Some recovery of the benthic communities is noted here.

When compared with the South McQuesten River, two drainages show evidence of reduced taxa and individuals.

The site Christal Creek at the Keno Highway is impacted by Christal Lake which receives discharges from the Galkeno 900 adit. Populations are generally much lower here than in the South McQuesten River sites when compared on an annual basis.

TABLE 3.7 HISTORIC SUMMARY OF BENTHIC ANALYSES

Study Area	1975	1985	N. BOWEN 1986	N. RICHES 1987	1988	1989	1990	1994
S. McQUESTER R.								
US CHRISTAL CR								
Total # of individuals	117	693					629	1757
Total taxa	21	26					62	46
Dominance and %	2.83.9	0.76.3					11.90.6	11.39.0
CHRISTAL CR @ KENO								
RD CROSSING								
Total # of individuals	187	656					495	2674
Total taxa	16	31					47	45
Dominance and %	6.71.7	11.74.2					11.40.7	11.48.3
							11.36.7	11.30.3
S. McQUESTER R.								
US FLAT CR								
Total # of individuals	1126	140	1070	1820	551		285	5015
Total taxa	34	20	42	63	35		41	49
Dominance and %	0.27.6	0.12.6	0.67.9	0.74.4	11.44.5		11.46.6	11.61.5
							11.70.3	
FLAT CR US								
S. McQUESTER R.								
Total # of individuals	5	55	3045	1976	282		166	931
Total taxa	5	14	32	25	21		24	36
Dominance and %	0.62.6	0.42.1	0.80.7	11.02.4	11.50.1		11.45.4	11.53.7
							11.31.4	11.35.5
S. McQUESTER R.								
US FLAT CR								
Total # of individuals	639	1499	2005	775	740		355	1305
Total taxa	15	25	34	37	35		42	48
Dominance and %	11.28.5	11.92.8	11.04.1	11.40.5	11.40.6		11.58.8	11.58.9

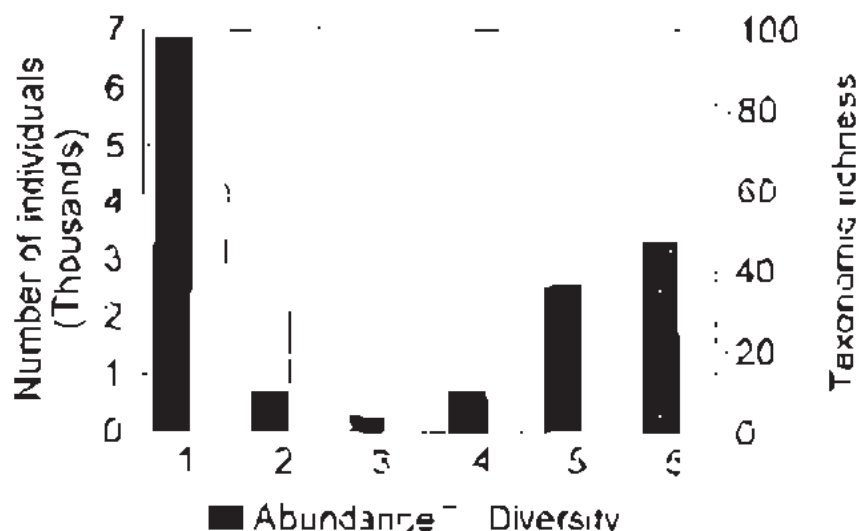
Q = Gales
P = Pseudophryne
D = Cladocera

The site on Flat Creek receives mine drainage waters from the main tailings ponds. Generally, the lowest populations were observed here. Flat Creek has been impacted from a previous tailings dam failure.

Environment Protection, in 1990, also sampled the benthic communities in the South McQuesten River, nine and 27 kilometres downstream of the Flat Creek confluence. Their data, reproduced below, shows that both abundance and diversity decrease after the confluence with Cristal Creek; however, the sites start to recover downstream of Flat Creek and continue to improve to the site 27 kilometres downstream of Flat Creek (Environment Canada, 1995). Specifically the sites sampled were

1. South McQuesten River approximately 1.5 kilometres upstream of Cristal Creek;
2. South McQuesten River at the pumphouse (ZDD-S10) approximately 6 kilometres downstream of Cristal Creek;
3. South McQuesten River approximately 15 metres upstream of Flat Creek;
4. South McQuesten River approximately 2 kilometres downstream of Flat Creek;
5. South McQuesten River approximately 8 kilometres downstream of Flat Creek; and
6. South McQuesten River approximately 27 kilometres downstream of Flat Creek.

ABUNDANCE AND DIVERSITY on the South McQuesten River, 1990



3.8.1.2 Benthic Communities in 1994

A biological monitoring survey was done in the Elsa area on Flat Creek, Christal Creek and the South McQuesten River in the field season of 1994. A total of seven sites were sampled. These sites correspond to the water quality stations LES 1, 3, 4, 5, 6, 7 and 9.

Populations at all of the sites, especially those in the South McQuesten River, were very high compared to other years. This may be partially due to the hot dry summer experienced in this area in 1994, which could have increased productivity in these waters. Both the Flat Creek and Christal Creek drainages also reported improved community abundance and diversity.

The 1994 data are examined in detail in Technical Appendix IV.

3.8.1.3 Summary

There appears to be a general trend of increased recovery in the benthic communities as one progresses further downstream on the South McQuesten River from the Christal Creek and Flat Creek confluences. The Flat Creek and Christal Creek drainages are the most impacted drainages in terms of benthic communities. This data correlates well with water quality and metal loadings data collected at these sites.

It appears that the benthic populations have improved at most of the sites over the past few years, based on diversity and abundance data. However, many variables can contribute to benthic community diversity and abundance including climatic and flow conditions, time of season sampled and the life cycles of the various organisms, disturbance of the substrate by anthropogenic or natural sources, and the quality of the water and the stream sediments. It is not possible to accurately state whether any of these or other factors may have played a role in the general enhancement of the benthic communities.

3.8.2 Fisheries

3.8.2.1 Introduction

White Mountain Environmental Consulting (WMEC) conducted fisheries investigations in the waters influenced by mining near United Keno Hill Mines property at Elsa, Yukon

between August of 1994 and August of 1995. The following discussion summarizes the results of these investigations. The detailed report is provided in Technical Appendix V.

The goal of these preliminary investigations was to obtain current data in order to assess habitat availability and utilization. Comprehensive studies on the fish resources in this area had not been conducted previous to this investigation. The only other information was reports of fish occurrence from DFO files.

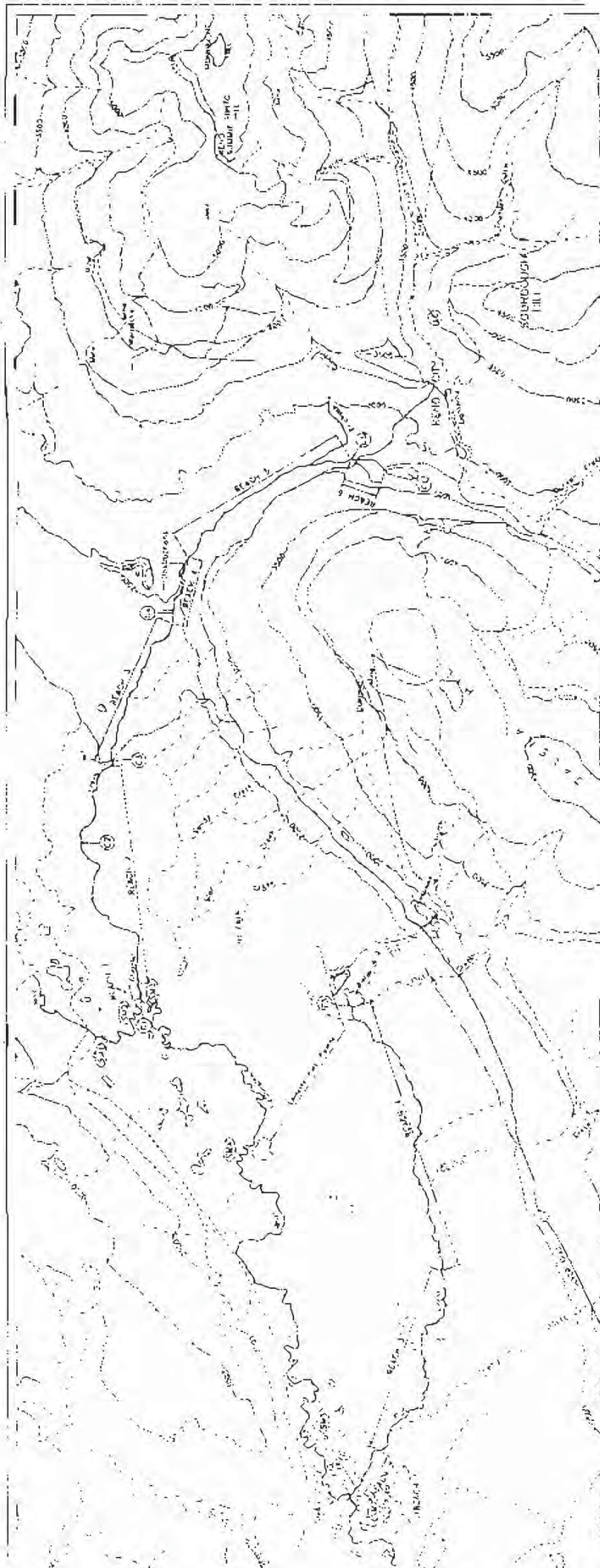
3.8.2.2 Study Area

The principal areas of study for this investigation were the drainages influenced by historic and current mining activities, as shown in Figure 3-10. Benthic invertebrate and water quality data assisted in determining these drainages for fisheries investigations. These include Christal Creek, Flat Creek and the receiving waters of the South McQuesten River. Lightning Creek in the Mayo River drainage was also investigated.

Christal Creek was investigated from Christal Lake to its mouth at the South McQuesten River. Flat Creek was investigated from the point immediately below UKHM's settling ponds to its mouth at the South McQuesten River. The South McQuesten River was investigated from McQuesten Lake to Seattle Creek. Investigations into Lightning Creek were restricted to a reach that extended from 350 m upstream of the outlet of Thunder Gulch to the confluence with Duncan Creek.

3.8.2.3 Methods

Fish habitat and utilization assessments on the South McQuesten River, Flat Creek, Christal Creek, Christal Lake and Lightning Creek were conducted at three different seasonal periods to provide a representation of spring, summer and fall utilization.



LEGEND

- Contour lines, waterbeds
- Primary Highway
- Secondary Road
- Trail



Slough areas
Sediment pits

Location of water bed - 1000 feet



0 1000 2000 3000 METERS

UNITED KENO HILL MINES LIMITED

1994-95 UKHM FISHERIES INVESTIGATIONS
WHITE MOUNTAIN ENVIRONMENTAL SERVICES

ACCESS MINING CONSULTANTS LTD
DATE: 10/10/95
DRAWN BY: JWG
CHECKED BY: JWG



Study Area

Scale: 1:500,000

Fall work was conducted between September 13 and 16, 1994. Spring investigations included two separate periods of investigation. The first period ran from May 19 to 23, 1995, and the second period from June 1 to 4, 1995. Summer investigations were conducted between July 14 and 21, 1995.

Habitat assessments were conducted by walking the length of each creek and recording the general characteristics of each reach of creek. Mapping habitat types, included an assessment of; depth, flow, velocity, bottom substrates, terrestrial and aquatic vegetation, bank stability and structure, and channel configuration. Anomalies and obstructions were also recorded.

Sampling for utilization was conducted at selected locations on each drainage. The mouths of both Flat and Christal were intensively investigated as were two other sites on Flat Creek and 4 other sites on Christal Creek. Christal Lake was also investigated. A total of 14 sites on the South McQuesten were sampled intensively. These included assessments above the influence of Christal Creek, between Christal and Flat Creeks and at three sites below the mouth of Flat Creek (Figure 3-10).

Most of the utilization assessments included repeat sampling four to seven days after the original sampling during all three sample periods. This was done in order to address a concern raised by DFO relating to the tendencies of many of the fish in these areas to school.

A variety of techniques were used during the investigations to determine the presence and abundance of fishes; these were; seine nets, electro-shocker, gill nets, angling, surber sampling, visual observations, and two different types of minnow trap baiting.

3.8.2.4 Summary of Findings

The South McQuesten River and its tributaries Christal and Flat Creeks contain a wide variety of fish habitats and fish species typical of those found in the Yukon River drainage. In total 5,316 fish were recorded during the course of this study representing a total of 11 different species, including; Arctic grayling, slimy sculpin, round whitefish,

northern pike, Arctic lamprey, chinook salmon, burbot, long nose sucker, least cisco and lake chub.

Slimy sculpins were the most widely dispersed species in the study area, and Arctic grayling were the most abundant. Both grayling and longnose sucker fry were typically encountered in groups or schools. Chinook salmon fry were found in the South McQuesten River, but not above the mouth of Haggart Creek. The extent of chinook utilization of the South McQuesten River is poorly understood. Other species recorded were found in small numbers, usually as individuals and in specific habitats.

The mouths of clear water tributaries were found to play an important role as rearing habitat. This may be because the tributaries provide a source of oxygenated water, nutrients and cover from larger predatory fish. The mouths of both Christal and Flat Creeks exemplify this situation and were shown to be important rearing areas for Arctic grayling fry.

Flat Creek

Flat Creek was divided into five reaches, four of these were studied. The lowest reach within 40 meters of the South McQuesten River offers the best available habitat on Flat Creek. This reach has predominantly cobble gravel substrates with pool riffle sequences. Above this reach the channel flows through a reach with heavy willow and alder growth which forms a canopy cover over much of the creek. A 4,000 meter reach above this flows through mature forest, with stream substrates comprised mostly of gravel, sand and silt. Open pools and riffles offer some fish habitat, however this type of habitat is dispersed and infrequent. Above the forested reach, Flat Creek flows for five km through an open wetland to just below UKHM's tailings pond. This reach offers very little in the way of fish habitat, substrates consist entirely of silts (possibly old tailings from early mine works) and the narrow deep channels offer poor cover.

Utilization of Flat Creek was restricted to the lowest 400 meters of the creek. The lowest 40 meters, the mouth area, was utilized extensively by grayling fry and to a lesser degree by sculpins, northern pike and burbot. A single grayling fry was found 350 meters upstream of the mouth and a single sculpin was captured 470 meters up from the

mouth in a small pool created by an old bridge. No fish were observed or captured above this point.

Christal Creek

Christal Creek has a variety of habitats throughout its 15 km reach. The lower reach consists of a mix of gravel bottomed runs, riffles and silt bottomed deep pools, a narrow channel with well defined banks and several beaver ponds. The mid reach area has gravel bottomed riffle, run, pool sequences with fast flowing waters. The upper reaches have both steep sided canyons with large boulders and more gentle sloped meandering stretches with gravel bottoms. A canyon area in the mid reach of the creek has two bridges that have partly collapsed and created barriers to fish passage into the upper reach of the creek. A small pool near the confluence with the South McQuesten River provides important habitat.

Fine solids, thought to be tailings transported from Christal Lake area during the 1950's can be seen in the bottom substrate of the creek at various places. Tailings migration into the creek resulted in a "hard pan" layer in most of the creek. Over time this layer has been broken up by ice action and currently exists as remnants along the creeks length and creek substrates have mostly returned to a natural state.

Juvenile Arctic grayling, burbot and slimy sculpins were found in the lowest reaches adjacent to the South McQuesten River. During summer and fall adult Arctic grayling were found utilizing larger pool areas as far up stream as the obstruction below the canyon. Results indicated that adult grayling do not overwinter in Christal Creek, however individuals may become trapped behind beaver dams, and forced to overwinter.

Significant numbers of grayling fry were found utilizing the mouth of Christal Creek during the summer and fall, although the extent of this utilization was limited to within 30 meters of the mouth. Several fry were observed 2 km upstream of the mouth and a single fry was captured near the Hanson Lake Road. Slimy sculpins were the only fish found above the canyon and the obstructions, but were not abundant.

Christal Creek has many areas of good habitat above the canyon that did not appear to be utilized.

Christal Lake

Christal Lake a small, shallow, sub-alpine lake has an organic silt bottom overlaying a heavy tailings sludge. The tailings were likely placed in the lake during the later part of the 1950's, when a grizzly mill was located on the east side of the lake. Reports of tailings deposition into Christal Lake have not been confirmed.

Several large adult slimy sculpin (18 grams) were captured from the lake. No other fish species were encountered in Christal Lake.

South McQuesten River

This river system contains a wide variety of fish habitats and fish species typical of those found elsewhere in the Yukon River drainage. A variety of flow regimes occur along the river in the study area, the most predominant being gravel bottomed riffle/ glide areas followed by deep, often silted pools.

Fish were encountered at all sites sampled on the South McQuesten River. All species recorded were found utilizing the South McQuesten River. Most species occurred at all sample sites. The exceptions were least cisco found only at the outlet of McQuesten Lake, lake chubb found only upstream of Christal Creek, and chinook salmon which were not found upstream of the confluence with Haggart Creek.

Lightning Creek

The reach of Lightning Creek surveyed extends from a point just below the town site of Keno City, then upstream to a point approximately 200 meters above the influence of Thunder Gulch, which is placer mined. Typical of creeks with placer mining influence, adult Arctic grayling were found upstream of the influence of turbid water from Thunder Gulch and sub-adult Arctic grayling were encountered in the turbid waters below the influence of Thunder Gulch.

3.8.2.5 *Heavy Metal Fish Samples*

Samples of fish from Flat Creek, Christal Creek, and the McQuesten River upstream of the confluence with Christal Creek were sent to Quanta Trace Labs for analysis of heavy metal content, a total of 57 metals were sampled for. The results of these analysis showed that some samples from this area had elevated zinc levels in comparison to fish from other locations in the Yukon. For comparison purposes, Table 3-8 summarizes metals data from this study, while Table 3-9 summarizes fish metals data from other areas in the Yukon. These tables are also contained in Technical Appendix V, (Table 9 and Table 11), but have been converted to express all results in wet weights. It should be noted in reviewing the tissue metals data that metals levels in sculpin or arctic grayling are not reported in Table 3-9. Table 3-9 provides an indication of fish tissue metal levels from selected lakes around the territory.

The highest levels of metals were found in a slimy sculpin taken from Christal Creek near the Keno Road crossing (187.06 µg/g wet weight). Sculpins from Christal Lake had the next highest levels of metals (91.8 µg/g wet weight). Slimy sculpin are bottom dwelling fish feeding mainly on aquatic insect larvae. This fish species is not harvested commercially.

Grayling taken from Christal Creek below the canyon had levels higher than those from fish taken in Flat Creek and the South McQuesten River. Samples collected from South McQuesten River fish above the influence of Christal Creek had the lowest levels of any of the fish analyzed during this investigation.

Studies have shown that Arctic grayling will avoid waters with high zinc levels. It appears that arctic grayling captured from Christal Creek do not show this behaviour. These fish may have developed a tolerance to zinc. Chronic effects on fish from exposure to zinc is unclear at present.

Table 3-9. Heavy metal levels found in fish from selected Yukon locations. Mean concentration of metals expressed as ug/g wet weight.

Location	Date	Species	Sample Description	Cu	As	Zn	Pb	Cd	Cr	Co	Hg	Ni
Mayo Lake	1990/91	lake trout	liver	23.38	1.21	41.0	nd	0.12	nd	2.67	0.15	nd
			muscle	0.20	nd	11.7	nd	0.03	nd	0.08	0.11	nd
		Northern Pike	liver	10.50	0.80	42.5	nd	0.10	0.045	0.85	0.05	nd
			muscle	0.25	0.74	6.1	nd	0.07	0.069	0.07	0.11	nd
		lake whitefish	liver	10.23	0.71	27.7	nd	0.19	0.07	0.98	0.12	nd
			muscle	0.14	1.59	18.0	nd	0.03	nd	0.091	0.09	nd
		burbot	liver	5.75	nd	17.3	nd	0.05	nd	0.50	0.03	nd
			muscle	0.205	0.75	4.3	0.75	0.0007	0.10	0.14	0.11	nd
Wareham Lake	1995	Whitefish	liver	8.88	-	31.8	nd	0.30	-	-	0.07	-
			muscle	0.32	-	33.2	nd	0.0035	-	-	0.04	-
		Northern Pike	liver	10.95	-	40.5	nd	0.12	-	-	0.04	-
			muscle	0.19	-	16.1	nd	0.008	-	-	0.11	-
Aishihik Lake	1990/91	lake trout	liver	10.15	0.98	4.5	0.42	0.13	10.1	0.07	0.11	0.06
			muscle	1.05	0.93	11.7	nd	nd	1.05	nd	0.09	nd
		Northern Pike	liver	6.93	0.88	86.6	0.74	0.07	0.24	0.05	0.11	0.09
			muscle	0.59	nd	10.8	0.09	nd	0.13	nd	0.13	nd
		lake whitefish	liver	15.16	1.10	35.4	0.59	0.19	0.19	0.07	0.08	0.06
			muscle	0.61	0.67	7.3	nd	0.01	0.08	nd	0.04	nd

nd = non-detectable

- = not reported

Data compiled from report entitled "Survey of Metal Contaminants in Fish Species from Aishihik, Canyon, Klondike, Mayo, Selkirk, Tatlain and Wareham Lakes, Yukon Territory 1990-1995", Fish and Wildlife Branch, Department of Renewable Resources, Whitehorse, Yukon, April 1996. Internal report

3.8.3 Stream Sediments

3.8.3.1 Methods

Composite sediment samples were collected in July 1994 from each of the sites listed in Table 3-10. Sample sites were selected from an exposed area of the stream bank, generally characterized by the finest grain size evident at the site. All samples were of recently actively transported stream bed load. Samples were collected with a stainless steel trowel and placed in zip-lock plastic bags. The samples were packed on ice when shipped to Quanta Trace Laboratories in B.C.

The samples were dried, passed through a 100 mesh (0.15 mm) stainless steel sieve, and then run through an ICAP analysis to determine total metals levels, using methods found in *Standard Methods for the Examination of Water and Wastewater 17th Edition* (Clesceri et. al., 1989) and U.S. EPA protocols found in *Test Methods for Evaluating Solid Waste, Physical Chemical Method, SW846*.

3.8.3.2 Results

The stream sediment samples were analyzed for 33 metals. These data are presented in Appendix IV. Table 3-10 presents data from the seven receiving water sites in the South McQuesten River, Flat Creek and Christal Creek for the five metals, arsenic, cadmium, copper, lead and zinc. These metals were selected because of their likely occurrence in the area as well as their potential for toxicity to aquatic life.

Since the study area lies within an area of mineralization, it is not surprising that the background site (Station 1 on the South McQuesten River upstream of Christal Creek) is relatively high in all these metals with the exception of lead. The remaining samples suggest that there has been considerable transport of metal into streams of the district as the levels are many times background. It seems likely that this metal was transported as particulate matter rather than precipitated from the water column since lead is elevated to levels nearly half that of zinc. The very high metal levels in Flat Creek suggests the presence of tailings as there have been many instances of tailings loss to Flat Creek reported over the years.

Table 3-10 Stream Sediment Metal Concentrations For Selected Metals

STATION NUMBER	STATION DESCRIPTION	ARSENIC		CADMIUM		COPPER		LEAD		ZINC	
		{ug/g}		{ug/g}		{ug/g}		{ug/g}		{ug/g}	
1	S. McQuesten R. d/s Christal Cr	18		1.6		22.4		10		310	
2	S. McQuesten R. u/s Flat Cr	210		17.00		48.4		1100		1610	
4	S. McQuesten R. d/s Foul Cr (S-11)	166		18.5		41.9		980		1640	
5	S. McQuesten R. d/s 9 km d/s Flat Cr	116		8.5		29.2		344		1150	
6	Christal Cr @ Kewo Hwy (S-10)	128		19.2		34.5		280		2090	
7	Christal Cr @ Hanson Road (S-19)	174		12.4		27.9		680		1950	
9	Flat Cr u/s S. McQuesten R (S-3)	395		51.3		116		4520		5180	

Sediment samples were collected at these seven sites in 1985 and 1990 by Environment Protection of Whitehorse. Table 3-11 and Figures 3-11 and 3-12 show a comparison of these data with the 1994 data collected for this study. The results suggest that the increasing trend in metal content at several sample sites between 1985 and 1990 may have reversed itself or may not have been a meaningful trend at all. The metal content of stream sediments appears to be slowly decreasing however the trends are inconsistent. The high levels of metal in Crystal Creek and the South McQuesten River were noted in the early 1960's sediment survey of the area by the Geological Survey of Canada. While levels are lower now, it appears that high metal levels in sediments will be present for many years to come.

Figure 3-11

COMPARISON OF LEAD IN STREAM SEDIMENTS
FOR 1985, 1990 AND 1994

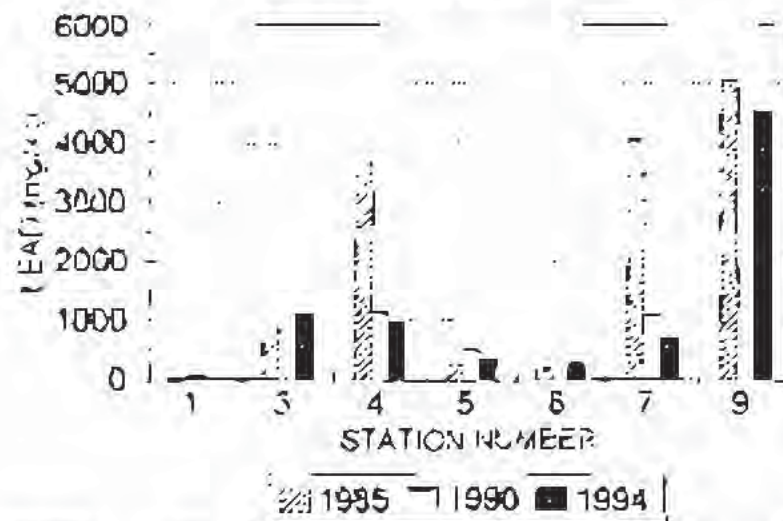
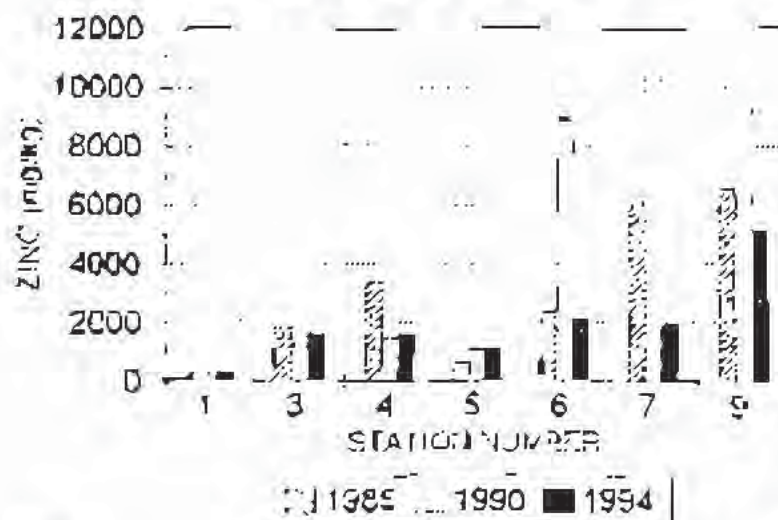


Figure 3-12

COMPARISON OF ZINC IN STREAM SEDIMENTS
FOR 1985, 1990 AND 1994



6. Site Water Chemistry

6.1 Water Chemistry Database

6.1.1 Database Contents and Organization

Water quality sampling and analysis has been done by both the Company and by various regulatory authorities over the years of operation. The data have been compiled into spreadsheet format, and used for the calculations of metal loading and evaluations of impact on local and regional water chemistry in the following discussions.

The database comprises the following sources of data:

- monthly water quality sampling and analysis by UKHM of 20 stations, including the water licence stations, from 1990 through to 1995. There are earlier data which are not entered into the database for all stations;
- water quality sampling by UKHM with analysis at an external laboratory for samples within the above period;
- water quality sampling and analysis by DIAND periodically from 1985 through to 1995. Stations sampled were primarily receiving waters, and some adit discharge stations. In some cases this sampling was done at the same time as samples were collected by UKHM to provide a basis for comparison of data;
- water quality sampling and analysis by Environment Canada, Environmental Protection Service of receiving water stations (notably Christal Creek) and contributing point sources (notably Galkeno 900 adit), periodically from 1986 through to 1995;
- water quality sampling by Laberge Environmental Services (LES) for UKHM, with analysis at Quanta Trace Laboratories in Vancouver. These programs cover property more thoroughly and have been conducted with greater frequency than any other. The intention of these programs was to identify current and potential sources and pathways of metals. The sampling stations

included all UKHM sampling stations plus receiving waters throughout the site area. Six sampling events were done in 1994 and 1995. These are summarized in Table 6-1;

- to complement the LES sampling, seep sampling was done in 1994 and 1995 by external consultants to select additional stations for more regular monitoring (including selection of groundwater monitoring stations) or to address specific water quality questions, e.g. waste dump drainage water quality. Analyses were done at Analytical Services Laboratories (ASL) in Vancouver.

The UKHM records indicate that there have been a few additional periods of duplicate sampling by regulatory and mine personnel for which the data were not collected during compilation of this database. Efforts will be made to obtain these data if available, and any additional data available from reviewers.

The water sample analyses done on the samples vary with the laboratory and the time period of sampling and include any, or all, of:

- Total metals analysis: ICP analysis on an unfiltered, preserved (nitric acid), digested water sample (methods as described in “Standard Methods for the Examination of Water and Wastewater” 18th Edition published by the American Public Health Association, 1992, or EPA Methods 3015 and 200.15). Total metals are described as “total” or “tot.” in the database;
- Extractable metals analysis: by external laboratories, ICP analysis on an unfiltered, preserved water sample (APHA, 1992). Extractable metals are denoted by “ext.” or “Me_E” in the database, depending on the analytical laboratory;
- Extractable metals analysis: by UKHM laboratory, AA analysis on an unfiltered, preserved water sample. Extractable metals are denoted by “ext.” in the database;
- Dissolved metals analysis: ICP analysis on a filtered (0.45µm filter), preserved water sample (APHA, 1992 or EPA Method 200.15);

Table 6-1 Water Quality Site Descriptions and Sampling Frequency

LEES SITE #	SITE DESCRIPTION	1st Sampling Date	2nd Sampling Date	3rd Sampling Date	4th Sampling Date	5th Sampling Date	6th Sampling Date
1	South McQuesten R upstream Christal Cr	July 26/94	Sept 7/94	Oct 27/94	July 14/95	Sept 6/95	
1B	South McQuesten R downstream Christal Cr	Oct 27/94	July 14/95	Sept 6/95			
2	South McQuesten R @ Pumpphouse (S-10)	July 28/94	Sept 6/94	Oct 28/94	July 14/95	Sept 7/95	
3	South McQuesten R. upstream Flat Cr	July 28/94	Sept 6/94	Oct 26/94	Apr 27/95	July 12/95	Sept 6/95
4	South McQuesten R downstream Flat Cr (S-11)	July 28/94	Sept 6/94	Oct 26/94	Apr 27/95	July 12/95	
5	South McQuesten R 9 km downstream Flat Cr	July 29/94	Sept 5/94	Oct 26/94	July 12/95		
6	Christal Cr @ Keno Highway (S-18)	July 26/94	Sept 7/94	Oct 28/94	Apr 27/95	July 11/95	Sept 5/95
7	Christal Cr @ Hanson Road (S-19)	July 26/94	Sept 7/94	Oct 27/94	Apr 27/95	July 11/95	Sept 5/95
7B	Christal Cr. @ mouth	Oct 27/94	July 14/95				
8	Flat Cr @ Keno Highway	July 26/94	July 12/95	Sept 7/95			
9	Flat Cr upstream South McQuesten R (S-9)	July 28/94	Sept 6/94	Oct 26/94	Apr 27/95	July 12/95	Sept 6/95
10	Haldane Cr @ South McQuesten Road	July 29/94					
11A	Galena Creek upstream Elsa Road	Oct 27/94	July 13/95	Sept 7/95			
11	Galena Cr upstream Silver King adit	July 27/94	July 13/95	Sept 7/95			
11B	Galena Cr 700 m d/s Silver King tailings ponds	July 13/95	Sept 7/95				
12	Silver King adit (S-13)	July 27/94	Oct 27/94	Sept 5/95			
12A	Silver King decant, pond # 2	July 12/95	Sept 5/95				
14	Husky South West adit (S-17)	July 27/94	July 12/95	Sept 5/95			
18	Bermingham adit (S-3)	July 27/94	Sept 5/95				
19	Ruby adit (S-15)	July 27/94	Sept 5/95				
20	No Cash 500 adit (S-4)	July 27/94	Oct 27/94	Sept 5/95			

Table 6-1 (Cont'd) Water Quality Site Descriptions and Sampling Frequency

LES SITE #	SITE DESCRIPTION	1st Sampling Date	2nd Sampling Date	3rd Sampling Date	4th Sampling Date	5th Sampling Date	6th Sampling Date
21	No Cash Creek @ Keno Highway	July 27/94	Oct 27/94	July 11/95	Sept 5/95		
21A	No Cash Creek u/s Adit, above old wood culvert	Sept 5/95					
22	No Cash Creek upstream Hwy (1.4km NW of Keno Highway)	Oct 28/94					
22A	No Cash Creek just u/s of confluence with old ditch	Sept 5/95					
30	UN adit (S-2)	July 27/94	Sept 5/95				
31 or 31E	Galkeno 900 adit (S-5)	July 27/94	July 11/95				
31A	Galkeno 900 from Pond # 1	Apr 27/95	July 11/95	Sept 5/95			
31B	Galkeno 900 decant Pond # 2	July 11/95	Sept 5/95				
31C	Galkeno 900 seep below Pond # 1	July 11/95	Sept 5/95				
31D	Galkeno 900 seep below Pond #2	July 11/95	dry				
31 F	Galkeno 900 Seep near Swamp effluent	July 11/95	Sept 5/95				
31G	Galkeno 900 flow along old path 5m u/s Christal L.	July 11/95	Sept 5/95				
31H	Galkeno 900 Seep below wetland access road	July 11/95	Sept 5/95				
32	Galkeno 300 adit	July 27/94	July 12/95	Sept 5/95			
34	Erickson Gulch @ Road to Lucky Queen	July 27/94	July 12/95	Sept 5/95			
35	Sadie Ladue adit (S-7)	July 28/94	July 12/95	Sept 5/95			
37	Lightning Cr upstream Hope Gulch	July 28/94	Sept 8/94	July 12/95	Sept 4/95		
38	Keno 700 adit (S-6)	July 27/94	July 12/95	Sept 5/95			
39	Bellekeno adit (S-12)	July 27/94					
39A	Bellekeno decant from tailings ponds	July 12/95	dry				
39B	Bellekeno, seep below decant	July 12/95	Sept 4/95				

Table 6-1 (Cont'd) Water Quality Site Descriptions and Sampling Frequency

LES SITE #	SITE DESCRIPTION	1st Sampling Date	2nd Sampling Date	3rd Sampling Date	4th Sampling Date	5th Sampling Date	6th Sampling Date
40	Onek adit (S-8)	July 27/94	July 12/95	Sept 5/95			
41	Lightning Cr @ Keno City Road Crossing	July 26/94	Sept 8/94	Apr 27/95	July 12/95	Sept 5/95	
42	Tailing Pond # 3 water	July 28/94					
45	Brefalt Cr upstream Porcupine Diversion	July 29/94	Oct 28/94	July 13/95	Sept 7/95		
46	Flat Cr upstream Porcupine Diversion	Oct 27/94	July 13/95	Sept 7/95			
47	Porcupine Diversion (Flat Creek) downstream of all inputs	July 28/94	Oct 27/94	July 13/95	Sept 7/95		
48	Hope Gulch	July 28/94	Sept 8/94	July 11/95	Sept 4/95		
50	Blank	July 29/94					
51	Combined Seepages in Porcupine Div. u/s Brefalt Cr	Aug 9/94	Sept 6/94	July 14/95	Sept 7/95		
52	Thunder Gulch upstream Bellekeno adit	Aug 11/94	Sept 8/94	July 12/95	Sept 4/95		
53	Old Galkeno freshwater pumphouse water	Aug 11/94	July 11/95	Sept 4/95			
54	Thunder Gulch downstream Bellekeno adit	Sept 8/94	July 12/95	Sept 4/95			
55	Inflow to south end of Christal Lake	Sept 8/94	July 12/95	Sept 4/95			
56	Christal Lake	Sept 8/94	July 11/95	Sept 4/95			
57	Galena Cr @ mouth (just upstream of Flat Cr)	Sept 15/94	Oct 27/94	July 13/95	Sept 7/95		
58	Mystery Cr (approximately 1 km upstream of S-10)	Sept 16/94	Oct 28/94				
59	Buried Tails Seepage (Elsa side)	Oct 28/94	July 14/95	Sept 7/95			
60	Exposed Tails Seepage (Pond side)	Oct 28/94	July 14/95	Sept 7/95			
61	Small flow into Christal Cr. parallel to Hwy @S-18 near	July 11/95	Sept 5/95				
62	Small flow into Christal Cr. @ S-18, farthest from road	July 11/95	Sept 5/95				
63	Sandy Creek @ Highway	July 11/95	Sept 4/95				

Table 6-1 (Cont'd) Water Quality Site Descriptions and Sampling Frequency

LES SITE #	SITE DESCRIPTION	1st Sampling Date	2nd Sampling Date	3rd Sampling Date	4th Sampling Date	5th Sampling Date	6th Sampling Date
64	Unnamed Creek 60m towards Elsa on Keno Hwy from Hanson turnoff	July 11/95	Sept 4/95				
65	Galkeno 300 Seep below power line along Hwy	July 12/95	Sept 5/95				
66	Spring along Duncan Cr Road	July 12/95	Sept 4/95				
67	Porcupine Gulch @ Calumet Rd X-ing	July 12/95	Sept 4/95				
68	Flat Creek @ Ballpark Rd X-ing	July 12/95	Sept 4/95				
69	Flat Creek midway between tailings and Husky S.W.	July 13/95	Sept 7/95				
70	Flat Creek between Husky S.W. and Galena	July 13/95	Sept 7/95				
71	Flat Creek d/s Galena Creek	July 13/95	Sept 7/95				
72	Tailings decant (S-1)	July 13/95	Sept 7/95				
73	Seepage at toe of #3 dam	July 13/95					
74	Husky Southwest flow 500 m d/s adit	July 13/95	Sept 6/95				
75	Seepage along road between Galkeno 300 & Duncan Cr Rd.	Sept 4/95					
76	Star Creek @ Keno Hwy	Sept 4/95					
77	Husky Shaft	Sept 5/95					
78	Seep along road to Galkeno 900, 80 m from adit clearing	Sept 5/95					

- Field pH, conductivity and TDS measurements using hand-held calibrated probes with automatic temperature correction;
- Laboratory pH, conductivity measurements using laboratory probes; and
- TDS (total dissolved solids), sulphate, ammonia, and cyanide analysis as in Standard Methods (APHA, 1992).

