

Western Copper Corporation

Project Proposal – Revision No. 2

Carmacks Copper Project

Yukon Territory

**Volume I
Main Report**



February 2007

Prepared by





Western Copper Corporation

February 6, 2007

Yukon Environmental and Socio-economic Assessment Board
3059 – 3rd Avenue
P.O. Box 31642
Whitehorse, Yukon Y1A 6L2

Attention: Mr. Stephen Mills, Executive Committee, YESAB

Dear Mr. Mills:

Re: Western Copper Corporation - Carmacks Copper Project - Project Proposal Revision No. 2 (2006-0050)

Western Copper Corporation (Western Copper) hereby submits a revised Project Proposal (Revision No. 2) for the Carmacks Copper Project (the project). This Project Proposal is revised to address YESAB's Adequacy Review Reports (April 28, 2006 and January 12, 2007) and other feedback and advice provided by YESAB.

Since receipt of YESAB's Adequacy Reports Western Copper has continued to work with Yukon Government on the Yukon environmental assessment and with Little Salmon Carmacks First Nation (LSCFN), Selkirk First Nation, the Village of Carmacks, and other interested parties as part of the environmental and socio-economic assessment for the project. Western Copper will continue to engage the community and stakeholders to provide project updates, with a view to long-term cooperative and mutually beneficial relationships with all communities in the vicinity of the Carmacks Copper property.

The Project Proposal has been revised to provide the complete up to date project description along with supporting documentation. This report is based on the original Project Description and Environmental Assessment Report (Volumes I and II) that was previously submitted to YESAB (February 27, 2006) and has been updated to address YESAB's Adequacy Review Report. Revised information is presented in a format that is readily determined.

Western Copper's Project Proposal comprises twenty-five hard copies and an electronic copy (CD) of the following: Main Report Volume I; Supporting Appendices (Volume II and III) and accompanying additional supporting documentation (CD only). New reports, studies or information are fully presented in the Supporting Appendices. A second CD has also been included that contains results of the Williams Creek Geochemical Assessment and Hydrologic Modeling.

The updated project information as contained in the Project Proposal is intended to address project issues raised during the assessment process and support project development and closure plans. The additional studies support the Project Proposal environmental and socio-economic assessment and have not materially altered the results of the environmental and socio-economic assessment presented in the original PD&EAR.

Western Copper looks forward to initiating the public review of the YESAA process with the YESAB and working co-operatively towards completion of the assessment process. We appreciate your ongoing advice and assistance with completing the review process.

Sincerely,
WESTERN COPPER CORPORATION



Jonathan E. Clegg, P.Eng
V.P. Engineering

cc. Dan Cornett, Access Consulting Group

**Project Proposal
Carmacks Copper Project
Yukon Territory**

Submitted by:

*Western Copper Corporation
2050 – 1111 West Georgia Street
Vancouver, British Columbia V6E 4M3*

DISTRIBUTION LIST

25 Copies + 5 PDF*	Yukon Environmental and Socio-economic Assessment Board
1 Copy + 1 PDF	Yukon Government (YG) Energy, Mines and Resources, Minerals Management Branch
1 Copy + 1 PDF	YG Executive Council Office, Development Assessment Process Branch
1 Copy + PDF	Village of Carmacks
1 Copy + 1 PDF	Little Salmon Carmacks First Nation
1 Copy + 1 PDF	Selkirk First Nation
2 Copies + 1 PDF	Access Consulting Group
4 Copies + 1 PDF	Western Copper Corporation
1 PDF	Alexco Resource Corp.

*PDF = digital version of report on CD

PROJECT CONTACT LIST

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CONTEXT OF THIS DOCUMENT

This Project Proposal presents a summary of detailed project information for Western Copper Corporation's ("Western Copper" / "the Company") Carmacks Copper Project ("the project") and provides an environmental and socio-economic assessment for the project. The report is presented in three volumes: Volume I – Project Proposal, and Volumes II and III – Supporting Appendices.

Environmental assessment legislation has undergone a number of changes in recent years. This Project Proposal was originally intended to fulfill the requirements of the Yukon Environmental Assessment Act (YEAA) and the Canadian Environmental Assessment Act (CEAA) when it was filed in June 2005. At that time there was recognition of the pending Yukon Environmental and Socio-economic Assessment Act (YESAA) legislation and the changes resulting from implementation of this new assessment process.

YEAA requires that all projects with a "trigger" be subject to a detailed environmental assessment. The proposed Carmacks Copper Project "triggers" YEAA since it falls within the definition of a "project"; that being "any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work" or "any proposed physical activity" and it is subject to the *Law List Regulations*. A "work" includes such undertakings as construction of a mine.

The Carmacks Copper Project falls under the *Law List Regulations* since it will be subject to approvals under the provision of the Yukon Waters Act, and the Quartz Mining Act, which are included in the *Law List Regulations*. The project also falls under the YEAA *Comprehensive Study List Regulations*, since the mine will be producing more than 3,000 tonnes of ore per day.

As of November 28, 2005 the Yukon Environmental and Socio-economic Assessment Board (YESAB) and YESAA came into full effect. At the time the project was still being assessed under YEAA, and is therefore now considered to be a "transition project" between the two sets of legislation. On December 5, 2005 YESAB provided Western Copper with a list of Consultation Requirements in an effort to create a smooth and efficient transition for the project assessment. On February 27, 2006, the Company filed a formal Project Proposal with YESAB comprised of the original Project Description and Environmental Assessment Report provided under YEAA (Volumes I and II, and digital Supporting Documentation), an Addendum containing recently completed project studies, and a Consultation Summary Report in accordance with YESAB's Consultation Requirements. On April 28 2006, YESAB responded to the Company with an Adequacy Review Report requesting the Carmacks Copper Project Proposal be "repackaged" and resubmitted to incorporate supplementary and updated information in an easier format to read. The detailed supplementary information that YESAB requested was required by the Company to fulfill the YESAB Rules for Executive Committee Screening, and the types of information necessary to complete the review. The company has provided this information.

As such, the Project Description and Environmental Assessment Report has been amended from the original June 2005 and subsequent 2006 submissions to meet YESAB's adequacy requirements and to provide more recent project information (italicized text). This report is now referred to as the Project Proposal in accordance with

YESAB requirements. It should be noted however that supporting figures, drawings, and other documentation to the Project Proposal have not been revised and reference the original Project Description and Environmental Assessment Report which uses the Western Silver Corporation logo. For the purposes of this document the Western Silver Corporation logo is synonymous with Western Copper Corporation's logo. Recently completed studies have been undertaken to support the Project Proposal and are included in Volumes II and III – Supporting Appendices (listed below). A table of concordance has been prepared to summarize updates to the original Project Description and Environmental Assessment Report. The table (below) lists the Project Description and Environmental Assessment Report table of contents and indicates where updates have been made on a section specific basis. Updates to tables, figures, and appendices are also indicated.

The project was originally presented to government for environmental assessment in 1995. Western Copper Corporation undertook a number of detailed biophysical, engineering, and other related studies to document local environmental conditions and provide supporting information for the project's engineering designs. Much of this information is still relevant and has been relied upon during the preparation of this Project Proposal. *More recent studies have been conducted in 2005/2006 and are referenced in the Appendices throughout this document.* Reports issued by various consultants contain their professional opinions as to the interpretations made and conclusions drawn through the analyses of available information. The results and conclusions drawn from these studies have been incorporated into this document. In particular, information contained in this report has been drawn from the "1997 Basic Engineering Report and Definitive Cost Estimate" prepared by Kilborn Engineering Pacific Ltd. (Kilborn).

There is an extensive library of studies and other documentation related to the Carmacks Copper Project. The exploration properties that comprise the project have been subject to engineering studies and extensive environmental baseline studies. Several of the documents located in the References (Section 10) have been referred to, or relied upon for this report (indicated with the symbol "*"). These documents noted in Section 10 have been submitted with this Project Proposal and should be referred to for further details and information.

Supporting Appendices

Several design drawings for the project have been included in Appendix A, while some are presented as Figures in the main body of the report. The original drawings in Appendix A are from Kilborn, and Knight Piésold, and have been modified/revised slightly from their original format for presentation purposes. The original engineering design content has not been modified.

In April 2005, Access Consulting Group, on behalf of Western Copper Corporation, prepared an updated "Performance Standards and Design Criteria Parameters" report. This report is included in Appendix C.

In December 2004 EBA Engineering Consultants Ltd. (EBA) carried out a review of the Carmacks Copper heap leach pad design and prepared an alternative conceptual

design. The Heap Leach Pad Liner Design Report is located in Appendix D of this document.

In June 1997 a Conceptual Closure and Reclamation Plan was prepared for the Carmacks Copper Project; Appendix F of this document contains an updated version (2006) of the Conceptual Closure and Reclamation Plan.

Several project design and baseline environmental studies have been completed in 2005 and 2006 and are now included in the Project Proposal. The following is a list of recent studies that have been included in the Project Proposal Supporting Appendices:

- *Heap Leach Pad Loading Plan, prepared by Western Copper in July 2006 – Appendix D2;*
- *Water Balance Update – Memorandum CCL-CC7, prepared by Clearwater Consultants Ltd. in February 2006 – Appendix D3;*
- *Williams Creek Site Hydrology Update – Memorandum CCL-CC6, prepared by Clearwater Consultants Ltd. in January 2006 – Appendix D4;*
- *Technical Design Memorandum – Solution Storage/Events Pond Sizing, prepared by Alexco Resource Corp. in January 2006 – Appendix D5;*
- *EBA Responses to Environmental Assessment Review Questions (re Heap) (March 2006) – Appendix D6;*
- *The Conceptual LEACH/SE-EW Process, prepared by Western Copper in June 2006 – Appendix E1;*
- *Fate of lead at the anode of the electrowinning circuit – Carmacks Copper, prepared by Green World Science Inc. in August 2006 – Appendix E2;*
- *Detoxification and Rinsing Testwork Report, prepared by Alexco Resource Corp. in January 2006 – Appendix E3;*
- *Memorandum – Heap Rinsing Additional Information, prepared by Alexco Resource Corp. in June 2006 – Appendix E4;*
- *Technical Memorandum – Review of Documents and Meeting Notes related to Mineralogy of Leach Residues, prepared by Lawrence Consulting Ltd. in May 2006 – Appendix E5;*
- *Leach Residue Fine Fraction ABA Testing, prepared by Western Copper in September 2006 – Appendix E6;*
- *Water Treatment Report, prepared by Alexco Resource Corp. in August 2006 – Appendix F1;*
- *EBA, Preliminary Review of Existing Information – Waste Rock Dump (April 2006) – Appendix G2;*
- *EBA, Response to Review Questions – Waste Rock Storage Area (May 2006) – Appendix G3;*
- *Provisional Assessment of ARD Potential of Selected Rock Samples, (November 2006) – Appendix G4;*

- *Summary of Flow Measurements Recorded in June and July 2006 – Appendix H1;*
- *Summary of Baseline Water and Sediment Quality Data between 1989 and 2006 – Appendix H2;*
- *Environmental Monitoring Program Update and Data Summary – Revision #1, prepared by Access Consulting Group in January 2006 – Appendix H3;*
- *Wildlife Update, prepared by Grant Lortie in August 2006 – Appendix H5;*
- *Vegetation Information Update, prepared by Stu Withers, B.Sc. in August 2006 – Appendix H6;*
- *Consultation Summary Report (Project Consultations & Correspondence between 1991 and 2006), prepared by Access Consulting Group in February 2006. Previously submitted to YESAB and included in digital format only with other supporting documentation. A summary table of additional consultations in 2006 provided in Appendix I;*
- *Navigable Waters Letters on Navigability of Merrice & Williams Creek Crossings – Appendix O;*
- *Carmacks Copper Project Socio-economic Effects Assessment, prepared by Vector Research and Research Northwest in February 2007 – Appendix P;*
- *Williams Creek Geochemistry, prepared by Woolpert in September 2006 – Appendix Q.*

Volume I of this report is organized as follows:

Section 1 outlines the corporate profile for Western Copper Corporation as well as the purpose of the project.

Section 2 provides the project and assessment scope as well as regulatory approvals necessary for the project to proceed.

Section 3 provides the project description of the proposed mine including the project background and history, components and activities, mining manpower, water supply, and waste management.

Section 4 describes alternative means and alternatives to the project.

Section 5 describes the existing environmental conditions and setting for the project area. A number of discipline specific studies were undertaken in support of this project. The report focuses on these studies and existing records from past investigations to complete the environmental setting. *Baseline environmental and socio-economic conditions have been updated and studies are presented in the Supporting Appendices.*

Section 6 describes the consultation processes with regulatory agencies, First Nations, the public, and various other interested parties. Input gathered from these consultation processes is presented and summarized. *The Consultation Summary Report, submitted to YESAB in February 2006, summarizes project consultations and correspondence between 1991 and 2006 and is included in digital format only with other supporting documentation.*

Section 7 presents the approach to assessing potential environmental effects using a risk-based assessment. Potential effects to the physical and biological environment including heritage resources as a result of the project development are assessed. *An assessment of socio-economic effects is provided within Appendix P.* Where adverse environmental effects are predicted, appropriate mitigation methods are outlined. A determination of the significance of potential adverse environmental effects with mitigation is presented. Potential cumulative effects on the environment as a result of project development are addressed. Environmental health and safety and accidents and malfunctions; a conceptual closure plan; and the capacity of renewable resources are also all addressed.

Section 8 describes the follow-up programs for monitoring safety and environmental protection. Operational procedures and monitoring plans following construction of the project are described.

To aid the reader, new text or revised text in this report is italicized to distinguish new additional information to this Project Proposal.

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report provided in the Project Proposal

Project Description & Environmental Assessment Report Table of Contents		<i>Updates Provided in Project Proposal</i>
Section #	Section Heading	
	DISTRIBUTION LIST	<i>Western Silver Corporation is changed to Western Copper Corporation. Distribution List revised for submission to YESAB.</i>
	PROJECT CONTACT LIST	<i>Western Silver Corporation is changed to Western Copper Corporation. ALM Group to be replaced with Alexco Resource Corp.</i>
	CONTEXT OF THIS DOCUMENT	<i>Updated to describe nature of this transition project and list recent project studies completed.</i>
	EXECUTIVE SUMMARY	<i>Western Copper Corporation is a successor company of Western Silver Corporation. Updated for YESAA.</i>
1.0	CORPORATE PROFILE	<i>Update for Western Copper Corporation.</i>
1.1	Project Purpose and Need	<i>General edits.</i>
2.0	PROJECT AND ASSESSMENT SCOPE	<i>General edits.</i>
2.1	Scope of the Project	<i>General edits, additional discussion on scope of project.</i>
2.2	Mineral Assets	<i>Number of Western Copper claims updated.</i>
2.3	Assessment Scope	<i>Update for YESAA.</i>
2.4	Spatial and Temporal Boundaries	<i>No changes.</i>
2.5	Regulatory Approvals	<i>Updated to include information from Transport Canada, Navigable Waters Protection Division.</i>
2.6	Performance Standards and Design Criteria	<i>No changes.</i>
3.0	PROJECT DESCRIPTION	<i>Updated Freegold Road info and other general edits.</i>
3.1	Background / Introduction	<i>Updated.</i>
3.1.1	Location	<i>Updated Freegold Road info.</i>
3.1.2	History	<i>Updated to include summary of 2004 - 2006 activities.</i>
3.1.3	Geology & Mineralization	<i>No changes.</i>
3.1.3.1	Regional Geology	<i>No changes.</i>
3.1.3.2	Property Geology	<i>No changes.</i>
3.1.3.3	Mineralization	<i>No changes.</i>
3.1.4	Ore Body Modelling	<i>No changes.</i>
3.1.4.1	Polygonal Model	<i>No changes.</i>
3.1.4.2	Block Model	<i>No changes.</i>
3.2	Project Components / Structures	<i>No changes.</i>
3.2.1	Open Pit	<i>No changes.</i>
3.2.1.1	Pit Slope Design	<i>No changes.</i>
3.2.1.2	Drilling	<i>No changes.</i>
3.2.1.3	Blasting	<i>No changes.</i>
3.2.1.4	Loading	<i>No changes.</i>
3.2.1.5	Haulage	<i>No changes.</i>
3.2.1.6	Roads, Dumps and Pit	<i>No changes.</i>
3.2.1.7	Grade Control	<i>No changes.</i>
3.2.1.8	Dilution and Ore Recovery	<i>No changes.</i>
3.2.2	Waste Rock Storage Area	<i>Reference made to 1997 Design Report as well as responses prepared to review questions raised under the YEAA assessment.</i>
3.2.2.1	Evaluation of Options	<i>Updated.</i>
3.2.2.2	Design Objectives	<i>No changes.</i>
3.2.2.3	Design Basis	<i>No changes.</i>
3.2.2.4	General Arrangement	<i>No changes.</i>
3.2.3	Heap Leach Operation	<i>Reference made to current design information and new studies completed.</i>
3.2.3.1	Design Basis	<i>Reference made to responses prepared to review questions raised under the YEAA assessment.</i>

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Project Description & Environmental Assessment Report Table of Contents		Updates Provided in Project Proposal
Section #	Section Heading	
3.2.3.2	General Arrangement	<i>General edits.</i>
3.2.3.3	Foundation Preparations	<i>Updated to include clearing and grubbing of revegetated areas.</i>
3.2.3.4	Liner System	<i>Updated re lab testing of liner system during detailed design.</i>
3.2.4	Events Pond	<i>Reference made to current design information and new studies completed.</i>
3.2.5	Processing Facilities	<i>No changes.</i>
3.2.5.1	Crushing	<i>Reference made to new loading plan.</i>
3.2.5.2	Agglomeration	<i>No changes.</i>
3.2.5.3	Heap Leaching	<i>No changes.</i>
3.2.5.4	Solvent Extraction	<i>Reference made to new reports provided on the solvent extraction and electrowinning process.</i>
3.2.5.5	Electrowinning	<i>Reference made to new reports provided on the solvent extraction and electrowinning process.</i>
3.2.5.6	Sulphuric Acid Plant	<i>No changes.</i>
3.2.5.7	Reagents and Materials	<i>No changes.</i>
3.2.5.8	Process Controls and Instrumentation	<i>No changes.</i>
3.2.5.9	Equipment	<i>No changes.</i>
3.2.5.10	Process Buildings	<i>No changes.</i>
3.2.6	Haul Roads	<i>Updated to indicate no streams crossed by planned haul roads.</i>
3.2.7	Ancillary Facilities and Services	<i>No changes.</i>
3.2.7.1	Site Layout	<i>No changes.</i>
3.2.7.2	Access	<i>Information provided on possible YG highway maintenance, and traffic management.</i>
3.2.7.3	Power Supply and Distribution	<i>No changes.</i>
3.2.7.4	Explosive Storage	<i>No changes.</i>
3.2.7.5	Maintenance Shops and Warehouses	<i>No changes.</i>
3.2.7.6	Offices	<i>No changes.</i>
3.2.7.7	Laboratory	<i>No changes.</i>
3.2.7.8	Mine Dry Offices	<i>No changes.</i>
3.2.7.9	Building Heating, Fuel Storage and Distribution	<i>No changes.</i>
3.2.7.10	Vehicle Fuel Storage and Distribution	<i>No changes.</i>
3.2.7.11	Site Accommodation	<i>No changes.</i>
3.2.7.12	Lighting	<i>No changes.</i>
3.2.7.13	Maintenance Facilities	<i>No changes.</i>
3.2.7.14	Security and First Aid	<i>No changes.</i>
3.2.7.15	Communications	<i>No changes.</i>
3.3	Project Activities and Scheduling	<i>Discussion on project scheduling considerations; reference made to Socio-economic Effects Assessment Report.</i>
3.3.1	Mining Method Selection	<i>No changes.</i>
3.3.2	Mining Strategy	<i>No changes.</i>
3.3.3	Pre-production	<i>No changes.</i>
3.3.4	Production Mining	<i>No changes.</i>
3.3.5	Decommissioning and Reclamation	<i>Reference made to performance standards and terrestrial reclamation standards. Proposed reclamation activities discussed.</i>
3.3.5.1	Conceptual Closure Plan	<i>Previously Section 7.7, 7.7.1, and 7.7.2. Reference made to performance standards and terrestrial reclamation standards, as well as updated Conceptual Closure and Reclamation Plan. Proposed reclamation for the heap leach pad and amount of material required for cover discussed.</i>
3.3.5.2	Reclamation Security and Costs	<i>Previously Section 7.8. Preliminary reclamation cost estimates provided, updated for 2006/2007. Reference to performance standards and terrestrial reclamation standards.</i>
3.4	Mine Staffing	<i>Academic qualifications of staff discussed; reference made to Socio-economic Effects Assessment Report.</i>
3.4.1	Mine Engineering	<i>No changes.</i>
3.4.2	Maintenance	<i>No changes.</i>

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Section #	Section Heading	
3.4.3	Mine Surveying	No changes.
3.4.4	Personnel	Average total staff employed at the mine per year updated.
3.5	Water Management	Updated.
3.5.1	Water Balance	Updated.
3.5.1.1	General	General edits.
3.5.1.2	Heap Leach Pad	Reference made to new water balance update memorandum.
3.5.1.3	Waste Rock Storage Area	Reference made to new water balance update memorandum.
3.5.2	Water Supply	Updated.
3.5.2.1	Water Requirements	Updated; reference made to new water balance update memorandum; general edits.
3.5.2.2	Water Sources	Reference to drawings of sediment control ponds.
3.5.2.3	Water Distribution	No changes.
3.5.2.4	Fire Water System	No changes.
3.6	Waste Management	No changes.
3.6.1	Process Fluids Management	No changes.
3.6.1.1	Wastewater Treatment and Disposal	Clarification regarding two wastewater treatment systems.
3.6.2	Sewage Treatment	No changes.
3.6.3	Waste Rock	Reference made to 2006 assessment of ARD potential of rock samples from the open pit area.
3.6.3.1	Waste Rock Storage	Reference made to design report and prepared responses to review questions under the YEAA assessment.
3.6.3.2	Mineralogy of Waste Rock	No changes.
3.6.3.3	Multielemental Scan of Waste Rock	No changes.
3.6.3.4	Acid Base Accounting of Waste Rock and Ore	No changes.
3.6.3.5	Nitrogen Loadings from Waste Rock and Ore	No changes.
3.6.3.6	Raffinate Characterization	Reference made to results of more recent neutralization test work on process solutions.
3.6.3.7	Leach Pad Foundation Characterization	No changes.
3.6.4	Heap Detoxification	Reference made to new information on heap detoxification and rinsing test work. Results of test work summarized.
3.6.5	Solid Waste	No changes.
3.6.6	Special Waste	No changes.
4.0	ALTERNATIVE MEANS AND ALTERNATIVES TO THE PROJECT	Updated.
4.1	Processing Capacity and Processing Alternatives	No changes.
4.2	Location of the Mine and Mining Alternatives	General edits.
4.3	Mine Waste Rock Storage Area Alternatives	No changes.
4.4	Heap Leach Pad Alternatives	New section describing rationale behind selection of the valley heap leach method.
4.5	Heap Leach Site Alternatives	No changes, besides section number.
4.6	Selection of the Heap Solution Storage System	No changes, besides section number.
4.7	Selection of Site Infrastructure	No changes, besides section number.
4.8	Heap Stacking Alternatives	No changes, besides section number.
4.9	Mine Accommodation Alternatives	Accommodation being considered in or near Carmacks.
4.10	Alternative Power Supply Source	General edits; clarification re proposed power supply source.
5.0	ENVIRONMENTAL SETTING AND SOCIOECONOMIC CONDITIONS	Updated.
5.1	Physical Environment	Updated.
5.1.1	Climate	Reference made to updated site hydrology information; average precipitation and temperature conditions summarized.
5.1.2	Topography	No changes.
5.1.2.1	Physiography	No changes.
5.1.2.2	Soils	No changes.

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Section #	Section Heading	
5.1.2.3	Permafrost	<i>Additional information on thermistors; 2006 work mentioned.</i>
5.1.2.4	Seismicity	<i>No changes.</i>
5.1.2.5	Terrain Hazards	<i>No changes.</i>
5.1.2.6	Geotechnical	<i>No changes.</i>
5.1.3	<i>Water Resources</i>	<i>Updated.</i>
5.1.3.1	Surface Hydrology	<i>Reference made to updated site hydrology information; flow data collection in 2006 discussed.</i>
5.1.3.2	Surface Water Quality	<i>Baseline water quality database updated in 2005 and 2006; reference to photo documentation of sites.</i>
5.1.3.3	Hydrogeology	<i>Reference made to design report that provides a hydrogeological impact assessment for the heap leach pad and events pond area.</i>
5.1.3.4	Groundwater Quality	<i>Reference made to 2006 monitoring and data. Additional discussion provided on standpipe piezometer installations.</i>
5.2	Biological Environment	<i>Updated.</i>
5.2.1	<i>Aquatic Resources</i>	<i>Updated.</i>
5.2.1.1	Fisheries	<i>Reference made to 2005 and 2006 investigations.</i>
5.2.1.2	Benthic Invertebrates	<i>Reference made to planned 2006 sampling.</i>
5.2.1.3	Stream Sediment Quality	<i>Reference made to updated data summary table.</i>
5.2.2	<i>Wildlife</i>	<i>Updated.</i>
5.2.2.1	Wildlife Occurrence	<i>Reference made to 2005 and 2006 surveys.</i>
5.2.2.2	Habitat Potential	<i>Correlation between wildlife habitat types and associated terrain units described.</i>
5.2.2.3	LSCFN Fish and Wildlife Management Plan	<i>No changes.</i>
5.2.2.4	Wildlife Key Areas	<i>Wildlife Key areas along Freegold Road and Game Management Zones mentioned.</i>
5.2.2.5	Species at Risk	<i>No changes.</i>
5.2.3	<i>Vegetation</i>	<i>Reference made to 2006 field investigation and report.</i>
5.3	Heritage Resources	<i>No changes.</i>
5.3.1	<i>Williams Creek Valley Archaeological Assessment</i>	<i>No changes.</i>
5.3.1.1	Historic Use	<i>No changes.</i>
5.3.1.2	Traditional Use	<i>No changes.</i>
5.3.1.3	Historic Archaeological Sites	<i>No changes.</i>
5.3.2	<i>Proposed Transmission Line Archaeological Assessment</i>	<i>No changes.</i>
5.4	Current Land Uses	<i>Reference made to 2006 socio-economic effects assessment. Land tenure along Freegold road described and shown on a map.</i>
5.4.1	<i>Traditional and Cultural Resource Use</i>	<i>Updated.</i>
5.4.1.1	Wildlife	<i>Section removed - pertinent information incorporated into the socio-economic effects assessment (Appendix P).</i>
5.4.1.2	Fish	<i>Section removed - pertinent information incorporated into the socio-economic effects assessment (Appendix P).</i>
5.4.1.3	Recreation	<i>Section removed - pertinent information incorporated into the socio-economic effects assessment (Appendix P).</i>
5.4.1.4	Forestry and Native Plants	<i>Section removed - pertinent information incorporated into the socio-economic effects assessment (Appendix P).</i>
5.4.1.5	Access	<i>Section removed - pertinent information incorporated into the socio-economic effects assessment (Appendix P).</i>
5.5	Socio-economic Conditions	<i>Reference made to 2006 socio-economic effects assessment for updated information on a existing socio-economic conditions in the Village of Carmacks.</i>

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report provided in the Project Proposal

Project Description & Environmental Assessment Report Table of Contents		<i>Updates Provided in Project Proposal</i>
Section #	Section Heading	
5.5.1	<i>Population</i>	<i>Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.</i>
5.5.2	<i>Economy</i>	<i>Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.</i>
5.5.3	<i>Community Services</i>	<i>Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.</i>
5.5.4	<i>LSCFN Community Services</i>	<i>Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.</i>
5.6	Environmental Study Programs	<i>Reference made to additional studies completed in 2005 and 2006. Expected Monitoring Plans as part of the Water Use Licence and Quartz Mining Licence are discussed.</i>
6.0	PUBLIC ENGAGEMENT / INPUT	<i>Reference made to the Consultation Summary Report and additional consultations in 2006 are described.</i>
6.1	1991-1993 Public Consultations	<i>No changes.</i>
6.2	Recent Project Meetings / Discussions	<i>No changes.</i>
6.2.1	<i>Yukon Government</i>	<i>No changes.</i>
6.2.2	<i>First Nations Communications</i>	<i>No changes.</i>
6.2.3	<i>Village of Carmacks</i>	<i>No changes.</i>
6.3	Open Houses	<i>No changes.</i>
6.3.1	<i>Poster Displays</i>	<i>No changes.</i>
6.4	Notification	<i>No changes.</i>
7.0	POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	<i>No changes.</i>
7.1	Environmental Assessment Approach	<i>YESAB's descriptors incorporated.</i>
7.2	Valued Ecosystem and Cultural Components	<i>Updated to incorporate attributes that influence the selection of VECCs. Potential effects on VECCs examined within specified spatial and temporal extents.</i>
7.3	Summary of Potential Environmental Effects and Proposed Mitigation	<i>Revised significance assessment; YESAB descriptors incorporated.</i>
7.3.1	<i>Atmospheric</i>	<i>Air pollution in valleys discussed. Process controlled production of sulphuric acid = closed system. Reference to revised significance assessment.</i>
7.3.2	<i>Topography</i>	<i>Clarification provided on progressive reclamation. Reference to revised significance assessment.</i>
7.3.3	<i>Water Resources</i>	<i>Updated.</i>
7.3.3.1	<i>Surface Hydrology</i>	<i>Reference to performance standards and terrestrial reclamation standards and revised significance assessment.</i>
7.3.3.2	<i>Surface Water Quality</i>	<i>Updated with summary of results from Williams Creek geochemical assessment. A 30 m buffer from watercourses is proposed to protect riparian areas. Reference to performance standards and terrestrial reclamation standards and revised significance assessment.</i>
7.3.3.3	<i>Hydrogeology</i>	<i>No changes.</i>
7.3.3.4	<i>Groundwater Quality</i>	<i>Reference to revised significance assessment.</i>
7.3.4	<i>Aquatic Resources</i>	<i>No changes.</i>
7.3.4.1	<i>Fisheries</i>	<i>No changes.</i>
7.3.4.2	<i>Benthic Macroinvertebrates</i>	<i>Reference to performance standards and terrestrial reclamation standards and revised significance assessment.</i>
7.3.5	<i>Wildlife</i>	<i>No changes.</i>
7.3.5.1	<i>Species Concerns</i>	<i>No changes.</i>
7.3.5.2	<i>Direct Habitat Effects</i>	<i>No changes.</i>
7.3.5.3	<i>Indirect Habitat Effects</i>	<i>Reference to revised significance assessment.</i>
7.3.6	<i>Vegetation</i>	<i>Reference to performance standards and terrestrial reclamation standards and revised significance assessment.</i>

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report provided in the Project Proposal

Project Description & Environmental Assessment Report Table of Contents		Updates Provided in Project Proposal
Section #	Section Heading	
7.3.7	Heritage Resources	No disturbance of 'medium heritage site potential area' near Freegold Road; YG responsible for heritage assessment in this area. Western Copper committed to further heritage assessment of other two 'medium heritage site potential areas' along access road. Reference to Socio-economic Effects Assessment Report.
7.3.8	Current and Cultural Land Uses	Section removed - information provided within the Socio-economic Effects Assessment Report.
7.3.9	Socio-economic Effects	Summary of and reference to 2006 socio-economic effects assessment (now section 7.3.8).
7.3.9.1	Employment and Labour Force	Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.
7.3.9.2	Population	Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.
7.3.9.3	Housing and Real Estate	Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.
7.3.9.4	Community Infrastructure and Services	Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.
7.3.9.5	Social Effects	Section removed as more up to date information presented in the Socio-economic Effects Assessment Report.
7.3.10	Effects of the Environment on the Project	Reference to revised significance assessment (now section 7.3.9).
7.4	Environmental Health and Safety and Accidents and Malfunctions	Public will be restricted from entering the property.
7.5	Cumulative Environmental Effects	No changes.
7.5.1	VECC Project Interactions	No changes.
7.5.2	Other Projects and Activities	No changes.
7.5.3	Interactions and Significance Assessment	No changes.
7.6	Risk Assessment	No changes.
7.7	Conceptual Closure Plan	Moved to Section 3.3.5.1.
7.7.1	Closure Objectives	Moved to Section 3.3.5.1.
7.7.2	Closure Issues	Moved to Section 3.3.5.1.
7.8	Reclamation Security and Costs	Moved to Section 3.3.5.2.
7.9	Capacity of Renewable Resources	No changes; now Section 7.7.
7.9.1	Introduction	No changes; now Section 7.7.1.
7.9.2	Renewable Resources Identification	No changes; now Section 7.7.2.
7.9.3	Significance of Effects	Now Section 7.7.3; YESAB descriptors incorporated.
7.9.4	Summary	No changes; now Section 7.7.4.
8.0	FOLLOW-UP PROGRAMS	Updated.
8.1	Project Performance Standards and Objectives	Updated.
8.1.1	General Approach	Expanded discussion on performance standards and objectives.
8.2	Monitoring Programs	No changes.
8.2.1	Introduction	No changes.
8.2.2	Environmental Management System	Previous Section 8.3 moved here. Expansion on EMS discussion.
8.2.2.1	Inspections and Monitoring	New section describing inspections to support EMS.
8.2.2.2	Adaptive Management Plans (AMP)	New section describing AMP as part of the EMS.
8.2.2.3	Reporting	New section providing discussion on reporting of environmental monitoring and management issues as directed by YWB and YG.
8.2.3	Construction Monitoring	No changes.
8.2.3.1	Physical and Geotechnical Monitoring	No changes.
8.2.3.2	Environmental Monitoring	No changes.
8.2.4	Operational Monitoring	No changes.
8.2.4.1	Geotechnical Monitoring Plans	No changes.

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report provided in the Project Proposal

Project Description & Environmental Assessment Report Table of Contents		<i>Updates Provided in Project Proposal</i>
Section #	Section Heading	
8.2.4.2	Mine and Plant Operations	<i>No changes.</i>
8.2.5	<i>Environmental Monitoring Plans</i>	<i>Revised to incorporate triggers for action and responses. Expansion of discussion on monitoring plans.</i>
8.2.5.1	Meteorology	<i>No changes.</i>
8.2.5.2	Hydrology	<i>No changes.</i>
8.2.5.3	Surface and Groundwater Quality Monitoring	<i>No changes.</i>
8.2.5.4	Annual Receiving Water Biological Assessment	<i>No changes.</i>
8.2.5.5	Waste Rock	<i>No changes.</i>
8.2.5.6	Reclamation Research Monitoring	<i>No changes.</i>
8.2.5.7	Environmental Surveillance Monitoring	<i>No changes.</i>
8.2.6	<i>Wildlife Population and Habitat Monitoring</i>	<i>Further details on the wildlife monitoring program provided.</i>
8.2.7	<i>Socio-economic Monitoring</i>	<i>Reference to 2006 socio-economic effects assessment.</i>
8.2.8	<i>Closure and Post Closure Monitoring</i>	<i>No changes, besides section number.</i>
9.0	ACKNOWLEDGEMENT AND CERTIFICATION	<i>Revised as per YESAB guidelines. New individuals/consultants added.</i>
10.0	REFERENCES	<i>Updated.</i>

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report

Table #	Table Name	Updates Provided in Project Proposal
Table 3-1	Reagents and Materials	No changes.
Table 3-2	Initial and Ongoing Equipment Requirements	No changes.
Table 3-3	Carmacks Copper Project Schedule - 1 Year After Project Approval	No changes.
Table 3-4	Annual Mining Production Schedule	No changes.
Table 3-5	Reclamation Cost Summary	Previously Table 7-17; cost estimates updated for 2006/2007.
Table 3-6	General Administration Staff	Academic qualifications added (new table #).
Table 3-7	Mining Manpower Complement	Academic qualifications added (new table #).
Table 3-8	Process Plant Personnel	Academic qualifications added (new table #).
Table 3-9	Annual Make-Up Water Requirements (m ³ /year)	Table removed - reference to Memorandum CCL-CC7 Water Balance Update tables.
Table 3-10	Annual Treat and Release Volumes (m ³ /year)	Table removed - reference to Memorandum CCL-CC7 Water Balance Update tables.
Table 3-11	Normal Maximum Solution Storage Volumes (m ³)	Table removed - reference to Memorandum CCL-CC7 Water Balance Update tables.
Table 4-1	Production Capacity and Process Alternatives Evaluation Matrix	No changes.
Table 4-2	Mining Method Alternatives Evaluation Matrix	No changes.
Table 4-3	Mine Waste Rock Storage Area Alternatives Evaluation Matrix	No changes.
Table 4-4	Heap Leach Pad Alternatives Evaluation Matrix	New table describing rationale behind selection of the valley heap leach method.
Table 4-5	Process Solution Storage Alternatives Evaluation Matrix	No changes (new table #).
Table 4-6	Heap Stacking Alternatives Evaluation Matrix	No changes (new table #).
Table 4-7	Workforce Accommodation Alternatives Evaluation Matrix	No changes (new table #).
Table 4-8	Power Supply Alternatives Evaluation Matrix	No changes (new table #).
Table 5-1	Hydrological Data for the Williams Creek Area	Table replaced with updated information - Average Monthly Precipitation Conditions - Williams Creek Site.
Table 5-2	Average Values for Key Hydrological Parameters	Table removed - reference to Memorandum CCL-CC6 Williams Creek Site Hydrology Update tables.
Table 5-3	Temperature Breakdown for the Carmacks Area	Table replaced with updated information - Monthly Average Temperatures at Williams Creek (Table 5-2).
Table 5-4	Summary of Basin Characteristics	Table 5-3, no changes.
Table 5-5	Hydrology Data Sources	Table removed - reference to Memorandum CCL-CC6 Williams Creek Site Hydrology Update tables.
Table 5-6	Water Quality and Hydrology Monitoring Stations	Table 5-4, no changes.
Table 5-7	Summary of Physical Water Quality Parameters for Williams Creek Oct 1989 to Oct 1992	Table 5-5, no changes.
Table 5-8	Summary of Total Metal Concentrations for Williams Creek, Oct 1989 to Oct 1992	Table 5-6, no changes.
Table 5-9	Summary of Dissolved Metal Concentrations for Williams Creek, Oct 1989 to Oct 1992	Table 5-7, no changes.
Table 5-10	Summary of Stand Pipe Piezometers at the Process Plant Site	Table 5-8, no changes.
Table 5-11	Summary of Groundwater Monitoring Wells - 1996 Drill Program	Table 5-9, no changes.
Table 5-12	Groundwater Quality for Selected Parameters	Table 5-10, no changes.
Table 5-13	Summary of Fish Sampling Results for Three Sample Periods between August 1991 and August 1992 in the Williams Creek Study Area	Table 5-11, no changes.
Table 5-14	List of Fish Species Found in the Yukon River Drainage and Summary of General Life History Requirements	Table 5-12, no changes.
Table 5-15	Summary of Total Insect Numbers and Taxonomic Richness for Triplicate Samples collected at Sites in the Williams Creek Drainage during 1991 and 1992	Table 5-13, no changes.
Table 5-16	Summary of Sediment Metals Concentrations - Williams and Nancy Lee Creeks	Table 5-14, no changes.
Table 5-17	CCME Sediment Quality Guidelines Compared to Range of Metal Concentrations - Williams Creek Sites	Table 5-15, no changes.
Table 5-16	Wildlife Habitat Types and Associated Terrain Units	New table to show correlation between terrain units and wildlife habitat types.
Table 5-18	Carmacks Copper Project Wildlife Habitat Potential	Table 5-17, approximate percentage of habitat types within the project area included.
Table 5-18	Properties Adjacent to Freegold Road	New table to show land tenure adjacent to Freegold Road.

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report

Table #	Table Name	Updates Provided in Project Proposal
Table 7-1	Significance of Effects Descriptors	YESAB's descriptors incorporated.
Table 7-2	Summary of the Assessment of Potential Environmental Effects Resulting from the Proposed Carmacks Copper Project	YESAB's descriptors incorporated; socio-economic parameters removed as provided in SEEA Report.
Table 7-3	Identification of Valued Ecosystem and Cultural Components	Revised to include who identified VECC's and attributes.
Table 7-4	VECC Spatial and Temporal Boundaries	New table describing spatial and temporal boundaries for each VECC and rationalization.
Table 7-5	Impact of Effluent (Waste Rock) During Operation on the Water Quality of Williams Creek at Station W4	No changes (new table #).
Table 7-6	Impact of Effluent (Waste Rock) During Operation on the Water Quality of Williams Creek at Station W10	No changes (new table #).
Table 7-7	Impact of Effluent (Waste Rock & WTP) on the Water Quality of Williams Creek at Station W4	No changes (new table #).
Table 7-8	Impact of Effluent (Waste Rock & WTP) During Operation and Closure on the Water Quality of Williams Creek at Station W10	No changes (new table #).
Table 7-9	Identification of Local Effects on VECC's and their Mitigation	No changes (new table #).
Table 7-10	Significance Ranking Definitions	No changes (new table #).
Table 7-11	VECC Project Interaction and Significance Ranking for Potential Cumulative Effects	No changes (new table #).
Table 7-12	VECC and Other Activities Effects Significance Rankings	No changes (new table #).
Table 7-13	Component Hazard Identification and Potential Release Mechanisms	No changes (new table #).
Table 7-14	Hazard Assessment Descriptors	No changes (new table #).
Table 7-15	Consequence Assessment Descriptors	No changes (new table #).
Table 7-16	Qualitative Risk Characterization	No changes (new table #).
Table 8-1	Carmacks Copper Project Summary Performance Standards and Objectives	Table updated to include Triggers and Actions/Responses and describe monitoring requirements.
Table 8-2	Environmental Monitoring Programs	Table updated to summarize VECC's that will be monitored, and equipment and protocols that will be used. Further details on the wildlife monitoring program are also provided.
Figure #	Figure Name	Updates
Figure 2-1	General Location Map of the Yukon	No changes.
Figure 2-2	Project Area Overview	No changes.
Figure 2-3	Approach to Project Development	No changes.
Figure 2-4	Environmental Assessment Process	Figure removed and replaced with YESAA Executive Committee Screening Flow Chart.
Figure 3-1	General Arrangement	No changes.
Figure 3-2	Overall Site Plan - Facilities	No changes.
Figure 3-3	Simplified Flowsheet of the Carmacks Copper Project Process	No changes.
Figure 3-4	Geological Reserves	No changes.
Figure 3-5	Final Open Pit Plan - Year 8	No changes.
Figure 3-6	Waste Rock Storage Area	No changes.
Figure 3-7	Heap Leach Pad Conveyor Layout	No changes.
Figure 3-8	Events Pond	No changes.
Figure 3-9	Waste Rock Storage Area Water Balance - End Year 1	Figure removed.
Figure 5-1	Terrain Hazards	No changes.
Figure 5-2	Terrain Hazard Map - Mine Site Area	No changes.
Figure 5-3	Water Quality Sample Station Locations	No changes.
Figure 5-4	Borehole and Test Pit Locations	No changes.
Figure 5-5	Reach Boundaries and Fisheries Investigation Sample Stations	No changes.
Figure 5-6	Heritage Resources and Current Land Uses	No changes.
Figure 5-7	Game Management Zones and Wildlife Key Areas	No changes.
Figure 7-1	Qualitative Environmental Risk Assessment	No changes.
Figure 7-2	Likelihood and Risk of Failure Mechanisms Occurring	No changes.
Appendix #	Appendix Title	Updates Provided in Project Proposal
A	Detailed Project Design Drawings	No changes.
B	Western Silver Corporation Safety and Environmental Policy	Western Copper Corporation Safety and Environmental Policy - no changes.
C	Carmacks Copper Project Performance Standards and Design Criteria Parameters (2001)	No changes.
D	EBA Engineering Consultants Carmacks Copper Mine Heap Leach Pad Liner Design Report (2005)	No changes.
D1	Report on Updated Design of the Heap Leach Pad and Events Pond (1997)	New Appendix - relevant design for events pond and embankment brought forward.