The water sampling stations are shown on Figure 6-1. UKHM water licence sampling stations are denoted by “2DD-S#” or simply “S-#”. The LES sampling stations are numbered, according to the descriptions in Table 6-1. In cases where the LES stations are the same as UKHM stations, both numbers are shown on the Figure.

The database is provided in its entirety in Technical Appendix VII. Calculations of seasonal statistics are also included. The database has been organized into a series of files; one for each sampling station. Within each file, there are separate spreadsheets for each the UKHM, “government”, and LES data (which includes data from other external consultants if applicable).

6.1.2 Database Analysis

As with any data set, there are a number of different statistical and graphical tools that can be used to analyze the data, and extract pertinent relationships. However, it is important to establish the objectives of such analyses. For this closure plan development, the key objectives in the data analysis were to determine or understand:

- trends in adit discharge water quality over time to anticipate future water quality concerns. These are summarized in Table 6-2;
- comparison between data sets and appropriateness of each for interpreting site geochemistry;
- changes in water chemistry along a flowpath (e.g. No Cash adit and No Cash Creek or the Christal Creek catchment) to identify and, to some extent, quantify natural and anthropogenic sources and sinks; and,
- relationships between parameters such as chemistry and flow to identify mechanisms controlling water chemistry - particularly where a physical mechanism such as the extent of flushing and the water flow path may dominate the water chemistry, rather than the geochemical processes.

The files have been set up with spreadsheets to calculate statistics for each data set. Values quoted as less than the detection limit are considered in the database as to be at the detection limit. The conclusions of these analyses are provided in this report and in the technical appendices.

6.2 Discussion of Site Water Chemistry

The following subsections discuss the water chemistry data for each of the mine areas and sampling stations. The discussions generally focus on the questions posed above for analysis, and specifically on identifying current and potential issues of water quality at the UKHM Elsa mining complex.

Table 6-2 Summary of Trends in Water Chemistry

Station	Data Source	Flow	pH	SO4 or Cond.	IZn	Cl ₂	Fe	Comments
Birmingham								
SJ	UKHM	no change	no change	slight increase	no change	decreasing	peaks increasing	
LES 18	GovVLES		no change	no change	no change	decreasing		peak in 1997, than lower
Seasonal?		yes but only	yes but variable	yes but variable	summer peak	summer peak	variable	
Elso								
S16	UKHM	no change	no change	increasing	no change	increasing	no change	
Seasonal?		yes	yes	slight	no	slight	slight	
Galkeno 900								
S5	UKHM	decreasing	no change	same	increasing	increasing	decreasing	
LES 31	GovVLES	no change	no change	increasing?	same	no change	decreasing	
Seasonal?		yes					variable	
Husby SW								
S17	UKHM	no change	increasing	same - variable	no change	slight increase	increasing	in high in 1997/1998
LES 14	GovVLES		same	same	slight decrease	no change		
Seasonal?		no	no	variable	slight			
No Cash 500								
S4	UKHM	year 93 increase	no change	slight increase	slight decrease	slight decrease	slight	all high in 81, than low and increasing now
LES 20	GovVLES	overall increase	no change	slight increase	slight decrease	slight decrease		
Seasonal?		yes	yes low in summer	yes	yes	yes	slight	
Ruby								
S16	UKHM	no change	no change	no change	decreasing	slight decrease	slight decrease	current data similar to
LES 10	GovVLES		no change		decreasing	slight decrease	slight decrease	1995/96?
Seasonal?		yes	yes	yes	yes	yes but lower	yes lowest	
Shady King								
S13	UKHM	no change	decreasing	increasing	increasing	no change	increasing	
LES 11	GovVLES	no change	decreasing	increasing	increasing	no change	increasing	
Seasonal?		varies, no	lower late summer	peak late summer	peak late summer	no change	yes	
UN								
S2	UKHM	variable, low	no change	variable	slight decrease	increasing	increasing	recent slight increase
LES 30	GovVLES		slight increase	slight decrease	slight decrease	no change	no change	
Seasonal?		yes	peaks related					
Summary								
Summary to High flow								

Table 6-2 Summary of Trends in Water Chemistry

Station	Data Source	Flow	pH	SO ₄ or Cond.	Zn	Co	Fe	Comments
Keno 300								
58	UKHM	no change	no change	no change	increasing to 150	no change	increasing to 50	late 4th peak in metals, SO ₄
LES 36	GOVULES	yes x 2	no change	no change	no change	value 52	no change	SO ₄ peak
Seasonal?			yes increasing to 7-8 over summer			not consistent		
Lucky Queen								
514	UKHM			increasing	decreasing	no change	no change	2nd peak
Seasonal?		yes						
Onah								
58	UKHM	no change	no change	no change	no change	no change	no change	
LES 40	GOVULES		no change	no change	no change	increasing peak		
Seasonal?		yes	no change	slight increase	no change	no change		95 data similar to 50:100
Sade Lodge								
57	UKHM	increasing	no change	no change	increasing to 150	peak	increasing to 50	similar to 50:100
LES 10	GOVULES	increasing	no change	no change	no change	no change	no change	
Seasonal?		summer increase lower in summer	lower in summer	no	yes	no change	no change	
Brickboro								
512	UKHM	no change	recent slight decrease	similar to 50	decreasing	no change	no change	
LES 30	GOVULES	slight decrease	no change	variable	no change	no change	no change	
Seasonal?		no	no	no not variable	yes, inc in summer			

In the absence of any other reference, the terms “elevated” and “high” are relative either to background values or to other data for the same site or area. The term “contaminants” is used in a general sense to refer to parameters which are considered potentially deleterious to water quality; notably metals and, to a lesser extent, sulphate and acidity.

In most cases, total and extractable metal analyses are similar and thus the term “total metals” is used to refer to results for unfiltered samples. This is necessary where there are limited data, or data for either total or extractable metals.

It must be noted that zinc analyses by UKHM in spring 1995 until July are questionable. The nitric acid used in the assay sample preparation was contaminated with zinc, and possibly cadmium and lead. Thus, the reader is cautioned to consider the source of the data and the analytical laboratory when evaluating data - particularly peaks or periodic trends in a few parameters that do not appear consistent with the remainder of the data set.

6.2.1 Bermingham

The water draining from the Bermingham adit is supplied both by groundwater flowing into the underground, and by surface precipitation funnelled through the main open pit via old shafts and faults.

Water quality sampling data sets are consistent, and show a distinct seasonal trend. Peaks in both flows and concentrations tend to occur in the spring or early summer months. These can be seen both in the water quality graphs, Figures 6-2, 6-3 and 6-4, and in the seasonal statistics appended.

The drainage water chemistry is somewhat different than other zones, in that there is no evidence of on-going oxidation, acid generation, or acid neutralization. The pH is alkaline, at pH 7. Alkalinity values are high, close to saturation. Sulphate concentrations are low at 70 mg/L, similar to surface streams (Galena Creek). The carbonate minerals in the deposit are primarily iron carbonates (siderite) which do not provide neutralization above about pH 5. There is no evidence of neutralization

6.2.14 Bellekeno

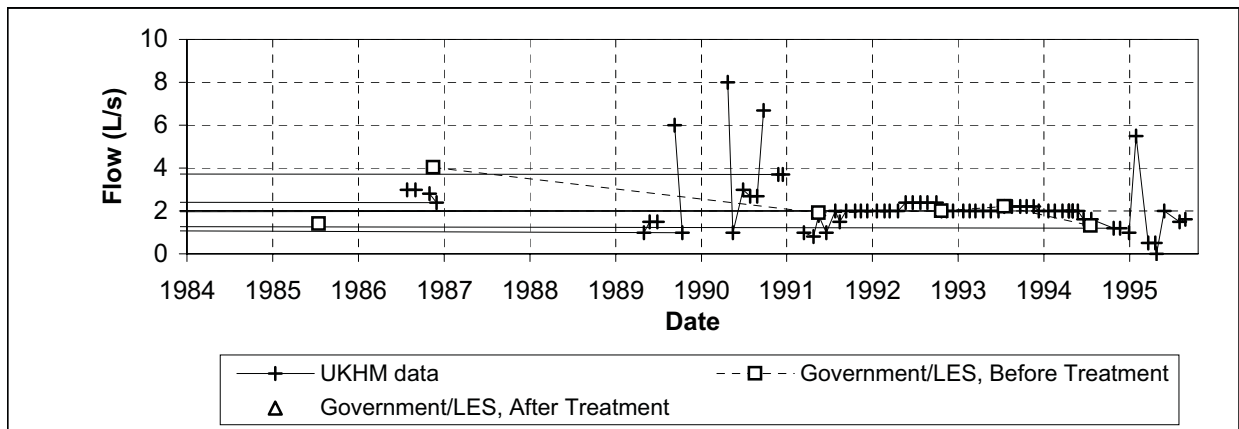
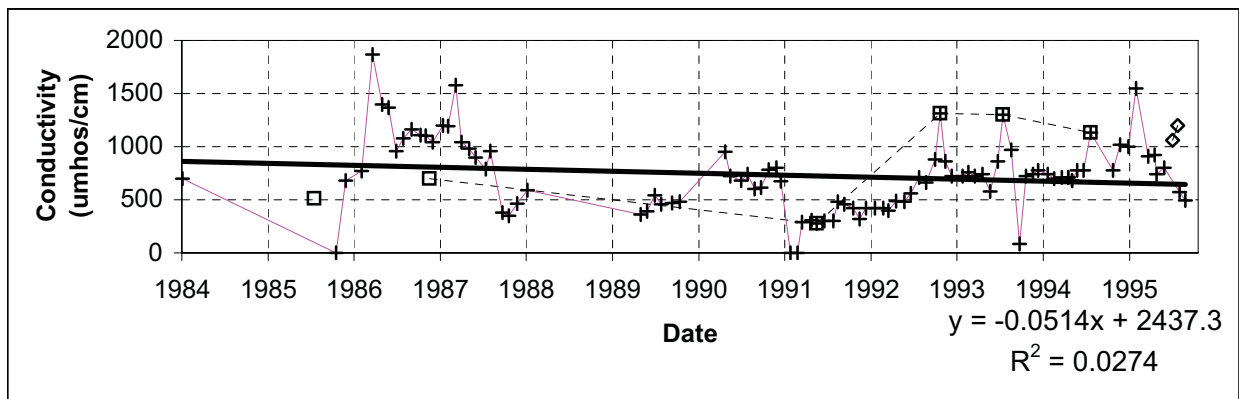
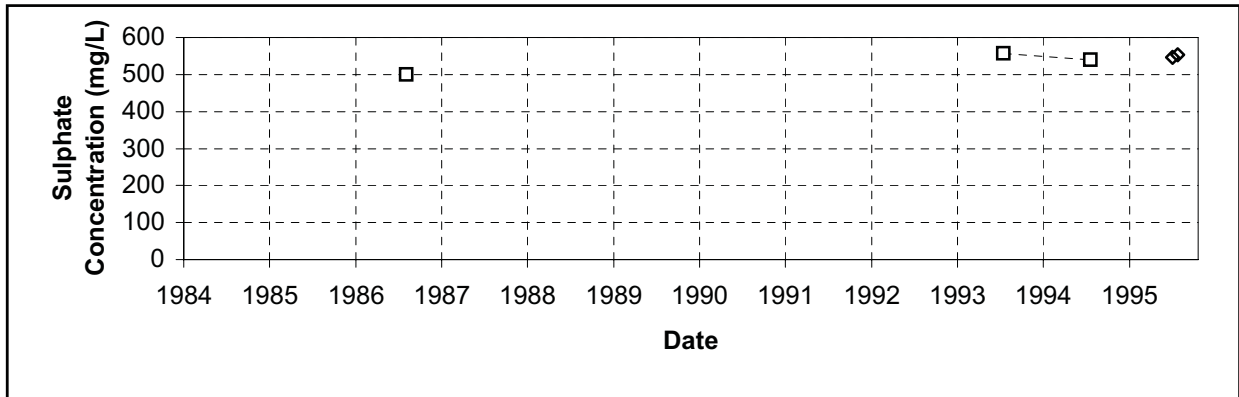
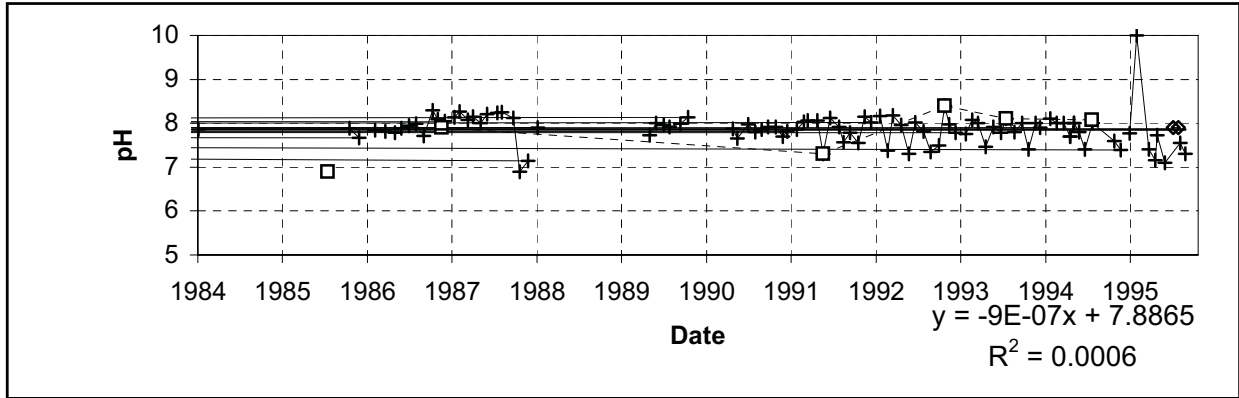
This station is sometimes referred to as the “600” adit but is more correctly the 625 level.

Since exploration began again in 1994, the flooded underground workings have been dewatered and pumping continues. The water quality data summarized in Figures 6-31 and 6-32 show:

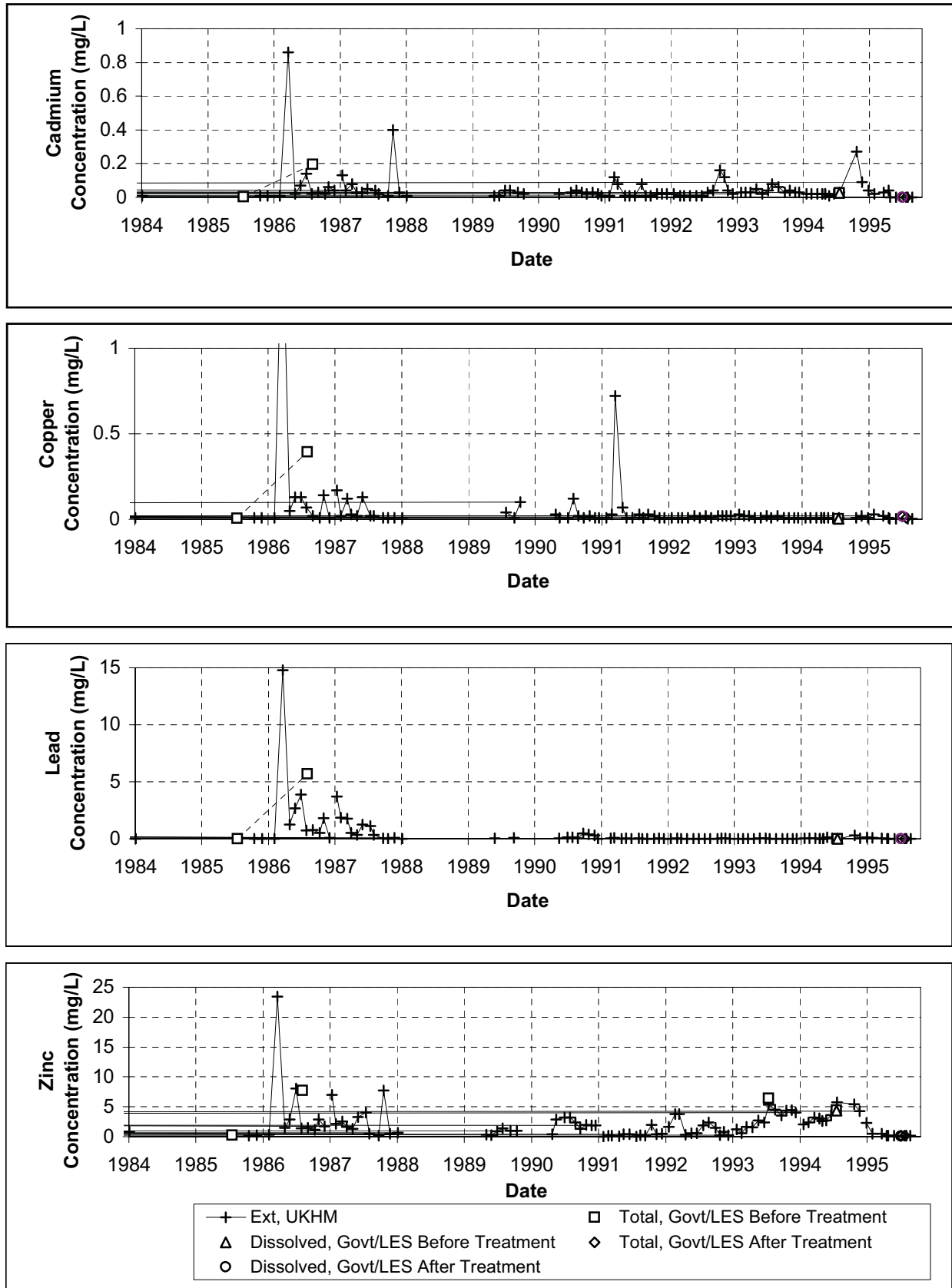
- consistently alkaline pH values, between 7 and 8;
- variable conductivity values in the range of 700 $\mu\text{mhos/cm}$, but no clear and consistent change over time in conductivity, sulphate or TDS;
- no clear seasonal variations in either drainage chemistry or flow, indicating that there is little surface recharge to the workings;
- the UKHM and government data sets are reasonably consistent in the 1990's, with the exception of conductivity measurements;
- iron concentrations are very low, consistent with the alkaline pH and lack of sulphide oxidation;
- data from the company indicate that there have been cadmium values above detection, however analyses at independent laboratories consistently show total cadmium at $<0.05 \text{ mg/L}$;
- zinc is the only metal to show an apparent increase in the last three years however the values in 1993/94 are comparable to those in the mid 1980's;
- high Pb and Zn during production in 1985 to 1988 (no settling pond).

Thus Bellekeno underground workings, and therefore the associated waste rock, are not of concern with respect to ARD. The chemistry of the drainage water appears to be reasonably constant with time, and there are no parameters which indicate that there is an ARD “problem” developing. Leaching of zinc, probably from oxidation of zinc sulphides, is the only real concern from this adit. It appears from the data that zinc concentrations in the range of 2 mg/L can be anticipated although monitoring must continue to be evaluated, to determine if there is an increasing trend (beyond the 1980's level).

Bellekeno 600 Adit (S 12)
(LES 39)



Bellekeno 600 Adit (S 12)
(LES 39)



6.2.15 Receiving Waters

Sampling stations are located along each of the creeks and rivers in the study area. The locations of stations were selected to address three main issues:

- identification of the sources and sinks for contaminants along the natural water courses;
- identification of “background” water chemistry i.e. in areas unaffected by mining; and,
- effect of the different mine discharge areas on the quality of water and therefore aquatic life in the receiving environment.

As seen in Figure 6-1, there are a large number of stations along Christal Creek, Flat Creek, Galena Creek. These data are presented in the Appendices, and used for the load balance model. Following this section, there is a series of graphs which illustrate the changes over time and in some cases changes with flow, for these stations. A few of the key stations are discussed below to highlight current water chemistry. The detailed discussions are presented with the site contaminant loading balances and the impact assessment in Chapter 8.

As a general observation, the UKHM data for receiving waters tend to show concentrations of metals higher than do the external data sources when values approach detection. All data sets are shown on the figures and used to discuss trends in water chemistry, however, the discussion of specific concentrations is generally based on sampling by external laboratories.

6.2.15.1 South McQuesten River upstream from Christal Creek (LES 1)

As seen on the map, this station most closely represents the upstream or background station on the River for the Elsa area. The results are summarized in Figures 6-33 and 6-34.

8. Assessment of Impacts

8.1 Introduction

This section discusses the impacts of the UKHM Elsa operations on the local receiving environment, including aquatic and terrestrial resources and other resource users. The previous chapters have discussed the property history, regional setting and provided a detailed description of the individual project components. These, with the site water chemistry and geochemical testing program discussed in the preceeding two chapters provide the basis for the impact assessment.

Undertaking an impact assessment at an existing mine site presents unique challenges. The local environment was not characterized prior to commencement of mining activities as is now typically done for new mining projects. Pre-mining or baseline environmental conditions were not established and therefore the basis for comparing and assessing impacts on the surrounding environment is made more difficult. In addition, while each mine site is relatively small, the area of activity is quite large, and is influenced by other mining activities and local land usage. Multiple watersheds are affected by development activities.

The approach taken for the impact assessment has been to recognize and use the local property history, field studies and existing site information to establish the present environmental conditions. Experience at other mine sites has indicated that while terrestrial and other resources users impacts may be significant, the effects are limited to a local area, when compared to potential impacts associated with surface water quality contamination and aquatic resources. Therefore, in this assessment, emphasis was placed on understanding and assessing impacts on the aquatic resources.

Water flow and contaminant loading balances (Section 8.2) are used to quantify contaminant loads and concentrations and thus provide a basis for environmental impact assessment (Section 8.3). This section integrates the information provided in the previous chapters in an overall impact assessment. Since the loading balances, and hence the impact assessment, are done for the catchments as a whole, they include the effects of all activities within each watershed. Many of the historic, and in some cases

current, activities are not controlled by UKHM - or were not operated by UKHM. Clearly, however, it is not possible to separate the impacts attributable to development by others.

8.2 Site Water and Chemical Loading Balances

8.2.1 General

One of the prime objectives of the closure plan for the UKHM Elsa site is the protection of aquatic resources which can be achieved by alleviating contaminant loadings to the receiving environment, and particularly the South McQuesten River. Given the complexity and extent of the UKHM site workings, it was essential to develop a water balance and contaminant loading balance for the study area in order to:

- identify the sources and the sinks for contaminants;
- quantify the contaminant loading from the workings and in the receiving environment; and,
- from the above, determine the potential environmental impacts and therefore set priorities for closure and remediation measures.

The subsections below describe the steps undertaken to construct the water and chemical loading balances.

8.2.2 Mine Site Water Balance

Development of the water balance essentially involved two broad steps, namely:

- to conceptualize the mine site as a system of components; and,
- to quantify the amount of flow generated by the said components.

The results of performing the first task are graphically illustrated in the water balances of Figures 8-1 and 8-2. The legend for the two figures is provided in Figure 8-3. The boxes and circles on these figures are used to symbolize the various system components. In developing the conceptual representation of the mine site, three different types of system components were identified, namely sub-catchments, point sources, and water treatment facilities. Each of these types has been assigned its own

symbol on the figures. Lines and arrows are used on the figures to show the movement of water between the various system components.

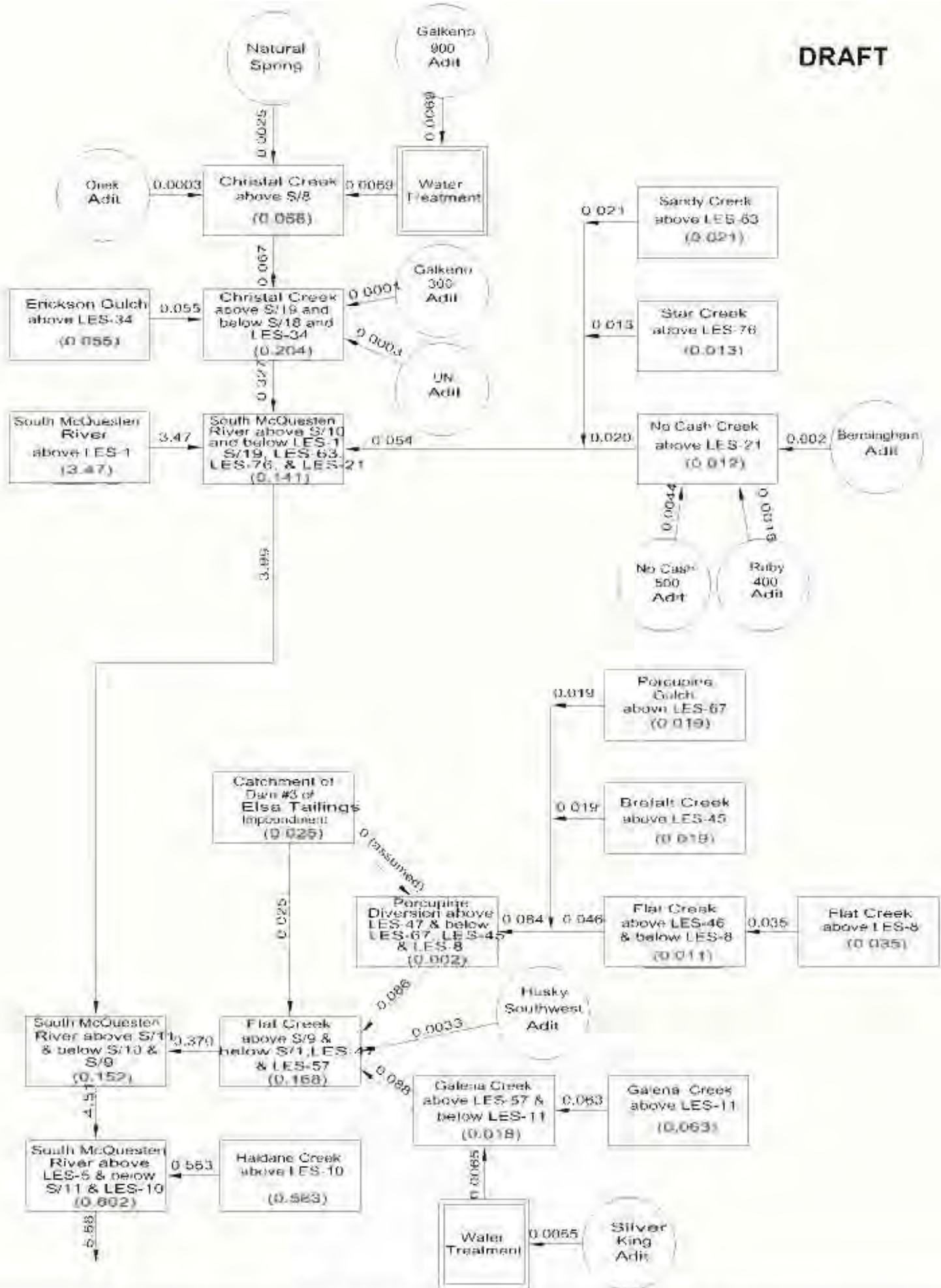


Figure 6-55a. Average Annual Water Balance -
Minesite Drainages within the South McQuesten Watershed



Lightning Creek Watershed

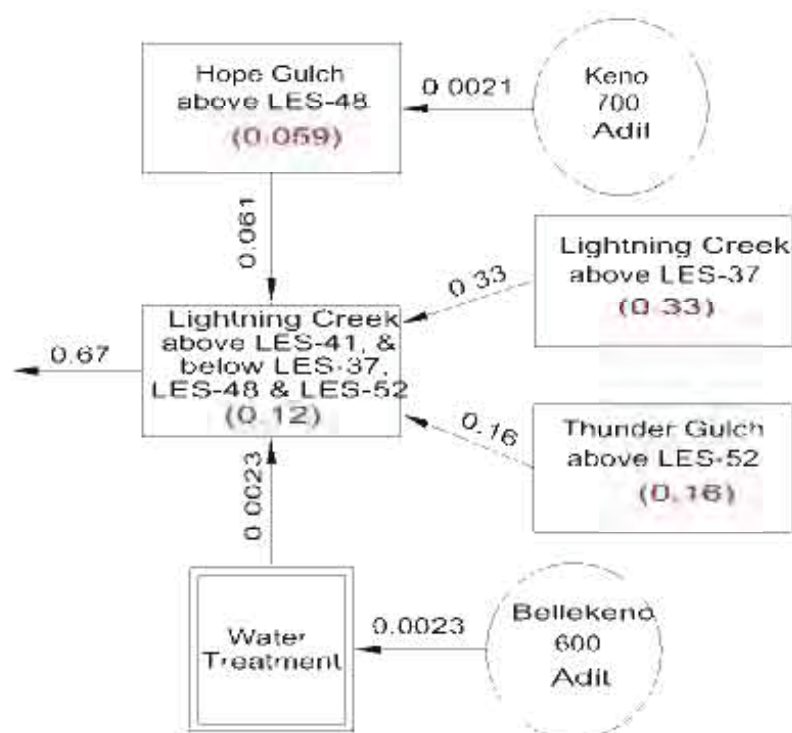


Figure 6-55b. Average Annual Water Balance Schematic - Minesite Drainages within the Ladue Creek and Lightning Creek Watersheds

LEGEND



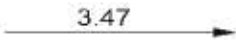
Catchment (bracketed number denotes estimated mean annual runoff generated by catchment in $\text{m}^3/\text{s}.$)



Point source (e.g., discharge from adit or spring.)



Water treatment facility



Flow line (number denotes estimated average annual flow in $\text{m}^3/\text{s}.$)

Figure 6-55c. Legend for Minesite Water Balances

The most important type of system component is the sub-catchment. For the purpose of developing the water balance, the mine site was subdivided into a total of 24 of these, as dictated by the locations of water quality sampling points and streamflow gauging stations. The outlines of the adopted subcatchments were discussed in Chapter 3, and are shown in Figures 3-6 and 3-7.

The conceptual representation of the mine site also includes a total of 14 point sources. These comprise discharges from 13 adits and a single spring. In addition, the conceptual representation includes three water treatment facilities, one each at the portals of the Galkeno 900, Silver King, and Bellekeno 600 Adits.

Having developed a conceptual representation of the mine site, the next step in preparing the water balance was to estimate the flows generated by each of the system components. This was accomplished by using either of two approaches. The first involved using site-specific data (i.e., records of measured flows collected at points within the mine site). The second entailed using synthesized flows which were derived by a technique known as regional analysis. This technique involved making correlations between the runoff measured at regional streamflow gauging stations and the physiographic characteristics of the catchments which generated the runoff. The resulting correlations were then used to predict flows at ungauged sites. A description of the regional analysis performed for the UKHM mine site is presented in Section 3.7.

In general, the site-specific data were used to assess the average flows emanating from the point sources. Regional analysis, on the other hand, was used to estimate the average flows generated by the subcatchments. The ideal situation would have been to use site-specific data to assess the magnitude of all the water balance flows, not just those of the point sources. This situation, however, could not be met because the measured flows on the mine site streams are, as yet, too limited to accurately characterize the sub-catchment runoffs. In a few years time, this story should be different when longer streamflow records have been collected at the five streamflow gauging stations which were established at key points around the mine site during 1994 and 1995 (see Appendix III for details).

The estimated flows for the water balance are presented on Figures 8-1 and 8-2. All flows represent the long-term average discharge rate, expressed in units of cubic metres per second.

In examining Figures 8-1 and 8-2, the reader should note the following two points about the water balance.

- a) The mine site straddles three drainage divides and, accordingly, its runoff may drain to any one of three watersheds (i.e., the South McQuesten River, Ladue Creek, or Lightning Creek). Figures 8-1 and 8-2 were organized to reflect this fact. The northern slopes of Keno Hill drainage directly to the Keno Ladue River. The southern slopes of both Keno Hill and Galena Hill drain to Duncan Creek, which in turn discharges to the Mayo River. The remainder of the mine development drains to the South McQuesten River, a major tributary of the McQuesten River. This latter portion of the mine site includes the northern and eastern slopes of Galena Hill and the western flank of Keno Hill. Most of the drainage from this latter portion is conveyed to the South McQuesten River by either Christal Creek or Flat Creek.
- b) An effort was made to avoid, at least partially, any double accounting of the adit discharges within the water balance. This was accomplished by using only the effective drainage areas in estimating the sub-catchment runoffs (i.e., all enclosed basins which drain to the mine site open pits were excluded in the runoff calculations). The runoff which flows into the open pits is undoubtedly a significant source of the waters which discharge from many of the mine site adits.

8.2.3 Mine Site Loading Balance Calculations

This section describes the steps undertaken to establish the present-day chemical loadings generated at the UKHM mine site. Chemical loadings were obtained by the product of concentration and flow. As described in Sections 6.1, UKHM maintains an extensive network of water quality monitoring stations at the mine site. The data collected at this network were used to specify the required chemical concentrations for

the load calculations. The information assembled above for the mine site water balance was used to specify the flow component of the load calculations.

Load estimates were prepared for two contaminants, namely sulphate and zinc. Sulphate was selected both because it is a relatively conservative parameter (chemically), and because it is an indicator of oxidation and reduction processes. Zinc, on the other hand, was identified as the primary contaminant released from the mine development to the receiving environment.

Earlier in this chapter the water balance for the site catchments was shown (Figures 8-1 and 8-2). This water balance is also the basis for the contaminant load balances. These loading balances are useful to identify contaminant sources and to evaluate the impact of alternative closure measures, which leads to the evaluation of environmental impact at closure.

The complete water chemistry database was used to evaluate trends in water quality, as discussed in Chapter 6.2. For the loading balances, the water quality data collected since 1990 were used as this period contains reasonably detailed data for both water flow and water chemistry. In addition, the data are reasonably consistent from year to year, and did not have any data sets which would bias the data; that is, no data showed a significant trend that would be “damped” by averaging over a three to five year period.

The loading calculations were done first on an annual average basis to understand the loadings to the environment for each of the catchments, using a spreadsheet model. The stations evaluated on an annual basis included those which were recently established, as part of the water chemistry characterization program for this study. For these stations, the record is not sufficient for seasonal analyses to be meaningful. These calculated values are presented in the schematics for each catchment described in the following section.

An examination of the data for the receiving waters and for the adit discharges revealed that there were distinct seasonal trends in both flows and water chemistry. In recognition of these seasonal trends, the load calculations were performed on a seasonal basis to improve the accuracy of the estimated annual total loadings.

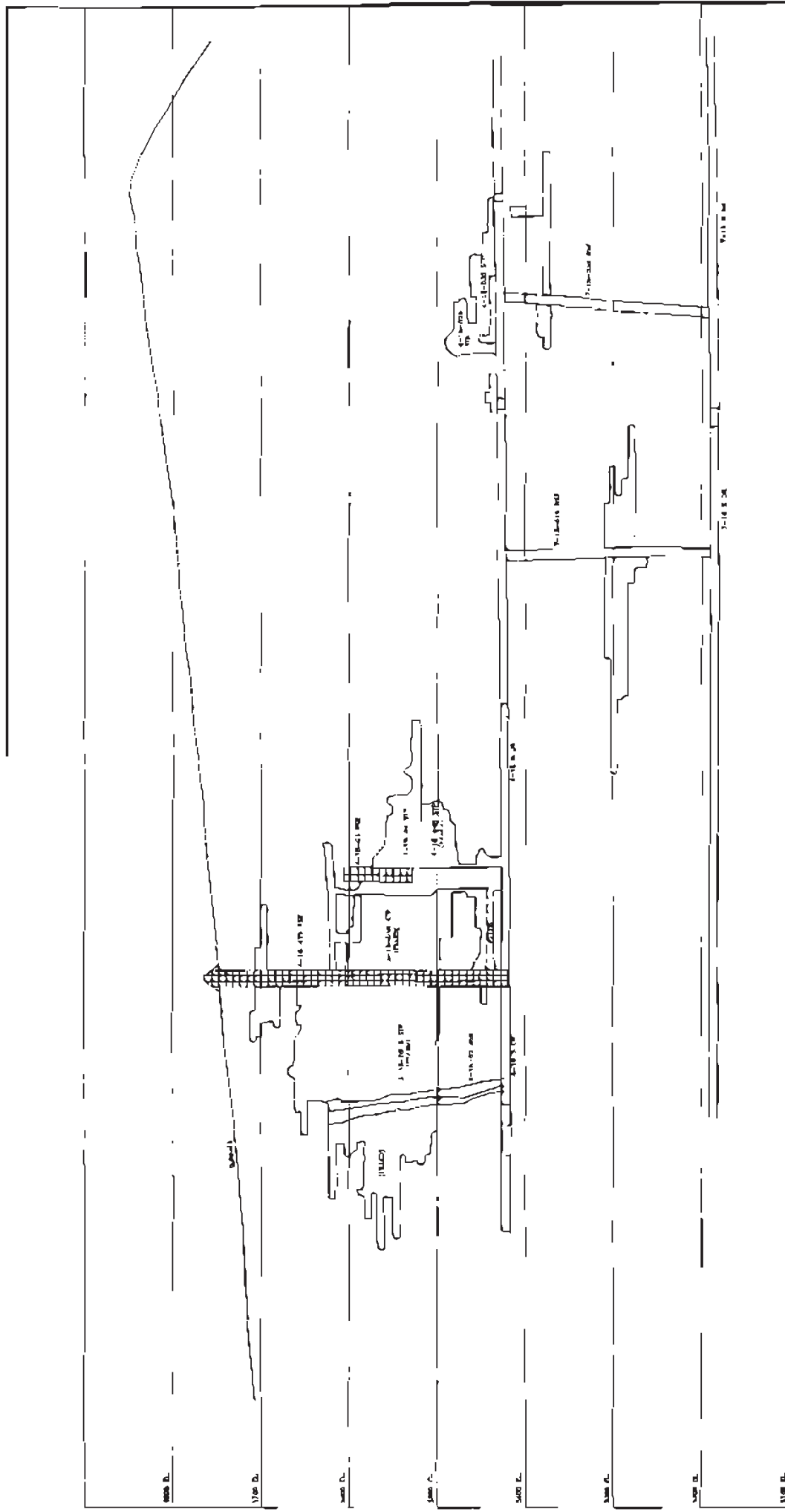
A spreadsheet model was developed to facilitate the calculation of the chemical loadings on a seasonal basis. This model was set-up to operate on quarterly periods (i.e., January to March, April to June, and so on). Figures 8-1, 8-2 and 3-6 are graphical representations which illustrate the basic structure of the spreadsheet model. As can be seen from these figures, the spreadsheet model is constructed of an interconnected network of channel elements. These elements are used to simulate the movement of water and chemical loadings throughout the mine site. Each element can receive inflows of water and loadings from a number of different sources, namely flows at the upstream end of the channel, lateral flows along the length of the channel, and point discharges (e.g. adit discharge).

The output created by the spreadsheet model is presented in Appendix X for the scenarios discussed below. This output shows:

- the basis for all water flow estimates including drainage areas and estimated unit runoffs for the subcatchments; and,
- a description of the sources of data used to characterize the water chemistry for each point of interest on the mine site drainages.

8.2.4 Discussion of Loading Balances

It has long been recognized for the UKHM Elsa site that drainage from the adits is probably the most significant source of metals released from the site. The tailings deposits in the Flat Creek valley have also been perceived as a significant source of metals and various types of water treatment have been used over the past 20 years, primarily for control of zinc in the decant. A graphical comparison of these loadings is presented in Figure 8-4. This figure is particularly useful for understanding the relative contributions of metal loads from the different sources, and for comparison with loadings within and around each catchment as shown in the subsequent detailed loading balances.



UNITED KENO HILL MINES LIMITED
MINE WORKINGS

SHAMROCK MINE, J-TA VEIN
VERTICAL LONGITUDINAL SECTION (Looking NWS) (Hwy 21)

SCALE: NONE .FILE: SHAMISEC.DWG DATE: 24/05/24

Figures 8-5 and 8-6 show the calculated sulphate loading balance for the “current conditions”, based on the data since 1990. A legend for these figures is found in Figure 8-7.

While sulphate is not a water quality concern in itself at Elsa, it is often used in water and load balances at sites where sulphide oxidation and leaching is an issue, since it is considered a conservative parameter. At UKHM, sulphate is also important as the water quality data indicate that there is attenuation of metals from drainage water within the natural environment, particularly within the natural wetlands areas. The mechanism of metal removal is believed to be sulphate reduction and subsequent metal sulphide precipitation. In these models therefore, sulphate is not “conservative” but rather provides an indication of sulphate reduction in appropriate wetland areas.

Zinc has been chosen as the metal of interest for the load balances since it is the main contaminant of concern for the site, and also since it is a good indicator of other metals in solution, as discussed in Section 6.2. The zinc loading balance was evaluated for two time periods, reflecting the effects of both remediation and exploration activities on site water quality:

- the period from 1990 to fall of 1993 which is prior to the installation of the Galkeno 900 plug and water treatment to control the discharge of zinc from the adit; and,
- the period from late 1993 to present which represents “current” conditions, based on the external sampling data, i.e. not the internal UKHM monitoring data for both the Galkeno 900 and the Silver King water treatment.

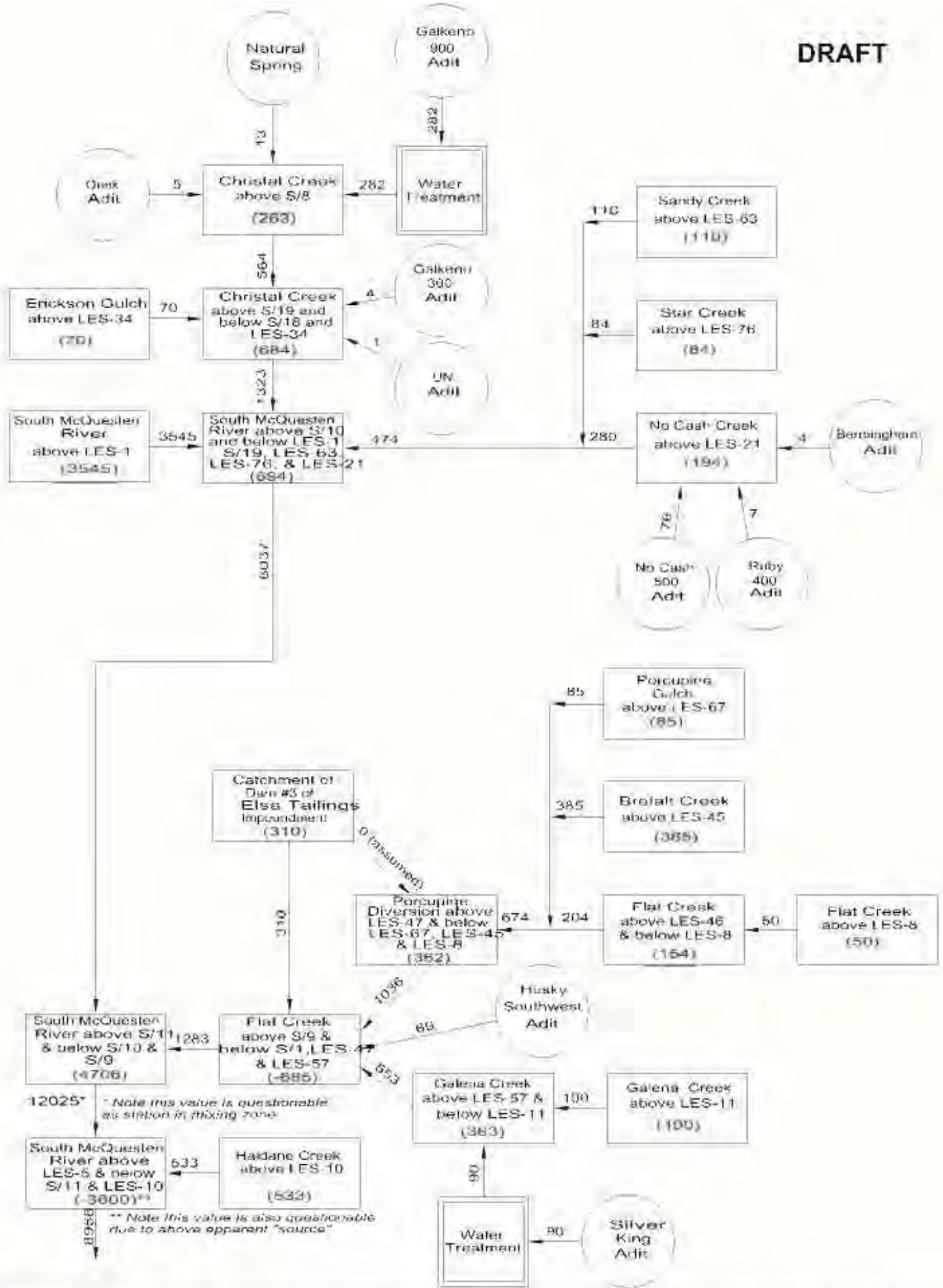


Figure 6-58a. Current Average Annual Sulphate Balance Schematic Minesite Drainages within the South McQuesten Watershed

Ladue Creek Watershed

DRAFT



Lightning Creek Watershed

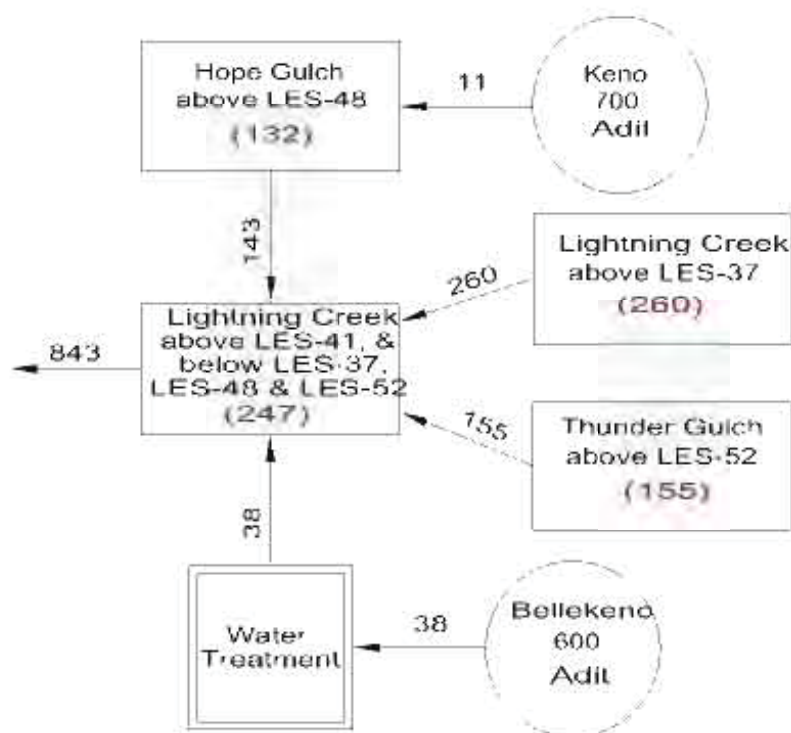


Figure 6-58b. Average Annual Sulphate Balance Schematic - Minesite Drainages within the Ladue Creek and Lightning Creek Watersheds

LEGEND



Catchment (bracketed number denotes estimated mean annual sulphate load generated by catchment in tonnes.

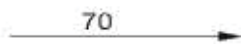
A negative value indicates a net sink for zinc in catchment.)



Point source (e.g., discharge from adit or spring.)



Water treatment facility



Flow line (number denotes estimated mean annual sulphate load in tonnes.)

Figure 6-58c. Legend for Sulphate Load Balances

Figure 8-8 shows the zinc loading for the South McQuesten watershed for conditions prior to any exploration or remediation measures, as does Figure 8-9 for the Ladue Creek and Lightening Creek watersheds. In 1993 the plug and water treatment remediation measures were put in place on Galena Hill, and Figure 8-10 shows the calculated zinc loadings in the South McQuesten watershed as a result of these measures. Figure 8-11 is the legend for these figures.

As discussed in Chapter 6, there are apparently sources of metal loading from some of the waste dumps and adit discharge. However, monitoring of the receiving environment to date does not show zinc or sulphate loadings from these sources in the downstream receiving environment. In 1995, shallow groundwater monitoring was installed at the toe of several of these dumps installed to provide additional data regarding the loadings from these dumps.



Lightning Creek Watershed

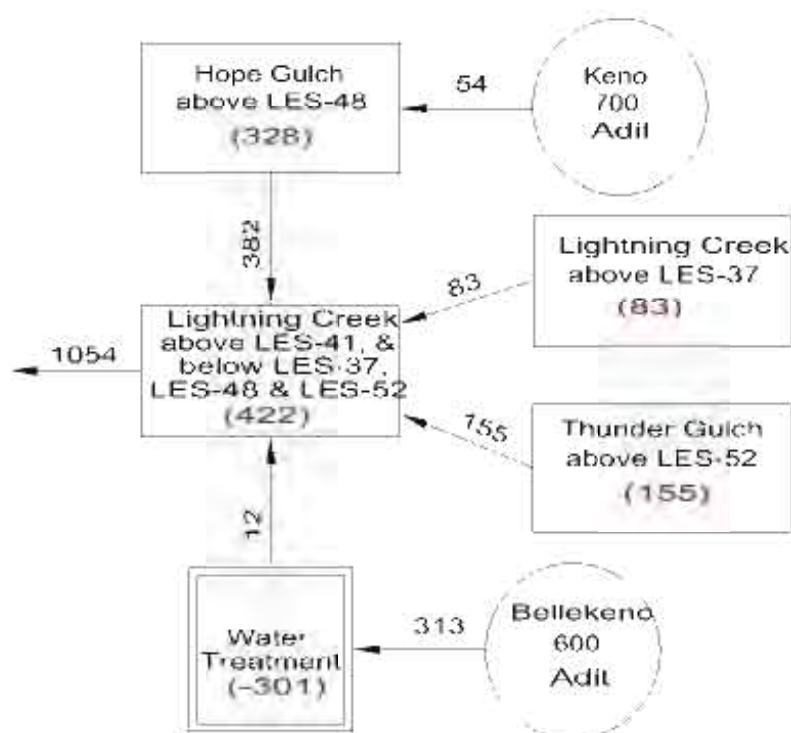


Figure 6-59b. Average Annual Total Zinc Balance Schematic - Minesite Drainages within the Ladue Creek and Lightning Creek Watersheds

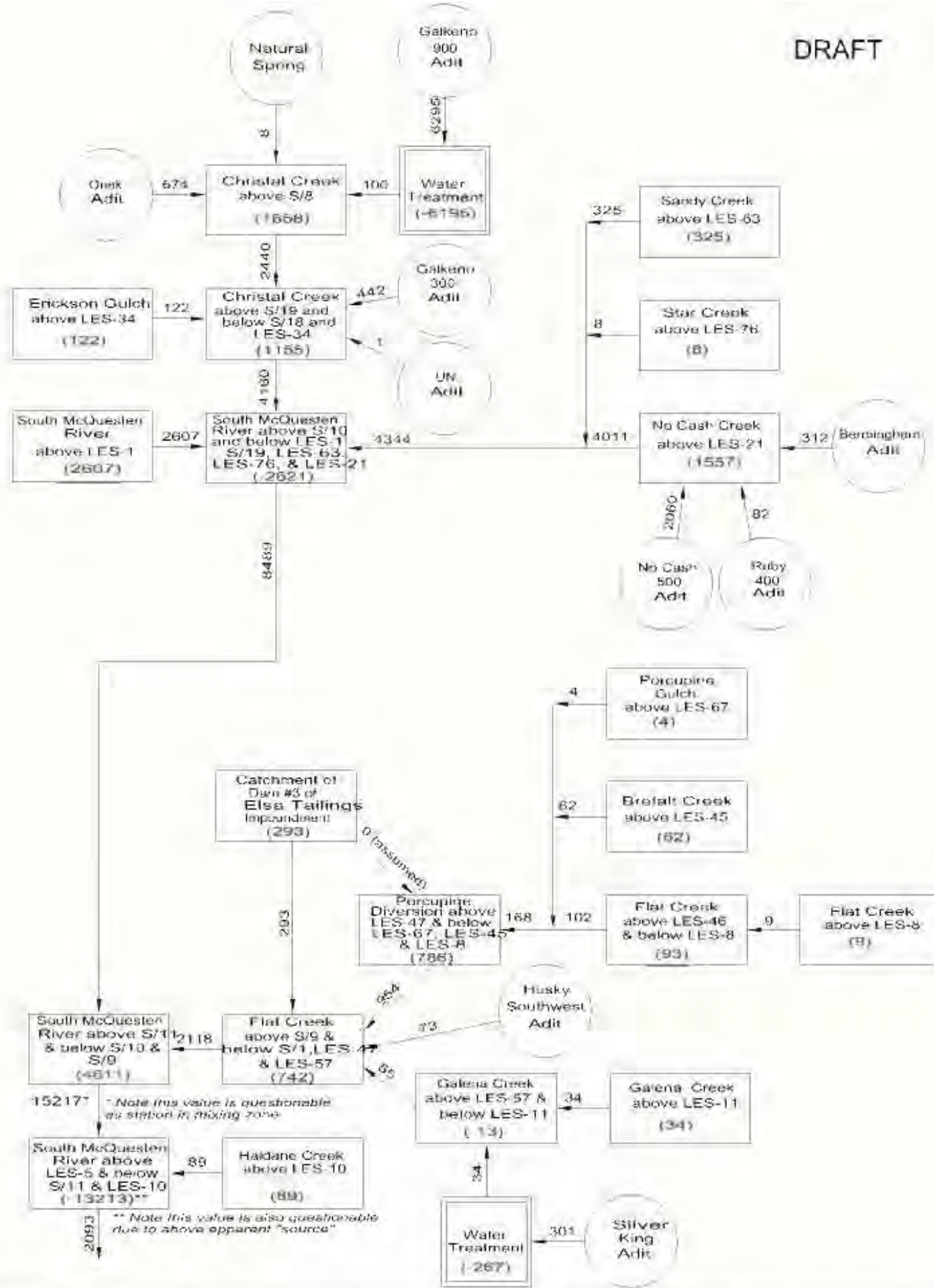
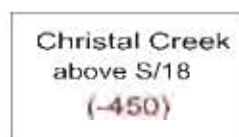


Figure 6-59a. Current Average Annual Total Zinc Balance Schematic Minesite Drainages within the South McQuesten Watershed

LEGEND



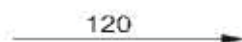
Catchment (bracketed number denotes estimated mean annual zinc load generated by catchment in kg. A negative value indicates a net sink for zinc in catchment.)



Point source (e.g., discharge from adit or spring.)



Water treatment facility



Flow line (number denotes estimated mean annual zinc load in kg.)

NOTE: The numbers on Figures 6-59a and 6-59b represent total metal content, i.e. dissolved zinc plus particulate zinc.

Figure 6-59c. Legend for Zinc Load Balances

8.2.5 Observations from Loading Balances

8.2.5.1 General

The loading balances are useful to identify key sources and sinks for contaminants. The results presented in Figures B-1 through B-11 show:

- the main sources of zinc loadings are the Galkeno 900 adit and the No Cash 500 adit;
- it is interesting note that there appear to be additional sources or sinks within some of the subcatchments for zinc and, to a lesser degree, sulphate;
- while there are significant zinc loads issuing from the Galkeno and No Cash adits, there appears to be considerable capacity for attenuation of zinc in the watersheds. Using the average data, the zinc load contributed from these two adits appears to be removed (possibly by mechanisms discussed in the water chemistry and Galkeno 900 sections) as loadings in the South McQuesten upstream and downstream of the site seem to decrease from the data set;
- the change in sulphate loading the South McQuesten from upstream of the mine to downstream shows that the mine drainage are reaching the South McQuesten River. There is some removal of sulphate locally (Flat Creek) but overall there is an increase in sulphate loading to the river, corresponding to an change in concentration from 30 to 50 mg/L, similar to background values;
- the loadings in both the Ladue Creek and Lightning Creek watersheds are insignificant compared to the sources in the South McQuesten watershed and still correspond to zinc concentrations of about 0.05 mg/L and 40 mg/L sulphate;
- there is a significant load of zinc and sulphate from upstream of the mine (station LES-1) on the South McQuesten River. The source is probably from the Earn Group, as discussed in both the geology and water chemistry sections.

8.2.5.3 Effect on the Receiving Environment of Treatment at Bellekeno 500

Treatment of the Bellekeno adit discharge waters would affect the water chemistry initially at station LES-41 on Lightning Creek. Since the monitoring data are limited for this station, particularly for the period prior to treatment, the evaluation of the effect of treatment on the receiving environment is based on calculation of loadings without treatment:

Figure 8-5 shows that, with treatment of Bellekeno adit discharge, Lightning Creek receives zinc loadings from other upstream "natural" sources resulting in a concentration of about 0.05 mg/L total Zn. With treatment, the Bellekeno adit drainage contributes about 1% of this load of zinc, and about 5% of the total load of sulphate in Lightning Creek. Without water treatment, the contribution of the Bellekeno adit discharge would result in a zinc concentration of about 0.06 mg/L Zn in Lightning Creek.

8.2.5.4 Effect on the Receiving Environment of Treatment at Silver King

The effects of discharge of the adit drainage from Silver King would first be evident in Galena Creek, and then in Flat Creek at Station S-9. Figure 8-13 shows the data at Station S-9, with relatively little change over the period when water treatment was installed. This is perhaps not surprising given that the adit discharge, even at the source, only represents 15% of the total load observed at S-9. It is also anticipated that there would be some removal of metals along the flowpath, decreasing the metal load.

Using a similar analysis to the above for Bellekeno, and with similar cautions about the receiving water database, the effect of water treatment for the Silver King adit discharge of the adit water would result in a significant increase in zinc concentrations in Galena Creek immediately below the discharge (station LES-57), although the predicted concentration is comparatively low at 0.12 mg/L. The change in concentrations at S-9, in Flat Creek, would not be detectable however based on previous data and flow calculations.



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

APPENDIX I

**GEOTECHNICAL EVALUATION – POTENTIAL MILL SITES
BELLEKENO PROJECT NEAR KENO CITY, YUKON**

DECEMBER 2008

Prepared by: EBA Engineering Consultants Ltd.

December 8, 2008

EBA File: W14101178

Alexco Resource Canada Corp.
3-151 Industrial Road
Whitehorse, Yukon Y1A 2V3

Attention: Mr. Rob McIntyre
Vice President

**Subject: Geotechnical Evaluation – Potential Mill Sites
Bellekeno Project near Keno City, Yukon**

1.0 INTRODUCTION AND BACKGROUND

Alexco Resource Canada Corp. (Alexco) is evaluating potential sites for the construction of a mill and dry-stacked tailings facility (DSTF) for their Bellekeno mine and further mines near Keno City and Elsa, Yukon. Alexco and EBA Engineering Consultants Ltd. (EBA) selected three potential sites out of an original set of nine for further evaluation. The original nine sites were evaluated in August 2008 through a visual appraisal by Richard Trimble from EBA and Rob McIntyre from Alexco. The geotechnical suitability was based on existing knowledge of the area.

Alexco retained EBA to undertake a preliminary geotechnical investigation at each of the three short-listed potential sites using an air track rotary drill. The purpose of the investigation at each site was to provide geotechnical information to be used in the final selection of a site, and subsequent design of the mill foundation and DSTF.

The recommendations included herein are based on geotechnical information from the investigation conducted on site. This report has been prepared in accordance with generally accepted Geotechnical Engineering practices. For additional conditions regarding this report, please refer to the attached General Conditions.

1.1 PROJECT DESCRIPTION

The three short-listed potential sites investigated were Mackeno, Onek, and Bellekeno. All three sites are located near Keno City, Yukon, and shown on Figure 1.

Mackeno lies approximately 2 km west of Keno City just south of the Silver Trail Highway. Locally, the site is divided into an upper and lower bench. The upper bench is located on a bedrock shelf. The approximate UTM (NAD83 datum) coordinates of the site are 7,087,670 N and 483,920 E in Zone 8 on the mapsheet 105 M/14.

Onek is located approximately 1 km to the northeast of Keno City near the existing Onek open pit. Locally, the site lies at the entrance ramp to the open pit. The approximate UTM

(NAD83 datum) coordinates of the site are 7,087,300 N and 485,600 E in Zone 8 on the mapsheet 105 M/14.

Bellekeno lies approximately 3 km east of Keno City on the south side of Lightning Creek, near the Bellekeno 625 portal. Locally, the site lies on the hillside adjacent to Lightning Creek. The approximate UTM (NAD83 datum) coordinates of the site are 7,087,130 N and 487,260 E in Zone 8 on the mapsheet 105 M/14.

2.0 SITE INVESTIGATION

The geotechnical investigation was conducted on October 29 and 30, 2008 and included advancing 15 boreholes to depths ranging from 3.5 m to 18.0 m. The distribution of boreholes by site is summarized in Table 1. Detailed borehole logs are attached to this report.

TABLE 1: DISTRIBUTION OF BOREHOLES BY LOCATION

Site Location	Number of Boreholes	
	Mill	Tailings
Mackeno Upper Bench	3	-
Mackeno Lower Bench	-	4
Onek ⁽¹⁾	3	-
Bellekeno	2	3

(1) If Onek site is selected, tailings will be deposited in existing open pit.

Golden Hill Ventures Ltd. of Whitehorse, Yukon provided a 345 Hydraulic Reed Drill rig with a 100 mm bit for the investigation. Mr. Justin Pigage, EIT, was EBA's representative onsite and conducted all of the borehole logging and sample collection. The drill cuttings collected were returned to EBA's Whitehorse laboratory for index property testing. Results from moisture content testing are shown on the attached borehole logs.

The borehole coordinates were determined in the field with the use of a handheld GPS unit accurate to 10 m. All coordinates are UTM, based on NAD83 datum. The borehole elevations were obtained by importing the borehole coordinates picked up by the handheld GPS into a 1 m contour map of the area provided by Alexco.

3.0 MACKENO

3.1 SITE CONDITIONS

3.1.1 Surface Features

Surface features at the site were difficult to discern due to snow cover but observations at the borehole locations indicate a sand and gravel fill on the surface of the top bench and an organic ground cover supporting willow shrubs and small coniferous trees on the lower bench. The local topography consists of a flat upper bench and a lower bench that slopes west towards Christal Lake. The two benches are separated by a slope approximately 10 m in height with a slope angle of approximately 25°.

3.1.2 Subsurface Conditions

The subsurface conditions at the site were determined through interpretation of data from the seven boreholes advanced by EBA on October 29, 2008.

The subsurface conditions encountered on the lower bench of the Mackeno site consisted of overburden soil that was gravelly silt and sand. The bedrock interface was not encountered in any of the boreholes in this area and drilling was halted at a depth of 8.0 m because the drill lost circulation and cuttings were not returned to the surface.

The subsurface conditions on the upper bench of the Mackeno site consisted of a gravel and sand fill containing a trace of silt over bedrock. The bedrock was identified as quartzite by comparing geology maps with recovered drill cuttings. The bedrock interface ranged in depth from 0.4 to 4.1 m. A summary of the subsurface conditions encountered on the upper bench at Mackeno is shown in Table 2.

TABLE 2: MACKENO UPPER BENCH – SUBSURFACE CONDITIONS

Subsurface Conditions	Strata Depth Range (m)		
	W14101178-BH01	W14101178-BH02	W14101178-BH03
SAND AND GRAVEL (Fill)	0 – 3.5	0 – 4.1	0 – 0.4
BEDROCK	--	4.1 – 8.0	0.4 – 7.0
End of Borehole	3.5	8.0	7.0

3.2 GROUNDWATER

Groundwater was not confirmed in any of the boreholes at the Mackeno site. However it appears groundwater may be shallow on the lower bench of the site.

3.3 PERMAFROST

Permafrost was not encountered in any of the boreholes on the upper bench of the Mackeno site.

Elevated moisture contents in the drill cuttings returned to the surface on the lower bench of the Mackeno site indicate possible permafrost.

3.4 RECOMMENDATIONS

3.4.1 Mill Foundation

EBA recommends building the mill on standard concrete spread and strip footings. The underside of the footings should be at least 1.2 m below the final graded surface.

The mill foundations can be designed and constructed based on the following recommendations:

- All existing fill and any old organic layers or soil must be excavated, to expose competent bedrock, from the entire building footprint plus an additional 1 m outside the footprint for every 1 m of excavation depth (i.e. if the excavation is 5 m deep, the excavation crest should be 5 m out from the building edge in all directions).
- All existing fill should be excavated to at least 1 m below the final elevation of all parking areas, and the subgrade surface compacted using at least a 10 tonne vibratory drum roller prior to placement of any granular fills.
- Excavation should be backfilled with engineered fill or waste rock. If engineered fill is selected, follow recommendations in Option 1. If waste rock is selected, follow recommendations in Option 2.

Option 1: Backfill Excavation with Engineered Fill

- Subsequent to subcutting, the excavations should be backfilled to 0.15 m below the underside of the footing or parking area with a granular engineered fill that conforms to the specifications detailed in Table 3. The engineered fill should be placed in 0.3 m lifts and compacted to at least 98% of the maximum dry density using standard effort (as per ASTM D698) to an elevation 0.15 m below the bottom of any concrete element or the parking area final elevation.
- The existing fill may be acceptable as engineered fill; further testing is required to confirm this.
- The final 0.15 m below all concrete elements or parking areas should be backfilled with base course gravel conforming to the specifications detailed in Table 3. The base course

gravel should be compacted to at least 98% of the maximum dry density using standard effort (ASTM D698) prior to the placement of any concrete.

- Footings can be designed on the basis of an allowable static net bearing pressure of 250 kPa when constructed on an engineered fill consisting of materials meeting the particle size distributions in Table 3. The minimum allowable footing widths shall be 0.406 m for strip footings and 0.914 m for spread footings.
- Total elastic settlement of the footings founded on the engineered fill should be less than 25 mm with a maximum differential settlement of 19 mm.
- Footings must be cast onto clean compacted granular backfill. It is important that no loose or disturbed material be allowed to remain on the bearing surface of the footing excavation. An acceptable surface must be prepared by moisture conditioning and the use of mechanical compaction equipment.
- Footing excavations must be protected from the inflow of surface water at all times and footings should not be cast directly onto or over seasonally frozen soil.
- A moisture barrier, such as polyethylene sheeting, should be placed immediately beneath the floor slabs to enhance curing.
- Final site grading must direct all water away from the foundation elements of the structure. Ponding adjacent to the building must be prevented, as infiltration adjacent to the foundation elements could have detrimental effects on the structural elements. Runoff from the roof must be directed onto splash pads and away from the building. This is particularly important during the late fall, just prior to freeze-up.