Table of Concordance - Listing of Revisions to Project Description & Environmental Assessment Report

Appendix #	Appendix Title	Updates Provided in Project Proposal
D2	Western Copper Heap Leach Pad Loading Plan (July 2006)	<i>New Appendix to present new work.</i>
D3	Water Balance Update - Memorandum CCL-CC7 (February 2006)	<i>New Appendix to present updated water balance.</i>
D4	Williams Creek Site Hydrology Update - Memorandum CCL-CC6 (January 2006)	<i>New Appendix to present updated site hydrology.</i>
D5	Technical Design Memorandum - Solution Storage/Events Pond Sizing (January 2006)	<i>New Appendix to present new work.</i>
D6	EBA Engineering Consultants Responses to Environmental Assessment Review Questions (re Heap) (March 2006)	<i>New Appendix to present new work.</i>
E	Beattie Consulting Ltd. Report on Leaching and Decommissioning of Samples from Carmacks Oxide Copper Project (2001)	<i>No changes.</i>
E1	Western Copper Conceptual LEACH/SE-EW Process (June 2006)	<i>New Appendix to present new work.</i>
E2	Fate of lead at the anode of the electrowinning circuit - Carmacks Copper (August 2006)	<i>New Appendix to present new work.</i>
E3	Detoxification and Rinsing Testwork Report (January 2006)	<i>New Appendix to present new work.</i>
E4	Memorandum - Heap Rinsing Additional Information (June 2006)	<i>New Appendix to present new work.</i>
E5	Technical Memorandum - Review of Documents and Meeting Notes related to Mineralogy of Leach Residues (May 2006)	<i>New Appendix to present new work.</i>
E6	Leach Residue Fine Fraction ABA Testing (September 2006)	<i>New Appendix to present test results.</i>
F	Conceptual Closure and Reclamation Plan (2006)	<i>Updated.</i>
F1	Operational Treatment System (August 2006)	<i>New Appendix to describe contingency treatment plant during operations.</i>
G	Summary of Results from the Waste Rock Characterization Program (1995)	<i>No changes.</i>
G1	Waste Rock Storage Area Evaluation and Detailed Design Report (1997)	<i>New Appendix to present relevant design information.</i>
G2	EBA Preliminary Review of Existing Information - Waste Rock Dump (April 2006)	<i>New Appendix to present new work.</i>
G3	EBA Engineering Consultants Response to Review Questions - Waste Rock Storage Area (May 2006)	<i>New Appendix to present new work.</i>
G4	Provisional Assessment of ARD Potential of Selected Rock Samples, Carmacks Copper Project (2006)	<i>New Appendix to present new work.</i>
H1	Summary of Flow Measurements Recorded in June and July 2006	<i>New Appendix to present new flow data collected.</i>
H2	Baseline Water and Sediment Quality Data 1989 - 2006	<i>New Appendix to present new water quality and sediment data collected.</i>
H3	Environmental Monitoring Program Update and Data Summary - Revision #1 (January 2006)	<i>New Appendix to present updated monitoring program and baseline data collected up to December 2005.</i>
H4	Williams and Nancy Lee Creek Sample Station Photographs	<i>New Appendix to show water quality sample stations.</i>
H5	Wildlife Update (August 2006)	<i>New Appendix to present 2006 wildlife investigation.</i>
H6	Vegetation Information Update (July 2006)	<i>New Appendix to present 2006 vegetation investigation.</i>
H7	Land Tenure Adjacent to Freegold Road	<i>New Appendix to show land tenure along Freegold Road.</i>
I	Summary Consultation Tables (May - October 2006)	<i>Original Appendix removed and replaced with summary tables of consultations in 2006.</i>
J	Western Copper Newsletter and Posters for Consultation (2006)	<i>Original Appendix removed and replaced with 2006 newsletter and posters for consultation.</i>
K	Updated Summary of the Assessment of Potential Environmental Effects, Proposed Mitigation Measures and Significance Assessment (2006)	<i>Updated (2006) summary of the assessment of potential environmental effects, proposed mitigation measures and significance assessment.</i>
L	Spill Contingencies and Emergency Response Plan	<i>No changes.</i>
M	Qualitative Risk Assessment Worksheets	<i>No changes.</i>
N	Information Sheet for Quartz Mining Undertakings	<i>No changes.</i>
O	Navigable Waters Letters on Navigability of Merrice & Williams Creek Crossings	<i>New Appendix to present new information from Navigable Waters.</i>
P	Carmacks Copper Project Socio-economic Effects Assessment (2006)	<i>New Appendix to present new socio-economic assessment.</i>
Q	Williams Creek Geochemistry (September 2006)	<i>New Appendix to present new information on hydrologic modelling.</i>

EXECUTIVE SUMMARY

Western Copper Corporation ("Western Copper", "the company") is a successor company of Western Silver Corporation, which was acquired by Glamis Gold Ltd. in May 2006. Western Copper holds 100% ownership of the Carmacks Copper Project as well as Sierra Almoloya, an early stage exploration property in the Central Mexican Silver Belt. The Company is listed on the Toronto Stock Exchange (TSX:WRN).

A *basic engineering* study prepared by Kilborn Engineering Ltd. (Kilborn) in 1997 shows that the Carmacks Copper Project is feasible at prices above U.S.\$1.10/lb copper (*under the prevailing economic climate*). The Company believes that the outlook for long term copper demand is favorable, and this provides an opportunity for Western Copper, their shareholders, local First Nations and communities, and the Yukon Territory to benefit from the project development. Approximately 14,300 tonnes of copper will be produced per year, with a potential for value added local industries using the product.

The Company is moving forward with the Yukon Government environmental assessment and permitting processes so that development can proceed on a timely basis to take advantage of favorable economic conditions. The project requires both a Quartz Mining Production Licence (Yukon Quartz Mining Act) and a Water Use Licence (Yukon Waters Act) to enable project development. *These licenses required the completion of an environmental assessment under YEAA and more recently under YESAA. This Project Proposal was originally prepared on behalf of the Company to fulfill the requirements of the YEAA review process, and has been revised to include a socio-economic effects assessment and other additional information to fulfill the adequacy requirements of a Project Proposal as requested by YESAB.*

The Carmacks Copper Project is a proposed open pit copper mine and solvent extraction and electrowinning (SX/EW) processing facility being developed by the Company. The ore body is located in the Yukon Territory (Figure 1), 9 km west of the Yukon River, about 38 km northwest of the Village of Carmacks, or 192 km north of Whitehorse (Figure 2). The site is accessible by an existing exploration road that leads north off the government maintained Freegold Road from Carmacks. A year-round port at Skagway, Alaska, is located 180 km south of Whitehorse and connected via a government maintained secondary paved highway.

The deposit contains an open pit mineable reserve of 13.3 million tonnes at an average grade of 0.97% total copper located on *Western Copper mineral claims, which cover an area of approximately 4,400 ha*. The project will include an open pit, acid heap leach and copper extraction facility, waste rock storage area (WRSA), soil stockpiles, events pond, drainage ditches, sediment control ponds, roads, construction camp, and miscellaneous facilities to support mining operations. A crushing plant may also be constructed for ore and fill processing.

Mine operations in the open pit will be carried out using conventional mining equipment with a stripping ratio of 4.6 tonnes of waste to 1 tonne of ore (4.6:1). It is estimated that active mining will be undertaken for eight years, producing about 60 million tonnes of waste rock, and 13.3 million tonnes of copper ore. Geochemical testing of the *waste rock and spent ore* indicates that the material is non-acid generating.

Oxide ore will be placed on a heap leach pad to produce 14,310 tonnes of copper cathodes per year, at a recovery rate of 80%. The pad will be seasonally loaded and leached year round. Copper in solution will be recovered from the oxide ore by acid heap leaching.

A raffinate (barren acid solution) will be applied to the surface of the ore by a system of buried drip emitters. After leaching through the ore, the pregnant leachate solution will be collected in a network of pipes at the bottom of the heap and flow either directly to the SX/EW process plant, or to the events pond below the heap. Pregnant leach solution will be treated in a solvent extraction plant to purify and concentrate the weak leach solution to a more concentrated solution suitable for electrowinning. High purity copper cathodes produced in an electrowinning plant will be shipped via truck to Skagway, Alaska.

Water supply for the project will come from wells in the Williams Creek valley. Process water makeup will be sourced from surface run-off settlement ponds located below the WRSA and leach pad and shop area. Power will be generated on-site by 5 x 1.6 mW diesel generators complete with heat recovery equipment. Alternatively, Yukon Energy Corporation may supply power to the site via a transmission power line.

Sulphuric acid required for the leaching of copper from the ore will be produced on site from a commercial 120 tpd contact catalytic plant. The plant will burn molten sulfur to produce sulfur dioxide which will be converted, via a select catalyst and recirculated with a sulfuric acid stream, to produce concentrated (98%) sulphuric acid. Alternative acid production processes such as bio-oxidation of agglomerated elemental sulfur are under study and will continue to be investigated.

In addition to the mining and process facilities, the site facilities will include: water supply wells and distribution system, power supply distribution, fire protection, diesel fuel storage, acid storage, sewage treatment, communications system, offices, changehouse, operations camp, gatehouse/first-aid, workshops/warehouse and laboratory.

Design drawings for the project have been included in Volume II - Appendix A, with summary figures presented in the main body of the proposal (Volume I). The original engineering drawings in Appendix A are from Kilborn, and Knight Piésold Consulting, and have been modified/revised slightly from their original format for presentation purposes.

After mining ceases, site infrastructure will be dismantled and removed from the site. Where appropriate, slopes on the WRSA and heap will be recontoured, covered with stock piled overburden material, and revegetated. Roads and disturbed areas will be decompacted, scarified and revegetated. When leaching is no longer economic, an evaporative transpiration soil cover will be installed. The heap will be rinsed for approximately four and a half years with water and then neutralized. In situ biological treatment will be undertaken in the heap to assist in stabilization of metals. Active water treatment using conventional lime treatment will be used to reduce the heap solution inventory. Once heap effluent performance standards are achieved, a long-term passive treatment (infiltration gallery) is proposed for final closure.

Detailed engineering studies and extensive environmental baseline studies have been conducted on the Carmacks Copper Project to support project engineering and design, and environmental and socio-economic assessment for the project. These studies have focused on:

- Ground water and surface water quality;
- Surface and ground water hydrology;
- Detailed groundwater model of the heap leach pad area;
- Geology, foundation, geotechnical and hydrogeological studies for proposed infrastructure areas;
- Waste rock and spent ore characterization;
- Metallurgical testing;
- *Spent ore detoxification test work and characterization;*
- Water treatment performance and treatability testwork;
- Water treatment plant effluent and toxicity testing;
- Petrographic and mineralogical reports;
- Terrain hazard analysis;
- Seismic hazard assessment;
- Meteorological studies;
- Stream sediment survey;
- Fisheries studies;
- Benthic macro invertebrate surveys;
- Vegetation survey;
- Wildlife surveys;
- Archeological and heritage resource assessments;
- Traditional and cultural resource use assessment (traditional knowledge); and
- Socio-economic effects assessment of the local and regional communities.

A summary of local environmental and socio-economic conditions relevant to the project is provided with detailed references to specific reports provided.

The Carmacks Copper Project falls within the traditional territory of the Little Salmon Carmacks First Nation (LSCFN) and Selkirk First Nation (SFN). The LSCFN community is located in Carmacks, Yukon. LSCFN are considered the principal traditional users of lands located near the Carmacks Copper Project, *however SFN have also used the area traditionally*. Consultations have occurred with the LSCFN and SFN regarding the project development and to determine and document important cultural and heritage features and traditional use areas as well as valued ecological components.

Based on discussions with LSCFN and consultation with other interested parties, and studies of ecological features in the area, the following valued ecosystem and cultural components (VECC's) have been identified for the project:

Ecosystem Components:

- Air Quality;
- Surface Water Quality;
- Groundwater Quality;
- Permafrost;

- Fisheries Resources located in lower Williams Creek and Yukon River (Juvenile Chinook Salmon and Arctic Grayling; and
- Wildlife Resources, including moose and furbearers.

Socio-economic/Cultural Components:

- Traditional Use – Trapping;
- Traditional Use – Wildlife and Cultural;
- Heritage Resources;
- *Social Values (Demographics, Community Wellness, Justice, Education);*
- *Economic Values (Employment, Business Opportunity, Infrastructure/Community Services, Government);* and
- Human Health and Safety.

The VECC's identified for the project include both a local and regional context for components that will be affected by the project. Consultation with LSCFN, the Village of Carmacks, and regulatory agencies, knowledge of local environmental conditions, and best professional judgment lead to the selection of the project VECC's. The list of VECC's is considered comprehensive and accurate for the project.

The environmental assessment (EA) for this project has considered the environmental effects (biological and physical aspects) on the project area as well as socio-economic effects, including effects on traditional and cultural use, archaeological and heritage resources, social and economic values, and human health. The scope of the EA considered a local geographic study area as well as a regional context for certain environmental and social components, and considered all development phases including construction, operations, reclamation and decommissioning, and final closure for the temporal scope of the EA. An analysis of alternative means of carrying out the project and the potential environmental effects associated with those alternatives was undertaken. The EA identified project environmental effects and measures to mitigate potential environmental and socio-economic effects. A risk assessment and characterization was completed and included the identification of potential accidents and malfunctions associated with the project. The analysis of potential environmental and socio-economic effects integrated the project risk assessment to determine the significance of identified potential project effects. To support the EA, a cumulative effects assessment was completed to assess the combined effects resulting from project development with other regional activities.

The Company has been consulting with local communities and First Nations since the early 1990's in support of the project. A Consultation Summary Report has been filed with YESAB and includes a description of project consultations up to February 2006. Additional community consultations have been undertaken in spring and summer of 2006 and are described in Section 6 of the Project Proposal – Public Engagement/Input. Further community consultations will be undertaken with various parties as part of the assessment process. Community open houses are open to all members of the public. The Company will strive to work closely with the LSCFN and SFN to communicate on a regular basis with the local community to obtain input and feedback and apprise residents of ongoing activities and potential for socio-economic opportunities resulting from the project.

The Company is committed to minimizing the effects of its activities on the surrounding environment by using existing access infrastructure and minimizing the project footprint. The Company has developed the project using preventative engineering to minimize the potential for environmental effects. Specific mitigation measures have been incorporated into the project to provide environmental protection. Emergency response and contingency and monitoring plans are in place to ensure that potential effects to cultural and environmental features are minimized. An assessment has been completed to identify potential environmental and socio-economic effects, including cumulative effects, and mitigation measures have been developed to address those effects.

Potential effects have been assessed for significance using accepted criteria and best professional judgment. A risk assessment has been completed to augment the significance effects determination. Although the project will leave permanent features in the area, such as an open pit, the geographic extent of the project is relatively small. The project is expected to be constructed, operated, and decommissioned within a reasonable timeframe (20 years) based on a passive closure strategy that will leave all disturbances reclaimed and revegetated. The area does have important ecological and cultural attributes; however, the magnitude of potential effects is considered low, with most effects highly reversible. Potential project hazards, failure modes, and accidents and malfunctions have been identified and their exposure mechanisms and consequences assessed as part of a risk characterization. The risk characterization incorporates preventative engineering design measures to minimize the potential for project effects.

Both positive and negative social and economic effects to the local communities are expected, however, overall the potential effects are thought to be mitigable and provide benefits to community members and Yukoners. Based on the assessment, the project is not predicted to cause significant adverse environmental, socio-economic or cumulative effects with the implementation of planned mitigation measures.

The following table presents an overview of the project.

Carmacks Copper Project Overview

Annual Copper Production	Average production capacity of 14,310 tonnes per year of cathode copper
Total Copper Production	114,480 tonnes of cathode copper
Mine Life	8 years
Total Project Life	15 years (0 – 8 years construction and mine operation; 8 – 15 years decommissioning and reclamation, closure, and post closure)
Overall Copper Recovery	80%
Extraction Kinetics	80% recovery in 300 days
Ore Production Rate	Maximum rate of 9,872 tonnes per day for up to 230 days per year for eight years
Location	46 km by gravel road: Freegold Road (33 km) and an exploration trail (13 km) northwest of Carmacks, Yukon
Deposit Type	Carmacks Copper, copper-gold deposit hosted by feldspathic-mafic gneisses (generally quartz deficient) that form a roof pendant within Upper Triassic hornblende-biotite granodiorite of the Granite Mountain Batholith = No. 1 Zone. 91 drill holes with 12,900 metres of drilling.
Host Rocks	Yukon Cataclastic Terrane
Physiography	Yukon Plateau-Central Ecoregion
Mineable Reserves	13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper
Stripping Ratio	4.6 tonnes of waste per tonne of ore
Mining Method	Conventional seasonal open pit
Ore Mining and Placement Schedule	Ore mining for maximum of 230 days/year; 28,400 tpd (ore and waste); Maximum of 9,872 tpd ore placed for leaching for up to 200 days per year; 13.3 million tonnes of ore placed in the heap over 8 years, commencing in May of Year 1 and completed by June of Year 8

Carmacks Copper Project Overview (Cont'd)

Crushing	Trailer mounted unit consisting of open circuit primary jaw crushing followed by open circuit secondary gyratory crushing; 521 tonnes per hour.
Leach Schedule	365 days/year
Leach Pad Area	31.5 ha 47,400 m ² max area under leach at any time
Stacking	Valley fill heap - 8 m lifts and 1.6 t/m ³ dry density
Heap Leach Pad Liner	<i>Double composite liner with integral LDRS over the entire heap</i>
Reagent Consumption	Crusher Liners (steel) 0.03 kg/tonne ore; Sulphuric Acid 25 kg H ₂ SO ₄ /tonne ore; Guartec 0.5 kg/tonne Cu; Cobalt 100 ppm Co in bleed stream; Extractant 0.014 kg/tonne ore; Diluent (Kerosene) 0.040 kg/tonne ore.
Solution Application	Barren leaching solution applied using drip emitters at a total flow rate of 540 m ³ /hr @ 0.204 litres/min/m ²
Copper Recovery Process	Solvent extraction-electrowinning process (SX/EW)
Events pond	160,000 m ³
Work Force	109 persons average; 130 peak.
Airstrip	Carmacks
Power	Diesel generating plant (5 X 1.6 mW)
Water Supply	8 wells located in the bedrock confined aquifer underlying Williams Creek drainage; each well estimated to provide ~ 150 m ³ /day
Elevation	485 m to 1,000 m
Average Temperatures	January -30.6°C; July 12.8 °C.
Land Position	Western Copper 100% owner of 240 claims on the Carmacks Copper Property

Carmacks Copper Project Overview (Cont'd)

Exploration Potential	Zone 1 extends in trench exposures and drill intercepts over a 700 m strike length and 450 m down dip; 14 defined zones total.
Environmental Baseline	Completed throughout 1989 to 1999. Ongoing data collection programs <i>in 2005 to present.</i>
Project Permitting	Scheduled for completion in 2007
Mine Waste Rock	Design capacity of 60 million tonnes placed at 2.0 t/m ³ ; Annual waste rock production of about 7.5 million tonnes.
Effluent Testing	Passed acute toxicity tests for treat and release and end of mine life treated solutions
First Nations	Little Salmon Carmacks First Nation (LSCFN); Selkirk First Nation (SFN).
Archaeological / Heritage Sites	2 historic archaeological sites – outside of project footprint; 3 areas of medium heritage site potential along access road.
Environmental	No key wildlife habitat on site. Trapping concession in the project area
Total Reclamation Fund	No existing liabilities

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Appendix C	Carmacks Copper Project Performance Standards and Design Criteria Parameters (2005)
Appendix D	EBA Engineering Consultants Ltd., Carmacks Copper Mine Heap Leach Pad Liner Design Report (2005)
<i>Appendix D1</i>	<i>Report on Updated Design of the Heap Leach Pad and Events Pond (1997)</i>
<i>Appendix D2</i>	<i>Western Copper Heap Leach Pad Loading Plan (July 2006)</i>
<i>Appendix D3</i>	<i>Water Balance Update – Memorandum CCL-CC7 (February 2006)</i>
<i>Appendix D4</i>	<i>Williams Creek Site Hydrology Update – Memorandum CCL-CC6 (January 2006)</i>
<i>Appendix D5</i>	<i>Technical Design Memorandum – Solution Storage/Events Pond Sizing (January 2006)</i>
<i>Appendix D6</i>	<i>EBA Engineering Consultants Ltd., Responses to Environmental Assessment Review Questions (re Heap) (March 2006)</i>

Appendix E Beattie Consulting Ltd. Report on Leaching and Decommissioning of Samples from Carmacks Oxide Copper Project (2001)

Appendix E1 Western Copper Conceptual LEACH/SE-EW Process (June 2006)

Appendix E2 Fate of Lead at the Anode of the Electrowinning Circuit – Carmacks Copper (August 2006)

Appendix E3 Detoxification and Rinsing Testwork Report (January 2006)

Appendix E4 Memorandum – Heap Rinsing Additional Information (June 2006)

Appendix E5 Technical Memorandum – Review of Documents and Meeting Notes related to Mineralogy of Leach Residues (May 2006)

Appendix E6 Leach Residue Fine Fraction ABA Testing (September 2006)

Volume III – Supporting Appendices F - Q

Appendix F Conceptual Closure and Reclamation Plan (Updated 2006)

Appendix F1 Operational Treatment System (August 2006)

Appendix G Summary of Results from the Waste Rock Characterization Program (Hallam Knight Piesold Ltd., IEE Addendum No.1, June 1995)

Appendix G1 Waste Rock Storage Area Evaluation and Detailed Design Report (1997)

Appendix G2 EBA Engineering Consultants Ltd., Preliminary Review of Existing Information – Waste Rock Dump (April 2006)

Appendix G3 EBA Engineering Consultants Ltd., Response to Review Questions – Waste Rock Storage Area (May 2006)

Appendix G4 Provisional Assessment of ARD Potential of Selected Rock Samples, Carmacks Copper Project (November 2006)

Appendix H1 Summary of Flow Measurements Recorded in June and July 2006

Appendix H2 Baseline Water and Sediment Quality Data 1989 - 2006

Appendix H3 Environmental Monitoring Program Update and Data Summary – Revision #1 (January 2006)

Appendix H4 Williams and Nancy Lee Creek Sample Station Photographs

Appendix H5 Wildlife Update (August 2006)

Appendix H6 Vegetation Information Update (July 2006)

Appendix H7 Land Tenure Adjacent to Freegold Road

Appendix I Summary Consultation Tables (May – October 2006)

Appendix J Western Copper Newsletter and Posters for Consultation (2006)

Appendix K Updated Summary of the Assessment of Potential Environmental Effects, Proposed Mitigation Measures and Significance Assessment (2006)

Appendix L Spill Contingencies and Emergency Response Plan

Appendix M Qualitative Risk Assessment Worksheets

Appendix N Information Sheet for Quartz Mining Undertakings

Appendix O Navigable Waters Letters on Navigability of Merrice & Williams Creek Crossings

Appendix P Carmacks Copper Project Socio-economic Effects Assessment (February 2007)

Appendix Q Williams Creek Geochemistry (September 2006)

1.0 CORPORATE PROFILE

In February 2003, Western Copper Holdings Limited changed its name to Western Silver Corporation to reflect the Company's focus on silver. *Western Copper Corporation ("Western Copper", "the company") is a successor company of Western Silver Corporation, acquired by Glamis Gold Ltd. in May 2006. Western Copper holds 100% of the Carmacks Copper Project as well as Sierra Almoloya, an early stage exploration property in the Central Mexican Silver Belt. The Company is listed on the Toronto Stock Exchange (TSX:WRN). Contact information for the head office is presented below:*

*Western Copper Corporation
2050 – 1111 West Georgia Street
Vancouver, British Columbia
Canada, V6E 4M3*

*Telephone: (604) 684-9497
Fax: (604) 669-2926
Email: info@westerncoppercorp.com
Website: www.westerncoppercorp.com*

Western Copper's mission is to deliver exceptional returns to shareholders by:

- Maintaining their commitment to deliver on promises to shareholders, employees, and communities;*
- Advancing the Carmacks deposit to unlock shareholder value;*
- Assembling a uniquely qualified team giving Western Copper a competitive advantage in rapidly and accurately evaluating and responding to emergent opportunities to acquire valuable assets;*
- Creating a thriving internal culture of excellence and innovation which attracts and retains the highest-caliber employees to sustain operations at a high performance level;*
- Focusing on strategic metals which will have high value in the years ahead;*
- Acting ethically in all aspects of business practices, and*
- Operating in an environmentally responsible manner.*

Western Copper's focus is to develop the Carmacks property into a producing core asset and the identification and acquisition of attractive gold and copper projects, at the advanced exploration stage, for development into operating properties.

Western Copper has adopted a Safety and Environmental Policy, which is presented in Appendix B. The purpose of Western Copper's Safety and Environmental Policy is to provide a measurable framework for the performance of Western Copper's activities in an environmentally responsible manner, ensuring compliance by the Corporation and its employees with all applicable environmental regulations and commitments.

Western Copper will take positive action to protect the safety of its workers, conserve natural resources, and minimize the effect of its activities on the environment through diligent application of appropriate technology and responsible conduct at all stages of exploration, mine development, mining, mineral processing, decommissioning, and reclamation. The Company intends to develop and operate the project in an environmentally responsible and sustainable manner.

1.1 PROJECT PURPOSE AND NEED

Economic analysis of the Carmacks Copper Project *conducted in 1997* showed that the project is feasible at prices above US\$1.10/lb copper *based on the prevailing economic conditions*. With the recent move in copper prices above US\$1.10/lb, Western Copper is investigating ways to advance project development. After having spent considerable time, effort and money on the project in previous years, Western Copper is moving the EA permitting process to completion so that development can proceed in a timely basis to take advantage of higher copper prices.

Western Copper believes that the outlook for copper demand is favorable for the long term. This provides an opportunity for Western Copper, their shareholders, local First Nation's and communities, and the Yukon Territory as a whole to benefit from the project development. The Carmacks Copper Project will also provide an economic benefit to the Yukon economy, which in recent years, in the mining sector, has been quite poor.

2.0 PROJECT AND ASSESSMENT SCOPE

2.1 SCOPE OF THE PROJECT

The Carmacks Copper Project is a proposed open pit copper mine and *heap leach* solvent extraction and electrowinning (SX/EW) processing facility being developed by Western Copper. The orebody is located in the Yukon Territory (Figure 2-1), about 38 km northwest of the Village of Carmacks, or 192 km north of Whitehorse (Figure 2-2). The deposit contains an open pit mineable (*historical*) reserve of 13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper. The project will include an open pit, acid heap leach and copper extraction facility, WRSA, soil stockpiles, events pond, drainage ditches, sediment control ponds, *haul* roads, construction camp, and miscellaneous facilities to support mining operations, *including a new site access road from the existing Freegold Road to the site*. A crushing plant may also be constructed for ore and fill processing.

The scope of the project includes all phases and activities relating to the development, construction, operation, and decommissioning of the Carmacks Copper Project. The principle project is the construction, decommissioning or abandonment of a metal mine (open pit mining of copper oxide ore) with an ore production capacity of 5,400 t/day or more. The proposed accessory developments to the project consist of the following main components:

- Waste rock storage and handling;
- Ore crushing and handling to lined heap leach facility;
- Events pond and other water management structures (*use of water, and deposit of wastewater*);
- SX/EW processing facility and raffinate solution management;
- Acid plant;
- *Haul roads and site access road*;
- Ancillary facilities; and
- Support services (e.g. power supply, site accommodation, and communications).

2.2 MINERAL ASSETS

The reserves used in the Basic Engineering Report have been *estimated* to be 13.3 million tonnes of ore at an average grade of 0.97% total copper based on a cutoff grade of 0.29% total copper and a mining dilution of 10%. Western Copper is the 100% owner of *240* claims on the Carmacks Copper property (Figure 5-6, Section 5.4). Figure 3-4, (Section 3.1.2) prepared by HKP in 1995, shows the location of the No. 1 zone and the geological reserves in the area.

2.3 ASSESSMENT SCOPE

The approach to the EA for this project is outlined in Figure 2-3. This approach is a step-wise determination of the various development phases for the project.

Alaska (United States of America)

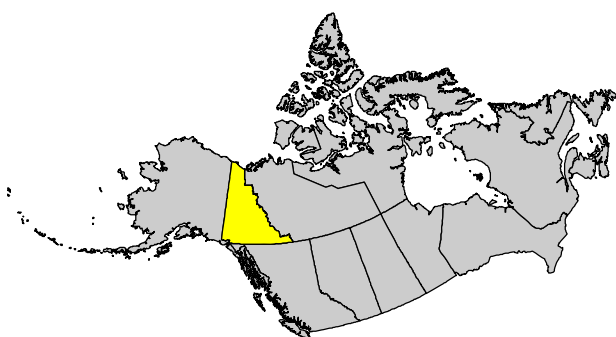
General Location Map of the Yukon Territory

Scale 1 : 6 000 000

50 0 50 100 150 200 250 300km

Project Location

British Columbia (Canada)



WESTERN SILVER CORPORATION

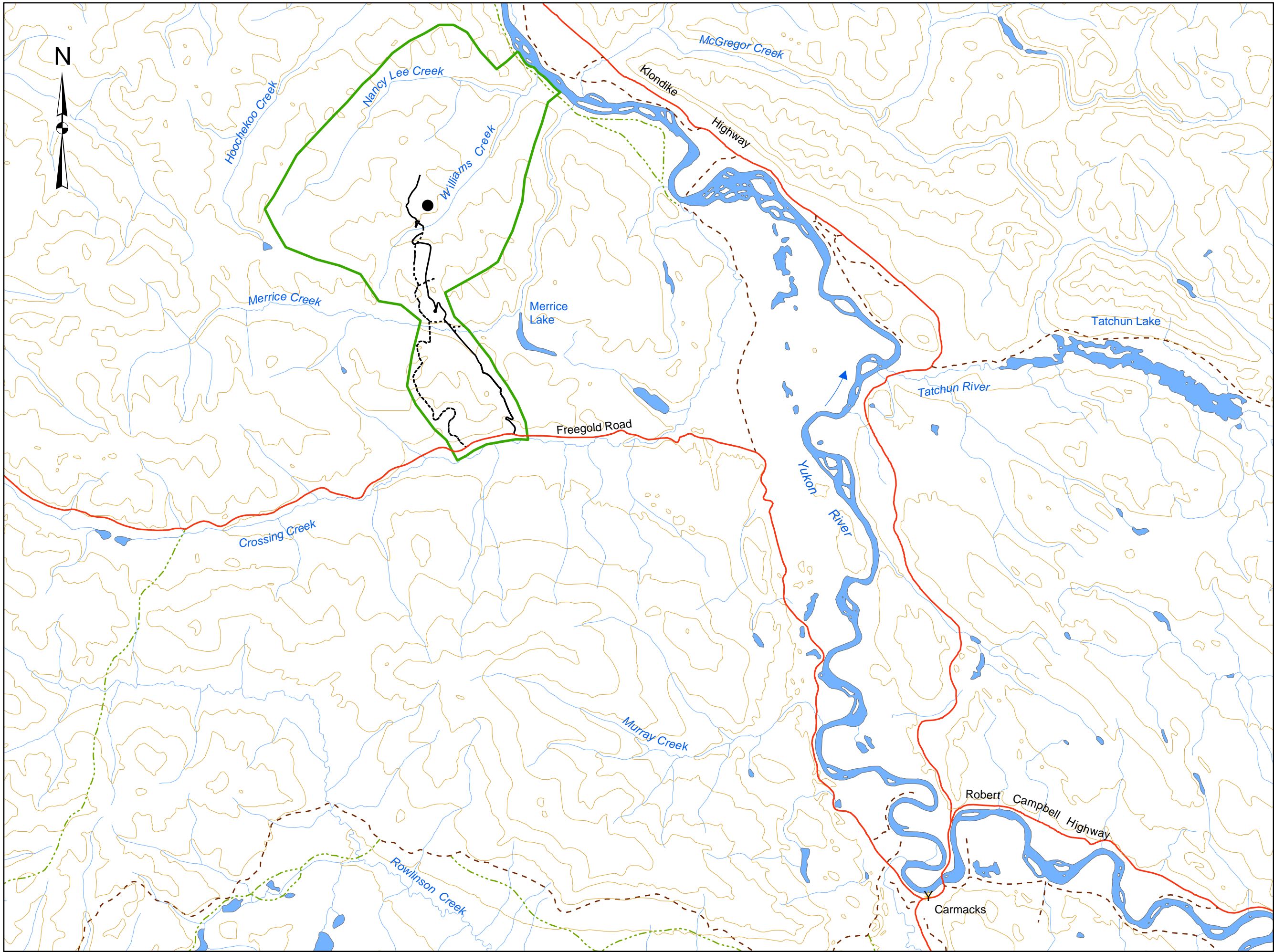


Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory

Drawn By: HD	Figure 2-1
Checked By: DC	Date: April, 2005

Our file:D:\Project\AllProjects\WCH-01 1\GIS\mxd\Fig2_1_Loc.mxd



**Project Description
& Environmental
Assessment Report**

**Carmacks Copper
Project
Yukon Territory**



Legend:

- Town
- Ore Deposit
- Water Course
- Proposed Access Road
- Exploration Road
- Limited-used Road
- Road
- Trail
- Contour
- Water Body
- Environmental Assessment Study Area

UTM Zone 8 NAD83 Meters

Project Area Overview

Figure Number:
2-2

Scale:
1:150,000



Drawn by: HD	Checked by: DC
Date: April, 2005	

Figure 2-3 Approach to Project Development

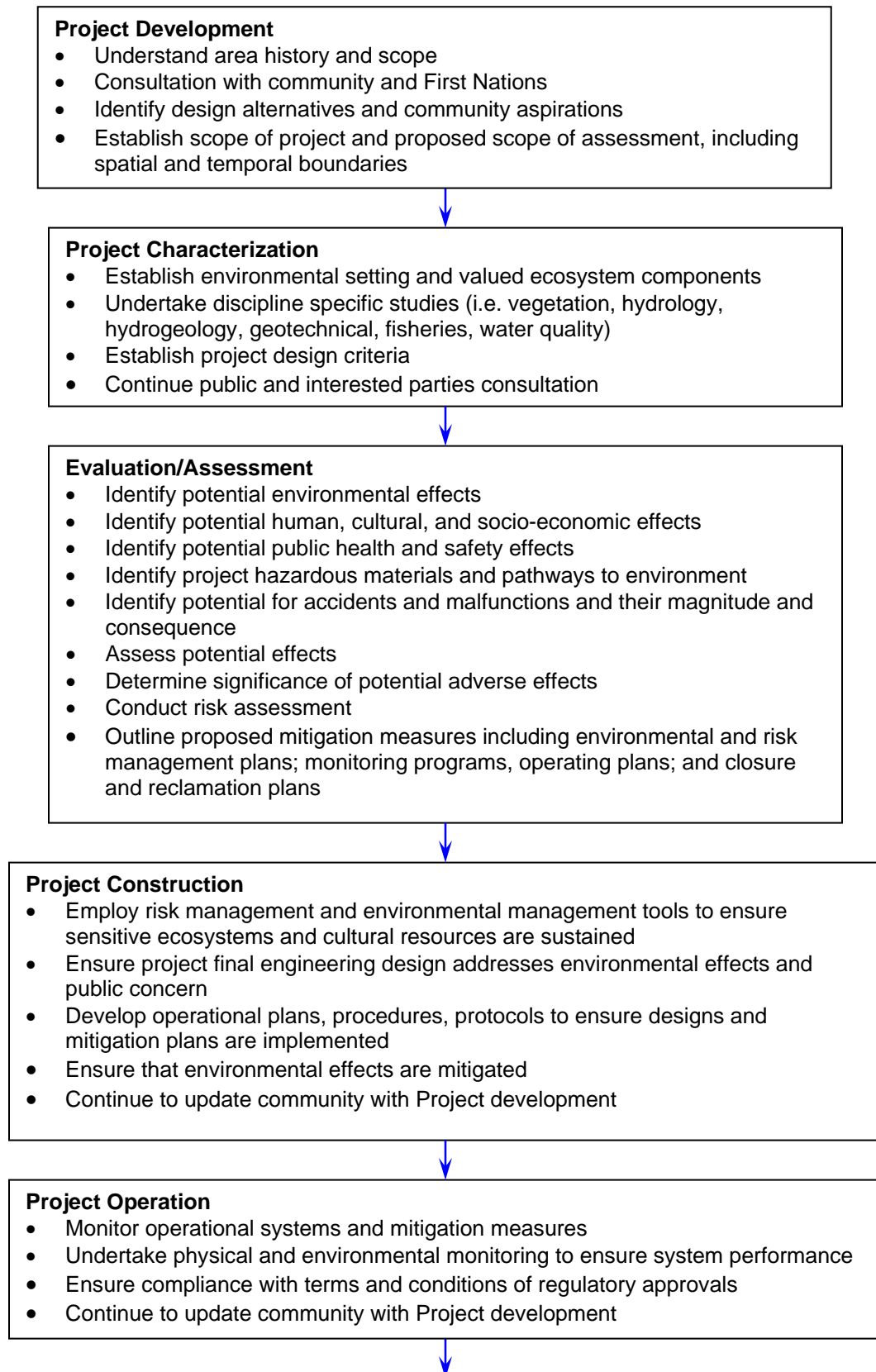
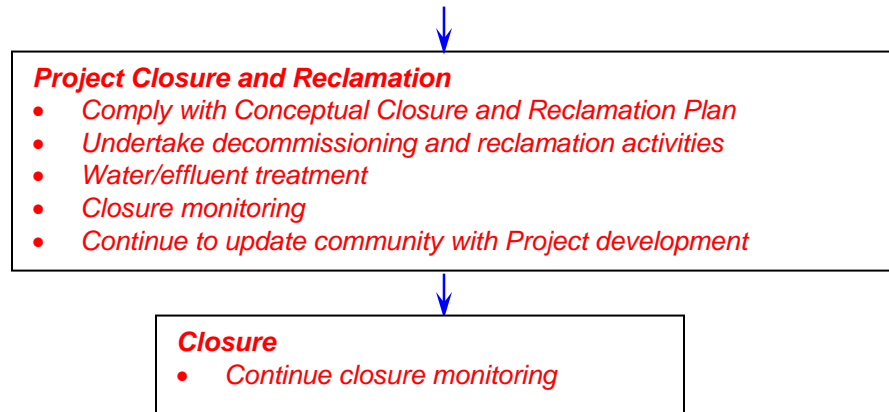


Figure 2-3 Approach to Project Development (Cont'd)

The environmental and socio-economic assessment for this project will consider all matters under section 42, and under section 47(2) of YESAA. These include:

- 42.** (1) In conducting an assessment of a project or existing project, a designated office, the executive committee or a panel of the Board shall take the following matters into consideration:
- (a) the purpose of the project or existing project;
 - (b) all stages of the project or existing project;
 - (c) the significance of any environmental or socio-economic effects of the project or existing project that have occurred or might occur in or outside Yukon, including the effects of malfunctions or accidents;
 - (d) the significance of any adverse cumulative environmental or socio-economic effects that have occurred or might occur in connection with the project or existing project in combination with the effects of:
 - (i) other projects for which proposals have been submitted under subsection 50(1), or
 - (ii) other existing or proposed activities in or outside Yukon that are known to the designated office, executive committee or panel of the Board from information provided to it or obtained by it under this Act;
 - (e) alternatives to the project or existing project, or alternative ways of undertaking or operating it that would avoid or minimize any significant adverse environmental or socio-economic effects;
 - (f) mitigative measures and measures to compensate for any significant adverse environmental or socio-economic effects;
 - (g) the need to protect the rights of Yukon Indian persons under final agreements, the special relationship between Yukon Indian persons and the wilderness environment of Yukon, and the cultures, traditions, health and lifestyles of Yukon Indian persons and other residents of Yukon;
 - (h) the interests of residents of Yukon and of Canadian residents outside Yukon;
 - (i) any matter that a decision body has asked it to take into consideration; and
 - (j) any matter specified by the regulations.
- (2) In addition to the matters referred to in subsection (1), the executive committee or a panel of the Board shall take the following matters into consideration:
- (a) the need for effects monitoring; and

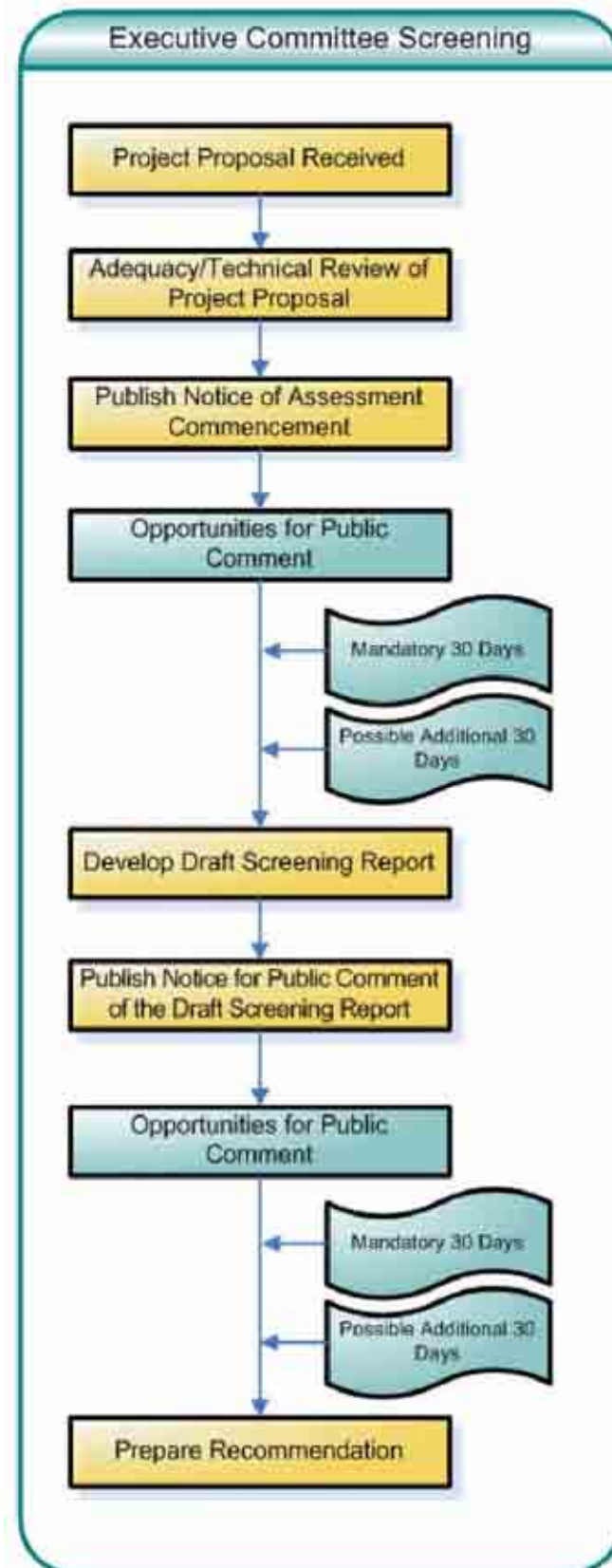
(b) the capacity of any renewable resources that are likely to be significantly affected by the project or existing project to meet present and future needs.

Valued environmental and socio-economic components for the project are discussed and presented in section 7.2. As the Carmacks Copper project is now subject to assessment under YESAA, an updated socio-economic baseline and effects assessment has been prepared in accordance with the requirements of the YESAA. The Socio-economic Effects Assessment Report is presented in Appendix P and provides a summary of existing social and economic conditions in the Village of Carmacks.

This report has identified potential environmental and socio-economic effects and proposed mitigation measures and assessed the significance and likelihood of these residual effects. *Appendix P provides specific socio-economic effects assessment and mitigation measures.*

A schematic representation of the **YESAB** review process for the Carmacks Copper Project, as Western Copper currently understands it, is shown in Figure 2-4.

Figure 2-4 YESAA Executive Committee Screening Flow Chart (YESAB, 2006)



Included from the YESAB Guide to Interested Persons and the Public to Participate in Assessments (2006), from Figure 1.