TABLE 3: RECOMMENDED GRANULAR MATERIAL SPECIFICATIONS

80 mm Engineered Fill		20 mm Base Course Gravel	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
80.000	100		
25.000	55 – 100	20.000	100
12.500	42 – 84	12.500	64 – 100
5.000	26 – 65	5.000	36 – 72
1.250	11 – 47	1.250	12 – 42
0.315	3 – 30	0.315	4 – 22
0.080	0 – 8	0.080	3 – 6

Option 2: Backfill Excavation with Waste Rock

- If the fill material available does not meet the particle size distribution in Table 3, a level pad can be constructed of waste rock placed in lifts no thicker than 0.6 m to a final

depth of 0.45 m below the underside of footing. The waste rock must be moisture conditioned and compacted using a 10 tonne vibratory compactor to the satisfaction of the Engineer.

- Subsequent to waste rock fill placement a 0.3 m lift of engineered fill, that conforms to the specifications in Table 3, should be placed and compacted to at least 98% of the maximum dry density using standard effort (as per ASTM D698).
- The final 0.15 m below all concrete elements or parking areas should be backfilled with base course gravel conforming to the specifications detailed in Table 3. The base course gravel should be compacted to at least 98% of the maximum dry density using standard effort (as per ASTM D698).
- Footings can be designed on the basis of an allowable static net bearing pressure of 500 kPa when constructed on a waste rock pad. The minimum allowable footing widths shall be 0.406 m for strip footings and 0.914 m for spread footings.
- Total elastic settlement of the footings founded on the waste rock pad should be less than 25 mm with a maximum differential settlement of 19 mm.
- Footings must be cast onto clean compacted granular backfill. It is important that no loose or disturbed material be allowed to remain on the bearing surface of the footing excavation. An acceptable surface must be prepared by moisture conditioning and the use of mechanical compaction equipment.
- Footing excavations must be protected from the inflow of surface water at all times and footings should not be cast directly onto or over seasonally frozen soil.
- A moisture barrier, such as polyethylene sheeting, should be placed immediately beneath the floor slabs to enhance curing.
- Final site grading must direct all water away from the foundation elements of the structure. Ponding adjacent to the building must be prevented, as infiltration adjacent to the foundation elements could have detrimental effects on the structural elements. Runoff from the roof must be directed onto splash pads and away from the building. This is particularly important during the late fall, just prior to freeze-up.

3.4.2 DSTF Foundation

The proposed location of the DSTF at the Mackeno site requires further investigation before foundation and construction recommendations can be made. The subsurface conditions require further investigation including the determination of permafrost conditions, and depths to the bedrock interface. If this site is selected for the construction of the DSTF a supplemental geotechnical evaluation will be required.

3.4.3 Seismic Conditions

The 2005 National Building Code requires that a site classification be established for proposed buildings. Based on subsurface conditions noted, it is EBA's conclusion that the ground in the vicinity of upper bench of Mackeno corresponds to that which is described in Site Classification B, per Table 4.1.8.4.A, NBCC 2005.

4.0 ONEK

4.1 SITE CONDITIONS

4.1.1 Surface Features

Surface features at the site were difficult to discern due to snow cover but observations at the borehole locations indicate a sand and gravel fill on the surface near W14101178-BH08 and -BH09. The surface near W14101178-BH10 is a waste rock fill. There is no vegetative cover on the site with the exception of some willow shrubs near the perimeter. The local topography is a rolling site which slopes gently from east to west.

4.1.2 Subsurface Conditions

The subsurface conditions at the site were determined through interpretation of data from the three boreholes advanced by EBA on October 30, 2008.

The subsurface conditions at the Onek site consist of sand and gravel fill underlain by bedrock. The bedrock was identified through the use of geology maps as being quartzite and greenstone. W14101178-BH10 was located on top of the waste rock pile to determine depth of fill over the bedrock interface. The subsurface conditions encountered at the Onek site are summarized in Table 4.

TABLE 4: ONEK SITE – SUBSURFACE CONDITIONS

Subsurface Conditions	Strata Depth Range (m)		
	W14101178-BH08	W14101178-BH09	W14101178-BH10
SAND AND GRAVEL (Fill)	0 – 1.0	0 – 0.8	--
WASTE ROCK (Fill)	--	--	0 – 6.0
BEDROCK	1.0 – 8.0	0.8 – 8.0	6.0 – 12.0
End of Borehole	8.0	8.0	12.0

4.2 GROUNDWATER

Groundwater was not encountered in any of the boreholes at the Onek site.

4.3 PERMAFROST

Permafrost was not encountered in any of the boreholes at the Onek site.

4.4 RECOMMENDATIONS

EBA considers the Onek site suitable for the construction of a mill. A DSTF site was not evaluated because the current plan for the tailings at this site is placement in the existing open pit.

4.4.1 Mill Foundation

EBA recommends constructing the mill directly on competent bedrock.

Foundations for the mill at the Onek site can be designed and constructed based on the following recommendations:

- A subcut to remove overburden material down to competent bedrock.
- Footings can be designed on the basis of an allowable static net bearing pressure of 1000 kPa when constructed directly on competent bedrock.
- Backfill placed around the footings should conform to engineered fill gradation detailed in Table 3. The engineered fill should be placed in lifts no greater than 0.3 m and compacted to at least 98% of the maximum dry density using standard effort (as per ASTM D698).
- Footings must be constructed on a competent bedrock surface free from weathered bedrock, loose or disturbed material.
- Footings must be cast onto clean, competent bedrock. It is important that no loose or disturbed material be allowed to remain on the bearing surface of the footing excavation.
- Footing excavations must be protected from the inflow of surface water at all times and footings should not be cast directly onto or over seasonally frozen soil.
- A moisture barrier, such as polyethylene sheeting, should be placed immediately beneath the floor slabs to enhance curing.
- Final site grading must direct all water away from the foundation elements of the structure. Ponding adjacent to the building must be prevented, as infiltration adjacent to the foundation elements could have detrimental effects on the structural elements.

Runoff from the roof must be directed onto splash pads and away from the building. This is particularly important during the late fall, just prior to freeze-up.

4.4.2 Seismic Conditions

The 2005 National Building Code requires that a site classification be established for proposed buildings. Based on subsurface conditions noted, it is EBA's conclusion that the ground in the vicinity of the site corresponds to that which is described in Site Classification B, per Table 4.1.8.4.A, NBCC 2005.

5.0 BELLEKENO

5.1 SITE CONDITIONS

5.1.1 Surface Features

Surface features at the site were difficult to discern due to snow cover but observations at the borehole locations indicate an organic moss covering supporting willows and small coniferous trees. The local topography on site slopes downward from south to north with a slope angle of approximately 20°. The slope continues down to Lightning Creek with approximately the same slope angle.

There is a terrace of mined placer tailings between the slope and Lightning Creek. It appears that during placer mining the terrace was mined into soils at the toe of the slope. This could lead to long-term stability issues.

5.1.2 Subsurface Conditions

The subsurface conditions at the site were determined through interpretation of data from the five boreholes advanced by EBA on October 30, 2008.

The subsurface conditions consist of sand that is gravely and silty. Bedrock was not encountered in any of the boreholes. The drill lost circulation in the boreholes and prevented the return of cuttings to the surface. A summary of the boreholes and their respective depths is shown in Table 5.

TABLE 5: BOREHOLE DEPTHS AT BELLEKENO SITE

Borehole Number	Termination Depth (m)
W14101178-BH11 ⁽¹⁾	9.0
W14101178-BH12	18.0
W14101178-BH13	12.0
W14101178-BH14	6.0
W14101178-BH15	10.0

(1) Ground Temperature Cable installed to 8.0 m

5.2 GROUNDWATER

Groundwater was not encountered in any of the boreholes at the Bellekeno site.

5.3 PERMAFROST

The moisture content testing completed on the samples collected indicates elevated moisture contents attributed to either the presence of permafrost or increased silt contents of the soils. A ground temperature cable was installed in W14101178-BH11 to 8.0 m. Preliminary readings taken from the ground temperature cable indicate the presence of warm permafrost (-1 to -0.5°C). The ground measured temperature profile is shown in Figure 5.

5.4 RECOMMENDATIONS

EBA considers the Bellekeno site suitable for the construction of a mill and DSTF. The mill should be founded on rock-socketed steel pipe piles. The DSTF should be designed such that it does not cause degradation of the warm permafrost underlying the site.

5.4.1 Mill Foundation

EBA recommends constructing the mill on rock-socketed steel pipe piles drilled into competent bedrock. Competent bedrock was not encountered at the Bellekeno site and additional drilling will be required to finalize the pile design.

5.4.2 DSTF Foundation

Tailings produced during the milling process will have temperatures greater than the natural soils at the Bellekeno site. For this reason the DSTF must be designed such that it does not cause permafrost degradation which can lead to structural instabilities.

Further investigation into the permafrost at the Bellekeno site is required for the detailed design of the DSTF.

5.4.3 Seismic Conditions

The 2005 National Building Code requires that a site classification be established for proposed buildings. Based on subsurface conditions noted, it is EBA's conclusion that the ground in the vicinity of the site, subsequent to permafrost thaw, corresponds to that which is described in Site Classification E, per Table 4.1.8.4.A, NBCC 2005.

6.0 GENERAL CONSTRUCTION RECOMMENDATIONS

6.1 EXCAVATION SIDESLOPES

Excavation in permafrost is not recommended. In non-permafrost areas, stripping or general excavations should have the perimeter sloped back at an angle no steeper than 1H:1V; however, some sloughing of the excavation walls should be anticipated. Spoil piles should be kept a distance away from the excavation crest equivalent to or greater than the excavation depth. If the excavation is deeper than 1.2 m the sideslopes must be shored or shaped in accordance with the most recent edition of the Occupational Health and Safety Regulations.

6.2 SITE GRADING

Backfill around any foundation system should consist of free-draining granular material, capped with topsoil or other relatively impervious soils. All non-structural fill should be placed in lift thicknesses not exceeding 0.3 m and compacted to at least 95% of the maximum dry density using standard effort (as per ASTM D698). Final site grading should enhance positive drainage and direct water away from the structure.

6.3 CONCRETE

It is recommended that all concrete be designed, mixed, and placed in accordance with the most recent edition of the Canadian Standards Associations (CSA) standard CAN/CSA-A23.1. According to this standard, concrete should be designed to at least satisfy minimum durability requirements as defined by its exposure class.

The exposure class of the concrete is dependent upon the presence or lack of chlorides, sulphates, freezing and thawing conditions and saturated conditions. Based on the aforementioned recommendations the foundation system will have concrete exposed to cycles of freezing and thawing, would be in dry conditions and not exposed to chlorides or sulphates. Type GU cement is considered acceptable. Furthermore, the governing exposure class for concrete footings and interior slabs at this site should be "F-2" and "N", respectively.

In addition to the above, CAN/CSA-A23.1 also provides recommendations for cold weather concrete placement. These include protecting freshly placed concrete from freezing temperatures.

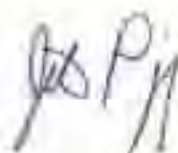
7.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the General Conditions included in this report.

8.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned.

Yours truly,
EBA Engineering Consultants Ltd.



Justin Pigage, EIT
Geotechnical Engineer, Yukon Region
Direct Line: 867.668.2071 x244
jpigage@eba.ca



Christopher J. Dixon, P.Eng.
Project Engineer, Yukon Region
Direct Line: 867.668.2071 x241
cdixon@eba.ca



J. Richard Trimble, P.Eng., ECF
Project Director, Yukon Region
Direct Line: 867.668.2071 x222
rtrimble@eba.ca

PERMIT TO PRACTICE	
EBA ENGINEERING CONSULTANTS LTD.	
SIGNATURE	<i>J. Richard Trimble</i>
Date	<i>Dec 8/08</i>
PERMIT NUMBER PP003	
Association of Professional Engineers of Yukon	

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgemental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

9.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

10.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

11.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

12.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

13.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

14.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.



LEGEND:
 - BOREHOLE LOCATION



ISSUED FOR USE

GEOTECHNICAL EVALUATION - POTENTIAL MILL SITES
 BELLEKENO PROJECT, YUKON

MACKENO BOREHOLE LOCATION PLAN

PROJECT NO.	WPA101178	DATE	1/11/08	REV.	0
DRAWN BY	EBA	CHECKED BY	JTP	DATE	0
APPROVED BY	EBA	DATE	DECEMBER 4, 2008		

Figure 2

ALEXCO

EBA Engineering Consultants Ltd.



LEGEND:
 - BOREHOLE LOCATION



ISSUED FOR USE

GEOTECHNICAL EVALUATION - POTENTIAL MILL SITES
 BELLEKENO PROJECT, YUKON

ONEK BOREHOLE LOCATION PLAN

PROJECT NO.	W/4101176	DATE	1/1/08	REV.	0
DRAWN BY	JTP	CHECKED BY	JTP	DATE	DECEMBER 4, 2008
DESIGNED BY	EBA-WHSE	APPROVED BY			

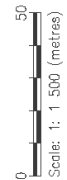
ALEXCO
 EBA Engineering
 Consultants Ltd.



Figure 3



LEGEND:
● - BOREHOLE LOCATION



ISSUED FOR USE

GEOTECHNICAL EVALUATION - POTENTIAL MILL SITES
BELLEKENO PROJECT, YUKON

BELLEKENO BOREHOLE LOCATION PLAN

PROJECT NO.	WPA101716	DATE	JTP	REV	0
DRAWN BY	EBA	CHECKED BY	JTP	DATE	DECEMBER 4, 2008
PROJECT NAME	BELLEKENO BOREHOLE LOCATION PLAN				
PROJECT LOCATION	BELLEKENO PROJECT, YUKON				
PROJECT OWNER	ALEXCO				
PROJECT MANAGER	EBA Engineering Consultants Ltd.				
PROJECT ENGINEER	EBA				



EBA Engineering
Consultants Ltd.



Figure 4

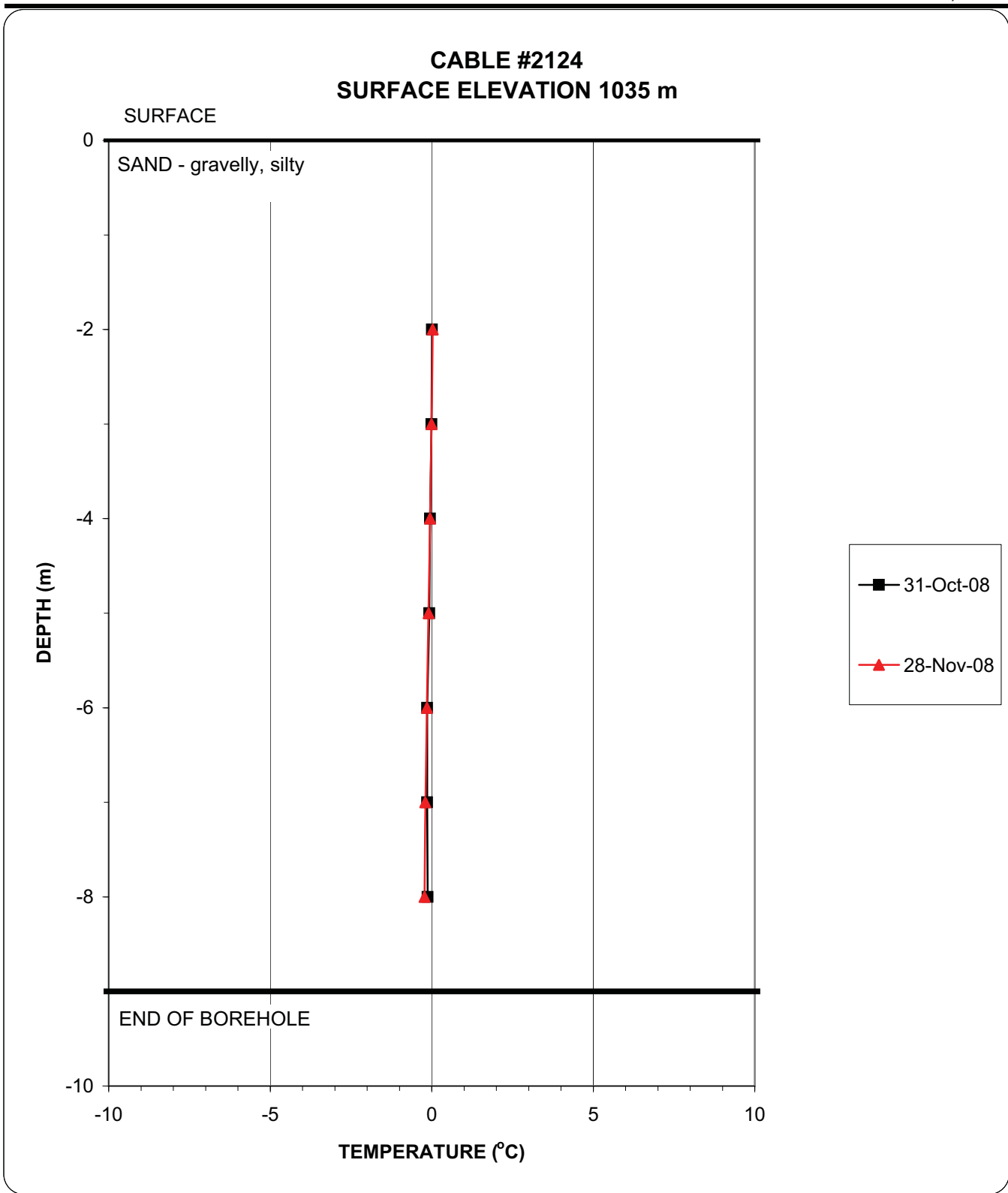


Figure 5
Ground Temperature Profile
Proposed Keno Mill Sites
Borehole #11 - Bellekeno

Geotechnical Evaluation-Potential V.L. Sites

Mackenzie Upper Bench

Keno City, YT

Client: Alexon Resource Canada Corp

Drill Type: 345 Hydraulic Rod Drill (air rotary)

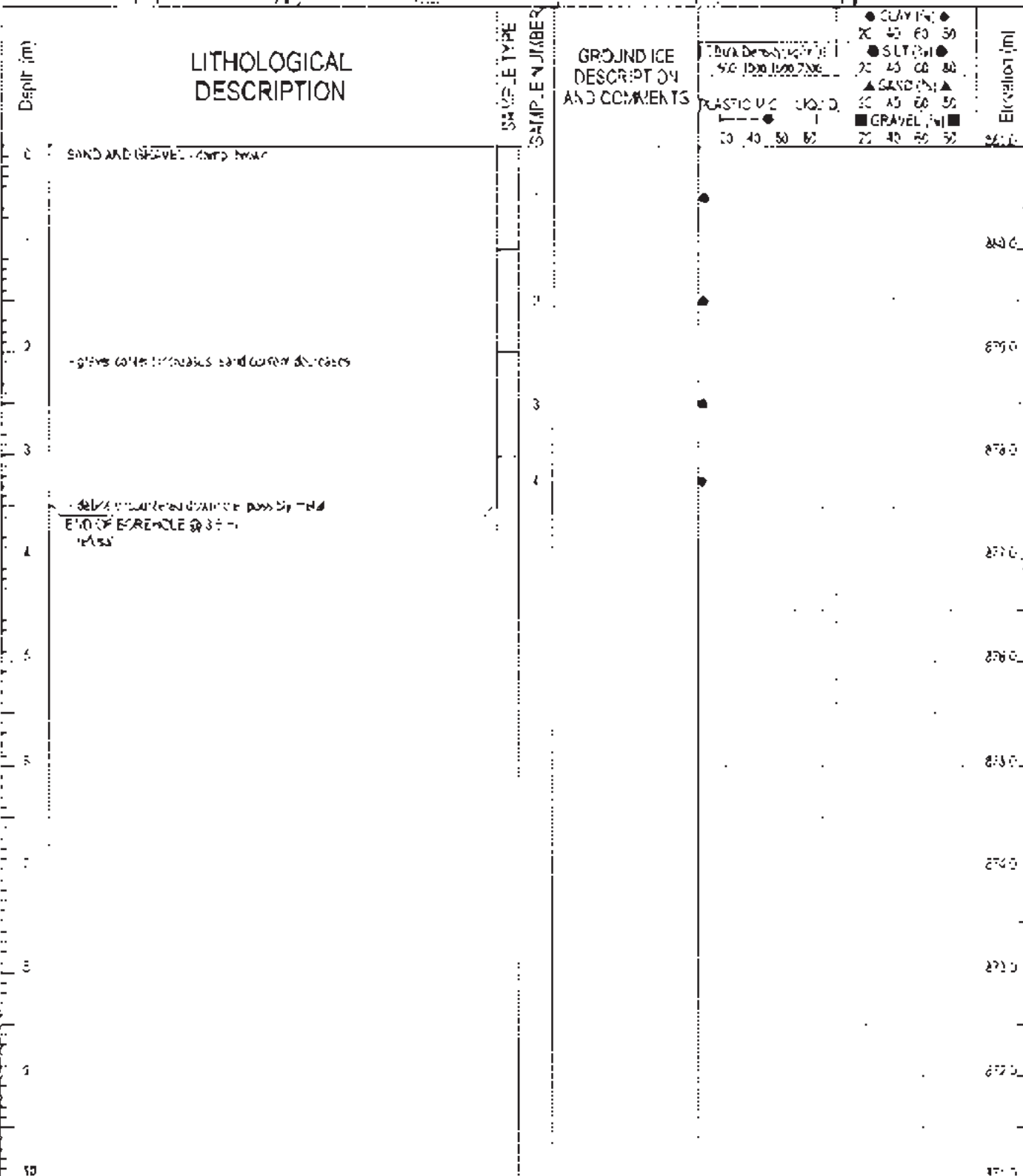
7027613N 483319E, Zone 8

BOREHOLE NO: W2410176-BH01

PROJECT NO: W2410176

ELEVATION: 881m

SAMPLE TYPE	☐ SAND SAMPLE	☒ NO RECOVERY	☒ SLURRY	☐ CORRE. PORE	☐ SHEET PILE	☐ GRAB CORE
BACKFILL TYPE	☐ BENTONITE	☒ FFA GRAVEL	☐ S. CLAY	☐ GROUT	☐ DRI. CUTtings	☐ SAME



EBA Engineering Consultants Ltd.

 LOGGED BY JTP
 REVIEWED BY C.D.

DRAWING NO: Figure 2

 COMPLETION DEPTH: 35m
 COMPLETE: 10/29/2003

Page 1 of 1

Geotechnical Evaluation Potential VIB Sites

Client: Alexco Resource Canada Corp

BOREHOLE NO: WH4-01178-BH02

MacKenzie (Upper Bench)

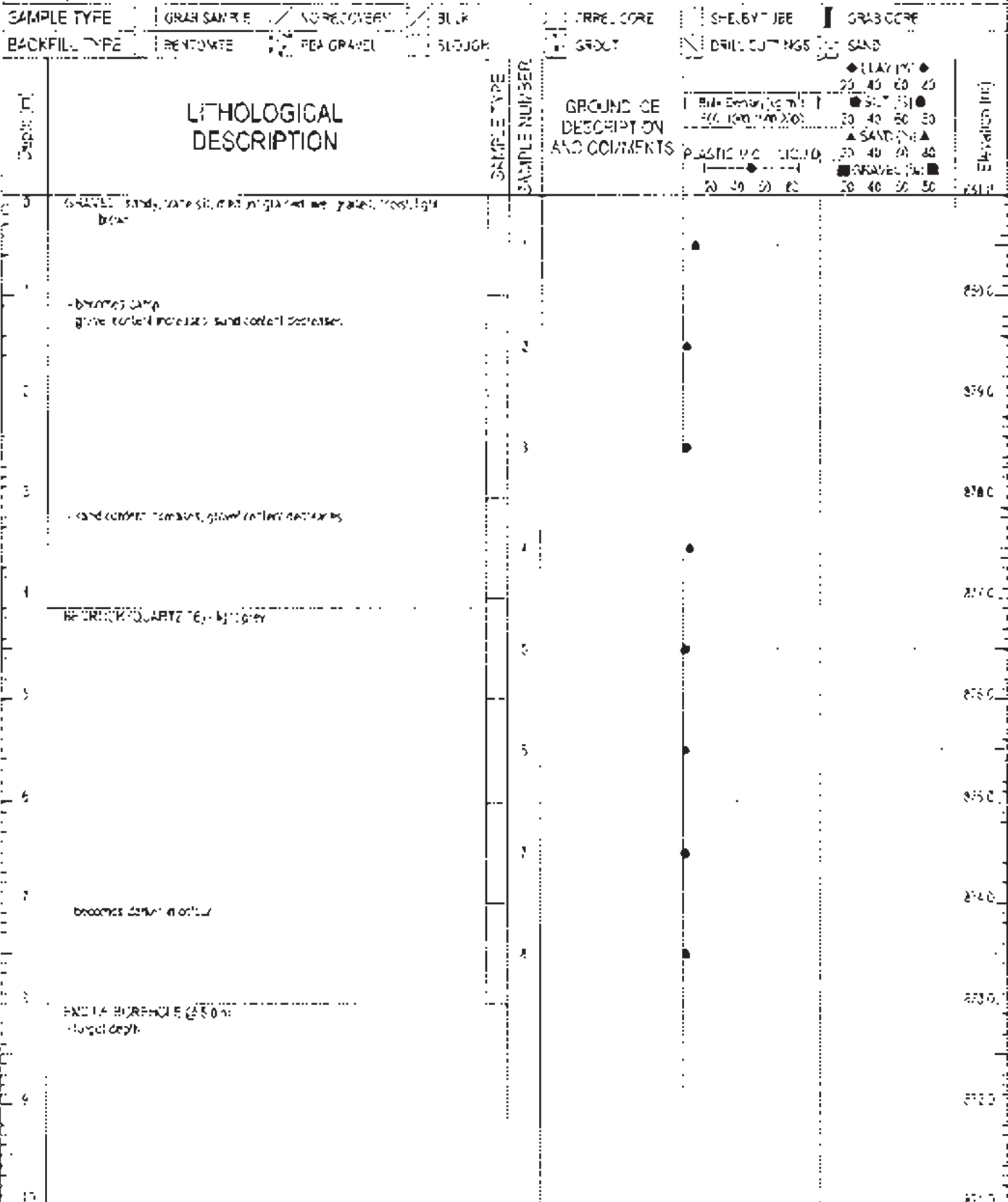
Drill Type: 345 Hydraulic Rod Drill (air-lift)

PROJECT NO: WH4-01178

Kenai City, YT

7087571N 483025E Zone 8

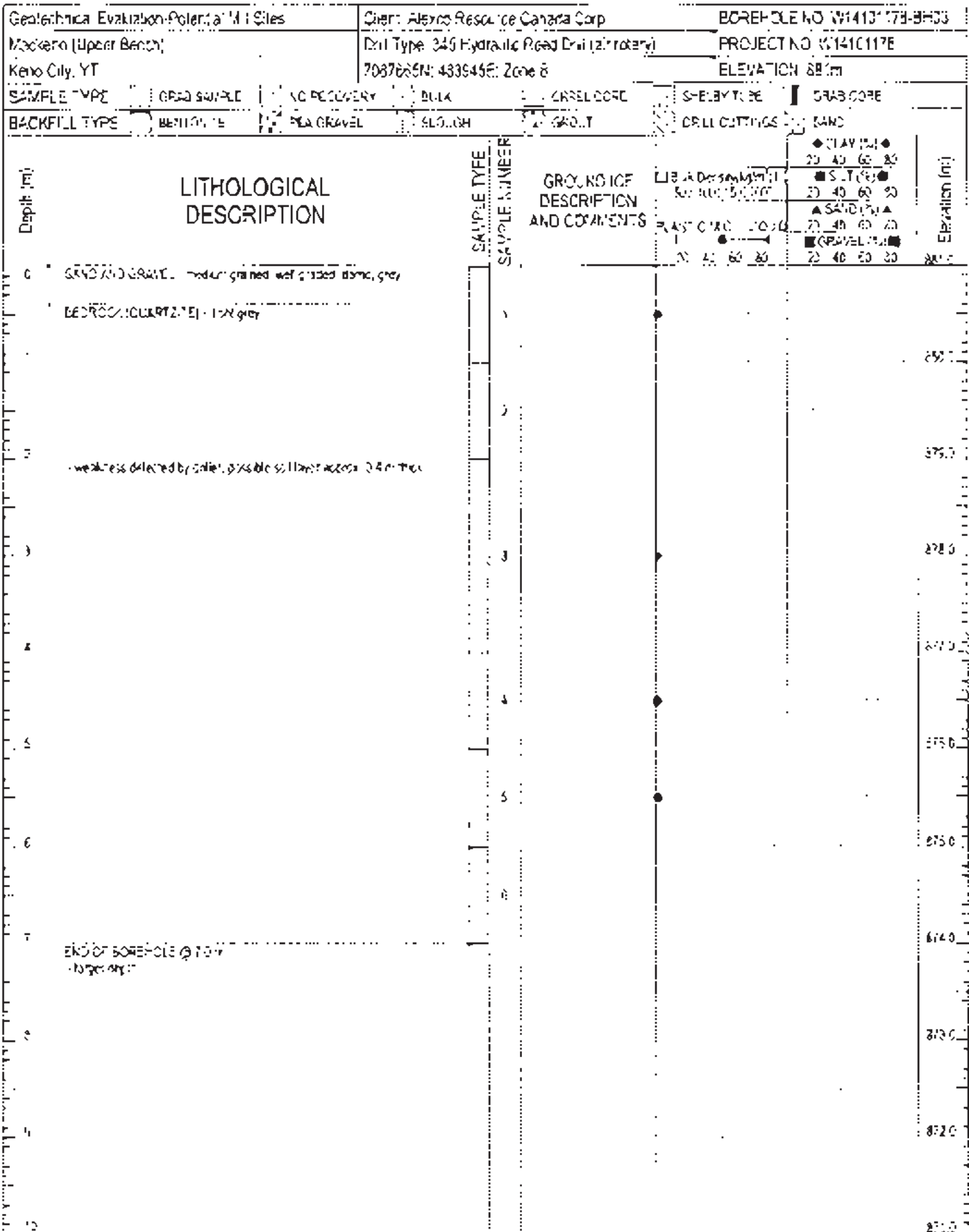
ELEVATION: 881m



EBA Engineering Consultants Ltd.

 LOGGED BY: JTP
 REVIEWED BY: GJD
 DRAWING NO: Figure 2

 COMPLETION DEPTH: 6m
 COMPLETE: 10/29/2008
 Page 1 of 1



EBA Engineering Consultants Ltd.

LOGGED BY: JTP
 REVIEWED BY: CJD
 DRAWING NO: Figure 2

COMPLETION DEPTH: 7m
 COMPLETE: 10/23/2008
 Page 1 of 1

Geotechnical Evaluation-Potential Risk Sites		Client: Alexco Resource Canada Corp		BORE-HOLE NO. W410/176-BH01			
Location: Lower Bench		Drill Type: 345 Hydraulic Reed Dr. (air rotary)		PROJECT NO. W410/176			
Kens C. ly. YT		7087726N 483926E, Zone 8		ELEVATION 828m			
SAMPLE TYPE	GRAB SAMPLE	NO DISCOVERY	BULK	CORE LOG	SLIDING LOG	GRAVE CORE	
BACKFILL TYPE	DETONATE	PER GRAVEL	SLUG	GROUT	DRILL CUTTINGS	SAND	
Depth (m)	LITHOLOGICAL DESCRIPTION		SAMPLE TYPE	GROUND OF DESCRIPTION AND COMMENTS	Test Description (m)	GRAVEL CORE	TEST
0	SAND - some gravel, moist dark brown organic material		1		100 1000 10000	20 47 67 80	222.0
1	becomes black in colour		2			20 47 67 80	257.0
2			3			20 47 67 80	260.0
3	becomes wet		4			20 47 67 80	263.0
4	no sample returned, dr. cell malfunction					20 47 67 80	264.0
5						20 47 67 80	265.0
6						20 47 67 80	267.0
7						20 47 67 80	268.0
8	END OF BORE-HOLE 3.50 m					20 47 67 80	269.0
9	no sample returned, dr. cell malfunction					20 47 67 80	270.0
10						20 47 67 80	271.0


EBA Engineering Consultants Ltd.

LOGGED BY: JTF
 REVIEWED BY: CJD
 DRAWING NO: Figure 2

COMPLETION DEPTH: 8m
 COMPLETE: 10/29/2008
 Page 1 of 1

Geotechnical Evaluation-Potential Mill Sites

Client: Alexco Resource Canada Corp

BOREHOLE NO: W14101178-BH05

Madison (Lower Bench)

Drill Type: 345 Hydraulic Reed Drill (air rotary)

PROJECT NO: W14101178

King City, YT

7087724N, 483545E Zone 8

ELEVATION: 3631

SAMPLE TYPE

GRAVE SAMPLE

NO RECOVERY

☒ BULK☐ GRAVE CORN☐ SHELLY MASS☐ GRAVE CORE

BACKFILL TYPE

☐ BENTONITE☐ PEAS GRAVE☐ SUGAR☐ GROUT☐ DRILL CUTTINGS☐ SAND

DEPTH (m)	LITHOLOGICAL DESCRIPTION	SAMPLE TYPE SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	Soil Density (g/cm ³) Soil Moisture (%)	GRAVIMETRIC ANALYSIS CLAY (%) SILT (%) SAND (%) GRAVEL (%)	ELEVATION (m)
0	SAND - some gravel, damp, black, irregular clumps	1		20 40 60 80	20 40 60 80	3631
1						3570
2	becomes wet no sample recovered, drilled and lost can be described in dry conditions as sand and gravel below water table					3650
3						3670
4						3670
5						3630
6						3620
7						3600
8	END OF BOREHOLE (3.80 m) borehole terminated at 100% resistance					3500
9						3550
10						3480



EBA Engineering Consultants Ltd.

LOGGED BY: JTP

REVIEWED BY: CJC

DRAWING NO: Figure 2

COMPLETION DEPTH: 8m

COMPLETE: 10-23-2006

Page 1 of 1

Geotechnical Evaluation: Potential Mine Sites

Client: Alexco Resource Canada Corp.