2.4 SPATIAL AND TEMPORAL BOUNDARIES

It is proposed that the approximate spatial boundaries for assessment be based on the potential geographic extent of effect. The spatial boundaries proposed for the assessment of biological environment, physical environment, aboriginal land use, and archaeological and heritage resources are defined in Figure 2-2 as the Environmental Assessment Study Area. The boundary shown in Figure 2-2 is intended to encompass all mine infrastructure including the access road and waterways in the downstream flow path from the mine. The assessment of socio-economic and economic effects is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole. *This assessment is presented in Appendix P.* There is also recognition that particular wildlife species are better assessed at a regional context and this has been considered for this assessment.

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

Construction and Mine Operation	0 – 8 years
Decommissioning and Reclamation, Closure, and Post Closure	8 – 15 years

2.5 REGULATORY APPROVALS

To proceed with the project, licence or permit applications for the following are required:

Type A Water Use Licence	Issued under the <u>Yukon Waters Act</u> , submitted to Yukon Water Board
Quartz Mining Licence	Issued under the <u>Yukon Quartz Mining Act</u> , submitted to Yukon Government (YG), Energy Mines & Resources
Explosive Licence (obtained by explosives supplier)	Issued under the <u>Explosives Act</u> and Ammonium Nitrate and Fuel Oil Order, submitted to Natural Resources Canada
Air Emissions Permit	Issued under the <u>Environment Act</u> , submitted to YG, Environment Yukon

On August 19, 2005, Transport Canada, Navigable Waters Protection Division issued statements respecting the navigability of creek crossings at Merrice Creek and Williams Creek. The waters of Merrice Creek at the site of the proposed bridge are considered non-navigable, as are the bridge crossing site on Williams Creek, and the culvert crossing on North Williams Creek. Therefore, applications are not required under the Navigable Waters Protection Act for this work. Refer to Appendix O for the statements issued by Transport Canada.

It is not anticipated that Department of Fisheries and Oceans (DFO) authorizations will be required for the Merrice Creek bridge crossing. The bridge abutments are not expected to encroach on the creek wetted perimeter and the design is for a clear span bridge. A culvert crossing is planned for the upper Williams Creek road crossing. No fish have been observed in upper Williams Creek based on fisheries investigations. A letter of advice from DFO may be required for the road stream crossing.

While no authorization is required for the *Metal Mining Effluent Regulations* (MMER), all effluent, which is discharged from the project, both during operation and at final decommissioning, shall meet the effluent quality standards provided in Schedule IV of the regulations.

Additional information requirements for the Water Use Licence Application are provided at the back of this report in Appendix N.

2.6 PERFORMANCE STANDARDS AND DESIGN CRITERIA

In April 2005, Access Consulting Group, on behalf of Western Copper Corporation, prepared an updated "Performance Standards and Design Criteria Parameters" report, which is included in Appendix C. This document presents performance standards and objectives for environmental protection consistent with industry best practices, and the design criteria and parameters that were used to update the design of the mine facilities. The document has been presented for discussion with government authorities to ensure that regulatory requirements are being met. Yukon Government (YG) performance standards have been included in Appendix A of the "Performance Standards and Design Criteria Parameters" report. The performance standards and design criteria will guide the construction, operation, and decommissioning of the project, and therefore, the EA and permitting process. Refer to Appendix C for additional information and details.

3.0 PROJECT DESCRIPTION

The following summary has been extracted from the “Western Copper Holdings Ltd., Carmacks Copper Project 1997 Basic Engineering Report” (Basic Engineering Report) prepared by Kilborn in December 1997 and updated as necessary. Figures 3-1 and 3-2 show the general arrangement of the project components and the overall site plan for the facilities, respectively. Figure 3-3 shows a simplified flowsheet of the Carmacks Copper Project process. Drawing 100-13-45 shows the overall site plan at year 2 while Drawing 100-13-08 shows the detailed ultimate overall site plan. Pertinent information from the Basic Engineering Report is summarized below.

- The Carmacks Copper Project is located 46 km by an *existing* gravel road (Freegold Road and an exploration trail) northwest of Carmacks in Yukon. *The Freegold Road is maintained by YG and provides access to the point where the company will construct a new site access road to the property.*
- The project site proposed for the development is located within a group of *240* mineral claims covering 1,000 ha.
- The open pit mine will have a stripping ratio of 4.6 tonnes of waste to 1 tonne of ore (4.6:1).
- Mine operations will be carried out using conventional mining equipment.
- The project will treat oxide ore to produce 14,310 tonnes of copper cathodes per year, at a recovery rate of 80%.
- Crushing and heap leach pad loading will take place during 200 days of the year (early summer to late fall). Ore leaching will continue year round with solution heating during winter operation utilizing waste heat from power generation and acid production, if available.
- Active mining is estimated to be for eight years, producing about 60 million tonnes of waste rock, and 13.3 million tonnes of copper ore. For about 300 days each year, the mine will use haul trucks (run of mine ore) or a series of mobile conveyors to place up to 9,872 tonnes per day of crushed ore on a 31.5 ha lined heap leach pad in 8 m lifts.
- Copper in solution will be recovered from the oxide ore by acid heap leaching of crushed minus 19 mm, agglomerated ore.
- Pregnant leach solution (PLS) will be treated in a solvent extraction (SX) plant to purify and concentrate the weak leach solution to a more concentrated solution suitable for electrowinning (EW).
- High purity copper cathodes will be produced in an electrowinning (EW) plant for shipment via truck to the ice-free port of Skagway, Alaska.
- The process facilities, ultimate leach pad, open pit and waste rock storage will occupy an area of approximately 100 ha.

Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory



Note: Drawing is for
illustrative purposes only,
NOT FOR CONSTRUCTION

Original drawing from Knight Piesold Limited,
"Overall Site Plan Year 2",
Drawing #100-13-45

General Arrangement

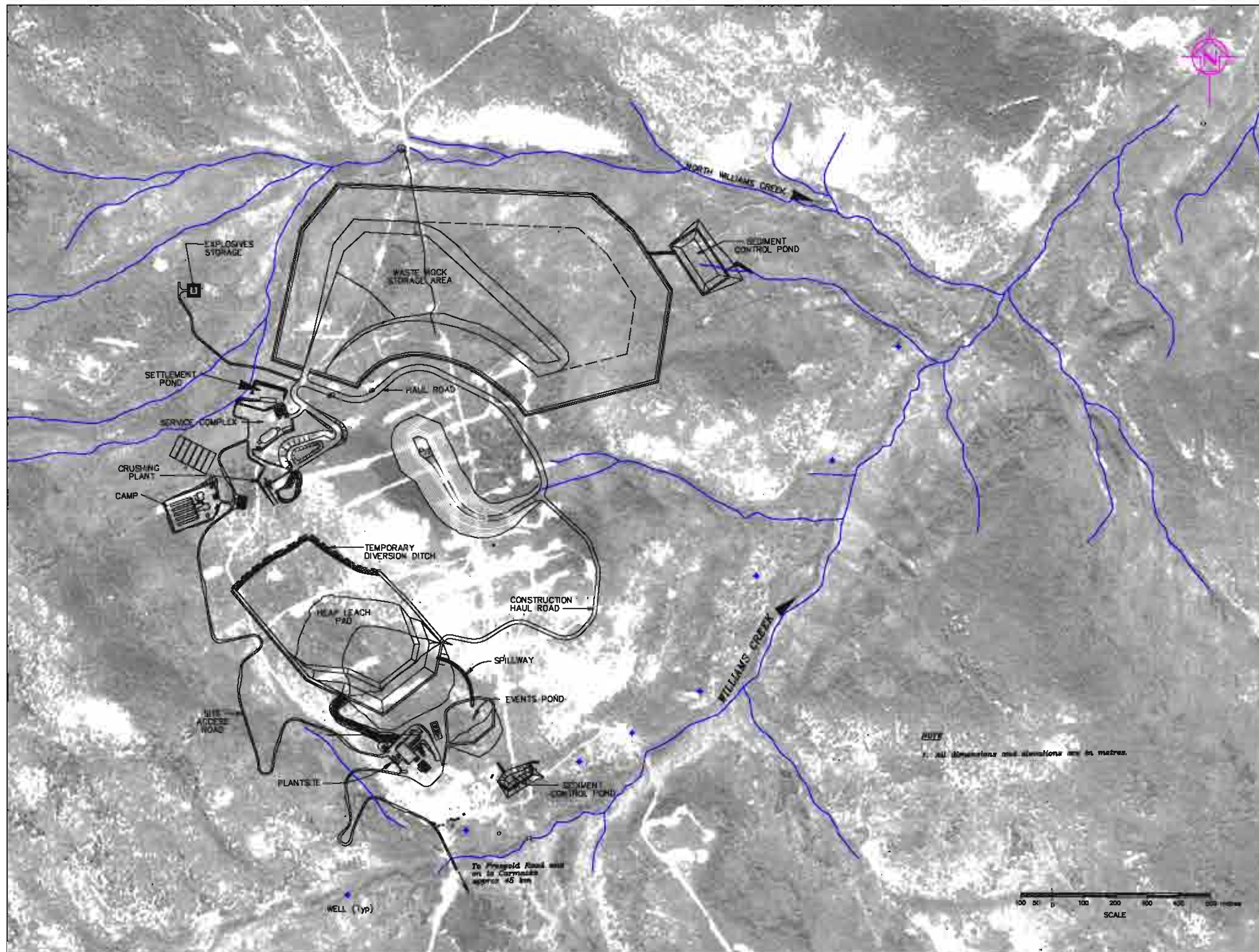
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Date: April, 2005

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**Project Description
& Environmental
Assessment Report**

**Carmacks Copper
Project
Yukon Territory**



Note: Drawing is for
illustrative purposes only,
NOT FOR CONSTRUCTION

Original drawing from Kibom,
The engineering data on this drawing is solely for the
purpose and project for which this drawing is issued.
"Overall Site Plan Pre-Production",
Drawing #700-13-43 Rev C

**Overall Site Plan -
Facilities**

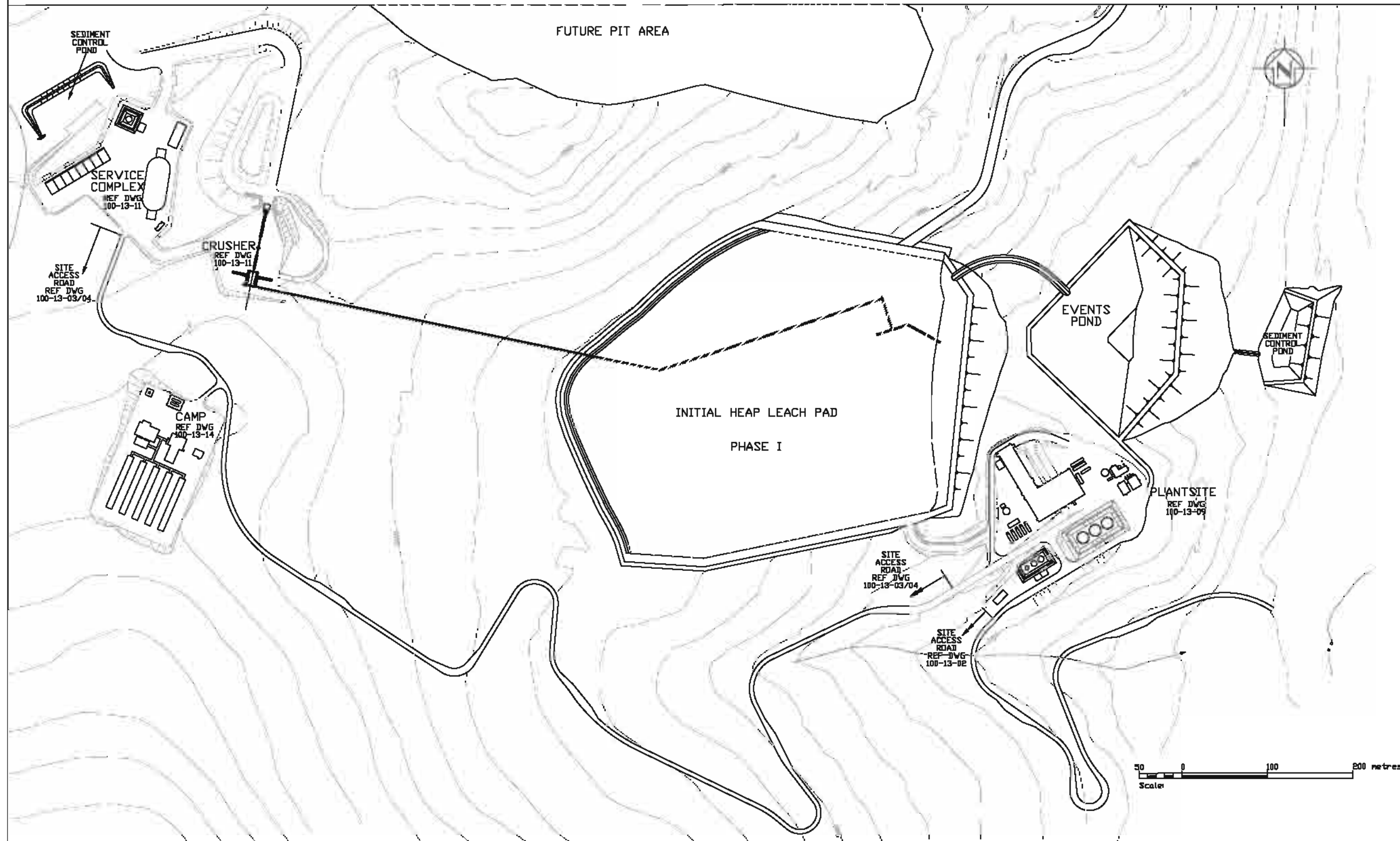
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3-2



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Date: April, 2005

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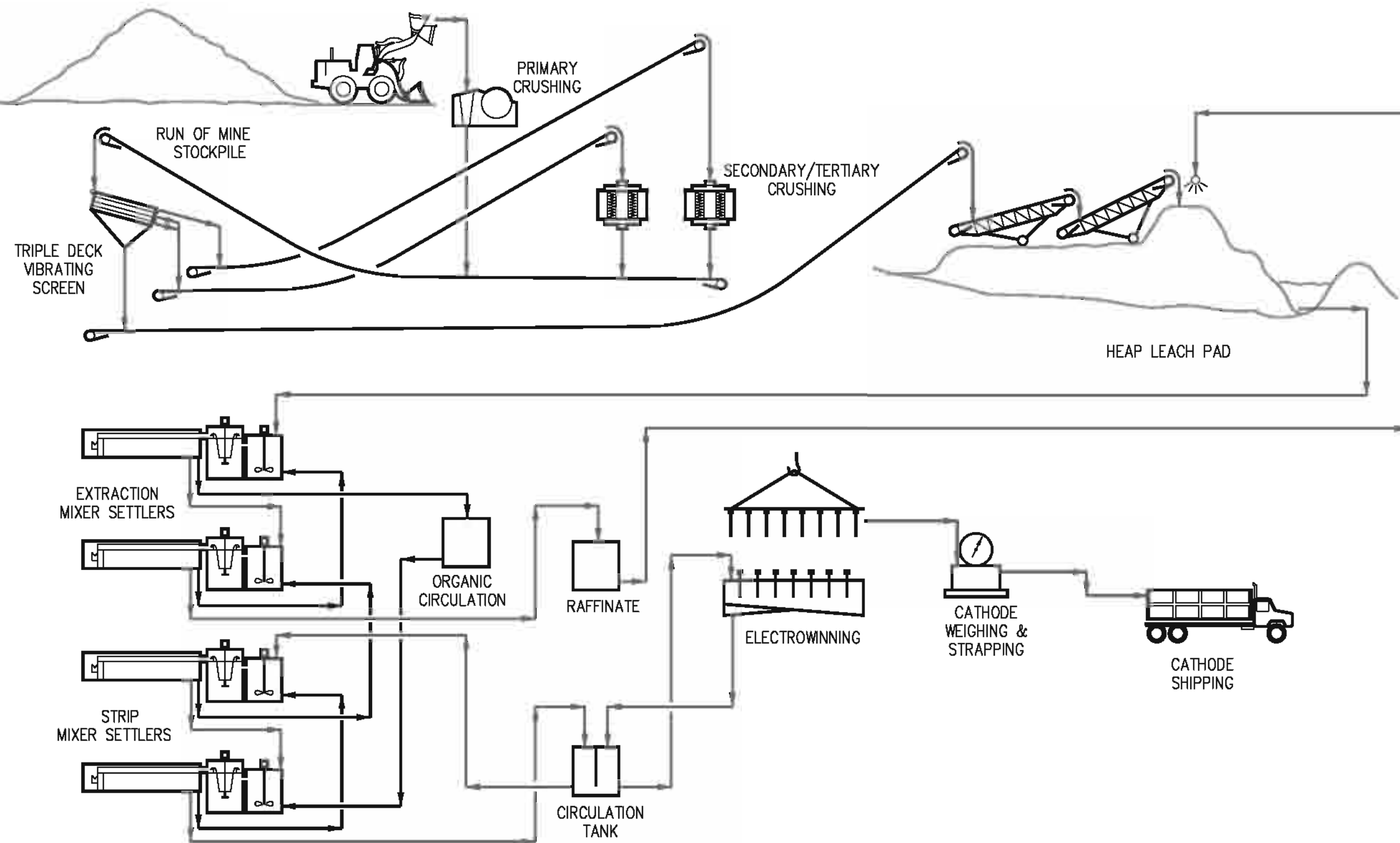


Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory



Note: Drawing is for
illustrative purposes only,
NOT FOR CONSTRUCTION



Original drawing from Kilbom,
"Western Copper Holdings Limited Carmacks
Copper Project Simplified Flowsheet",
Drawing #100-10-02

Simplified Flowsheet of the Carmacks Copper Project Process

Figure Number:
3-3



Revised by: HD Checked by: DDC

Date: April, 2005

- In addition to the mining and process facilities, the site facilities will include: water supply wells and distribution system, power supply distribution, fire protection, diesel fuel storage, acid storage, sewage treatment, communications system; offices, changehouse, operations camp, gatehouse/first-aid; work shops/warehouse and laboratory.
- Water supply for the project will come from wells in the Williams Creek Valley. The well water and surface run-off collected in settlement ponds located below the WRSA and leach pad and shop area will be the source of process water makeup. During winter, water will be provided by deep wells developed in bedrock below the Williams Creek valley. Water will be pumped to fire/freshwater tanks at the process plant and camp sites for distribution.
- Power will be generated on-site by 5 X 1.6 mW modulized diesel generators complete with heat recovery equipment and electrical/control cubicles. Recovered waste heat will provide hot water, which will be used for process solution and building space heating. Alternatively, Yukon Energy Corporation (YEC) may supply power to the site via a transmission power line.
- Sulphuric acid required for the leaching of copper from the ore will be produced at site from a commercial 120 tpd contact catalytic plant. The plant will burn molten sulfur to produce sulfur dioxide which will be converted, via a select catalyst and recirculated with a sulfuric acid stream, to produce concentrated (98%) sulphuric acid. Alternative acid production processes such as bio-oxidation of agglomerated elemental sulfur are under study and will continue to be investigated.
- The following off-site infrastructure has been included: 13 km of property access road (which has already been cleared and grubbed), and project administration offices and warehousing in Carmacks.
- The project site is located within a region where the average annual total precipitation is 372 mm with evaporation on average 402.4 mm, yielding a net loss of 30.4 mm. The average annual temperature is -5.8°C. There will be no *on-going* liquid discharges from the process facilities and surface run-off, from disturbed areas, will be collected and treated before discharge.
- Once on the heap, raffinate (a barren acid solution) from the process plant will be applied to the surface of the ore by a system of buried drip emitters. After leaching through the ore, the pregnant leachate solution will be collected in a network of pipes on top of the leach pad liner and flow either directly to the SX/EW process plant or to the events pond below the heap.
- After mining ceases, the heap will be leached for about two more years. When the leaching is no longer economical, the heap will be rinsed for about four and a half years with water then decommissioned *and covered with a soil cover (~0.5m)*. The solutions in the heap will be neutralized and in-situ biological treatment will be undertaken in the heap to assist in stabilization of metals. Active water treatment using known technology will be used to reduce the heap solution inventory.

Water treatment may be required for a period of time after heap neutralization to reach effluent performance standards; however, *contingency measures such as a long-term passive treatment (infiltration gallery) may be employed for final closure depending on results of ongoing monitoring.*

3.1 BACKGROUND / INTRODUCTION

3.1.1 *Location*

The Carmacks Copper Project is located in the Dawson Range at latitude 62°21'N and longitude 136°41' W, some 200 km north of Whitehorse, Yukon. The project site is located on Williams Creek, 8 km west of the Yukon River, and some 38 km northwest of the Village of Carmacks. The site is accessible by an existing 13 km exploration road that leads north from km 33 of the secondary, government maintained roadway (Freegold Road) from Carmacks. Carmacks, on the Yukon River, is 175 km by paved road north of Whitehorse, which is 180 km north of the year-round port at Skagway, Alaska.

The existing Freegold Road will be utilized for project access between Carmacks and the access road to the site. Discussions with YG Highways and Public Works (HPW) indicate that the existing road and bridges are fully serviceable for the project. The company will not be undertaking any upgrades to the Freegold Road to support the project; however, YG HPW may undertake maintenance activities to the Freegold Road as required.

The company will replace the existing exploration trail, which joins to the Freegold Road, with a new constructed site access road which will join the Freegold Road at approximately km 31.

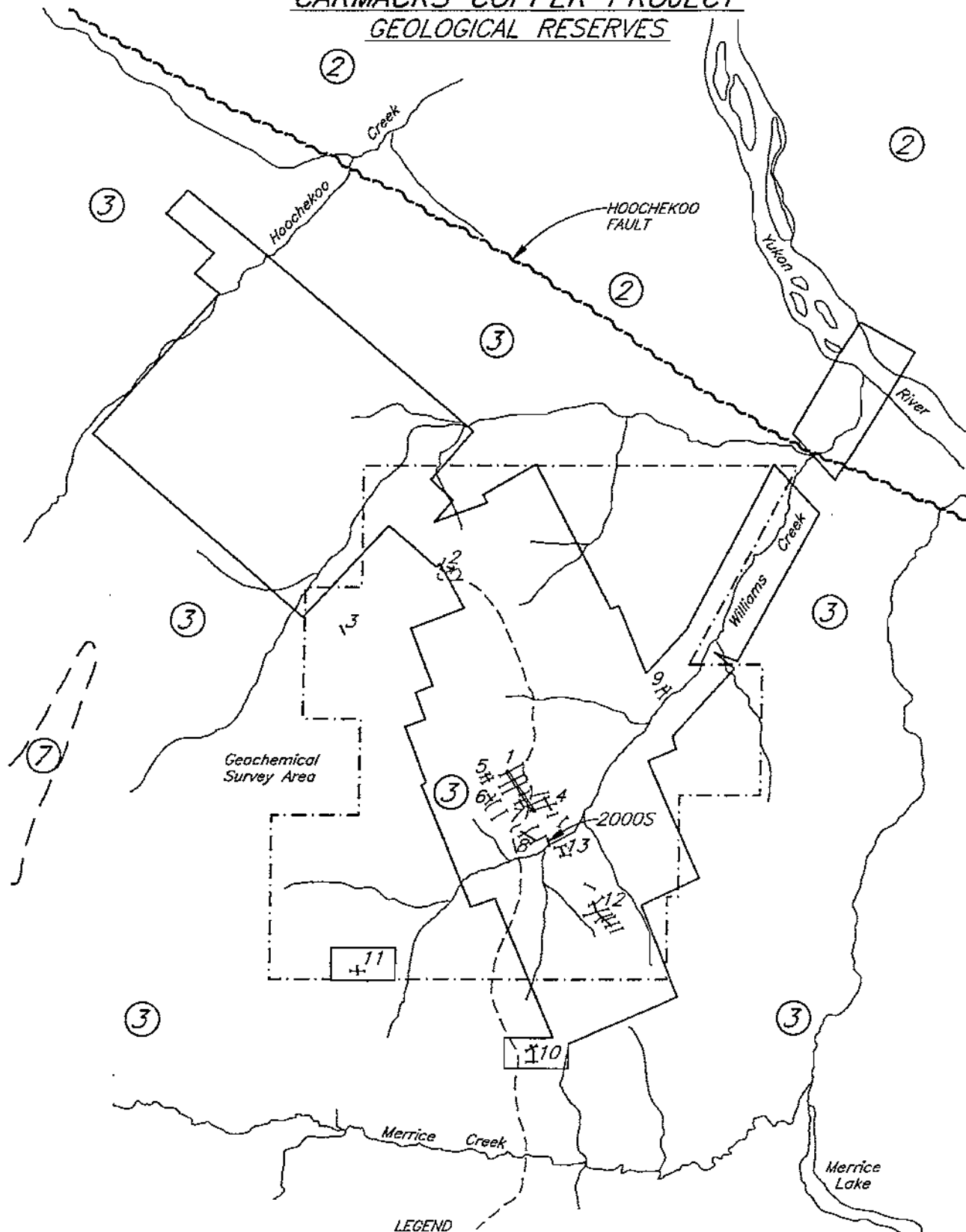
3.1.2 **History**

In the proposed project area, the first report of copper was made in 1887 and the first claims were staked in 1898 in Williams Creek and Merrice Creek canyons, east of the present Carmacks Copper deposit. The discovery of a copper deposit 104 km northwest of the Carmacks Copper deposit precipitated a staking rush that led to the staking of the Williams Creek property in 1970. During subsequent examinations, the present No. 1 and No. 2 zones were located, followed by 11 additional zones. Figure 3-4, prepared by HKP in 1995, shows the location of the No. 1 zone and the geological reserves in the area.

In the 1970's, exploration of the No. 1 zone consisted of bulldozer trenching, x-ray diamond drill holes, soil sampling, geophysical surveys, and road construction. In 1974, a legal survey was carried out over the key claims that covered most of the known showings, including the No. 1 zone. In the early 1980s, the downturn in copper essentially ended exploration and development.

In 1989, the property was optioned to Western Copper Holdings Ltd (WCHL) and Thermal Exploration Company (TEC). During 1989 WCHL and TEC collected 3 tonnes of surface oxide material for testing of leaching characteristics. In 1990, metallurgical tests were carried out and diamond drill holes were drilled on the No. 1 zone.

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
GEOLOGICAL RESERVES



NOTE: No reserve figures available for zones other than No. 1 zone.

LEGEND

- ② Carmacks Group - tuff & andesitic basalt flows
- ③ Granite Mountain Batholith - biotite hornblende granodiorite with feldspar hornblende biotite gneiss
- ② Povoas Fm. - andesitic basalt, volcanic breccia, tuff & conglomerate
- 1/2 Zone
- No. 1 Deposit
- Trench
- Geophysical survey area
- Property outline

Based on information from
Hallam Knight Piesold Ltd., May 16, 1995

Figure3-4

During 1991 and 1992 WCHL and TEC conducted major work programs: a total of 3,463.7 m of HQ size diamond drilling was carried out; 3,401 m in 35 holes on the No. 1 zone and 62.7 m in 1 hole on the No. 4 zone. Twenty-one trenches, totalling 1,856.2 m, were cut on the No. 1 and No. 4 zones. An area of approximately 1 ha was stripped at the southern end of the No. 1 zone. A geophysical program, consisting of electromagnetic (VLF-EM) and magnetic surveys, was carried out on a single grid of 62 survey lines, totalling 83.8 km. Baseline environmental studies for fish and wildlife populations and water quality commenced in 1991.

In another major program in 1992, WCHL and TEC carried out work on the Nos. 1, 2, 4, 5, 7, 12, 13 and 2 000 zones and on anomalies elsewhere on the property. Extensive metallurgical testing of drill core from the No. 1 zones was carried out.

A total of 6,520 m of trenching was conducted on the Nos. 1, 2, 4, 5, 7, 12, 13 and 2 000 zones, and for condemnation purposes, over potential leach pad, waste dump and plant site areas. A total of 856.79 m of reverse circulation drilling in 11 holes was conducted on Nos. 1, 5 and 2 000 zones, and on geophysical anomalies found in the 1991 survey. Ten HQ size diamond drill holes, totalling 1, 005.23 m were drilled, two on No. 1 zone, two on No. 4 zone, four on No. 12 zone and two on No. 13 zone. One oriented NQ size triple (split) tube diamond drill hole of 157.19 m was drilled on the No. 1 zone for geotechnical studies.

To summarize, a total of 12,900 m of drilling in 80 diamond drill holes and 11 reverse circulation drill holes has been completed on the property including zones other than No. 1. Several kilometers of surface trenching has been carried out at approximately 30 m intervals across the strike, with some trenches excavated along the strike to confirm continuity. Over 25 tonnes of bulk sample was gathered and shipped to Vancouver for metallurgical testing.

In September 1993, WCHL (Western Copper) contracted Kilborn to carry out a mining feasibility study of the Williams Creek property. In 1994 Western Copper began the permitting process and held preliminary economic development discussions with both the YG and Little Salmon Carmacks First Nation (LSCFN). In September 1994 Kilborn returned a positive feasibility study (subsequently updated in 1995) and Western Copper announced their intentions to place the property into production.

Western Copper continued geotechnical and engineering studies under the review process of CEAA from 1996-1998. During 1997 the Company cleared the access road, leach pad, and plant site and contracted Kilborn to carry out run-of-mine bulk sampling of the zone 1 deposit. Leaching and decommissioning testwork was then carried out by Beattie Consulting Ltd. to provide a basis for predicting copper recovery and neutralization requirements.

The company re-activated the project permitting in 2004. Baseline environmental studies were continued in 2005 and new technical studies were completed to update engineering designs for the project and address information deficiencies noted during the assessment processes. These included a revised heap leach pad liner design, spent ore detoxification studies, hydrological and geotechnical studies, neutralization test work and other information as requested.

In July 2006, the company also initiated a property drill program comprising 10,000 m of diamond drilling. The purpose of the drill program was to increase the mineral resources for the project.

3.1.3 Geology and Mineralization

3.1.3.1 Regional Geology

The Carmacks region lies within the Intermontane Belt, which in the Carmacks map-area is divisible into the Yukon Cataclastic Terrane, Yukon Crystalline Terrane and Whitehorse Trough.

Units of the Whitehorse Trough lie to the east of the Hoochekoo Fault, east of the Carmacks Copper property. The Whitehorse Trough comprises Upper Triassic intermediate to basic volcanic (Povoas Formation) capped by carbonate reefs (Lewes River Group) and Lower Jurassic greywacke, shale and conglomerate, derived from the underlying Upper Triassic granitic rocks (Laberge Group). The Yukon Cataclastic Terrane includes hornblende-biotite-chlorite gneiss with interfoliated biotite granite gneiss, Permian Selwyn Gneiss, intruded by Upper Triassic Klotassin Suite-Minto Pluton and Granite Mountain Batholith. Weakly foliated, mesocratic, biotite-hornblende, Granite Mountain granodiorite contains screens or pendants of strongly foliated feldspar-biotite-hornblende-quartz gneisses that host the Carmacks Copper deposit.

The Yukon Crystalline Terrane, extensively exposed southwest of the Carmacks Copper deposit, includes quartz-mica schist with quartzite, marble and amphibolite, Early Palaeozoic age and possibly equivalent to Pelly Gneiss, intruded by Cretaceous and Jurassic granites and syenites. Templeman-Kluit (1985) has included Upper Cretaceous Carmacks Group intermediate to basic volcanic and Cretaceous Mount Nansen intermediate to acid volcanic and sub-volcanic equivalents in the Yukon Crystalline Terrane.

Mesozoic strata of the Whitehorse Trough are only exposed in fault contact with the Yukon Crystalline Terrane and Yukon Cataclastic Terrane, but may rest depositionally on them or certain of their strata. The relationship between the Yukon Crystalline Terrane and Yukon Cataclastic Terrane is unknown.

Younger plutonic rocks intrude all three divisions of the Intermontane Belt and the contacts between them. Carmacks Group and Mount Nansen volcanic overlie portions of all older rocks, suggesting that they should not be classified in the Yukon Crystalline Terrane, but are younger rocks that obscure relationships between the older terrane rocks.

The predominant northwest structural trend is represented by the major Hoochekoo, Tatchun and Teslin faults to the east of the Williams Creek property and the Big Creek Fault to the west. East to northeast younger faulting is represented by the major Miller Fault to the south of the Williams Creek property.

3.1.3.2 Property Geology

The Carmacks Copper, copper-gold deposit lies within the Yukon Cataclastic Terrane. The deposit is hosted by feldspathic-mafic gneisses (generally quartz deficient) that form a roof pendant within Upper Triassic hornblende-biotite granodiorite of the Granite

Mountain Batholith. The deposit constitutes the No. 1 zone, which is one of 14 defined zones containing copper mineralization known on or in the immediate vicinity of the property.

Granite Mountain granodiorite is massive in appearance, medium to coarse grained and generally equigranular. A weak foliation is present, particularly at or near the hanging wall contact of the gneiss units. The granodiorite has been separated into five divisions; four based on quartz, biotite, hornblende, and K-feldspar contents and a fifth based on assimilated gneiss.

Petrographic examination indicates Granite Mountain granodiorites have a varied mineralogical content with areas of silica under-saturation and plagioclase over-saturation. These variations are probably the result of the assimilation of precursor rocks to the gneiss units.

The general lack or very low quartz content and the high mafic content suggest a volcanic origin for the gneisses. An origin of arkosic sediments derived from a basic volcanic or plutonic regime could also be considered, but the poor continuity of rock units down dip, as demonstrated in Cross-section 1000N, weighs against a sedimentary origin. An andesitic to basaltic pyroclastic volcanic, probably tuffaceous, agglomeratic or breccia precursor rock is considered the most likely.

Post mineralization aplite and pegmatites are common. They range in thickness from a few cm up to 3.0 m. Quartz veins are uncommon and average 2 to 5 cm in thickness. Thin mafic dykes that were feeders for Carmacks Group volcanic are also uncommon. The only copper mineralization in these dykes and veins is non-sulphide secondary copper in aplite and pegmatite.

The deposit, as presently defined, is the No. 1 zone which extends over a 700 m strike length and at least 450 m down dip. The deposit is open at depth. The deposit is a northwest trending tabular body approximately 30 m thick, 0.5 km long and dipping 70 degrees to the east. Figure 3-4 shows the location of the No. 1 zone and the geological reserves in the area.

Copper-gold mineralization at Carmacks Copper is hosted by feldspathic-biotite-hornblende-quartz gneisses. These gneisses have been subdivided into nine categories based on coarseness and biotite-hornblende content. All of the gneisses are silica undersaturated and mafic rich.

The character of the deposit changes along strike leading to a division into northern and southern halves. The northern half is more regular in thickness, dip angle, width and down dip characteristics. The southern half splays into irregular intercalations, terminating against sub-parallel faults down dip. Both the north and south ends of the deposit are offset by cross-cutting faults. The No. 4 Zone is interpreted as the southern offset extension of the No. 1 zone.

In the northern half of the zone, copper grades are higher in the footwall relative to the hanging wall. Oxide copper grades increase with depth in both the footwall and hanging wall. There is no association of copper values with rock type, mafic mineral content or grain size.

Gold values are higher in the north half of the deposit. They average 0.022 ounces gold per ton (0.75 g/t) compared with 0.008 ounces gold per ton (0.27 g/t) in the south half of the deposit. There is no apparent increase in values with depth and the highest grade gold values are not associated with the highest copper values; however, gold values in the northern half are higher in the footwall section. This lack of increase in gold values with depth suggests that the fold distribution reflects a primary distribution rather than a secondary distribution such as oxide copper values. As with oxide copper, gold content does not correlate with rock type, mafic constituents or grain size.

3.1.3.3 Mineralization

The majority of the copper, approximately 85%, in the Carmacks Copper No. 1 zone is in the form of the secondary minerals malachite, cuprite, azurite and tenorite (copper limonite) with very minor other secondary copper minerals (covellite, digenite, djurlite). Other secondary minerals include limonite, goethite, specular hematite and gypsum. Primary copper mineralization is restricted to bornite and chalcopyrite. Other primary minerals include magnetite, gold, molybdenite, native bismuth, bismuthinite, arsenopyrite, pyrite, pyrrhotite, and carbonate. Molybdenite, native bismuth, bismuthinite and arsenopyrite occur rarely.

Alteration minerals that could be considered strictly related to the mineralizing event rather than weathering or dyke intrusion are not recognizable. Epidotization and potassium feldspathization are obviously related to pegmatite dyke intrusion which is a post-mineralization event. Clay (montmorillonite type) and sericite development are clearly weathering products. Silica introduction, usually as narrow veinlets, is not common and may be related to aplite dyking or metasomatism. Chloritization of mafics, biotitization of hornblende, rare garnets, carbonates and possibly anhydrite all appear related to metasomatism and assimilation of precursor rocks to the gneissic units.

The upper 250 m of the No. 1 zone is oxidized. Within the oxidized area pyrite is virtually absent and pyrrhotite is absent. Weathering has resulted in 1% to 3% pore space and the rock is quite permeable. Secondary copper and iron minerals line and in-fill cavities, form both irregular and coliform masses, fill fractures and rim sulphides. Primary sulphide minerals and magnetite are disseminated and form narrow massive bands or heavy disseminations in bands. Non-copper sulphides are not common in the weathered zone and are usually intergrown or associated with each other when they do occur. They most commonly occur in hematite but also occur in copper sulphides and in the gangue minerals. Gypsum occurs as microveinlets. Carbonate occurs as pervasive matter, irregular patches or microveinlets, not commonly, but on the order of 1% where present. Gold occurs as native grains, most commonly in cavities with limonite or in limonite adjacent to sulphides, but also in malachite, plagioclase, chlorite and rarely in quartz grains. Gold is rarely greater than 5 microns in size.

Secondary copper mineralization does not appear to be preferential to a particular rock type. In the north half of the No. 1 zone, copper mineralization forms high and low grade zones that are reasonably consistent both along strike and down dip and these zones transcend lithologic boundaries. Higher grades tend to form a footwall zone while lower grades form a hanging wall zone.

Primary mineralization, below the zone of oxidation comprises chalcopyrite, bornite, molybdenite, magnetite, pyrite and pyrrhotite. Primary copper mineralization appears to be zoned from bornite on the north to chalcopyrite and finally to pyrite and pyrrhotite on

the south. Narrow veinlets of anhydride were found in the deepest drill hole. Refer to Appendix 1 of the IEE Addendum prepared by HKP in 1995 for a Petrographic Report on 21 samples (rocks) collected in the Carmacks Copper deposit area.

3.1.4 Ore Body Modelling

3.1.4.1 Polygonal Model

Polygonal modeling was carried out by first creating polygons in the vertical plane on each section line where trenching and diamond drilling was conducted. These polygons were assigned grades according to the trench or drill hole intercepts. The areas of the polygons were then calculated and distance-weighted with the adjacent sections to give a tonnage between sections. The tonnages were then totaled.

3.1.4.2 Block Model

Geological in-situ resources for the No. 1 zone were calculated by developing a block model and then using three-dimensional kriging.

Two block models were generated, one with 20 foot (6.10 m) high blocks and the other with 30 foot (9.14 m) high blocks. Although greater selectivity of higher grade blocks appeared possible using a 20 foot (6.10 m) bench height, the anticipated increase in mining costs outweighed the possible advantage of selectivity. As a result, only the 30 foot (9.14 m) model was completed and presented herein.

Using GEOMODEL software, plans were generated every 30 feet (9.14 m) vertically from the 1,885 foot (574.55 m) elevation, to a plane 200 feet (60.96 m) above the highest known surface elevation on the No.1 zone. These plans were generated from the cross-sections that were constructed to calculate the geological resource by polygonal method, and were established at the mid-point of each 30 foot (9.14 m) bench. Polygons were then digitized outlining the copper mineralization in gneiss and, separately, the seepage copper mineralization in granodiorite. The two types of mineralization were identified and the polygons were then exported to PC-MINE software.

In PC-MINE software, a block model was constructed with a 30 foot (9.14 m) block height, a 30 foot (9.14 m) block width and a 50 foot (15.24 m) block length. A partial block model was chosen to allow for better identification between copper mineralization in gneiss and seepage mineralization in granodiorite. The partial block model also allowed and undiluted reserve to be calculated. Within the model, separate models were built for waste rock type and density, ore rock type and density, percent ore, total copper grade and variance, gold grade and variance, topography and economics.

Grades for total copper oxide copper were calculated by ordinary three-dimensional kriging based upon the semi-variogram parameters for each type of copper. As the gold semi-variograms were not satisfactory, gold grades were calculated by inverse distance. Multivariate statistics showed that gold had a higher coefficient of correlation with total copper than with oxide copper so the same parameters used for total copper grade interpolation were used for total gold grade interpolation.

Grades were interpolated for each block with the following restrictions:

- Only composite samples within 200 feet (60.96 m) of the block centre were to be used;
- A minimum of three composite samples within the search area were required to calculate a grade for that block;
- A maximum of ten composite samples were used to calculate the block grade and if more were present they were sorted by a distance weighting factor and only the closest ten were used;
- Samples to be used were also restricted by rock type, i.e., only mineralized gneiss samples were used for grade interpolations of gneissic material and only seepage mineralization was used for grade interpolations of seepage copper in granodiorite;
- Any assay sample with an assay reported below detection limits was assigned a zero value;
- Any interval with a missing sample length was left out rather than assigned an average value or zero; and
- All composite samples with zeros were used in the interpolation of grades by kriging or inverse distance.

At various stages, the models were checked to ensure the correctness of rock type assignments and grade interpolations. Cross-sections with drill holes and trenches with 30 foot (9.14 m) composite grades, reserve polygons and block grades were plotted and compared to the model. Complete details are presented in the Basic Engineering Report.

3.2 PROJECT COMPONENTS / STRUCTURES

The following sections describe the various components and structures that comprise the Carmacks Copper Project. Figures showing the main components of the project are provided, and detailed drawings of additional project elements are located in Appendix A.

3.2.1 Open Pit

Mining will consist of a single open pit designed to mine No. 1 zone. The pit will be mined in 12 m benches at an average strip ratio of 4.6 tonnes of waste per tonne of ore. Reserves have been calculated as 13.3 million tonnes at an average grade of 0.97% total copper, at a marginal cutoff grade of 0.29% total copper. The resulting mine life will be 8 years. It is anticipated that a significant portion of the sub grade material that must be removed from the pit will be sent to a low grade stockpile. Depending on economic conditions, this material may be processed at a later date.

The open pit will have a long, narrow NW-SE configuration with a length of approximately 780 m, a maximum width of 450 m, and a depth of 240 m at its deepest point. Figure 3-5 shows the overall arrangement for the open pit plan.

Access to the pit will be provided by a 26 m wide haul road (including width allowances for an inside drainage ditch and an outside barrier) from the crusher along the SW side of the pit. The ultimate ramp on the SW wall will switch back once to the NW endwall.

The main access road provides for a two-way haulage route from the mine to move waste to the waste dumps and the ore to the primary crusher. Waste will be mined from the pit and placed in waste dumps to the north of the pit. All run-of-mine ore production

will be directly trucked to the primary crusher and/or to a small surge stockpile adjacent to the crusher.

During the early years of production the operation will generally be focused on the mining and processing of lower strip ratio ore. As the mine progresses, successively higher strip ratio ore will be mined until year 5 and, thereafter decreases to the end of mine life. Ore grade is relatively constant throughout the mine life.

Pit development plans by anticipated year are shown in Drawings 800-05-13, 800-05-14, 800-05-15, 800-05-16, and 800-05-17. Appendix C presents the performance standards and design criteria for the open pit.

3.2.1.1 Pit Slope Design

A geotechnical evaluation of pit slopes has been undertaken by Knight Piésold Ltd. This evaluation is based on geotechnical logging of selected trenches across No. 1 zone and one triple tube diamond drill hole.