BOREHOLE NO. WH110-178-5406

Location: (Lower Bench)

Drill Type: 345 Hydraulic Reed Drill (air rotary)

PROJECT NO. WH110-1178

Keno City, YT

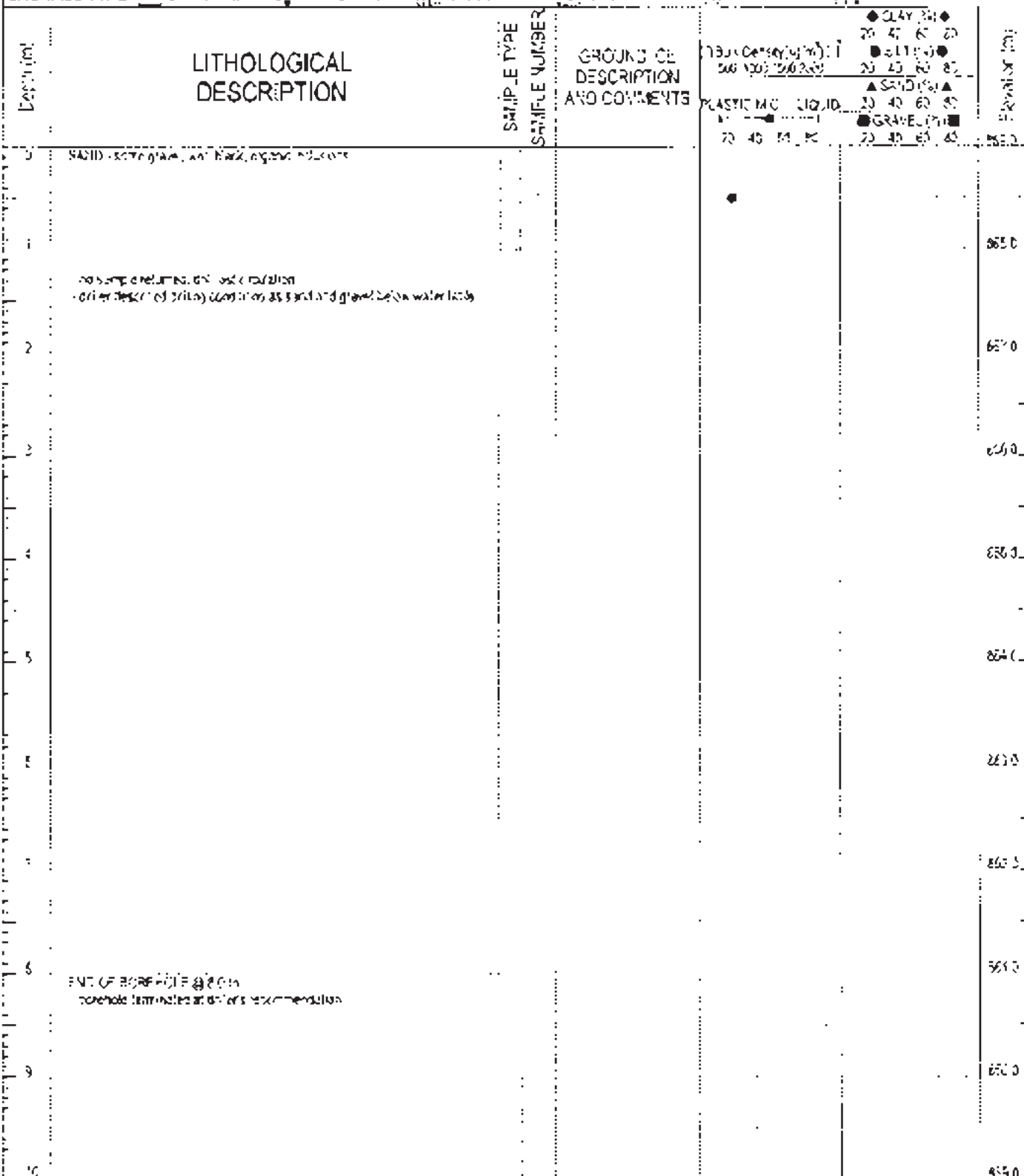
7087709N 463888E, Zone 8

ELEVATION: 389m

SAMPLE TYPE

☐ LEAS SAMPLE☐ NO RECOVERY☒ SLURK☐ CORE LOGS☐ 9-2.6" TUBE☐ GRAB CORE

BACKFILL TYPE

☐ BENTONITE☐ PEA SHAVER☐ STONOR☐ BRIDIT☒ DRILL CUTtings☐ SAND

EBA Engineering Consultants Ltd.

LOGGED BY: JTF

REVIEWED BY: CJD

DRAWING NO: Figure 2

COMPLETED BY: JTF

COMPLETE 10/28/2008

Page 1 of 1



Page 1 of 1

1-Kara C15, VT

Central Alenco Resource Canada Corp

Dial Type 345 Hydraulic Reed Drive (10/12/24)

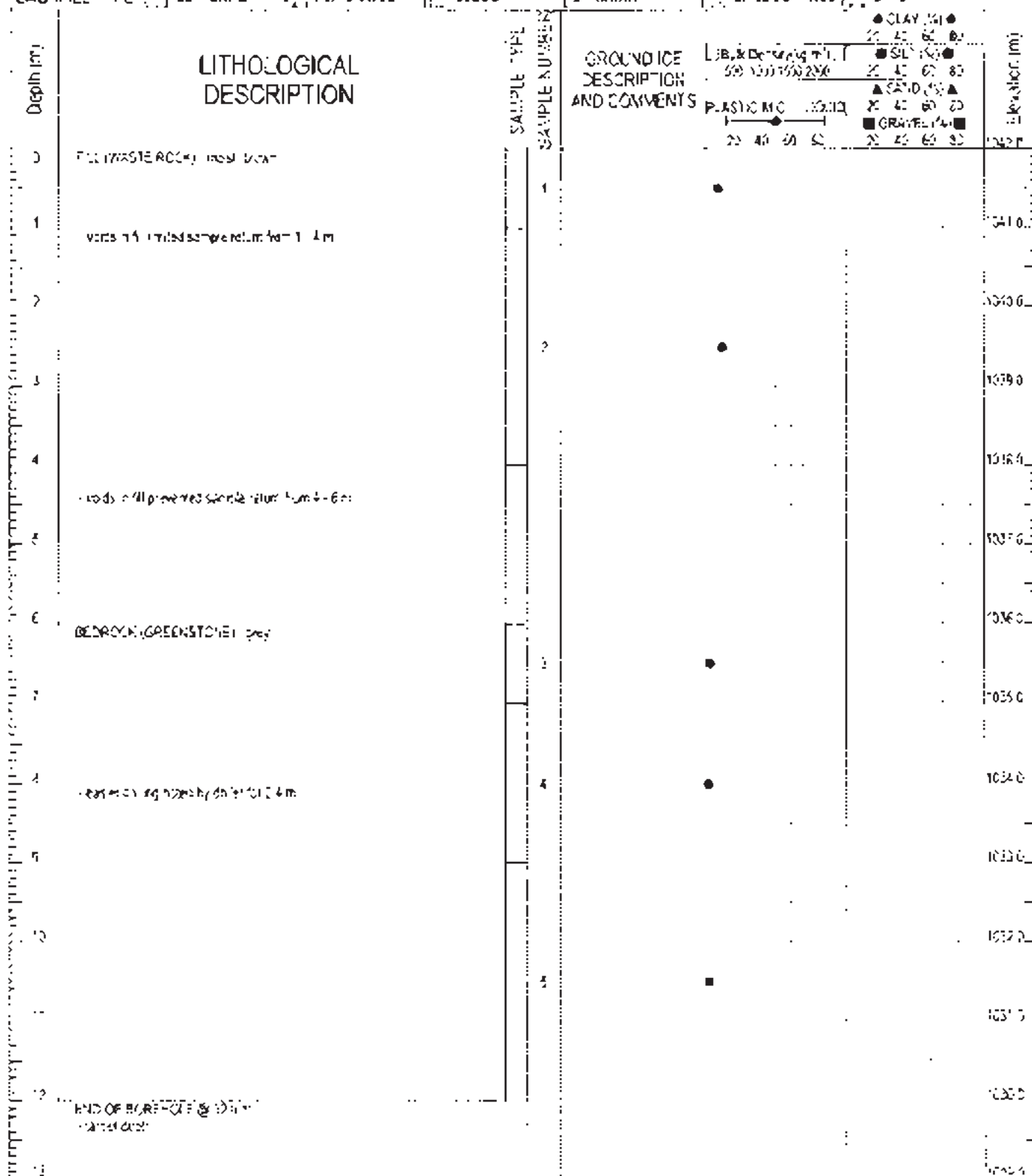
7087371N 145571E Zone A

BORE HOLE 45 1Y 413: 178.5410

PROJECT NO. W-4101174

ELEVATION 1242T.

SAMPLE TYPE ☐ GRAB SAMPLE ☒ NO RECOVERY ☒ BULK ☐ CERECORE ☐ SPLIT-LICE ☐ GRAB CORE
BACKFILL TYPE ☐ BEN-TONE ☐ PEA GRAVEL ☐ SLOUGH ☒ GROUT ☒ DRILL CUTTINGS ☐ SAND



EBA Engineering Consultants Ltd.

LOGGED BY JTF
REVIEWED BY CID
DRAWING NO: Figure 3

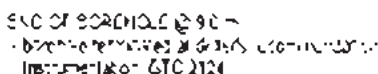
COMPLETION DATE: 12/

COMPLETE 10/30/2018

Page 1 of 1

ॐ नमो भगवते वासुदेवाय

! 54N2



Geotechnical Evaluation-Potomac Mill Sites

Bellefonte

Kane Co., VT

Client: Alcon Resource Canada Corp

Drill Type: 345 Hydraulic Rod Dr. (B1 Rotary)

738/131N, 48/262E, Zone 8

BOREHOLE NO. W-410178-BH-12

PROJECT NO. W-4101178

ELEVATION: 1032.6

SAMPLE TYPE		GRAB SAMPLE	NO RECOVERY	BLK	CRPEL CORE	SHELLY TUBE	GRAB CORE	
BACKFILL TYPE		BENTONITE	FLY ASH/GRANUL	SILICA	GRANIT	DRILL CUTTINGS	SAND	
DEPTH (m)	LITHOLOGICAL DESCRIPTION	SAMPLE TYPE		GROUNDICE DESCRIPTION AND COMMENTS		TEST DATA (g/cm ³)		ELEVATION (m)
0	SAND - silty to fine grained, wet zone grey, organic inclusions	1				20 40 60 80		1032.6
1	SAND - silty, dark grey	2				20 40 60 80		1031.0
2		3				20 40 60 80		1030.0
3		4				20 40 60 80		1029.0
4		5				20 40 60 80		1028.0
5		6				20 40 60 80		1027.0
6		7				20 40 60 80		1026.0
7	- becomes moist	8				20 40 60 80		1026.0
8		9				20 40 60 80		1024.0
9	- becomes wet	10				20 40 60 80		1023.0
10		11				20 40 60 80		1022.0
11		12				20 40 60 80		1021.0
12		13				20 40 60 80		1020.0
13		14				20 40 60 80		1019.0
14		15				20 40 60 80		1018.0
15		16				20 40 60 80		1017.0
16		17				20 40 60 80		1016.0
17		18				20 40 60 80		1015.0
18	END OF BOREHOLE 3-12 - - excessive term sand at bottom of borehole	19				20 40 60 80		1014.0
19		20				20 40 60 80		1013.0



EBA Engineering Consultants Ltd.

LOGGED BY JTP
REVIEWED BY GJC

DRAWING NO. Figure 4

COMPLETION DEPTH 18m
COMPLETE 10/06/2008

Page 1 of 1

ΚΕΛΛΟΤΕ ΤΗΝ ΨΥΧΗ

Central Mexico Resource Canada Corp

Doc. Type: 345 Political Record: 1911-1912

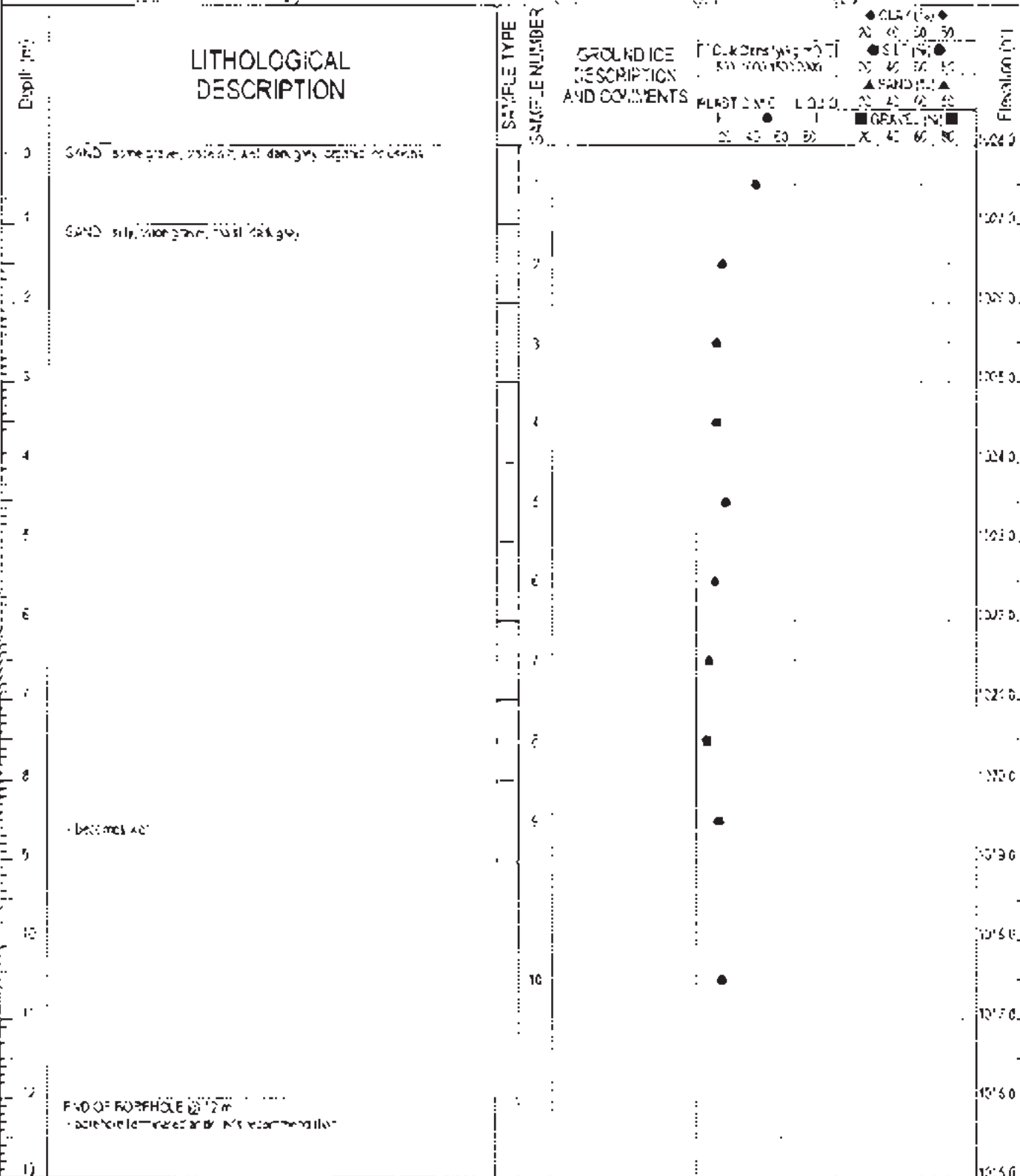
70971344 487' 53E, Zone 8

35K2-10L2 40 1114101178 0-153

PROJECT NO. 17-410-178

ELEVATION 1028.1

SAMPLE TYPE	GREEN SAMPLE	NO RECOVERY	BULK	TEST CORE	SPECKLE TUBE	GRAVEL CORE
BACKFILL TYPE	NONHYDRAULIC	SEA SPACE	SLUSH	GROUT	DRILL CUTtings	SAND



Geotechnical Evaluation Potential Hazard Sites

Belekeno

Keno City, YT

Client: Alexco Resources Canada Corp

Dredge Type: 345 Hydraulic Hired Drill (air rotary)

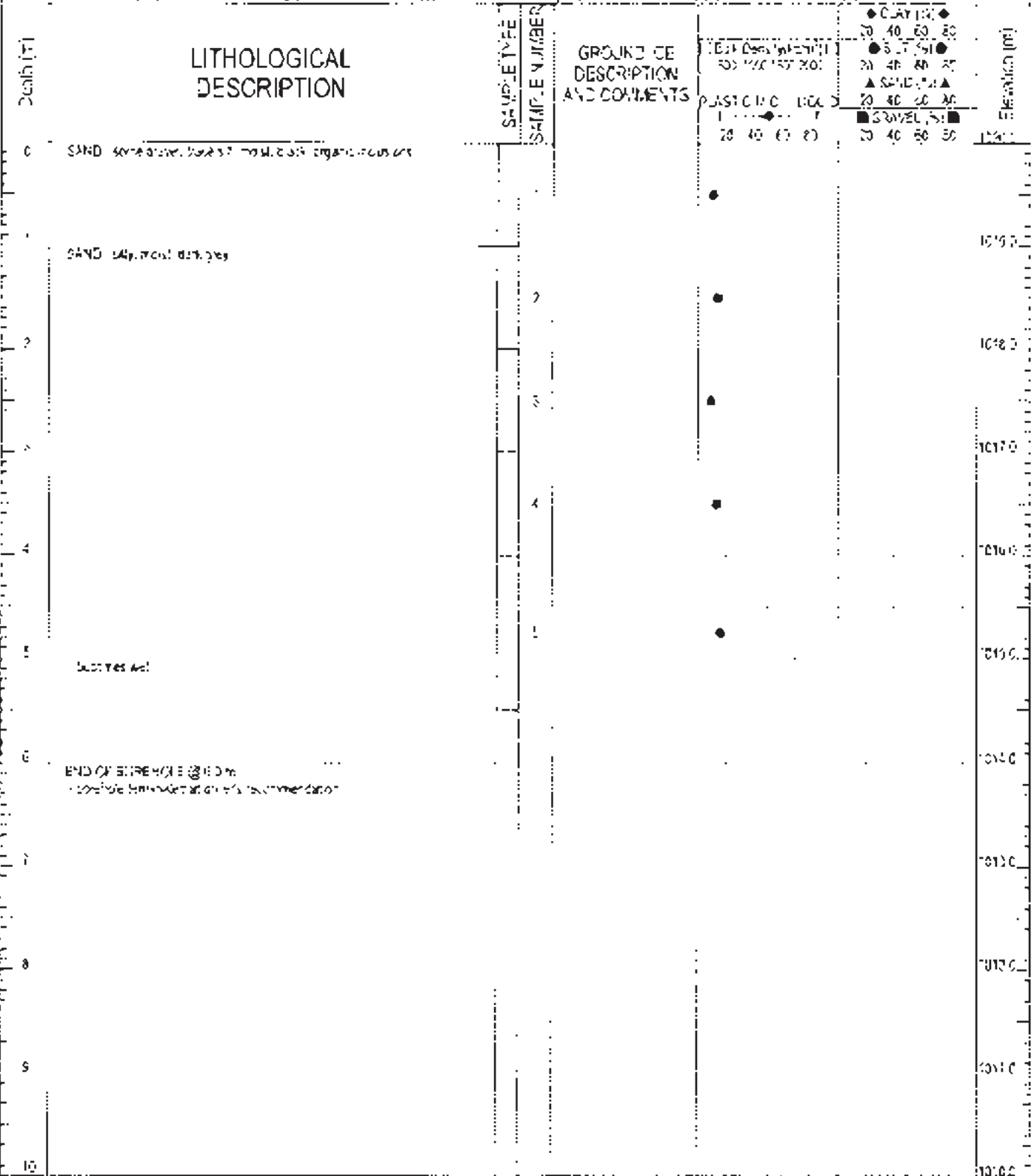
103°13'58"N, 45°04'41"E, Zone 8

BOREHOLE NO. W14101178-B-114

PROJECT NO. W14101178

ELEVATION: 1023m

SAMPLE TYPE	☐ GRAB SAMPLE	☐ ASPEROGRAPHY	☒ BULK	☐ EMER. CORE	☐ SLEEVE TUBE	☐ GRASS CORE
BACKFILL TYPE	☐ BENTONITE	☐ SEALED BAGS	☐ SILICASH	☐ GROUT	☐ DRILL CUTTINGS	☐ SAND



EBA Engineering Consultants Ltd.

LOGGED BY: JTP

REVIEWED BY: CJD

DRAWING NO. Figure 4

COMPLETION DEPTH: 6m

COMPLETE: 10/01/2008

Page 1 of 1

Geotechnical Evaluation - Porcupine Mill Sites

Client: Alexco Resource Canada Corp

BOREHOLE NO. W-410-178 BH-5

Deilekono

Drill Type: 345 Hydraulic Reed Drill (air rotary)

PROJECT NO. W-410-178

Keno City, Y1

7067139N 497204E Zone 8

ELEVATION 1037m

SAMPLE TYPE

CORE SAMPLE

✓ NO RECOVERY

✓ SOIL

✓ CORE CORN

SHEAR TEST

GRAB SAMPLE

BACKFILL TYPE

SEVENTONE

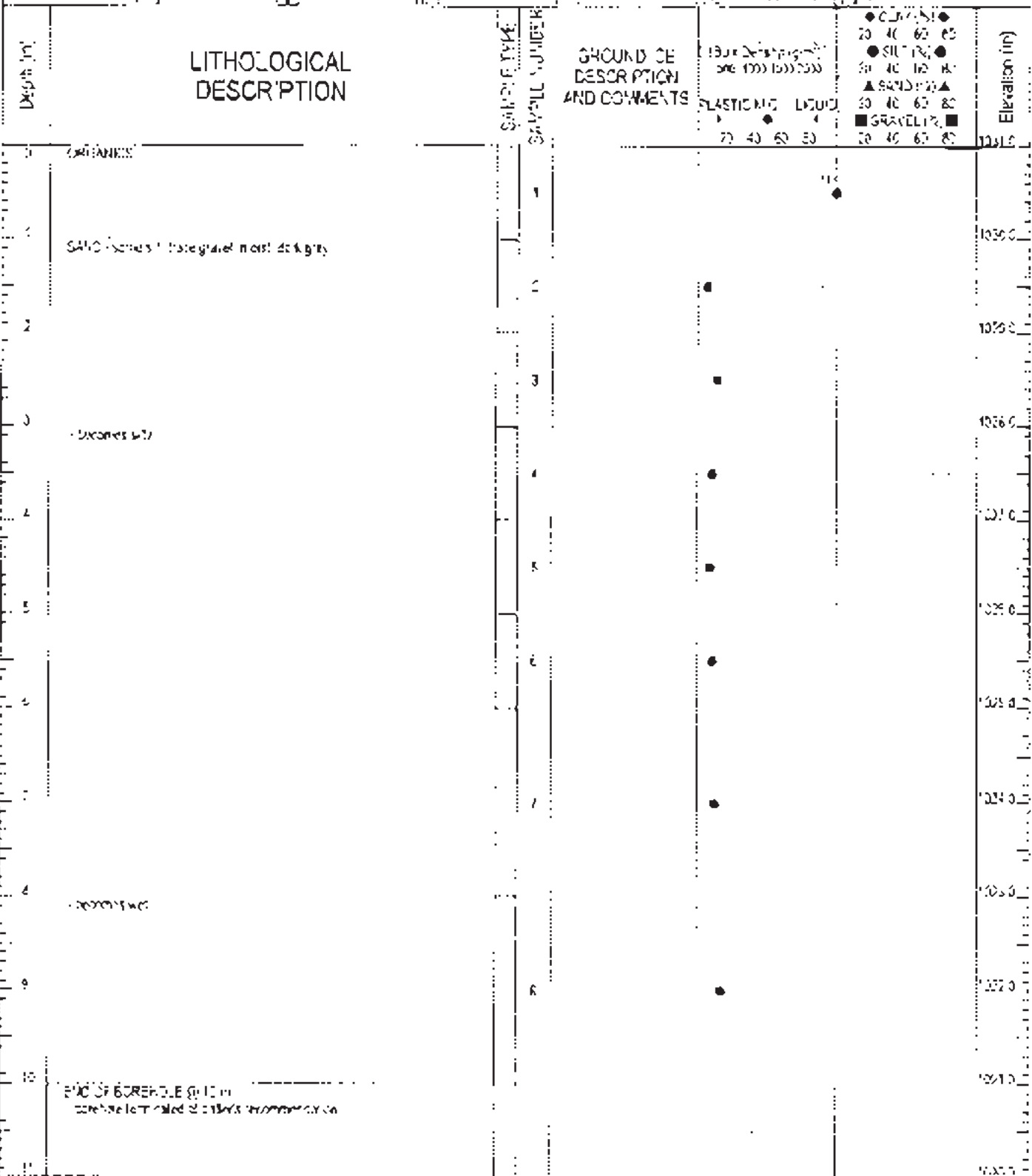
✓ DEBRIS GRAVEL

✓ SLOUGH

✓ GRAVEL

✓ DRILL CUTTINGS

✓ SAME



EBA Engineering Consultants Ltd.

LOGGED BY JTF

REVIEWED BY J.D.

DRAWING NO Figure 4

COMPLETION DEPTH 10m

COMPLETED 10/03/2008

Page 1 of 1



**ALEXCO KENO HILL MINING CORP.
YESAA PROJECT PROPOSAL FOR TYPE A WATER USE
& QUARTZ MINING LICENCE APPLICATIONS
BELLEKENO MINE DEVELOPMENT
KENO HILL SILVER DISTRICT
YUKON**

**APPENDIX J
CONCEPTUAL TAILINGS MANAGEMENT PLAN – MACKENO
UPPER BENCH, BELLEKENO PROJECT
NEAR KENO CITY, YUKON**

FEBRUARY 2009

Prepared by: EBA Engineering Consultants Ltd.

February 13, 2009

EBA File: W14101178.001

Alexco Resource Canada Corp.
#3-151 Industrial Road
Whitehorse, YT Y1A 2V3

Attention: Mr. Ethan Allen, M. Sc.
Geologist, Mine Permitting Assistant

**Subject: Conceptual Tailings Management Plan – Mackeno Upper Bench
Bellekeno Project near Keno City, Yukon**

ISSUED FOR USE

1.0 INTRODUCTION

Alexco Resource Canada Corp. (Alexco) is proposing to construct a silver, lead, and zinc concentrating mill near Keno City, Yukon. Alexco retained EBA Engineering Consultants Ltd. (EBA) to provide a conceptual level design for tailings and stormwater management at the Mackeno site.

On December 12, 2008, EBA provided a conceptual design for tailings and stormwater management at site north of the proposed mill site at Mackeno. Alexco also asked EBA to prepare a conceptual design for a site south of the proposed mill site at Mackeno.

EBA has completed a conceptual design of the dry-stacked tailings facility and stormwater management system for the new site. This letter summarizes the conceptual design, design assumptions, stability calculations, potential risks and mitigations, and closure plans.

2.0 BACKGROUND INFORMATION

Alexco is proposing to construct a concentrating mill and dry-stacked tailings facility (DSTF) at the Mackeno site. EBA previously provided a conceptual design for a DSTF north of the proposed mill site which was described in a letter dated December 12, 2008. This current letter summarizes the conceptual design for a potential mill site south of the proposed mill site.

EBA conducted a geotechnical investigation for the proposed mill site and the DSTF area north of the proposed mill site. Subsequently, Alexco excavated, logged, photographed, and sampled 10 testpits south of the proposed mill site; the locations of the testpits are shown in Figure 1. The information collected from those testpits was used in the conceptual design of the DSTF south of the proposed mill site. Subsurface conditions in

this area encountered in these testpits are summarized as follows, and test result data are attached to the letter:

- Shallow bedrock on the flat, sloping plateau that extends south from the proposed mill site, near TP07, TP08, TP09, and TP10 – no permafrost in previously cleared areas
- Thick (1 m to 3 m) deposits of organic peat to the east and west of a bedrock outcrop, near TP05 and TP06 – continuous permafrost encountered in both testpits
- Thick (at least 4 m) silt deposits with varying amounts of stratified ice in the slope east of the area of shallow bedrock, near TP01, TP02, TP03, and TP04 – continuous permafrost encountered in all four testpits

3.0 MACKENO DRY-STACKED TAILINGS FACILITY DESIGN ASSUMPTIONS

EBA used the following assumptions provided by Alexco in the design of the DSTF at the Mackeno site:

- Tailings discharge rate of 7.75 dmt/h (dry-metric tonnes per hour) for years 1 and 2 and 13.95 dmt/h for years 3 through 5;
- Tailings specific gravity of 3.95
- Tailings moisture content of 15% (mass of water divided the mass of dry solids)
- Only 50% of all tailings generated will be stored on surface
- The remaining tailings will be stored underground
- Design storm for water management is 1:200 year return period rainfall event
- Peak instantaneous flow for the design storm is determined from Figure B-3 of 1996 UKHM Closure Plan – Appendix B using 1000 minute duration
- Using Figure B-3 (as noted above), 1000 minute duration and 1:200 year return period, the peak instantaneous flow for the site is 500 L/s/km²
- An evapo-transpirative cover consisting of 0.6 m of vegetated till soil will be used for closure of the DSTF.

EBA used these additional assumptions:

- Placed dry density of tailings is 1800 kg/m³
- Bleed water resulting from compaction of the tailings pile will be 10% of porewater
- Compacted tailings are cohesionless and have an internal friction angle of 27 degrees
- Runoff coefficient of 1 (Rational Method C value) selected for DSTF area for the operational period

- Simple triangular hydrograph assumed to calculate runoff volume from the DSTF for the design storm
- Total runoff volume for the design storm is 1050 m³
- Foundation soils for the DSTF are frozen sandy silt in the short-term and thawed sandy silt in the long-term
- Active layer is a gravelly sand and thawed to 2 m below existing ground surface
- Active layer soil is cohesionless and has an internal angle of friction of 28 degrees
- Active layer soil has a bulk unit weight of 2140 kg/m³
- Current temperature of the frozen soils is anticipated to be -0.2°C
- Thawed sandy silt behaves as a drained frictional soil
- Thawed sandy silt is cohesionless and has an internal friction angle of 25 degrees
- Thawed sandy silt has a bulk unit weight of 1830 kg/m³
- Coefficient of consolidation (C_v) for the thawed sandy silt is assumed to be 0.03 cm²/s
- Waste rock is available for use as a construction material
- Waste rock is cohesionless and has an internal friction angle of 36 degrees
- Waste rock (loosely placed) has a bulk unit weight of 1800 kg/m³
- Design seismic event was selected to be 1:500 year return period (0.138 g for the selected site), as recommended in “Mined Rock and Overburden Piles Investigation and Design Manual” (Piteau, 1991).

4.0 MACKENO UPPER BENCH DSTF CONCEPTUAL DESIGN

The conceptual design of the DSTF at the Mackeno South Site involves the construction of drainage works, placement and compaction of the filtered tailings, and construction of slope stabilizing embankments. The plan and profile of the DSTF are provided in Figures 1 and 2.

The drainage works for the facility consist of an outer diversion berm, and seepage and runoff collection sumps. The outer diversion berm will be constructed from a low-permeability till, which can be sourced in the area. The outer diversion berm has two purposes: to direct seepage and runoff generated inside the footprint of the DSTF to one of two collection sumps, and to divert runoff generated outside the DSTF footprint around the facility. A location plan and section detail of the diversion berm is provided in Figures 3 and 4.

The collection sumps are sized to store the runoff generated in a 1:200 year rainfall event. The sumps will be constructed by excavating bedrock to the design elevation using drill and blast techniques. A 2H:1V slope as well as a sump base will be constructed within the blasted area. A geosynthetic liner will be placed over the prepared slope and base. The liner will be keyed into the existing ground using a combination of an extended liner runout and key trench.

The sumps will each have the capacity to retain the runoff generated in a 1:200 year rainfall event for their respective catchment areas. The north and south sump capacities will be 750 m³ and 300 m³, respectively. Due to the steep topography in the area the catchments may overlap during construction, so some additional volume has been added to each sump to account for this. Sump details and sections are provided in Figures 3 and 4.

The filtered tailings will have a moisture content of approximately 15%, which should be just above the optimum moisture content for compaction. The tailings will be placed in 300 mm lifts and compacted with a 10-tonne vibratory compactor, similar to the process used at the existing Minto Mine. The lift thickness can be increased to a maximum of 600 mm if a 15-tonne vibratory compactor is used. Tailings will be compacted to at least 95% of the maximum dry density using standard effort (as per ASTM D698). The pile will be a sidehill fill with a crest elevation of 919 m and a slope of 4H:1V. There will be a small bench of tailings near the toe that will have a crest elevation of 901 m and have a slope of 3H:1V. The organic soils will be left in place beneath the DSTF to provide some insulation and slow the rate of permafrost thaw.

Construction of the DSTF will occur over five years, as the tailings are generated by the mill. The north sump and east perimeter berms will be constructed prior to tailings placement. The south sump and perimeter berm will be constructed prior to beginning placement of tailings in Year 3. Plans and profiles of the yearly DSTF construction stages are provided in Figures 5 through 14 and the final configuration of the DSTF, prior to closure activities, is shown in Figure 1.

5.0 THAW-CONSOLIDATION OF THE DSTF

Construction of the DSTF will involve placing and compacting relatively warm tailings on relatively cold ground. This will change the thermal equilibrium that exists on the site, and it is anticipated that placement of warm tailings in combination with climate change will thaw the existing permafrost in the area. Thaw of the underlying permafrost will cause some surface deformation in the form of thaw-related settlement. EBA assumed a C_v value of 0.03 cm²/s based on data collected for typical compressible silt in the Whitehorse area. EBA chose to compare the soil at the Mackeno site with the Whitehorse soil as it is the most representative data available at the time of conducting the design. Site specific data will be collected during detailed design phase of the project. This comparison is considered to be conservative for thaw-consolidation calculations. The Whitehorse soil is classified as a

low-plastic clay, whereas the Mackeno soil is classified as a low-plastic silt. The Whitehorse soil is prone to higher compressibility and has poorer drainage than the Mackeno soil. This means that the Whitehorse soil can develop higher excess porewater pressures than the Mackeno soil. A comparison of the two materials is provided in Table 1.

An assumption in the thaw-consolidation theory used is that drainage is not impeded from the top of the consolidating layer. EBA believes that the current active layer (top 2 m of existing soils) is sufficiently coarse enough for this purpose. This assumption will be confirmed during detailed design.

TABLE 1: COMPARISON OF MACKENO SILT TO WHITEHORSE SILT		
Property	Mackeno Silt	Whitehorse Silt
Percent Clay	8	9
Percent Silt	49	90
Percent Sand & Gravel	43	1
Liquid Limit	44	28
Plasticity Index	6	8
USCS Description	ML	CL

Using a C_v value of $0.03 \text{ cm}^2/\text{s}$ and thaw-consolidation theory presented by Andersland and Ladanyi (2004), the rates of thaw required to generate excess porewater pressures of $r_u=0.1$ are summarized in Table 2. Based on EBA's experience it is not expected the placement of warm tailings on the permafrost slope will generate thaw rates quicker than those summarized in Table 2. Permafrost thaw rates will be confirmed through thermal modelling after the collection of additional soils information during the detailed design phase of the project.

TABLE 2: THAW RATES REQUIRED TO GENERATE EXCESS POREWATER PRESSURE OF $R_u=0.1$		
Thaw Depth (cm)	Time to Thaw (hours)	Time to Thaw (days)
5	1	--
10	4	--
30	39	--
60	--	6
100	--	18
150	--	40
200	--	72

EBA expects that in perpetuity the anticipated new permafrost equilibrium will be that all permafrost in the slope will be thawed.

6.0 STABILITY OF THE DSTF

The stability of the DSTF was determined using Geostudio 2007 – SlopeW module, which is a computer program that uses limit equilibrium theory to compute the factor of safety (FS) of slopes. The DSTF slopes were analyzed in several different conditions, including during construction (years 1 through 5) in a static scenario and after closure activities, in both static and pseudo-static scenarios. A minimum FS is suggested for each condition by the BC Mine Waste Rock Pile Research Committee (Piteau 1991).