Consideration of the slope design included an analysis of potential failure modes. Possible failure mechanisms which have been considered include failure involving structural discontinuities and deep-seated failure mechanisms. In the pit, the potential failure mechanism will be controlled by local structural discontinuities. For pit design purposes, Kilborn has adopted the recommendations of Knight & Piésold for maximum interramp final wall slopes of 55 degrees. Track dozer access to the catchment berms will be maintained to allow removal of accumulated debris.

Refer to the report prepared by Knight Piésold Ltd. in 1993 entitled "Report on Pit Slope Stability" for an evaluation of the stability of the open pit slopes.

3.2.1.2 Drilling

The majority of the waste rock and all of the ore will require mining by drilling and blasting. The near surface waste and topsoil will be ripped by bulldozers for removal.

Drill patterns will be established on benches prepared by a bulldozer equipped with a ripper tooth. The diesel powered rotary drills will drill holes 13.5 m deep with 1.5 m for subgrade, resulting in bench heights of 12 m. Patterns will be laid out initially on a 6 m by 6 m (burden by spacing) square or staggered pattern.

Initially one rotary blasthole drill will be required. As the strip ratio increases and greater pit planning flexibility becomes necessary, a second blasthole drill will be added in year 2.

A track mounted percussion drill will be operated for secondary drilling of hard final wall toes and also for boulders resulting from primary blasting in frozen ground conditions.

3.2.1.3 Blasting

Blastholes will be charged with ammonium nitrate/fuel oil (ANFO) blasting agent by means of a truck mounted ANFO supply and slurry mixing/dispensing unit.

Approximately 30% of all pit blasting is anticipated to be in wet conditions. Eighty-three percent of these holes will be lined with plastic liners to keep the explosive dry, while the remaining 17% will be loaded with a water-resistant slurry.

Non-electric, delayed blasting will be employed. The blasts will be initiated using a safety fuse assembly, detonating cord trunklines, capped nonel primacord downline, and one primer per blasthole. The powder factor is estimated to be 0.205 kg/t. Ore and waste will be blasted separately in order to minimize the amount of ore loss and waste dilution. Blast initiation will take place along strike as much as possible to assist in minimizing dilution.

It is anticipated that ore and waste rock will be well fragmented. As more operating experience is obtained, changes to the drill pattern design and blasting parameters may be required in order to optimize costs and rock fragmentation; the objective will be to provide a consistent minus 600 mm top size product to the crusher.

In order to maintain competent ultimate walls effectively for the life of the mine, experience-based controlled blasting techniques will be utilized.

3.2.1.4 Loading

The equipment units selected for loading will be one 10.7 m³ diesel hydraulic front end loader (FEL), and one 10.5 m³ diesel hydraulic shovel. The shovel will be used for waste mining and for bench clean-up to final pit walls. The FEL will load ore. Excess loader capacity will be utilized for; rehandling surge stockpile ore, handling crushed gravel, road maintenance and waste loading.

A rubber-tired dozer will be available for clean-up in loading areas.

3.2.1.5 Haulage

The open pit haulage equipment will be a fleet of used and refurbished 91 tonne capacity, off-highway mechanical drive haul trucks. The trucks will be four pass loaded by either of the loading units, and will be utilized for hauling ore, waste and overburden. Truck requirements start at two units for pre-production stripping and increase to nine units in year 5. Five units are required for year 8.

3.2.1.6 Roads, Dumps and Pit

Pit and mine site roads will be maintained by one of two ripper equipped track dozers, a grader, an excavator, a sand truck in winter and a water truck in summer. The dozer will be available on the waste dump for spotting dumping trucks and for dump maintenance work. A diesel generator powered light stand will provide additional visibility for night shift dumping and dump maintenance work, and for night shift in-pit operations.

The rubber tired dozer will be operated in-pit for shovel and loader face clean-up, and for ramp and toe clean-up. A second, smaller, ripper-equipped dozer will be utilized for breaking out bench face toes, for in-pit temporary and permanent ramp access work, and for catch berm scaling and clean-up.

3.2.1.7 Grade Control

Grade control will be provided by sampling and assaying cuttings produced by the production drills. Preliminary identification of ore limits will be based on exploration drilling. The mine geologist will ensure that the samples are properly taken by the drill operators, identified, and sent to the assay lab.

In order to assist the loading equipment operators in minimizing ore losses and reduce dilution from waste material, an ore control technician will stake digging limits for high grade ore, low grade ore and waste after each blast.

Allowances will be made for blasting displacement as appropriate. Bench elevations will be accurately monitored in order to control digging depths. A lighting plant will be operated as required to help improve visibility for the equipment operators.

The shift supervisor will be responsible for ensuring that material is hauled to its appropriate destination.

3.2.1.8 Dilution and Ore Recovery

Calculation of dilution and ore loss has been based on the assumption that the total quantity of material within the pit is finite, and losses are caused by the mixing of ore material with waste.

Dilution in the vertical direction will be controlled by mining the ore in 12 m high benches while dilution in the horizontal direction will be minimized by close spacing of production drill holes.

Dilution has also been based on the assumption that there will be some dilution from each adjacent ore/waste contact. The overall dilution factor has been calculated to be 10%. Recovery of the reserve is expected to be 100% at the expense of mining the additional waste dilution tonnage. An average grade of 0.00% Cu has been assigned to the diluting waste.

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Original drawing from Kilbom,
The engineering data on this drawing is solely for the
purpose and project for which this drawing is issued.
"Open Pit Plan End of Year 8 Ultimate Pit",
Drawing #800-05-17 Rev C

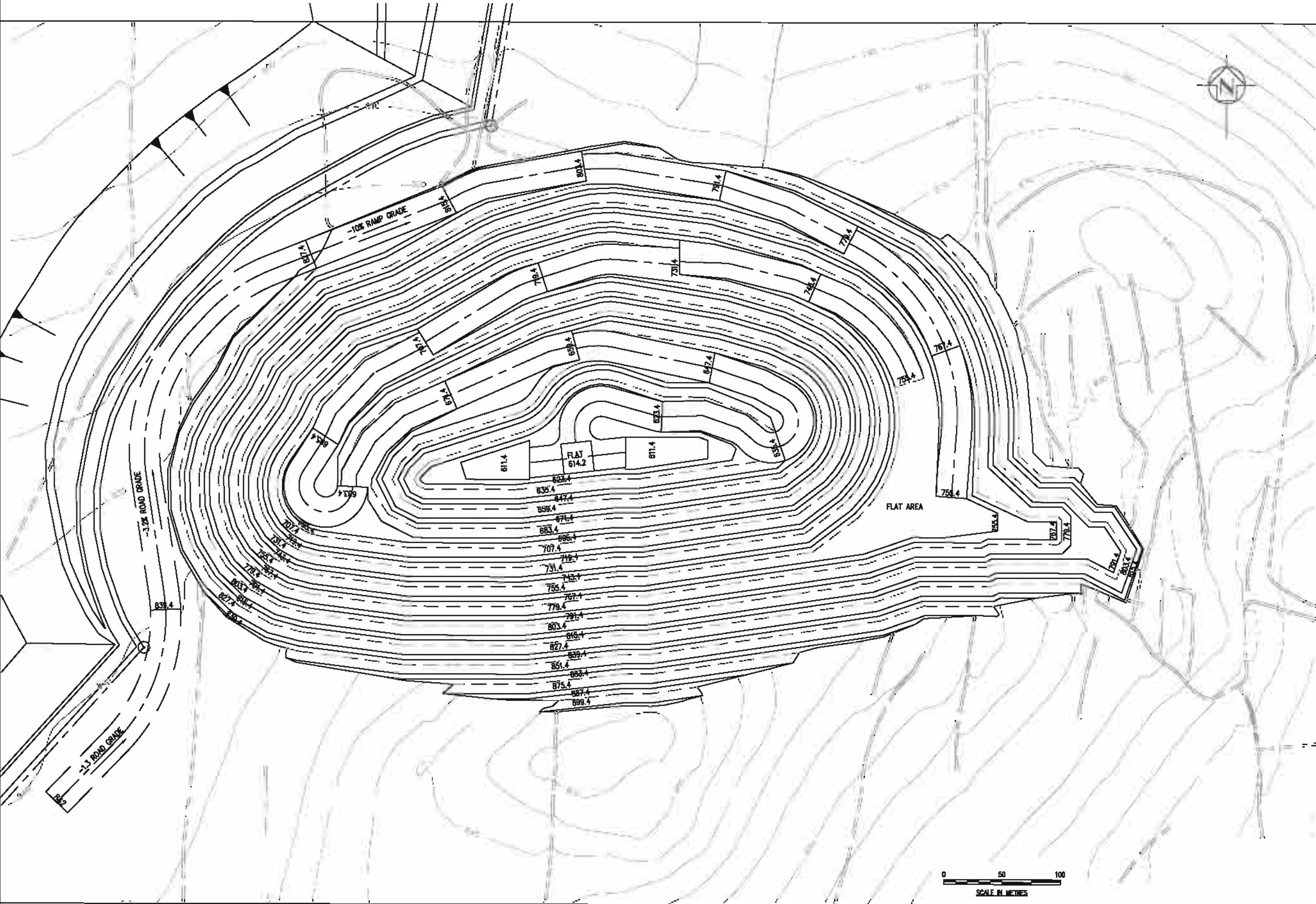
**Final Open Pit Plan -
Year 8**

Figure Number:
3-5



Revised by: HD Checked by: DDC

Date: April, 2005



3.2.2 Waste Rock Storage Area

The Waste Rock Storage Area Evaluation and Detailed Design Report (Western Copper Holdings Ltd., 1997), included in Appendix G1, provides a discussion of various options considered for the waste rock storage area (please note that water balance data present in this 1997 report has since been updated). The detailed design presented in Appendix G1 for the WRSA is the preferred location for this project component. Supporting engineering analyses and geotechnical information is included with this report.

Please refer to Appendix G2 for EBA Engineering Consultants Ltd.'s (EBA) April 19, 2006 Preliminary Review of Existing Information – Waste Rock Dump. The review was completed to address the possibility of relocating the waste rock storage area away from permafrost and potentially thaw unstable foundation soils. Appendix G3 contains EBA's May 29, 2006 Response to Review Questions – Waste Rock Storage Area, which was prepared to address comments made during the YEAA review of the WRSA design component of the Carmacks Copper Project.

The following information has been included from the “Waste Rock Storage Area Evaluation and Detailed Design Report” prepared by Western Copper Holdings Ltd. in June 1997. Please refer to Figure 3-6 for an overview of the WRSA.

3.2.2.1 Evaluation of Options

Several options for WRSA location, configuration and foundation preparations have been considered in development of the plan for the Carmacks Copper Project. These options include:

- a) placing rock on the existing surface on the south side of the valley north of the open pit without any special foundation preparation;
- b) stripping the area immediately north of the open pit of its vegetative cover, allowing thaw to begin and providing ditches to transport melt water with and without providing a contingency buffer area around the dump toe;
- c) preserving the permafrost in the location immediately north of the open pit by placing an insulating layer of rock on the original ground in winter and later depositing lifts of rock waste on top of the frozen ground year round;
- d) constructing of the dump on original ground with a stabilizing berm placed at the toe of the dump and keyed into thaw stable material;
- e) constructing the dump across the valley bottom north of the pit using the opposite valley wall to help add stability to the dump;
- f) locating the dump at higher elevation in the valley northwest of the pit and north of the heap leach pad;
- g) locating the dump south of the pit on steep slopes free of permafrost; and
- h) removing potentially thaw unstable material in two locations north of the pit before placing rock in the dump.

A review of the WRSA alternatives and the rationale for selecting the final option is presented in Section 4.3. The option selected for the WRSA is b) outlined above with a contingency buffer zone which allows further consideration of option d) if required at a later date. The selected option is briefly summarized below and described in detail in the "Report on Detailed Design of Waste Rock Storage Area" prepared by Knight Piésold in May 1997, included as Appendix A to the Waste Rock Storage Area Evaluation and Detailed Design Report (*Appendix G1*). This report includes detailed design drawings consideration of foundation preparation, dump sequencing, contingencies for increased stability, water balance and water management, stability analysis, proposed monitoring, and an outline of reclamation proposed.

3.2.2.2 Design Objectives

The principal objectives for the design of the WRSA are as follows:

- Provide a geotechnically stable and cost-effective configuration for staged waste rock storage with particular attention to permafrost and foundation conditions;
- Minimize potential effects to the groundwater system and surface runoff flows during the life of the mine operation and in the long term by providing collection ditches and a sediment control pond;
- Develop the facility in stages to allow for ground thawing and drainage;
- Incorporate field observation and performance monitoring during the initial stages of waste rock placement to ensure on-going stability and performance of the WRSA; and
- Provide adequate contingencies to deal with localized instabilities which may arise from areas of potentially thaw unstable foundation.

3.2.2.3 Design Basis

The following assumptions were made for the final design of the WRSA;

- A design capacity of 60 million tonnes placed at 2.0 t/m³;
- Annual waste rock production of approximately 7.5 million tonnes;
- Hauling and placing of mine waste rock occurs year round;
- Placement of waste material in maximum 25 meter lifts by end-dumping from the face of an advancing lift; and
- Material waste comprised of coarse, durable granodiorite and biotite gneiss rock types.

The following design parameters have been used for the design of the sediment control pond for the WRSA:

- Provide storage for the 1 in 10 year 24 hour storm event; and

- Provide a spillway that can safely pass the 1 in 200 year 24 hour storm event.

3.2.2.4 General Arrangement

The WRSA is located immediately north of the open pit on a gentle, north-east facing slope. The general arrangement for the WRSA and sediment control pond is shown on Drawing 1784.301. The WRSA covers an area of approximately 70 hectares and is designed to provide for permanent, secure storage and total confinement of the mine waste rock. This particular site was chosen to minimize the haul distances from the pit and also to minimize any potential effect on existing surface drainage courses. The design includes surface drainage ditches to drain the footprint of the waste dump. Surface runoff and seepage from the WRSA will be collected in perimeter collection ditches located at the toe of the facility and transported via the WRSA outlet channel to the sediment control pond.

For additional design information, the reader is referred to the “Report on Detailed Design of Waste Rock Storage Area” (see Appendix G1). Further details on the characteristics of the waste rock are presented in Section 3.6.3. The performance standards and design criteria for the WRSA are provided in Appendix C. Drawings 1784.301 and 1784.302 show the WRSA foundation preparation plan and the WRSA sections and details, respectively.

3.2.3 Heap Leach Operation

The heap leach facility has been designed for the valley heap leach method, which involves the preparation and placement of leach ore behind a confining embankment. Leaching of the ore is performed with subsequent lifts progressing up slope. Solution storage capacity is provided in an external solution pond designated the events pond, which is located down gradient from the heap leach pad. The valley heap leach method was selected for use in steep terrain and for severe climatic conditions. Drawing 1785.202 provides an overall rough grading plan for the heap leach facility.

Solutions from the leach pad will be collected by a network of solution pipes within the overliner and conveyed to the events pond and/or directed to the process plant via gravity flow solution pipes. The design includes an events pond with a high integrity engineered double composite liner system with a leak detection and recovery system (LDRS) located downstream of the heap leach pad.

The events pond is connected to the leach pad via gravity flow solution pipes and a double lined spillway. Diversion ditches collect and convey runoff around the facility to a sediment control pond.

The operation of loading the heap and leach solution handling described below includes: the raffinate distribution, PLS collection, interconnecting piping, the heap stacking sequence, solution management and the liner system preliminary design. The design and siting of the heap leach pad, retaining embankment and event ponds below the heap were undertaken by Knight & Piesold, and more recently by EBA. Refer to Appendix D for the document entitled “Carmacks Copper Mine Heap Leach Pad Liner Design” prepared by EBA for details on specific engineering components.

The “Report on Updated Detailed Design of the Heap Leach Pad and Events Pond” prepared by Knight Piésold Ltd. in 1997 (Appendix D1) provides current designs for the heap confining embankment and events pond along with an analyst and design of the spillways and diversions for the heap. A hydrogeological impact assessment is also provided within this report.

Also refer to Appendix D2 for Western Copper’s “Heap Leach Pad Loading Plan” (July 2006) which includes figures that show the heap leach facility staged construction plan and loading plans.

Revisions have been made to the heap leach facility water balance model presented in Design Memorandum CCL-CC4, and are presented in Memorandum CCL-CC7 “Water Balance Update” (Appendix D3) prepared by Clearwater Consultants Ltd. in February 2006.

Refer to the “Technical Design Memorandum, Carmacks Copper Project Solution Storage/Events Pond Sizing” prepared by Alexco Resources Corp. (January 2006) located in Appendix D5 for a discussion of the rationale for events pond sizing and solution storage.

Figure 3-7 shows the heap leach pad conveyor layout.

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Original drawing from Knight Piesold Limited,
"Waste Rock Storage Area Final Arrangement",
Drawing #1784.300

Waste Rock Storage
Area

Figure Number:

3-6

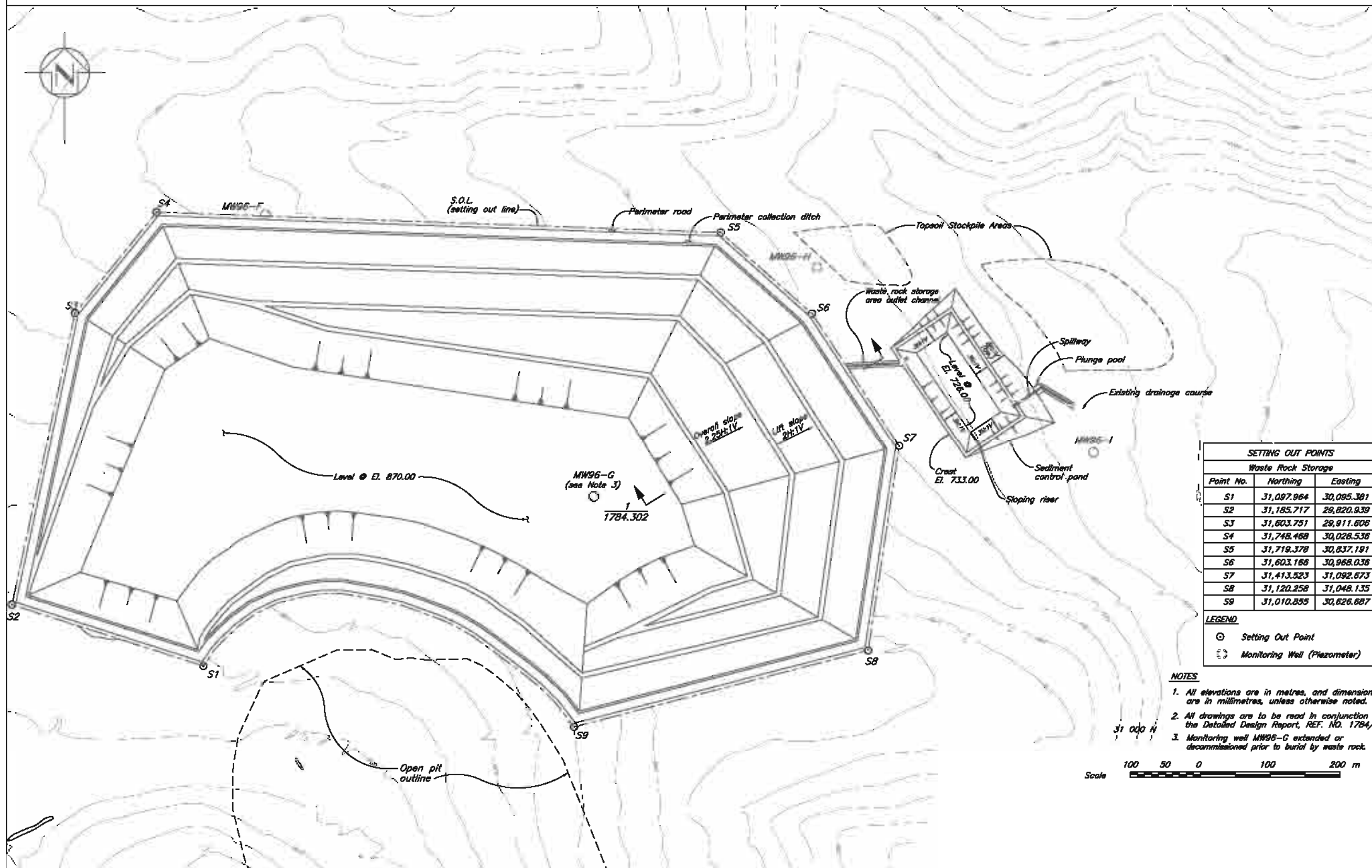


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Checked by: DDC

Date: April, 2005

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Project Description
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Carmacks Copper
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Original drawing from Kilbom,
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purpose and project for which this drawing is issued.
"Heap Leach Pad Conveyor Layout
Initial Phase Plan and Section - Year 2",
Drawing #700-10-03

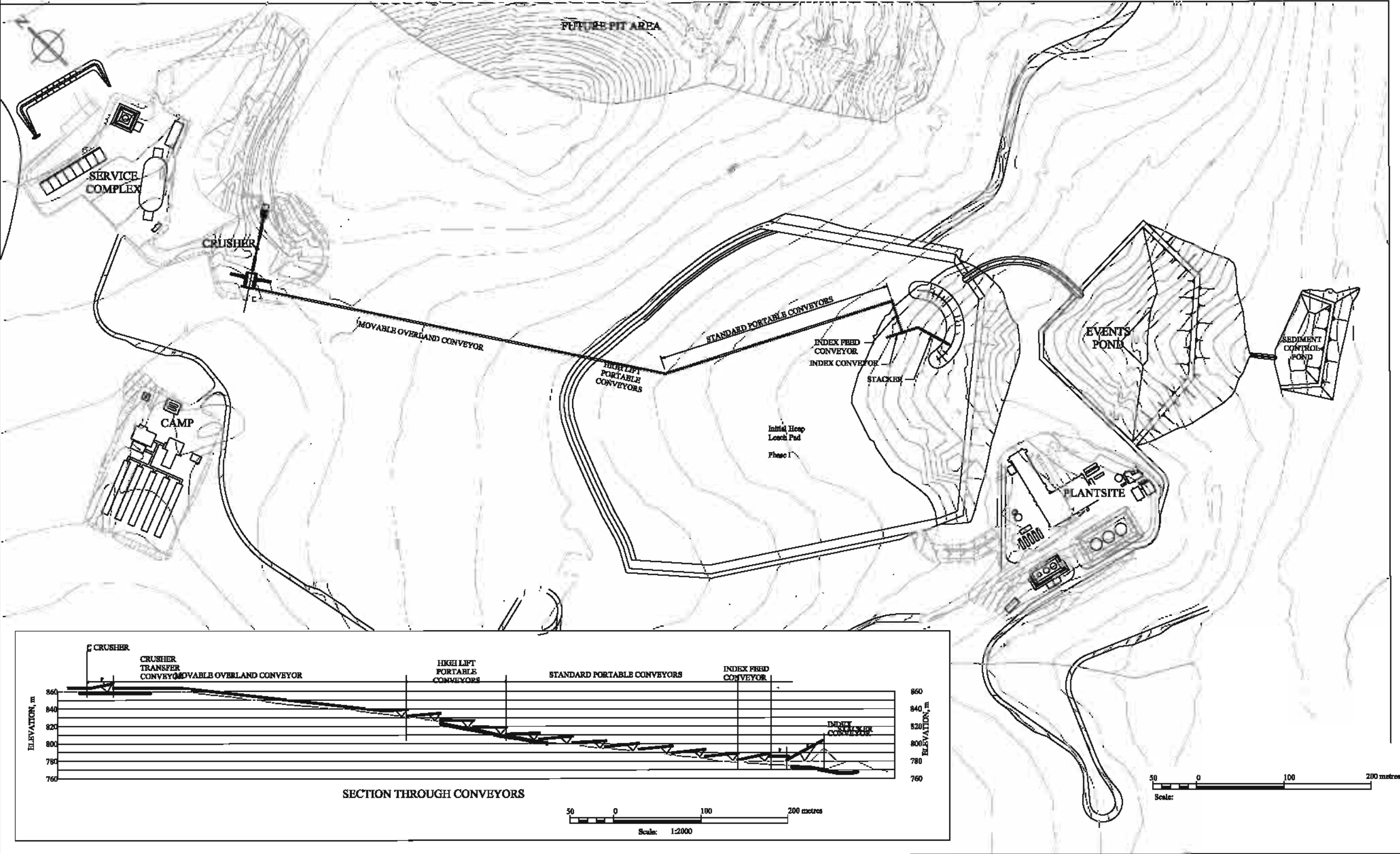
Heap Leach Pad
Conveyor Layout

Figure Number:
3-7



Revised by: HD Checked by: DDC

Date: April, 2005



3.2.3.1 Design Basis

The heap will be designed to store approximately 13.3 million tonnes of ore at a dry density of 1.6 tonnes/m³. The ore density may be higher in the later years of operation due to consolidation under load, possibly reducing the size of the final pad expansion. The leach pad could be expanded beyond this capacity to the west or the height could be increased. Ore will be placed for eight years at a maximum rate of 9,872 tonnes per day for up to 200 days per year. The 31.5 ha leach pad will be constructed in three stages ahead of ore placement. Ore will be placed in 8-m lifts at an overall slope of 2½h:1v using haul trucks. It is anticipated that two years of residual leaching, three years of heap rinsing and eventual decommissioning will follow the eight years of ore placement.