The stability of the DSTF during construction of the pile (short-term) was analyzed with the permafrost considered to be frozen. It is anticipated that the permafrost will not significantly thaw during construction of the DSTF. The stability of the DSTF in closure (long-term) was analyzed with the permafrost fully thawed and with an excess porewater pressure of $r_u=0.1$ in the active layer, tailings, and thawed permafrost. For all analyses conducted the phreatic surface was assumed to be along the existing ground surface. These assumptions are considered conservative and should be revisited during detailed design, when site specific data is available. Stability of surface refers to edge slumping, plane failure, and flow failure. Deep-seated stability refers to rotational failure (both embankment and foundation), wedge failure, translational failure and toe failure. A summary of the DSTF FS in several scenarios is provided in Table 3 and a plot of each slope stability analysis is attached to this letter.

TABLE 3: DSTF SLOPE STABILITY FACTOR OF SAFETY SUMMARY				
Stability Condition	Factor of Safety Suggested Minimum	Calculated for DSTF		
		Section A	Section B	Section C
Stability of Surface				
Short-Term (during construction – static)	1.0	1.0	1.8	2.0
Long-Term (after closure -static)	1.1	1.6	1.5	2.0
Deep-Seated Stability				
Short-Term (during construction - static)	1.1-1.3	1.4	1.5	2.0
Long-Term (after closure - static)	1.3	1.6	1.4	1.5
Long-Term (after closure - pseudo-static)	1.0	1.0	1.0	1.0

There is not currently sufficient geotechnical information to conduct a creep analysis of the DSTF; however, the visible ice-content of the foundation soils and anticipated loading pressures from the DSTF suggest that there may be some long-term creep observed after the construction of the DSTF. A creep analysis will be required during the detailed design of the DSTF.

7.0 MACKENO DSTF RISKS AND MITIGATIONS

The risks and mitigations associated with the DSTF are summarized in Table 4.

TABLE 4: DSTF RISK AND MITIGATION SUMMARY TABLE			
Risk	Design Constraint	Mitigation	Discussion
Deep-seated slope failure	Minimum FS = 1.3 (static); 1.0 (pseudo-static 1:500 year event)	Facility is designed to the applicable guidelines.	Probability of exceedance of the design seismic event is 10% in 50 years.
Long-term Surface Slope Failure	Minimum FS = 1.1 (static)	Facility is designed to the applicable guidelines	Surface failures can be repaired without major effort.
Short-Term Surface Slope Failure	Minimum FS = 1.0 (static)	Facility is designed to the applicable guidelines	Surface failures can be repaired with available on-site equipment.
Pile Erosion	Minimize surface runoff	Diversion berm included upgradient, and the facility is heaped above existing grade, minimizing surface water runoff.	Diversion berm is sized for the 1:200 year inflow design flood. Closure plan includes capping with a coarser material
Insufficient Drainage	Current assumption is that active layer soils should not impede drainage	Supplemental geotechnical investigation required prior to detailed design	If supplemental investigation reveals soils do impede drainage then a drain will be incorporated at the detailed design phase
Toe Liquefaction	Compact tailings and construct waste rock buttresses	Tailings are specified to be compacted with a steel drum vibratory compactor. Waste rock buttresses are to be constructed at the toe of the tailings. Foundation soils must be checked for undrained shear strength in detailed design phase.	Excavation of frozen soils may be required at the toe during construction of DSTF, to be replaced with a non-liquefiable backfill.
Snow and ice buried during pile construction	Operational issue	Operational procedures will be developed to minimize this.	Buried snow and ice could affect the stability and capacity of the facility.
Frost Heave	Limit excess porewater in frost-susceptible materials	Waste rock toe buttress promotes drainage from the toe. Free draining foundation soils limits excess porewater available to generate frost heave.	Frost heaving deforms the structure and affects the stability of the facility.
Leaking from capping material upon closure	Monitor pile upon closure	Monitoring stations located down-gradient from the facility will detect leaks and then repairs can be made. Water will be collected and treated if necessary.	Capping material can be repaired by mechanical means if a leak is detected

8.0 MACKENO DSTF CLOSURE PLAN

Since the DSTF will be constructed as a sidehill fill, progressive reclamation is feasible and will be conducted. To maintain long-term stability of the DSTF, two toe buttresses are required as shown in Figures 14 and 15. The first toe buttress is required along Section A to maintain the long-term dynamic stability of the DSTF embankment due to the longer slope at this location. The second toe buttress is required along Section G to maintain the long-term dynamic stability of the thawed foundation soils in this area. The toe buttress along Section A will require approximately 28,000 m³ of waste rock fill. The toe buttress along Section B will require approximately 19,000 m³ of waste rock fill. The fill for both of these toe buttresses can be placed throughout the operational phase of the project as progressive reclamation.

Once tailings placement in the DSTF is complete, evapo-transpirative cover (0.6 m of till soil) will be placed over the surface of the compacted tailings to reduce infiltration of runoff water in perpetuity. The area downslope of the DSTF will be re-contoured to promote drainage towards Christal Lake. The sumps and diversion berms will be left in place. The sumps will be able to act as bio-reactors if necessary, and the berms will continue to divert runoff water away from the DSTF area. The entire affected footprint will be re-vegetated with grass and other plants native to the area.

The pile will require an annual geotechnical inspection for at least 5 years after closure. The requirement for annual geotechnical inspections should be reviewed after 5 years. EBA also recommends that piezometers, ground temperature instrumentation and slope indicator instrumentation be installed for the long-term monitoring of the DSTF. These instruments can be installed as progressive closure activities during construction of the DSTF.

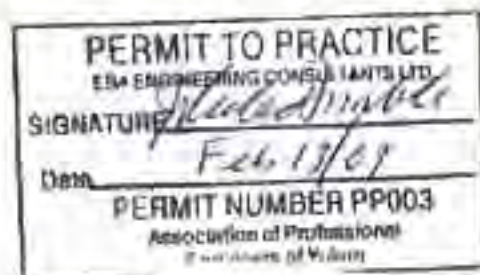
9.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Alexco Resource Canada Corp. and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Alexco Resource Canada Corp., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the General Conditions attached to this letter.

10.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned.

EBA Engineering Consultants Ltd.



Christopher J. Dixon, P.Eng.
Geotechnical Engineer, Yukon Region
Direct Line: 867.668.2071 x241
cdixon@eba.ca



Reviewed By
J. Richard Trimble, M.Sc. (Eng.), P.Eng.
Project Director, Yukon Region
Direct Line: 867.668.2071 x222
rtrimble@eba.ca

W.T. Home, M.Sc. P.Eng. (NT, AB)
Principal Consultant, Arctic Region
Direct Line: 780.451.2130 x276
bhome@eba.ca

/JHC

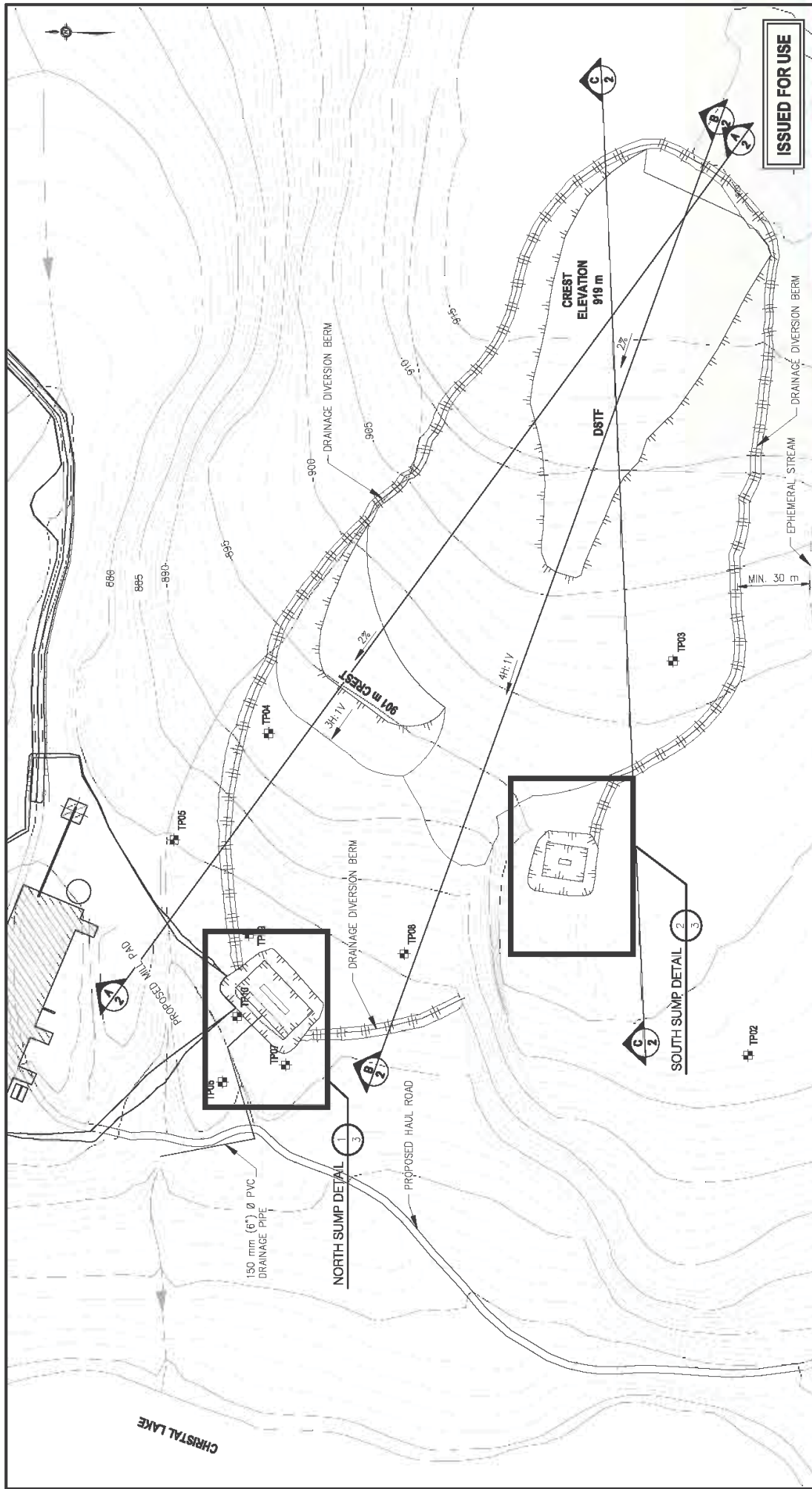
REFERENCES

- Andersland and Ladanyi, 2004. *Frozen Ground Engineering*. American Society of Civil Engineers and John Wiley & Sons, Inc. Hoboken, New Jersey, USA.
- Piteau Associates Engineering Ltd. 1991. "Investigation and Design of Mine Dumps – Interim Guidelines." Prepared for British Columbia Mine Waste Rock Pile Research Committee, May 1991.



FIGURES





LEGEND/NOTES:

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

DSTF
CAPACITY = 140,000 m³

CONCEPTUAL DESIGN VOLUMES

DRAINAGE STRUCTURES

DRAINAGE STRUCTURES

NORTH SUMP CAPACITY = 750 m ³	NORTH SUMP DRAINAGE AREA = 10,000 m ²
NORTH SUMP EXCAVATION = 4,100 m ³	NORTH SUMP CAPACITY = 300 m ³
SOUTH SUMP DRAINAGE AREA = 34,000 m ²	SOUTH SUMP EXCAVATION = 2,100 m ³
SEEPAGE / RUNOFF COLLECTION BERM - F	

0 50
Scale: 1: 1 500 (metres)

SOUTH SUMP EXCAVATION = 2,100 m³
SEEPAGE / RUNOFF COLLECTION BERM - FILL = 1,800 m³

ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON

DSTF LOCATION PLAN

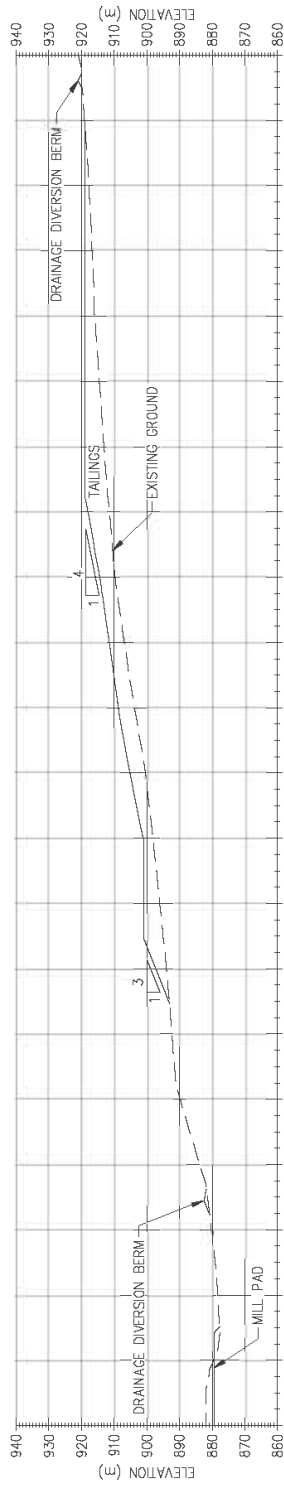
OXFORD



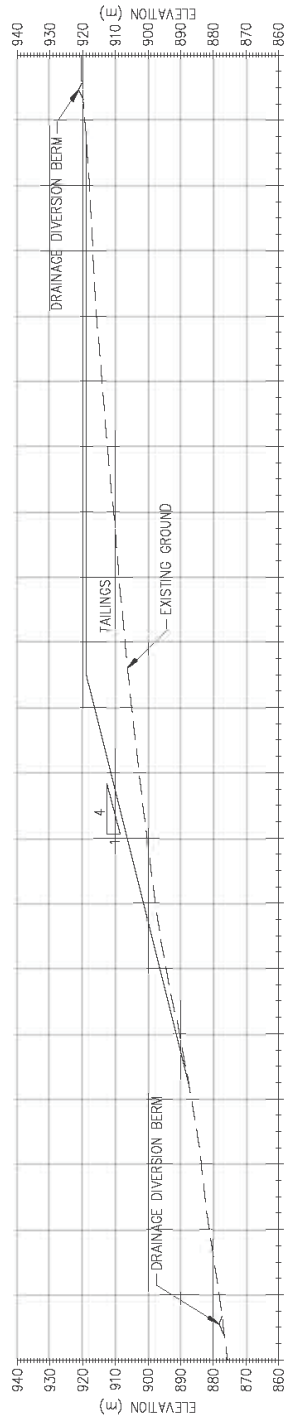
EBA Engineering Consultants Ltd.

PROJECT NO.
W14101178.001
OFFICE
EBA-WHSE

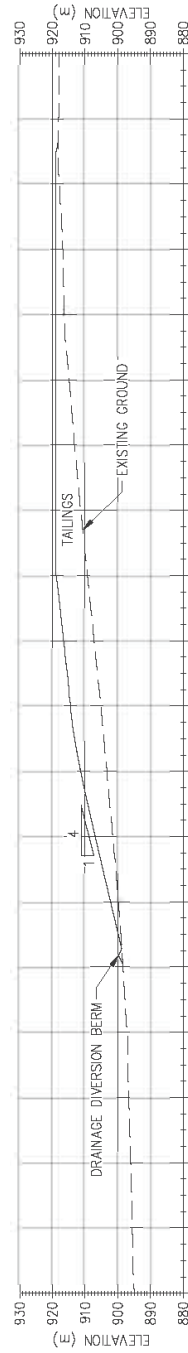
Figure 1



A DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500

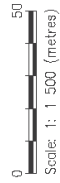


B DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500



C DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500

- NOTES:
1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
 2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON

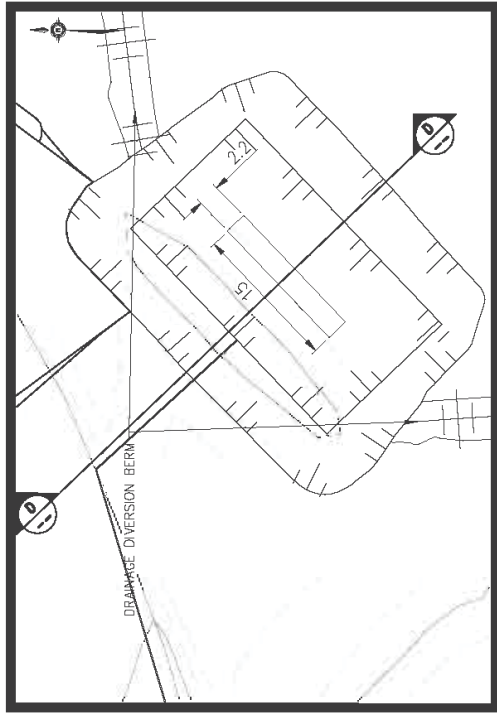


DSTF SECTIONS

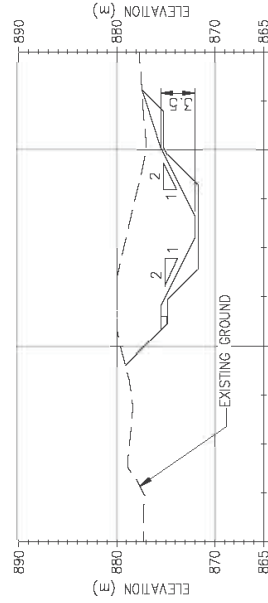


PROJECT NO.	WH410178.001	DATE	DEC 0	REV	0
DATE	07/02	BY	EBA-WHSE	CHECKED	
DATE	February 2008	BY		CHECKED	

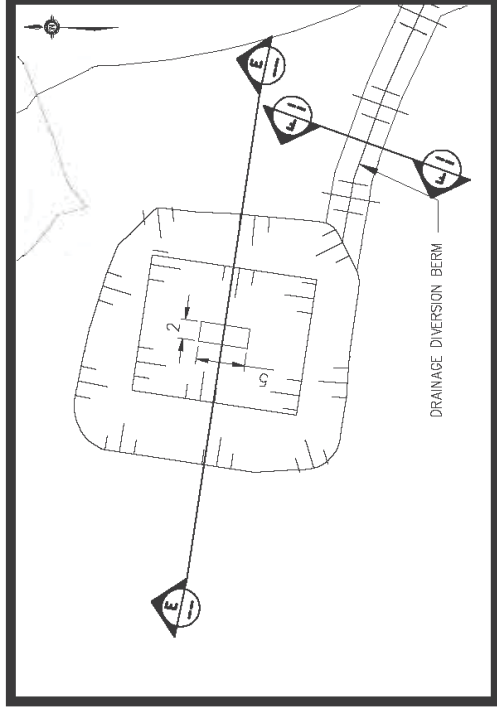
Figure 2



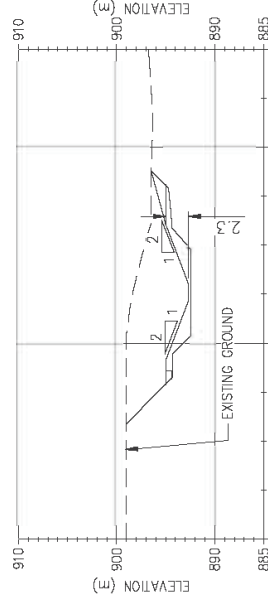
NORTH SUMP DETAIL
SCALE 1:500



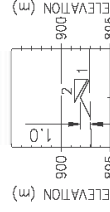
NORTH SUMP SECTION
SCALE 1:500



SOUTH SUMP DETAIL
SCALE 1:500

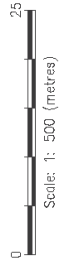


SOUTH SUMP SECTION
SCALE 1:500



DIVERSION BERM SECTION
SCALE 1:500

- NOTES:**
1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
 2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



ALEXCO

EBA Engineering Consultants Ltd.

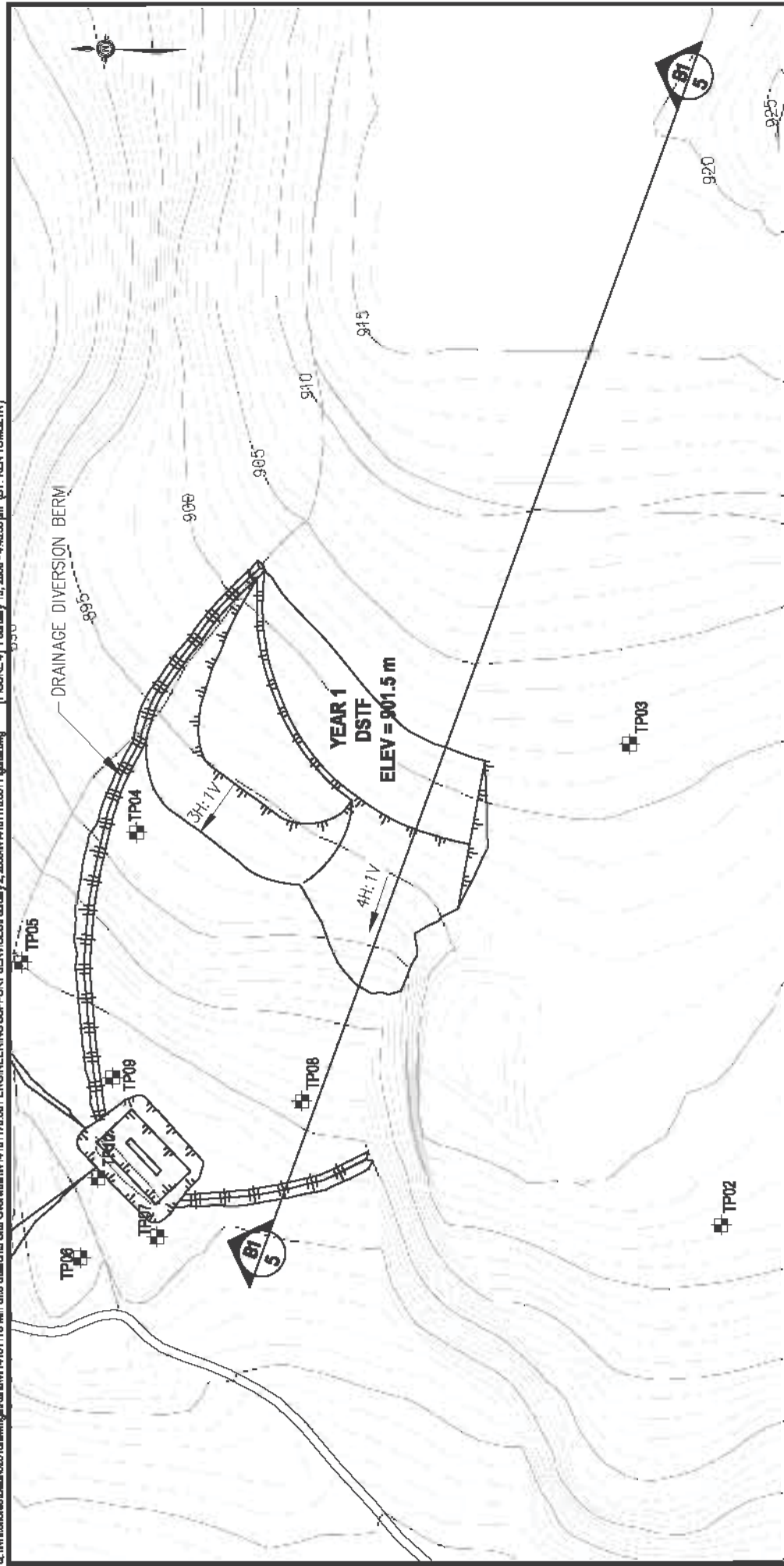
ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON

**NORTH AND SOUTH SUMPS
DETAILS AND SECTIONS**

PROJECT NO.	WY410178.001	DWG	KIT	DATE	REV
DATE	07/02	DATE	CJD	DATE	0
BY	EBA-WHSE	DATE	07/02	DATE	0

Figure 3

February 2008



ISSUED FOR USE



ALEXCO

EBA Engineering Consultants Ltd.



EBA

ENGINEERING SUPPORT SERVICES BELKENO MINE PROJECT, YUKON				
YEAR 1 CONSTRUCTION PLAN				
PROJECT NO.	DATE	REV	C.D.	REV
W14101178.001	KJT		CJD	0
BY: EBA-WHSE	DATE: February 2008			

LEGEND/NOTES:

- BOREHOLE LOCATION
- TEST PIT LOCATION

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

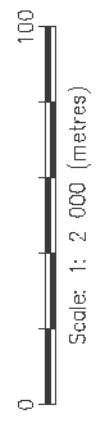
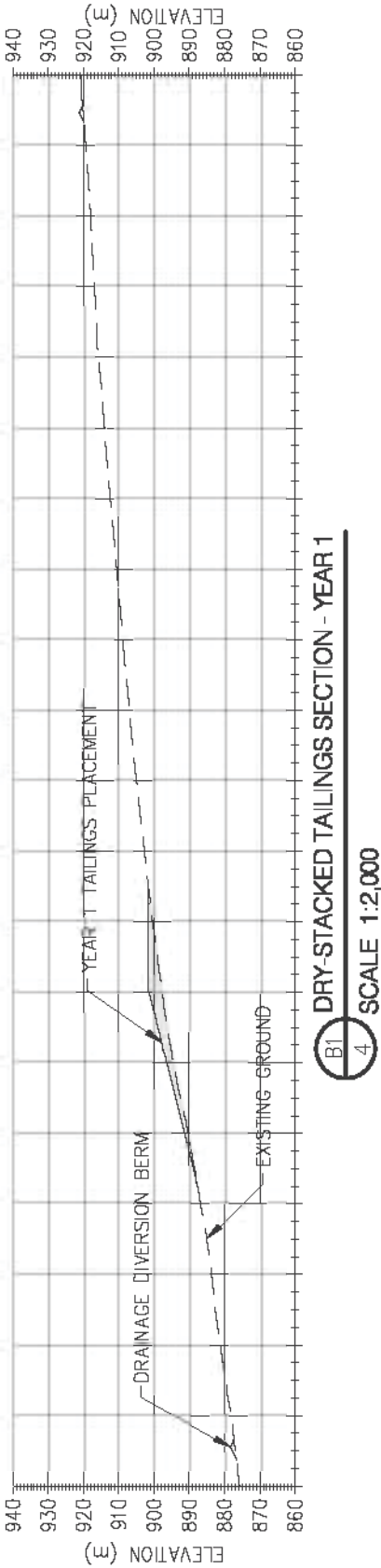


Figure 4



ISSUED FOR USE

YEAR 1 CONSTRUCTION
SECTION

NOTES

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



Q.001



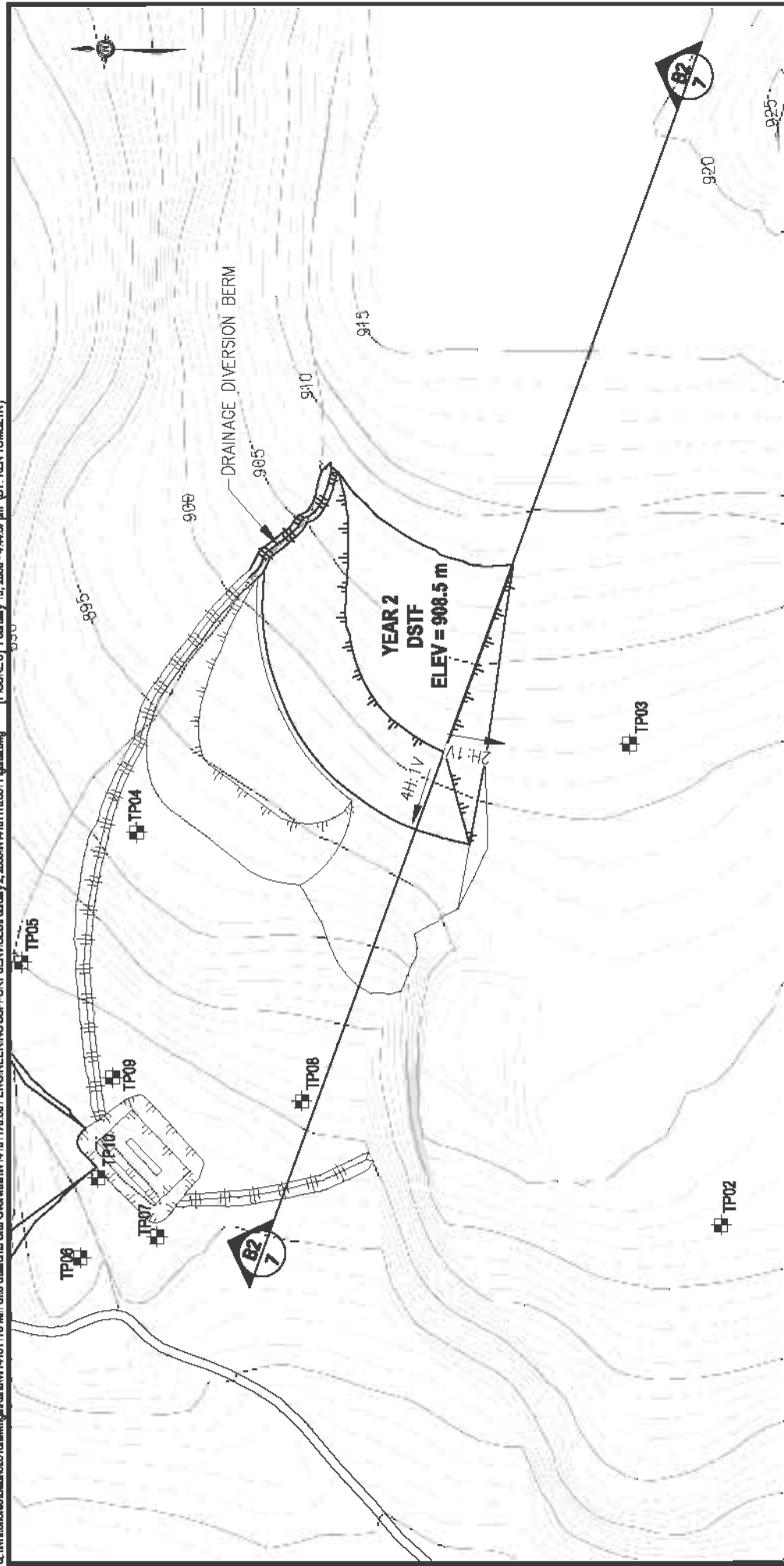
ALEXCO



ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON

PROJECT NO.	W14101178.001	DWG	KJT	C.D.	REV
BY	EBA-WHSE	DATE	February 2008	C.D.	0

Figure 5



ISSUED FOR USE



ALEXCO

EBA Engineering Consultants Ltd.



EBA

ENGINEERING SUPPORT SERVICES BELLEKENO MINE PROJECT, YUKON			
YEAR 2 CONSTRUCTION PLAN			
PROJECT NO.	DATE	C.D.	REV
W14101178.001	KJT	CJD	0
BY	DATE		
EBA-WHSE	February 2008		

LEGEND/NOTES:

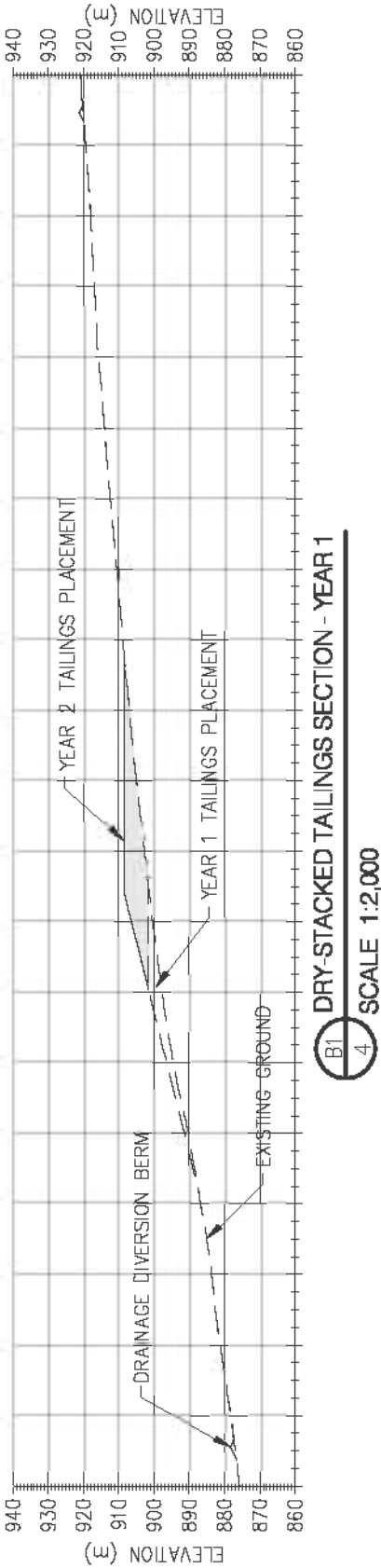
- - BOREHOLE LOCATION
- ⊕ - TEST PIT LOCATION

1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.

2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

Scale: 1: 2 000 (metres)

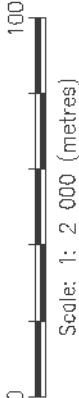




ISSUED FOR USE

NOTES

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



Q.001



ALEXCO

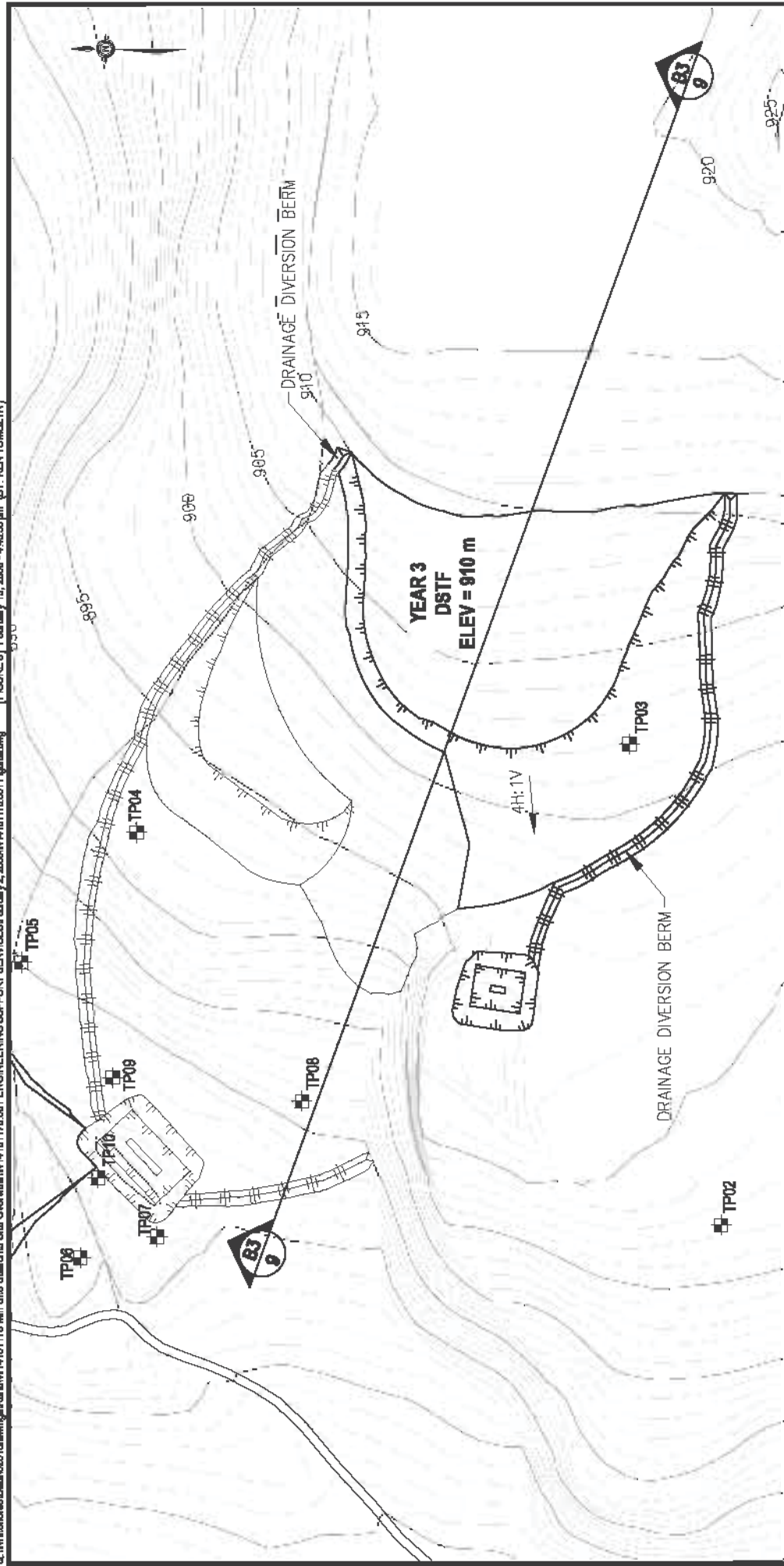


ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON

YEAR 2 CONSTRUCTION
SECTION

PROJECT NO.	DATE	CHK	REV
W14101178.001	KJT	CJD	0
BY: EBA-WHSE	DATE: February 2008		

Figure 7



ISSUED FOR USE



ALEXCO

EBA Engineering Consultants Ltd.



EBA

ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON

YEAR 3 CONSTRUCTION PLAN

PROJECT NO.	W14101178.001	DATE	February 2008
UNIT	KIT	C.D.	0
PROJECT	EBA-WHSE		

LEGEND/NOTES:

- - BOREHOLE LOCATION
- - TEST PIT LOCATION

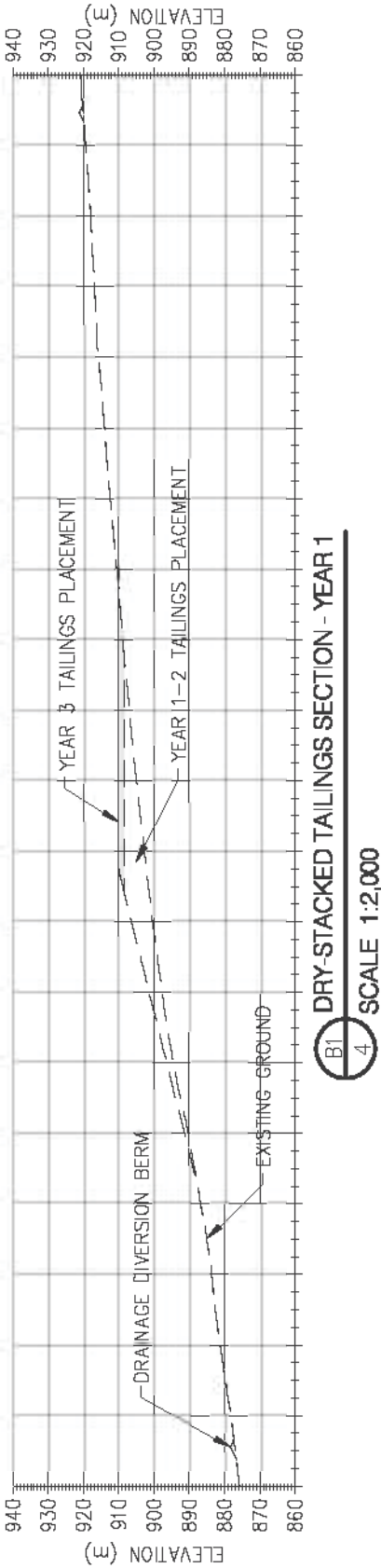
1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.

2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

Scale: 1: 2 000 (metres)



Figure 8



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON



YEAR 3 CONSTRUCTION
SECTION

NOTES

1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR
CONSTRUCTION

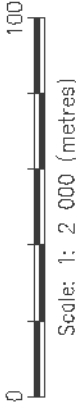
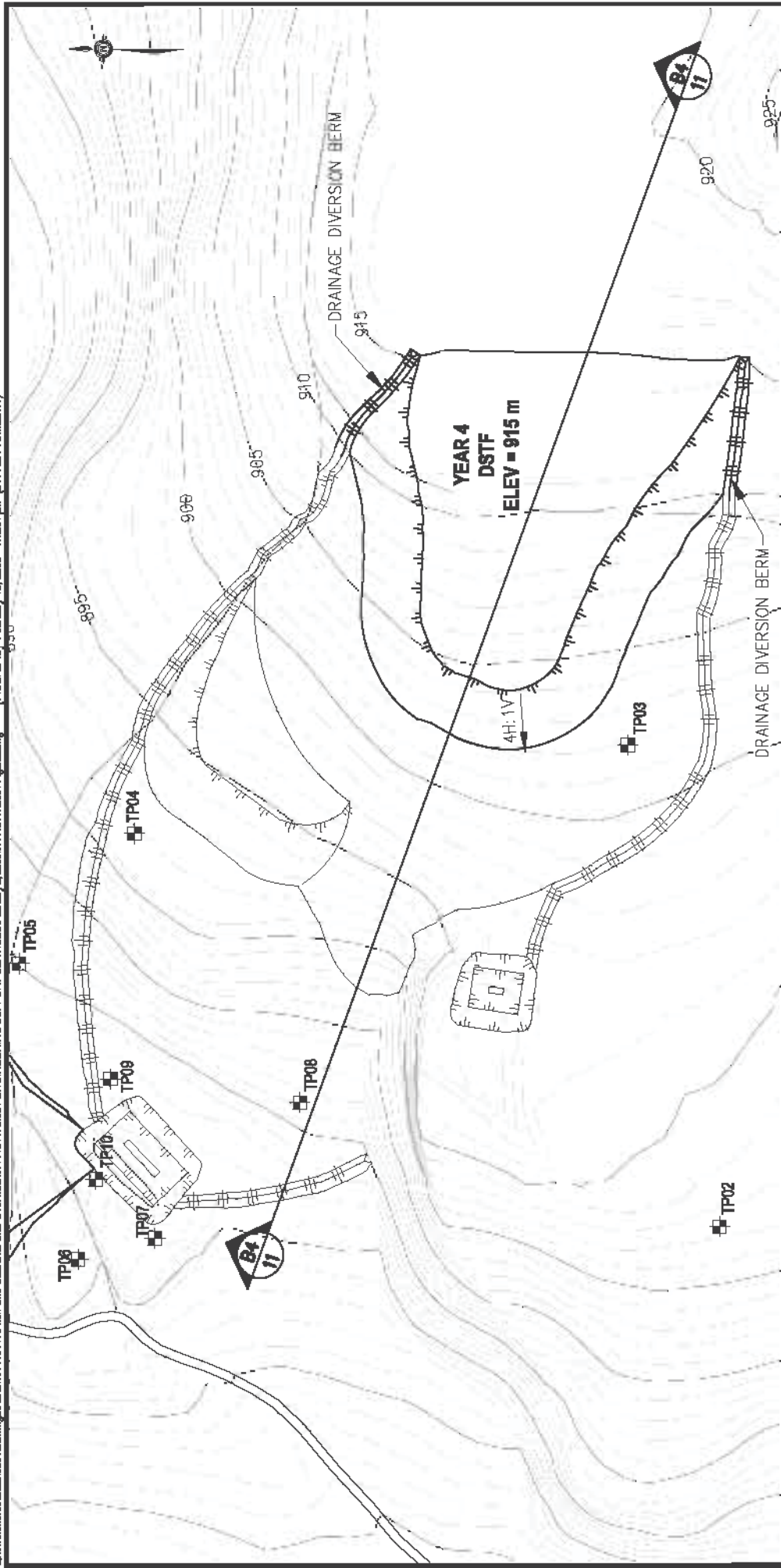


Figure 9



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEKENO MINE PROJECT, YUKON



ALEXCO

**EBA Engineering
Consultants Ltd.**

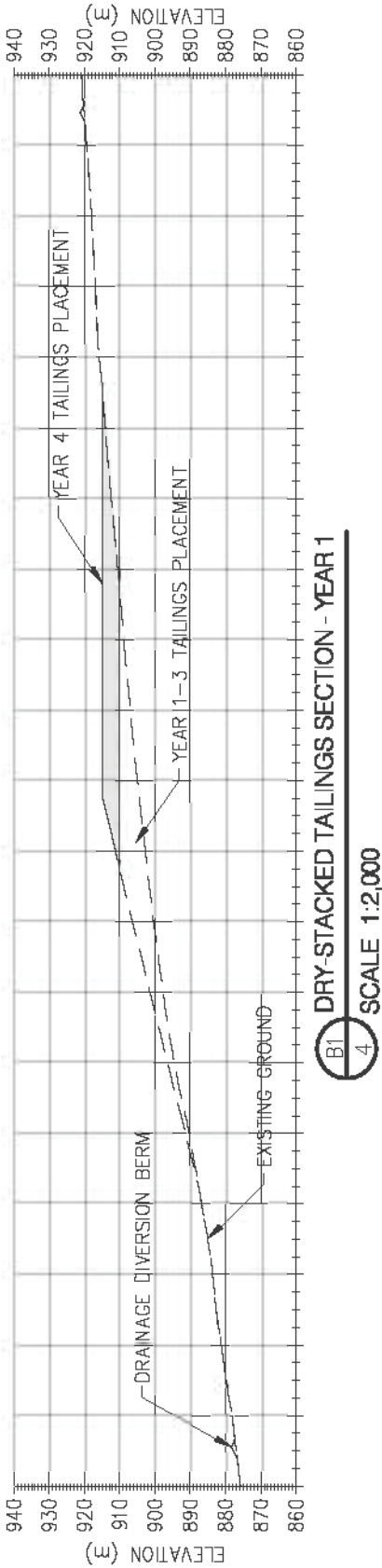
**YEAR 4 CONSTRUCTION
PLAN**

- LEGEND/NOTES:**
- 1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.
 - 2. CONCEPTUAL DESIGN ONLY - NOT FOR
CONSTRUCTION



PROJECT NO.	DATE	REV
W14101178.001	KJT	0
BY: EBA-WHSE	DATE	February 2008

Figure 10



ISSUED FOR USE

NOTES

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



Q.001

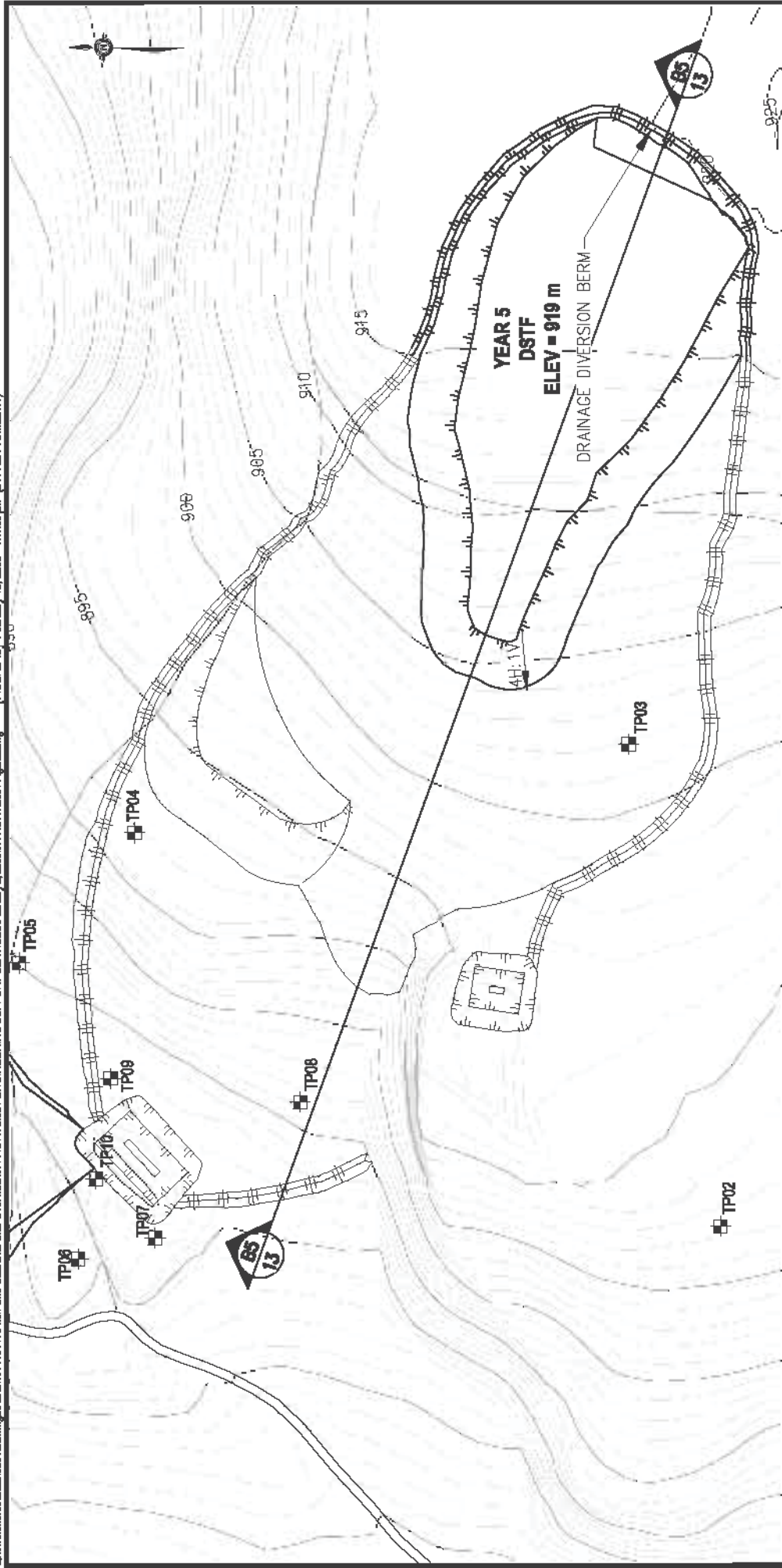


ENGINEERING SUPPORT SERVICES
BELLEFENO MINE PROJECT, YUKON

YEAR 4 CONSTRUCTION
SECTION

PROJECT NO.	W14101178.001	DWG	KJT	CJD	REV
DATE	EBA-WHSE	DATE	February 2008		0

Figure 11



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEFENO MINE PROJECT, YUKON

YEAR 5 CONSTRUCTION
PLAN

PROJECT NO.	DATE	REV
W14101178.001	KJT	0
BY: EBA-WHSE	DATE	February 2008

Figure 12

Q.101



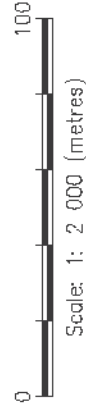
ALEXCO

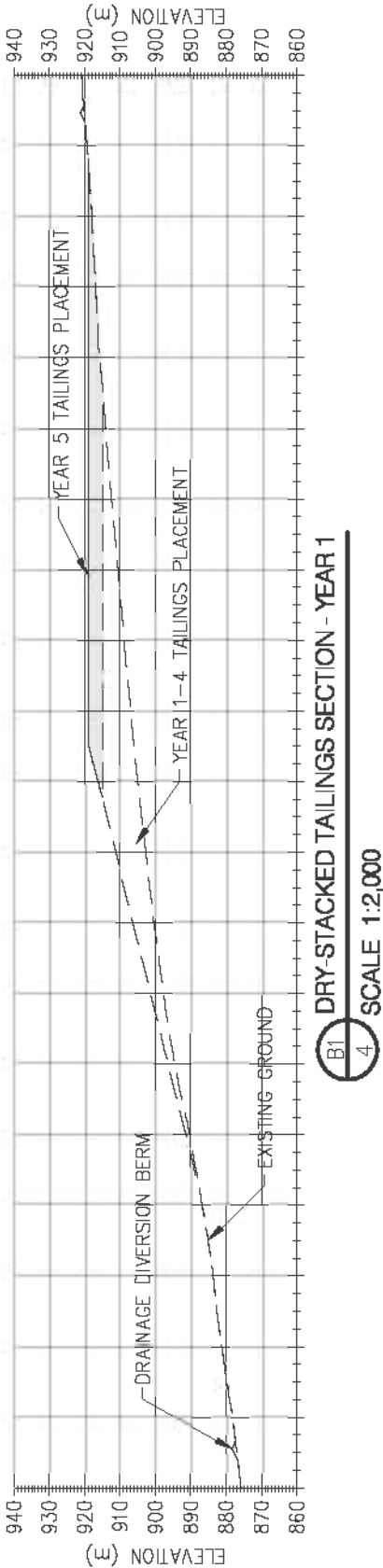


1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR
CONSTRUCTION

LEGEND/NOTES:

- - BOREHOLE LOCATION
- - TEST PIT LOCATION





ISSUED FOR USE

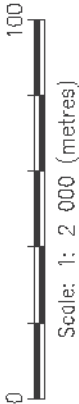
ENGINEERING SUPPORT SERVICES
BELLEFENO MINE PROJECT, YUKON



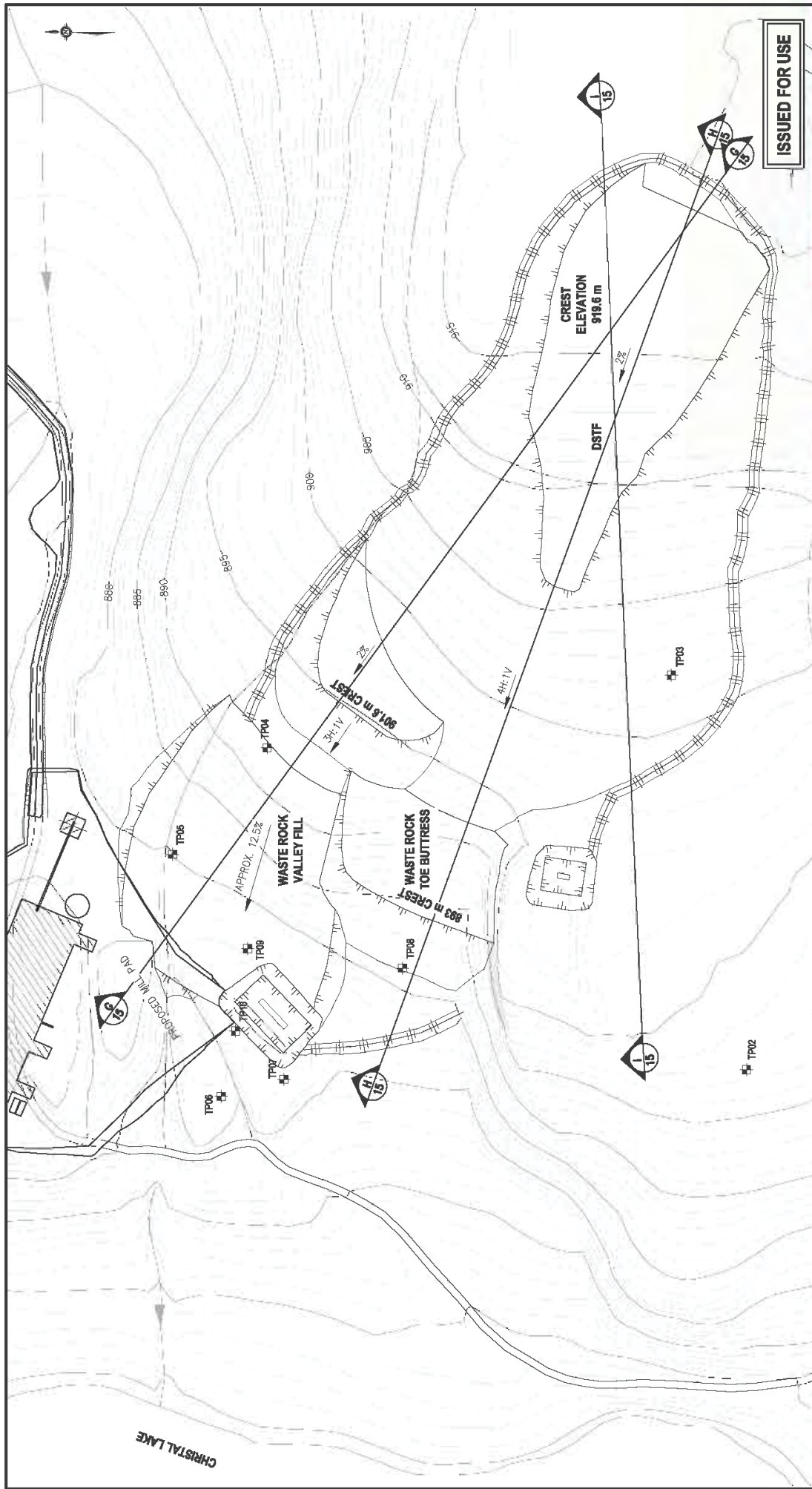
YEAR 5 CONSTRUCTION
SECTION

NOTES

1. BASE PLAN PROVIDED BY ALEXCO
RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR
CONSTRUCTION



PROJECT NO.	DATE	BY	CHK	REV
W14101178.001	KJT	CJD	0	
PROJECT	DATE	BY	CHK	REV
EBA-WHSE	February 2008			



ISSUED FOR USE

LEGEND:

- BOREHOLE LOCATION
- ⊕ TEST PIT LOCATION

1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION

WASTE ROCK TOE STRUCTURES
TOE BUTTRESS VOLUME = 19,000 m³
VALLEY FILL VOLUME = 23,000 m³

ALEXCO

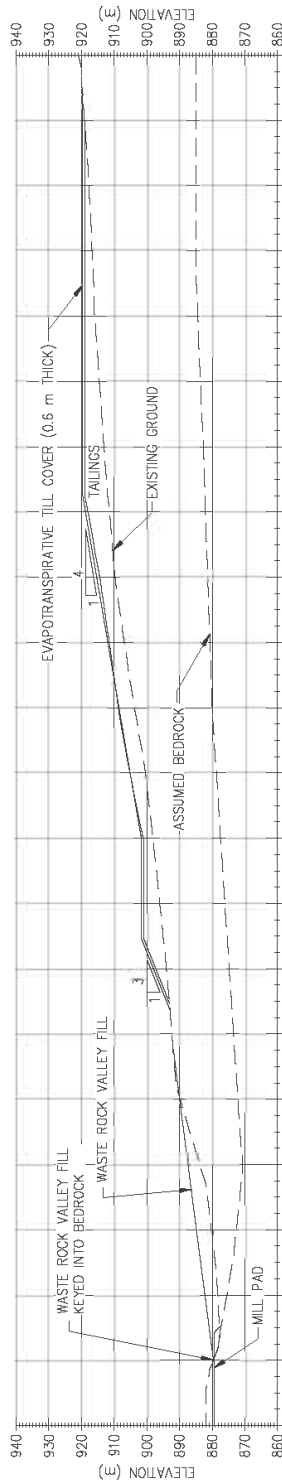
EBA Engineering Consultants Ltd.

ENGINEERING SUPPORT SERVICES
BELLEND MINE PROJECT, YUKON

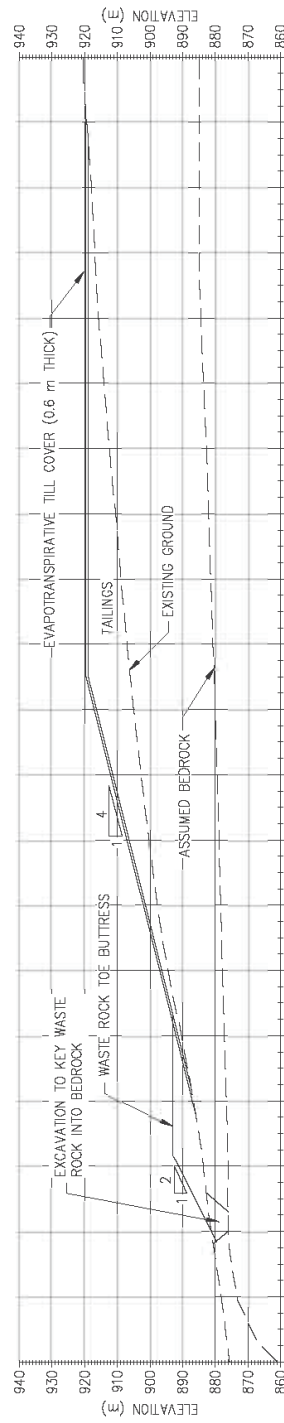
CLOSURE PLAN

PROJECT NO.	WY410178.001	DWG	KJT	REV	0
DATE	07/02	DATE	CJD	REV	0
BY	EBA-WHSE	DATE	07/02	REV	0

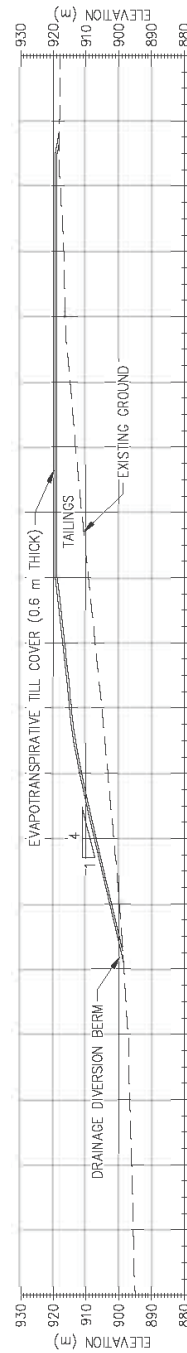
Figure 14



G DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500

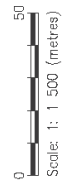


H DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500



I DRY-STACKED TAILINGS PILE SECTION
SCALE 1:1,500

- NOTES:
1. BASE PLAN PROVIDED BY ALEXCO RESOURCE CANADA CORP.
 2. CONCEPTUAL DESIGN ONLY - NOT FOR CONSTRUCTION



ISSUED FOR USE

ENGINEERING SUPPORT SERVICES
BELLEFOND MINE PROJECT, YUKON



EBA Engineering Consultants Ltd.

CLOSURE SECTIONS

PROJECT NO.	WY410178.001	DWG	KJT	DATE	07/02	REV	0
DATE	07/02	BY	EBA-WHSE	DATE	February 2008	BY	



SLOPE STABILITY PLOTS



Project Number: W14101178.001

Client: Alexco Resource Corp.

Date: February 2009

Section: Section A

Stability of Surface - Short Term

Method: Morgenstern-Price

Slip Surface Option: Grid and Radius

PWP Conditions Source: Piezometric Line with Ru

Seismic Condition: Static

Seismic PGA Value: 0

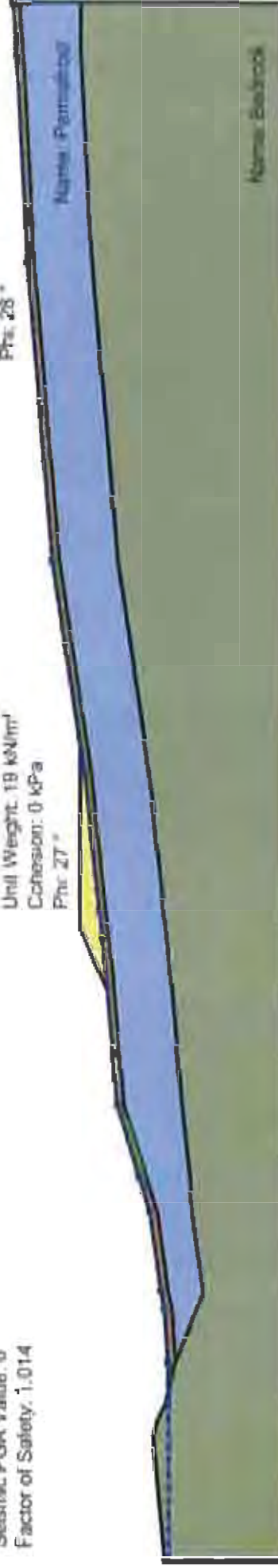
Factor of Safety: 1.014

Name: SAND - Gravelly, some silt
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 28°

Name: Tailings
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 27°

Name: Panshell

Name: Bedrock



Project Number: W14101178.001
 Client: Mexco Resource Corp
 Date: February 2009
 Section: Section A
 Stability of Surface - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.557

Name: SAND - Gravely, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28 °

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27 °

Name: Waste Rock
 Unit Weight: 17.5 kN/m³
 Cohesion: 0 kPa
 Phi: 36 °

Name: Perimeter
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 25 °

Name: Bottom



Project Number: W14101178.001

Client: Alexco Resource Corp

Date: February 2009

Section: Section A

Deep Sealed Stability - Short Term

Method: Morgenstern-Price

Slip Surface Option: Grid and Radius

PWP Conditions Source: Piezometric Line with Ru

Seismic Condition: Static

Seismic PGA Value: 0

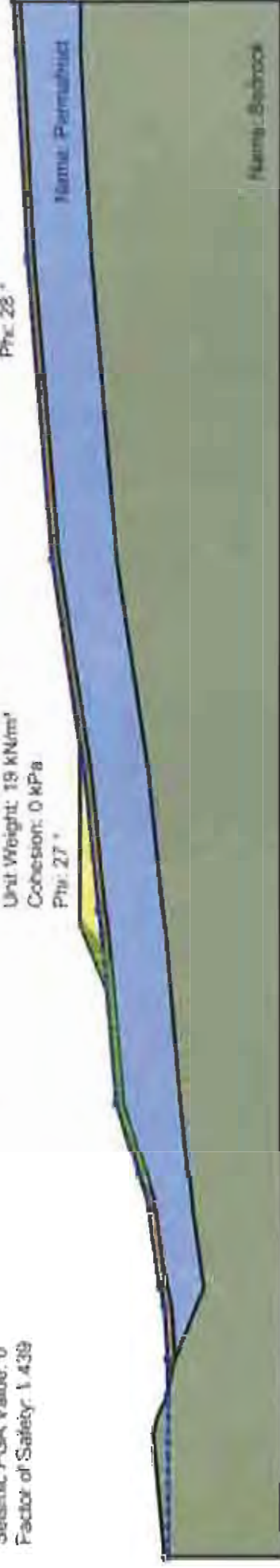
Factor of Safety: 1.439

Name: SAND - Gravelly, some silt
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 28.°

Name: Tailings
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 27.°

Name: Patahmuict

Name: Bedrock



Project Number: W14101178.001
 Client: Alcoa Resource Corp
 Date: February 2009
 Section: Section A
 Deep Sealed Stability - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.563

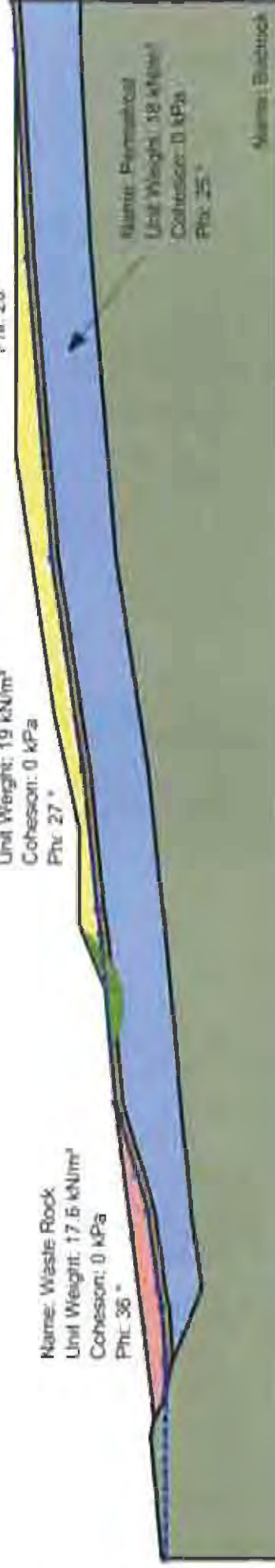
Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28 °

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27 °

Name: Waste Rock
 Unit Weight: 17.6 kN/m³
 Cohesion: 0 kPa
 Phi: 36 °

Name: Permeable
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 25 °

Name: Blotrock



Project Number: W14101178.001
 Client: Alexco Resource Corp.
 Date: February 2008
 Section: Section A
 Deep Seated Stability - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line
 Seismic Condition: Pseudo-Static
 Seismic PGA Value: 0.138
 Factor of Safety: 1.024

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28°

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27°

Name: Waste Rock
 Unit Weight: 17.6 kN/m³
 Cohesion: 0 kPa
 Phi: 35°

Name: Pastureland
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 25°

Name: Bedrock



Project number: 47410112001

Client: Alexco Resource Corp.

Date: February 2009

Section: Section B

Stability of Surface - Short Term

Method: Morgenstern-Price

Slip Surface Option: Grid and Radius

PWP Conditions Source: Piezometric Line with R_u

Seismic Condition: Static

Seismic PGA Value: 0

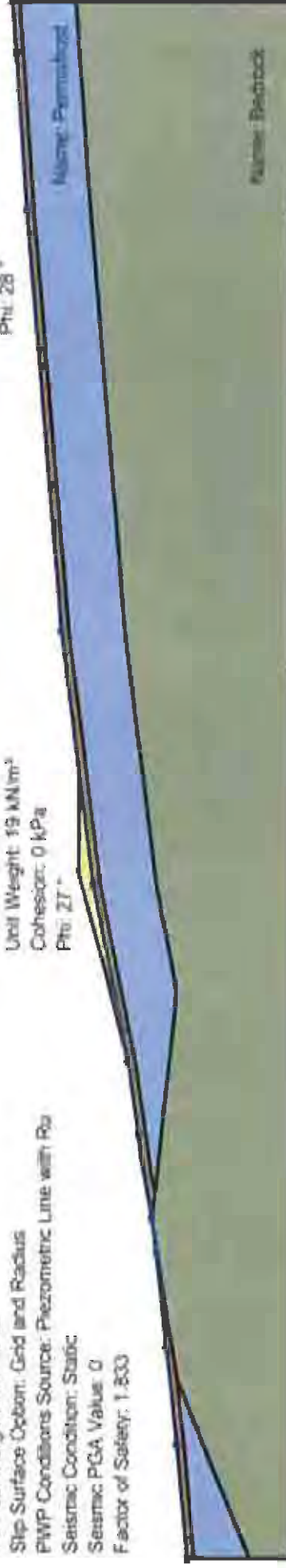
Factor of Safety: 1.833

Name: SAND - Gravelly, some silt
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 28 °

Name: Tailings
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Permafrost

Name: Bedrock



Project Number W14101178.001
 Client: Alexco Resource Corp
 Date: February 2009
 Section: Section B
 Stability of Surface - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.522

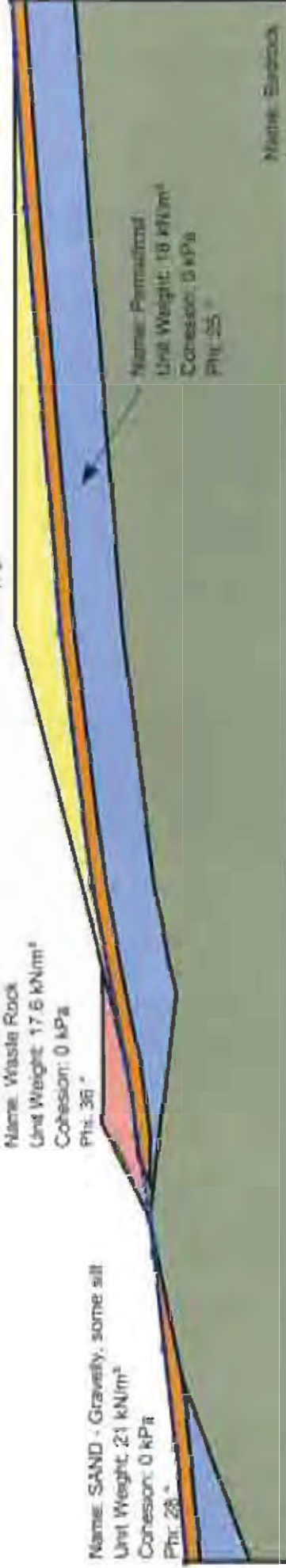
Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27 °

Name: Waste Rock
 Unit Weight: 17.6 kN/m³
 Cohesion: 0 kPa
 Phi: 36 °

Name: SAND - Gravels, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28 °

Name: Permafrost
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 55 °

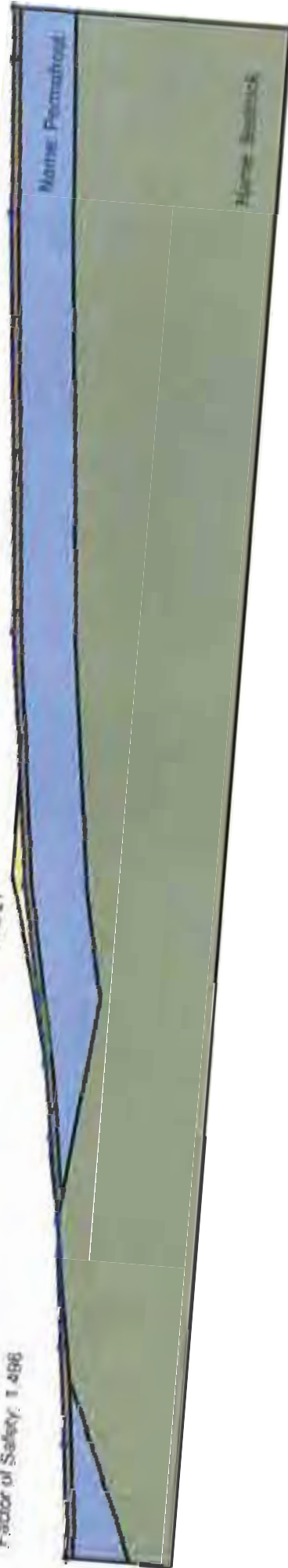
Name: Bedrock



Project Number: W14101178.001
 Client: Alexco Resource Corp
 Date: February 2009
 Section: Section B
 Deep Seated Stability - Short Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.496

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27°

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28°



Project Number: W14101178.001

Client: Alenco Resource Corp

Date: February 2009

Section: Section B

Deep Seated Stability - Long Term

Method: Morgenstern-Price

Slip Surface Option: Grid and Radius

PWP Conditions Source: Piezometric Line with Ru

Seismic Condition: Static

Seismic PGA Value: 0

Factor of Safety: 1.397

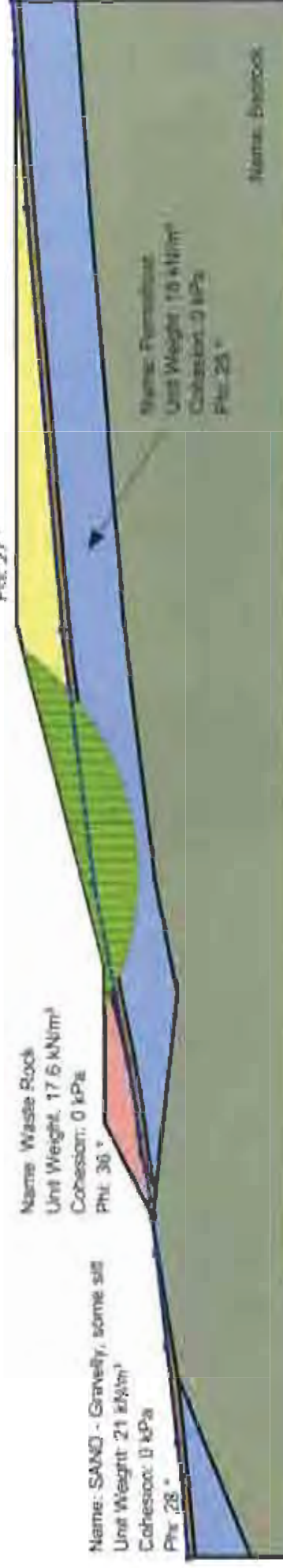
Name: Tailings
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 27 °

Name: Waste Rock
Unit Weight: 17.6 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: SAND - Gravelly, some silt
Unit Weight: 21 kN/m³
Cohesion: 0 kPa
Phi: 28 °

Name: Permeable
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 23 °

Name: Bedrock



Project Number: W14101178.001
 Client: Alexco Resource Corp
 Date: February 2009
 Section: Section B
 Deep Seated Stability - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grd and Radius
 PWP Conditions Source: Piezometric Line
 Seismic Condition: Pseudo Static
 Seismic PGA Value: 0.138
 Factor of Safety: 1.009

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27 °

Name: Waste Rock
 Unit Weight: 17.6 kN/m³
 Cohesion: 0 kPa
 Phi: 36 °

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28 °

Name: Fluvial
 Unit Weight: 18 kN/m³
 Cohesion: 0 kPa
 Phi: 25 °

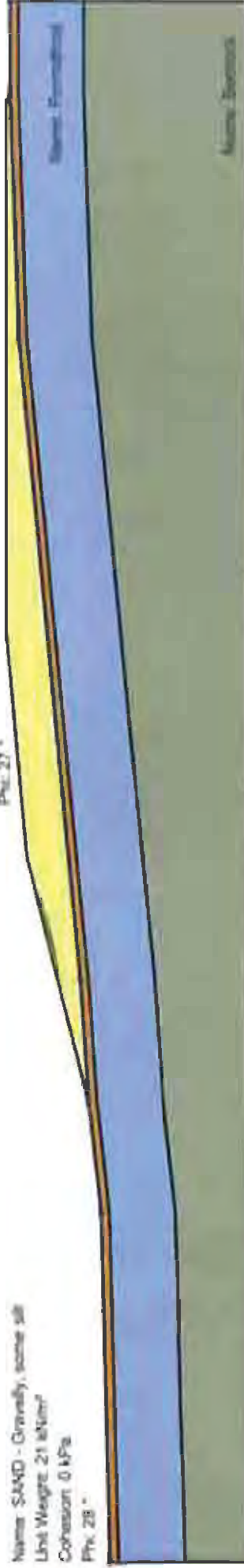
Name: Bedrock



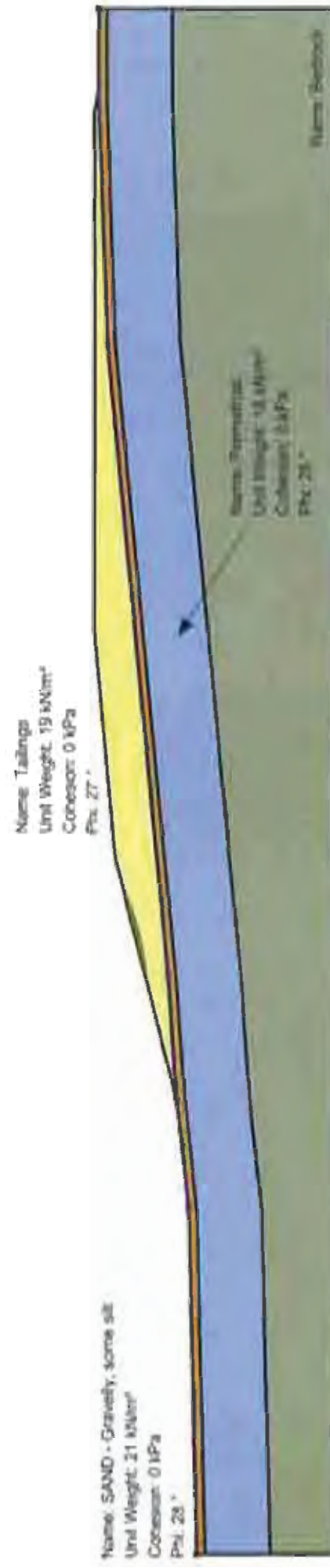
Project Number: WY1410178.001
 Client: Alvarado Resource Corp
 Date: February 2009
 Section: Section C
 Stability of Surface - Short Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions: Surface, Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 2.066

Name: Tailings
 Unit Weight: 10 kN/m³
 Cohesion: 0 kPa
 Phi: 27 °

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28 °



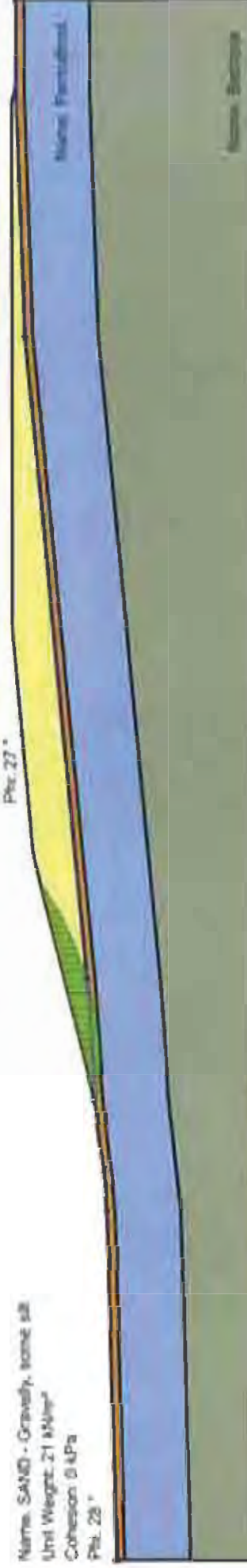
Project Number: W14101178-001
 Client: Alarco Resource Corp.
 Date: February 2009
 Section: Section C
 Stability of Surface - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PHP Conditions: Source: Piezometric Line with Ru
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 2.055



Project Number: W14101178.001
 Client: Alamos Resource Corp.
 Date: February 2009
 Section: Section C
 Deep Seated Stability - Short Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with P_u
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.971

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27°

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28°



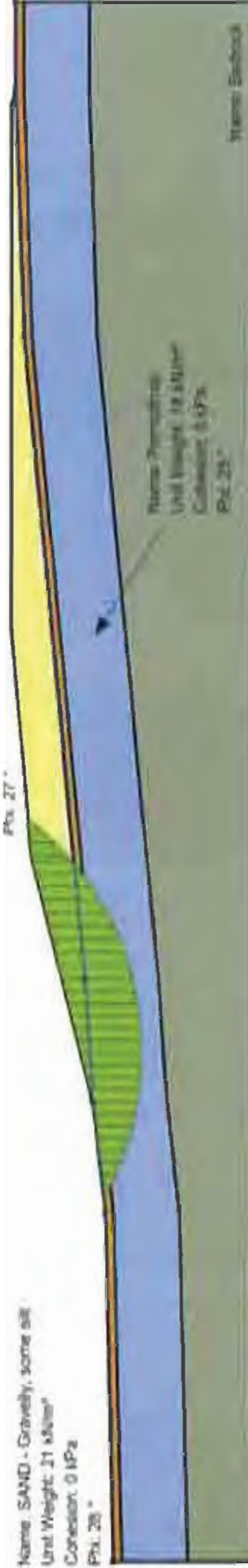
Project Number: W14 N61178.001
 Client: Alasca Resource Corp
 Date: February 2009
 Section: Section C
 Deep Seated Stability - Long Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line with R_u
 Seismic Condition: Static
 Seismic PGA Value: 0
 Factor of Safety: 1.484

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 ϕ : 27°

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 ϕ : 28°

Name: Permafrost
 Unit Weight: 18 kN/m³
 Cohesion: 8 kPa
 ϕ : 25°

Water Surface



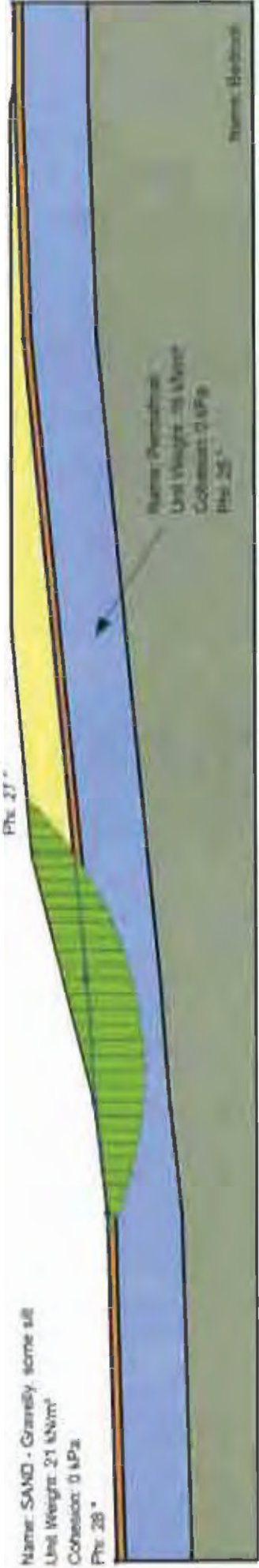
Project Number: W14101178.001
 Client: Alarco Resource Corp.
 Date: February 2009
 Section: Section C
 Design: Seismic Stability - Lung Term
 Method: Morgenstern-Price
 Slip Surface Option: Grid and Radius
 PWP Conditions Source: Piezometric Line
 Seismic Condition: Pseudo Static
 Seismic PGA Value: 0.138
 Factor of Safety: 1.003

Name: Tailings
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 27°

Name: SAND - Gravelly, some silt
 Unit Weight: 21 kN/m³
 Cohesion: 0 kPa
 Phi: 28°

Name: Pseudo-static
 Unit Weight: 19 kN/m³
 Cohesion: 0 kPa
 Phi: 28°

Name: Bedrock





LABORATORY TEST RESULTS



PARTICLE SIZE ANALYSIS TEST REPORT

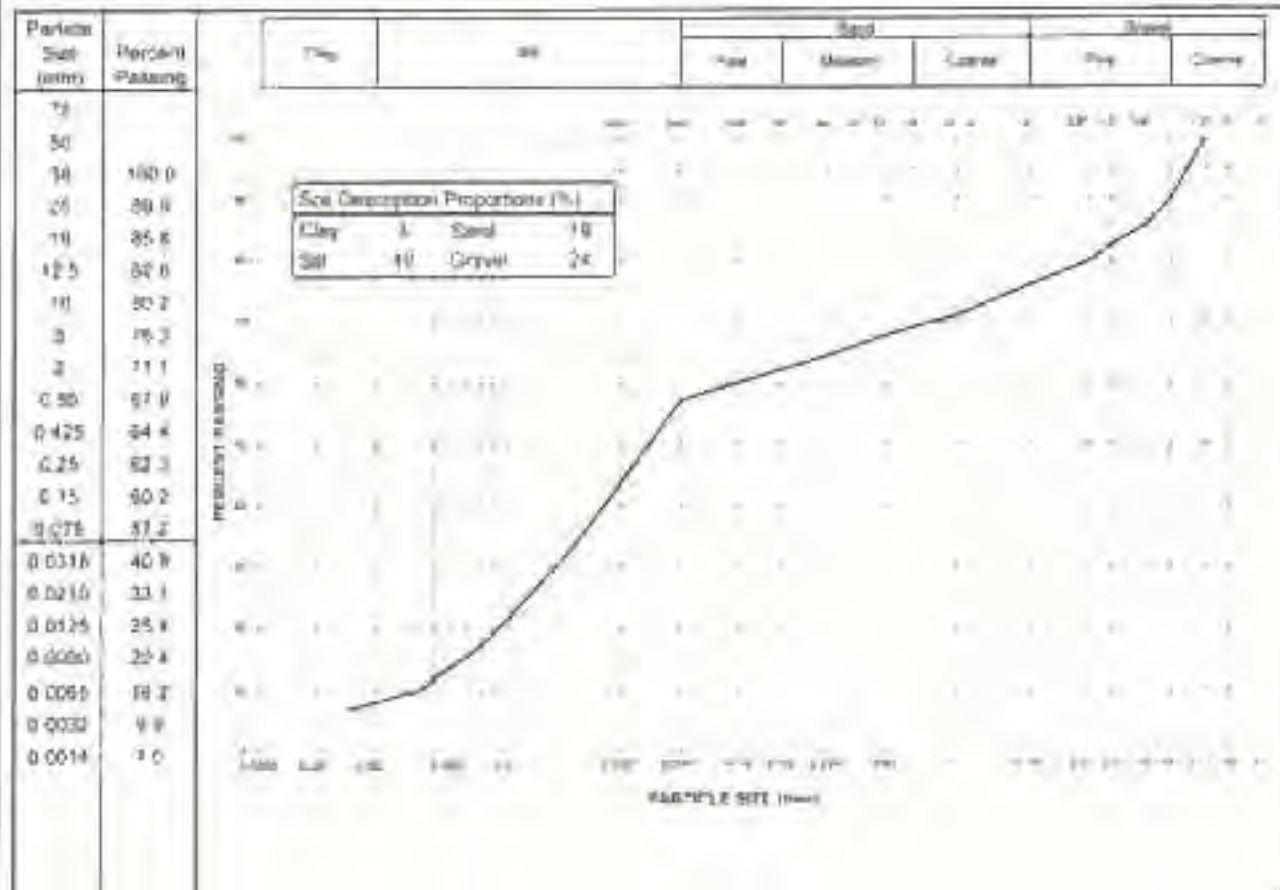
ASTM D422 & D79

Project: Potential Mill Sites
Project No.: W1410-176.001
Site: Keno City

Client: Alexco Resource Corp
Client Rep: Mr. Rob McIntyre

Material Type:
Sample No.: TP-01
Sample Loc: Mackenzie DIST
Sample Depth:
Sampling Method: Bulk
Date sampled:

Date Tested: 18-Dec-2008 By: RC
Soil Description: SILT - gravelly, some sand, trace clay
USC Classification: SM
Moisture Content: 22.7
Cu: 44.0
Cc: 0.8



Notes: The upper clay size of 2 µm per the Canadian Foundation Engineering Manual
The description is visually based & subject to SQA description protocols

Specification: _____

Remarks: _____

Reviewed By: _____

PARTICLE SIZE ANALYSIS TEST REPORT

ASTM D422 & C136

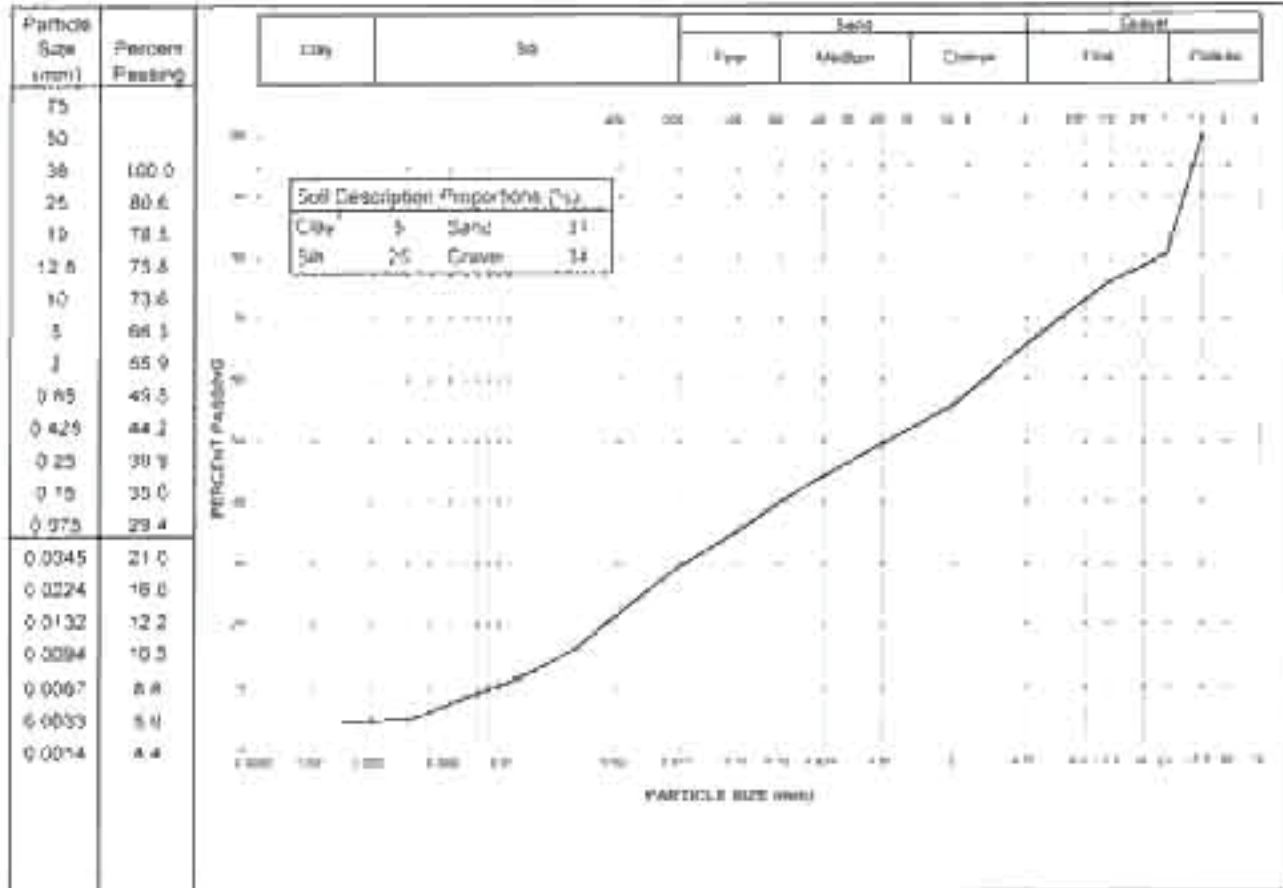
Project: Potential Mill Sites
Project No.: W14101178 001
Site: Keno City

Client: Alexco Resource Corp.
Client Rep: Mr. Rob McIntyre

Material Type:
Sample No.: TP-02
Sample Loc: Mackena DSTF
Sample Depth:
Sampling Method: Bulk
Date sampled:

Date Tested: 18-Dec-2008 By: RC
Soil Description: SAND gravelly, silty, trace clay

USC Classification: SP Cu: 370.6
Cc: 0.3
Moisture Content: 14.9



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to EBA description protocols

Specification: _____

Remarks: _____

Reviewed By: _____

PARTICLE SIZE ANALYSIS TEST REPORT

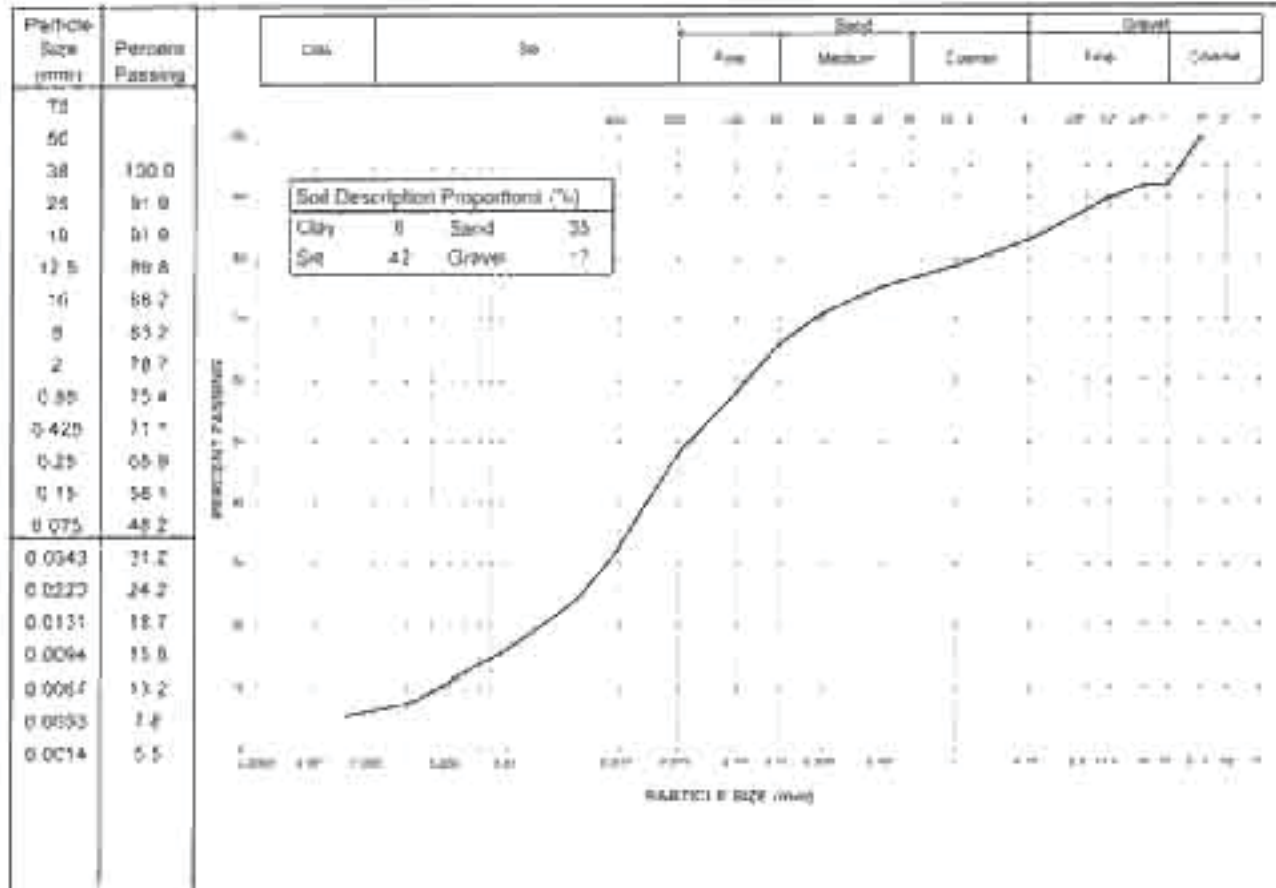
ASTM D422 & D2875

Project: Potential Mill Sites
Project No: W14101178 001
Site: Keno City

Client: Alexco Resource Corp
Client Rep: Mr. Rob McIntyre

Material Type:
Sample No: TP-03
Sample Loc: Mackeno DSTF
Sample Depth:
Sampling Method: Bulk
Date sampled:

Date Tested: 18-Dec-2008 By: RC
Soil Description¹: SILT AND SAND - some gravel
trace clay
USC Classification: SM
Moisture Content: 21.0
Car: 37.5
Cc: 1.3



Notes:
¹ The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to FSA description protocols

Specification: _____

Remarks:

Reviewed By: _____

PARTICLE SIZE ANALYSIS TEST REPORT

ASTM D422 & D 136

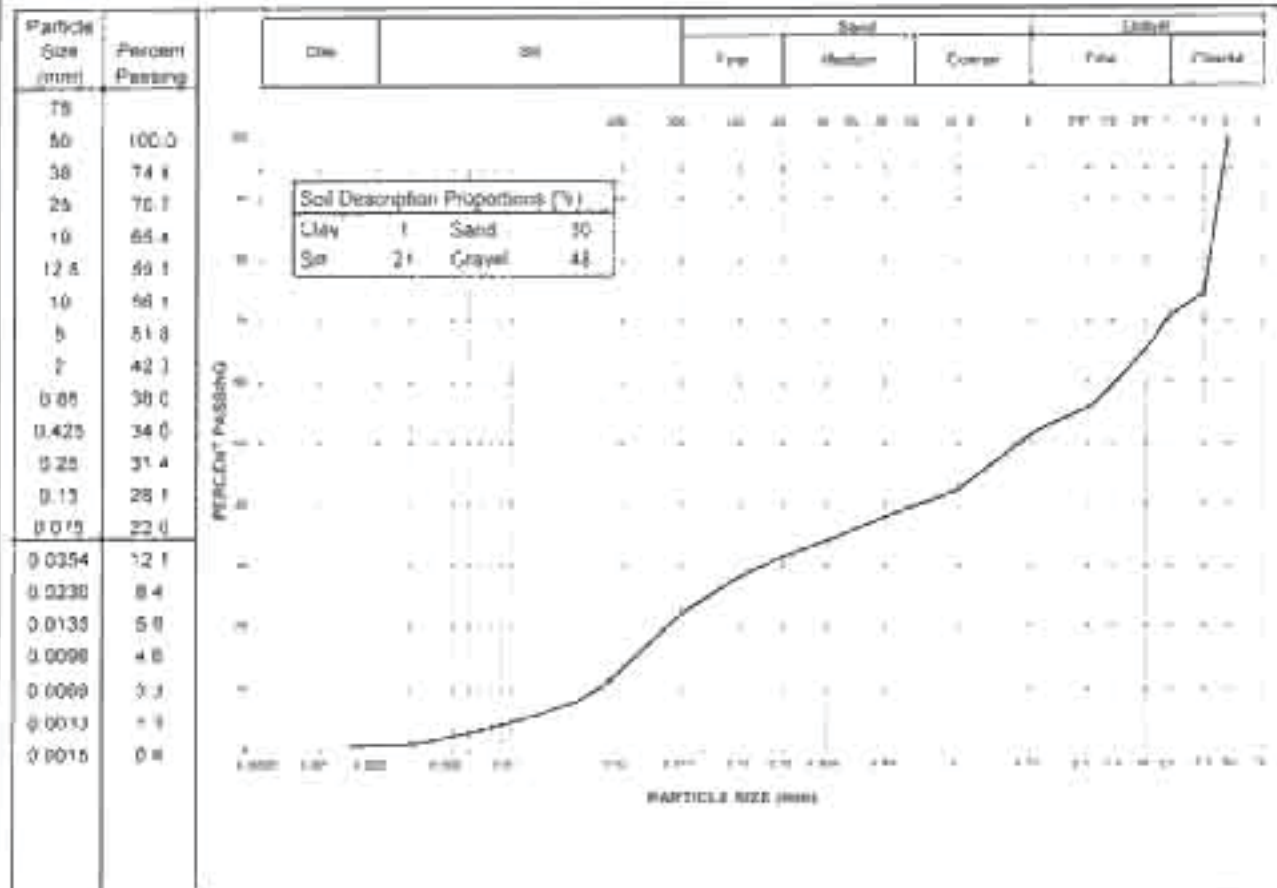
Project: Potential Mill Sites
Project No.: W14101178 001
Site: Keno City

Client: Alexco Resource Corp
Client Rep: Mr. Rob McIntyre

Material Type:
Sample No.: TP-04
Sample Loc: Mackeno DSTF
Sample Depth:
Sampling Method: Bulk
Date sampled:

Date Tested: 18 Dec-2008 By: RC
Soil Description: GRAVEL sandy, silty trace clay

USC Classification: GM Cu: 472.1
Cc: 0.1
Moisture Content: 20.1



Notes:

- ¹ The upper clay size of 2 μ m per the Canadian Foundation Engineering Manual
- ² The description is visually based & subject to CBA description protocols

Specification:

Remarks:

Reviewed By: _____

Atterberg Limits Test Form

ASTM D4318

Project: Potential Mill Sites

Keno City

Sample Number

Borehole Number: TPC1

Project Number: W14101178-001

Depth

Sample Description: Mackend DISTF

Date Tested: January 27, 2009

Bulk Sample

Tested By: JMP

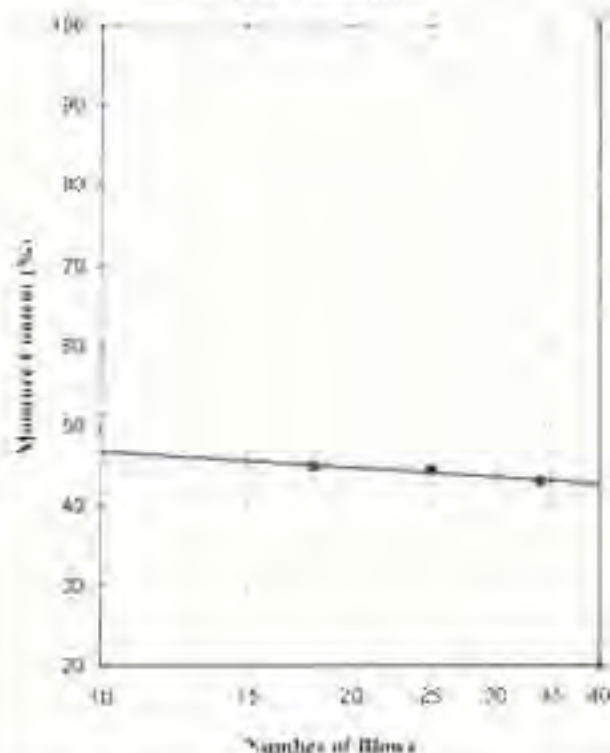
Plastic Limit Test

Trial Number	1	2	3
Tare Number	1	3	
Wt. Wet Soil + Tare	6.00	7.24	
Wt. Dry Soil + Tare	6.47	6.32	
Wt. of Tare	4.01	3.96	
Wt. of Water	0.53	0.92	
Wt. of Dry Soil	1.46	2.36	
Moisture Content (%)	36.3	39.0	

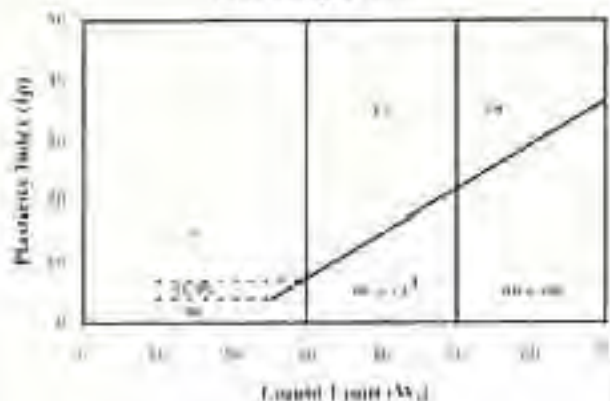
Liquid Limit Test

Trial Number	1	2	3
No. of Blows	18	25	34
Tare Number	2	4	5
Wt. Wet Soil + Tare	15.89	17.22	25.87
Wt. Dry Soil + Tare	12.23	13.14	19.26
Wt. of Tare	4.09	3.96	3.92
Wt. of Water	3.65	4.08	6.61
Wt. of Dry Soil	8.14	9.18	15.34
Moisture Content (%)	45.0	44.4	43.1

Liquid Limit (W_L)



Plasticity Chart



LIQUID LIMIT (%) 44

PLASTIC LIMIT (%) 38

PLASTICITY INDEX (%) 6

Soil Description: Medium Plasticity

USCS Symbol: ML

Remarks:

EBA Engineering
Consultants Ltd.