The raffinate will be applied through a system of drip emitters at a rate of 0.204 litres/min/m². The total raffinate flow to the heap will be 540 m³/hr for a design leaching cycle of 120 days. Solution will not be stored within the heap but will drain through perimeter piping and a low level outlet to the process plant or the events pond.

Please refer to Appendix D6 for EBA's March 20, 2006 "Response to Environmental Assessment Review Questions", which focuses on the geotechnical aspects of the previous design work on the heap leach pad foundation, liner, and confining embankment design.

3.2.3.2 General Arrangement

The ore will be placed on the valley-fill heap in 8 m lifts by haul trucks *or conveyors, or a combination thereof*, and leached in subsequent lifts, progressing up slope and atop previously leached lifts. Storage for excess solution and extreme precipitation events will be provided in an events pond located down gradient from the heap.

The proposed leach pad will be lined with a double composite liner system with LDRS. The pad will be surrounded by a 2-m high perimeter berm on the north and west sides and a perimeter bench on the east side. A confining embankment will form the lower limit of the leach pad to support the heap. With a crest elevation of 780 m, it will be about 22 m high and 350 m long.

There will be no in-heap solution storage behind this confining embankment. Solution from the heap will be collected by a network of corrugated polyethylene tubing (CPT) above the leach pad liner and conveyed by gravity flow to the process plant. There will be a double lined spillway over the heap confining embankment to the events pond to convey solution during extreme precipitation events. Diversion ditches will collect and convey runoff from upslope of the heap leach facility to a sediment control pond, thereby reducing the quantity of water reporting to the heap and minimizing PLS dilution.

3.2.3.3 Foundation Preparations

Pad Grading

Most of the organics and topsoil were stripped from the foundation area in 1997. *Since that time considerable revegetation has occurred which will be cleared and grubbed at*

the start of construction; any remaining windrows or piles will be removed and the area will be rough graded. Site preparation activities at this time will include:

- completion of a drilling investigation to delineate any potential unstable soil and assess suitability for soil liner material;
- removal or treatment of the unstable/unsuitable soils and controlled fill placement to subgrade elevation;
- in areas cut to subgrade elevation – scarification, moisture conditioning, and compaction of the subgrade level soils to depth of at least 300 mm;
- proof-roll of prepared subgrade; and
- construction of the liner.

As part of the pre-construction investigation, soil samples representative of the subgrade will be taken and tested for particle size, plasticity indices, and natural moisture content. There will also be enough control tests to relate the index properties and visual characteristics of the subgrade soils to the expected permeabilities. From the test results, the subgrade soils are to be classified as follows:

- Soil Liner Material - permeability of 10^{-8} m/s or lower. This material will satisfy the grading requirements for soil liner material, and will be suitable for compaction;
- Random fill – permeability greater than 10^{-8} m/s. These materials will be used selectively for site grading below the depth of any proposed soil liner or uses as appropriate in zoned earthfills based on grading requirements; and
- Waste Materials – waste materials will include organic rich materials, potentially unstable materials or any other materials deemed deleterious. These materials will be excavated and hauled to a designated waste stockpile.

All potentially thaw-unstable materials within 5 m of the ground surface that are identified during the delineation program will be excavated. Excavations deeper than 1 m below final subgrade will be filled to 1 m below final subgrade with acceptable rock fill, then filled with soil liner material. These materials will be placed and compacted as subgrade. Further details will be provided in a QC/QA Manual.

Areas where potentially thaw-unstable materials are deeper than 5 m will be assessed individually and specific treatments developed.

Foundation Drainage

A foundation drainage system will be installed beneath the leach pad to intercept and remove near-surface and seasonal groundwater flows and to reduce the possibility of uplift pressures beneath the liner. The foundation drains will be installed at least 1.5 m below the prepared subgrade surface and will comprise perforated CPT surrounded by select drain gravel and wrapped in geotextile. The select drain gravel will provide continued foundation drainage in the event of blockage or collapse of the CPT. The drains will be located in the natural drainage swales and extended to intercept any springs, seeps, or damp spots identified during pad grading and mapping. These drains will convey any intercepted groundwater seepage under the embankment to a foundation drainage collection sump located at the toe of the confining embankment. Flow into the sump will be tested periodically. If its quality is acceptable, it will be discharged below the events ponds; otherwise, it will be discharged into the events pond.

Once the foundation drains are installed they will be covered by compacted soil liner material and the double composite liner system. The upslope ends of the main collection pipes extend beyond the limits of the pad area through solid CPT pipe so they can be periodically flushed with dye-traced water to verify operation of the drain. The ends of the pipes will be capped to prevent animals from entering the pipe and to prevent icing. If blockage of the CPT is suspected an attempt will be made to pressure clean with water or mechanically clean the tubing. Given the redundant drainage provided by the surrounding drain gravel, no further attempt to recover the CPT installation will be made if cleaning is unsuccessful.

Perimeter Berm and Bench

The perimeter bench on the east side of the leach pad will be wide enough for the access road perimeter diversion ditch, perimeter piping and sumps, and the liner anchor trench. The perimeter berm on the north and west sides of the pad will incorporate the liner anchor trench and perimeter piping and sumps. The perimeter road and diversion ditch will be outside of this berm. The berm and bench will separate the surrounding diverted areas and the heaped ore. A channel, formed by the depression between the perimeter berm or bench and the sloping ore, will convey surface runoff from the heaped ore to the perimeter sumps. From there, it will be piped to the plant or events pond.

3.2.3.4 Liner System

General

The entire leach pad and the uphill face of the confining embankment will be lined with a double composite liner with an integral LDRS. Three separate designs are envisioned with protection for the environment appropriate to the potential for leakage in any given zone: these zones have designated as the upper works, lower works and trenches.

The upper works comprise the upper portion of the heap leach pad, at elevations greater than 830 m. In this zone, the base slope exceeds 7:1 with a consequence that PLS flow velocities are high and hydraulic heads are low.

The lower works comprise the lower portion of the heap leach pad adjacent to the confining embankment. In this zone, PLS velocities are low and the hydraulic head will approach 1.0 m. Therefore, there is a potential for higher leakage rates through the primary liner in this area.

The trenches are constructed in the LDRS to move PLS laterally. In the trenches, PLS velocities will be high but, because these are the collector system for the LDRS, the hydraulic head will also be high. There is therefore a higher potential for leakage of the primary liner in this area.

Subject to the results of product specific laboratory testing of the liner system, *which are typically done during detailed engineering design for the project prior to construction*, the components of the liner system for the upper and lower works will generally comprise the following:

Upper Works

The upper works liner system comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 60 mil textured HDPE lower liner; and
- Subgrade (with foundation drains).

Lower Works

The lower works liner system comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 60 mil textured HDPE lower liner;
- Compacted lower soil liner with a permeability not greater than 10^{-8} m/s; and
- Subgrade (with foundation drains).

Trenches

The trench design profile comprises (listed from the top down):

- High-permeability, durable overliner cushion layer with solution collection piping;
- 60 mil textured HDPE upper liner;
- 12 oz nonwoven polypropylene geotextile;
- Drainage layer comprising durable crushed ore or sand and gravel with permeability of at least 5×10^{-4} m/s and solution recovery piping;
- LDRS comprising a high transmissivity tri-planar geocomposite;
- 12 oz nonwoven polypropylene geotextile;
- 60 mil textured HDPE lower liner; and
- Subgrade.

The components of the various liner designs are further described as follows:

Subgrade

The subgrade will be suitable in-situ material that has been scarified and recompacted, or borrow material imported to backfill excavations of unsuitable material as described above. The design criteria for subgrade are:

- Random fill as defined in the technical specifications; and
- Maximum particle size equal to 75% of the approved layer thickness.

Soil Liner

Lower Works

Laboratory tests and correlations with index properties will confirm that the liner material meets the required permeability criterion of 10^{-8} m/s. These will be described in the QA/QC manual.

The soil liners will be compacted with a smooth drum vibratory roller in lifts of less than 150 mm, with careful inspection of the soil surface to ensure the removal of any stones larger than 10 mm under strict quality control. The liner installer will certify acceptance of the final surface as part of the QC and warranty process.

Upper Works

Beneath the upper works, subgrade preparation will require sufficient effort to remove any organic materials, provide a competent base and prevent rock fragments and gravel from puncturing the lower geomembrane liner. Product-specific laboratory testing under expected loads will dictate the maximum allowable particle size and final methods of subgrade preparation for the upper works.

Textured HDPE Liner

Both geomembrane liners will be 60 mil textured HDPE. Careful manufacturing quality control and construction quality assurance will confirm the specifications are achieved.

Leak Detection and Recovery System

An LDRS will be constructed using a high flow triplanar geocomposite. The geocomposite utilizes a tri-planar structure with rigid vertical ribs that significantly increase the tensile strength and compressive resistance of the geocomposite. These ribs are also supported by structural planar ribs that reduce intrusion into the high flow drainage core. The LDRS will be subdivided into cells of appropriate size to allow for solution management in each pad area.

Geotextile

A 12 oz, non-woven, needle punched geotextile will be used as a separation and filtration layer in the trenches ("French drain").

Overliner

A maximum 1.0 m thick layer of processed, durable crushed ore or sand and gravel will cover the upper HDPE liner to protect it from puncture under ore loading and to promote the effective under-drainage and collection of PLS from the ore. The design criteria for the overliner are as follows:

- Maximum particle size of 19 mm to prevent liner puncture, unless specific testing shows a larger size is acceptable;
- Durable, hard rock resistant to acid degradation; and
- Permeability of at least 5×10^{-4} m/s to enhance PLS recovery and to minimize hydraulic head on the upper liner.

Within the overliner, there will be a network of pipes to collect the solution within the overliner and transfer it to either the process plant or the events pond. This system of

solution recovery piping also will reduce the hydraulic head on the upper liner. As within the LDRS, the overliner will be subdivided into cells of appropriate size to allow solution management above the liner.

Leakage Criteria

Previous leakage criteria used in the Yukon were reviewed to develop the liner design. These criteria require an allowable leakage rate into the LDRS of 100 L/day averaged over a twelve-month period, with a maximum of 300 L/day averaged over a 3-month period. Initially, because of the lack of a defined area in the criteria, we used the leakage rate to define the largest detection “cell” that could be allowed in the design.

At the outset of EBA’s design, it was believed that the design criteria could be accommodated with a conventional double-lined geomembrane system, commonly used in hazardous waste impoundments in low precipitation situations. However, when we apply accepted design standards for the geomembrane as proposed by Giroud and Bonaparte (1989) and updated by Maxxon and Feeney (1993), the leakage into the LDRS required a large number of cells to be constructed to remain below the leakage criteria.

The permeability of the various layers used in the design is as follows:

- Overliner: $k > 5 \times 10^{-4}$ m/s;
- Textured HDPE liners: $k < 1 \times 10^{-10}$ m/s (permeability controlled by construction defects);
- LDRS: $k > 1 \times 10^{-4}$ m/s; and
- Soil liner: $k < 1 \times 10^{-8}$ m/s.

Liner Terminations

All HDPE liners will be terminated in anchor trenches. These trenches will be either permanent trenches along the perimeter berm, bench and embankment, or temporary trenches on the edges of pad extensions. The design criteria for the trenches are:

- to ensure water cannot enter drainage systems by seeping through the trench backfill; and
- to provide adequate anchoring resistance to withstand the pullout forces generated by gravity and thermal expansion and contraction of the HDPE geomembranes.

Frost Protection

To protect the soil portion of the leach pad liner from frost damage, the liner will be covered with at least 4.5 m of ore and overliner prior to winter. At least 1.5 m of ore will provide frost protection of the active drip emitter pipes, with exothermally-generated heat from the leaching process, solution heating, and snow insulation providing the remaining protection.

Geotechnical Instrumentation

Geotechnical instruments will be used to monitor and confirm design assumptions and performance of the solution collection system, perimeter berms and heap confining

embankments. They will include permanent surface movement monuments on the system embankment crest, and piezometers within the pad foundation, overliner and confining embankment. All piezometers will be monitored regularly but will not form a requirement for continued operation of the facility should they cease to function.

Leach Pad Settlement

Leach pad settlement could potentially result from several sources – thaw of ground ice in permafrost, and subsequent consolidation of thawed soils from overburden pressure; and elastic compression of coarser-grained soils, and consolidation of fine-grained soils due to vertical loads imposed by the heap.

The design criteria for the leach pad settlement are as follows:

- Differential settlements will not compromise the integrity of the liner system;
- Tensile strains of less than five percent in the synthetic and soil liner systems will be maintained;
- Positive drainage of foundation drains and LDRS and PLS collection pipes will be maintained by “overbuilding”. All drainage grades and locations will be determined with an allowance for settlements of the foundations; and
- Pipe joints will be capable of sustaining settlement-induced tensions without separation.

For additional design details on the liner system please refer to EBA’s “Heap Leach Pad Liner Design” report in Appendix D.

3.2.4 Events Pond

The “Report on Updated Detailed Design of the Heap Leach Pad and Events Pond” prepared by Knight Piésold Ltd. in 1997 (Appendix D1) provides current designs for the events pond.

Also refer to the “Technical Design Memorandum, Carmacks Copper Project Solution Storage/Events Pond Sizing” prepared by Alexco Resources Corp. (January 2006) located in Appendix D5, which provides a rationale for sizing of the events pond.

Normally, solution will flow directly from the heap to the plant. When there is a high-rainfall or high-precipitation event, or when the plant cannot accept solution, the flow can be directed from the heap to the events pond. The events pond will have a capacity of approximately 160,000 m³ to store the following combinations of events:

- The operating solution volume, plus
- Excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus,
- An allowance for heap draindown as follows:
 - During the first year of operation, 100% of the total potential heap draindown volume, or
 - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m³/hr this volume is 26 000 m³.

The total available solution storage volume of 160 000 m³ will provide storage for 100% of the total potential draindown volumes in the winter months. This volume is calculated to be 22,000 m³ more than the maximum required solution storage volume (Clearwater Consultants Ltd., 1998). At the start of the winter season and until the start of the snowmelt every year, the events pond will be empty thereby ensuring that the full solution storage capacity of the system is available during the winter and in advance of the annual snowmelt. Therefore, 100% of the total potential draindown volume may be stored in the winter at all times throughout the mine life for all precipitation conditions.

The events pond comprises: installation of a foundation drainage system independent of the leach pad system, a prepared basin surface, construction of an earthfill confining embankment, and lining of the basin facility with a double composite liner system with LDRS. The events pond area will be stripped of vegetation, down to mineral soil. The basin will be shaped, and the subgrade will be prepared to a smooth surface, free of protruding rocks, roots, etc. which could damage the liner. A zoned confining embankment will be constructed using similar materials defined for the leach pad confining embankment.

The engineered liner system for the embankment is comprised of two synthetic roughen HDPE 60 mil liners placed on a prepared soil liner and separated by a plastic geonet for an integral LDRS. The LDRS will recover leakage along the low point of the embankment toe from a collection pipe and ditch which will drain to a sump.

The removal of solutions from the LDRS is accomplished by a submersible pump at the bottom of the sump comprising a sloping riser pipe located between the two liners on the confining embankment. The pump will be activated by level switches to prevent the build-up of water in the LDRS. The flow from the pump will be continuously monitored.

Leakage rates through the inner and outer liners were estimated and presented in KP's "Report on Updated Detailed Design of Heap Leach Pad and Events Pond."

Under normal operational conditions the events pond will contain only 14,000 m³ (12 hrs) operational solution volume. During storm events, however, the pond will fill to some level above this (depending on the severity of the storm) and for the maximum storage level in the pond the maximum leakage rate would apply. In this case, the pumping rate of 235 m³ per hour would be implemented in order to remove the excess solution in the pond and minimize the leakage rate into the LDRS.

The embankment for the events pond has the same structural section and foundation conditions as the confining embankment for the leach pad. The requirements for foundation preparation with respect to the removal of ice rich permafrost will be the same. A drainage blanket will be constructed beneath the embankment to ensure that additional pore water from thawing is drained, and therefore increases in pore water pressure will be avoided.

Detailed engineering designs for the heap events pond is presented in the KP "Report on Updated Detailed Design of the Heap Leach Pad and Events Pond" (1997).

Revisions have been made to the heap leach facility water balance model presented in Design Memorandum CCL-CC4, and are presented in Memorandum CCL-CC7 Water Balance Update (Appendix D3) prepared by Clearwater Consultants Ltd. in February 2006.

The events pond is shown in plan on Drawing 1785.215 with typical sections and details on Drawing 1785.216 and 1785.217. Figure 3-6 presents an overall arrangement for the events pond plan.

3.2.5 Processing Facilities

Copper will be extracted from the ore using conventional acid heap leach technology followed by solvent extraction for concentration of the resulting copper sulphate solutions and electrowinning (SX/EW) for the recovery of product cathode copper metal. Drawing 400-10-06 shows the plan for the overall recovery arrangement and Drawing 400-03-04 shows details of the flotation and organic treatment system.

The projected operating schedule for ore from the mine, crushing plant and heap leach loading is 200 days per year. Solution processing facilities including solution flow to the heap, solvent extraction and electrowinning will operate year round.

Drawing 100-13-09 shows the layout plan for the processing plant site.

3.2.5.1 Crushing

The crushing plant will be a modular, trailer mounted unit consisting of open circuit primary jaw crushing followed by open circuit secondary gyratory crushing. The plant will be composed of six trailers with interconnecting conveyors. Ore haul trucks will normally discharge into a 140 tonne capacity dump hopper fitted with a sloped stationary grizzly with 600 mm openings. Surge capacity for variations in the mine production schedule will be provided by a coarse ore stockpile located prior to the crusher. The design capacity of the crushing plant will be 521 tonnes per hour resulting in a required operating availability of 80%.

Mined ore with an estimated maximum lump size of 600 mm will be delivered to the dump hopper or coarse ore stockpile by 91 tonne haul truck. Oversize will be caught on a 600 x 600 sloping stationary grizzly mounted on top of the hopper. Ore will be drawn from the hopper to the primary jaw crusher by a vibrating grizzly feeder with a slot opening of 152 mm. The vibrating grizzly oversize will be crushed to a nominal 150 mm in a 1,067 mm x 1,220 mm jaw crusher. The grizzly undersized material and the crusher product will be combined on the primary crushing product conveyor. The ore will then discharge into a radial stacker conveyor which can direct ore to the secondary crusher feed conveyor or to the crushed ore stockpile. The stockpiled material may be returned back to the crushing circuit by FEL and belt feeder. The secondary crusher feed conveyor will transfer primary crushed ore to the secondary 220 kW gyratory crusher, which will have a 38 mm closed side setting, operating in a closed circuit. The nominal 25 mm crushed product will be returned back to the secondary screen deck. The 100% passing 25 mm screen product sized material will feed onto the pad loading conveyors.

Project Description
& Environmental
Assessment Report

Carmacks Copper
Project
Yukon Territory



Note: Drawing is for
illustrative purposes only,
NOT FOR CONSTRUCTION

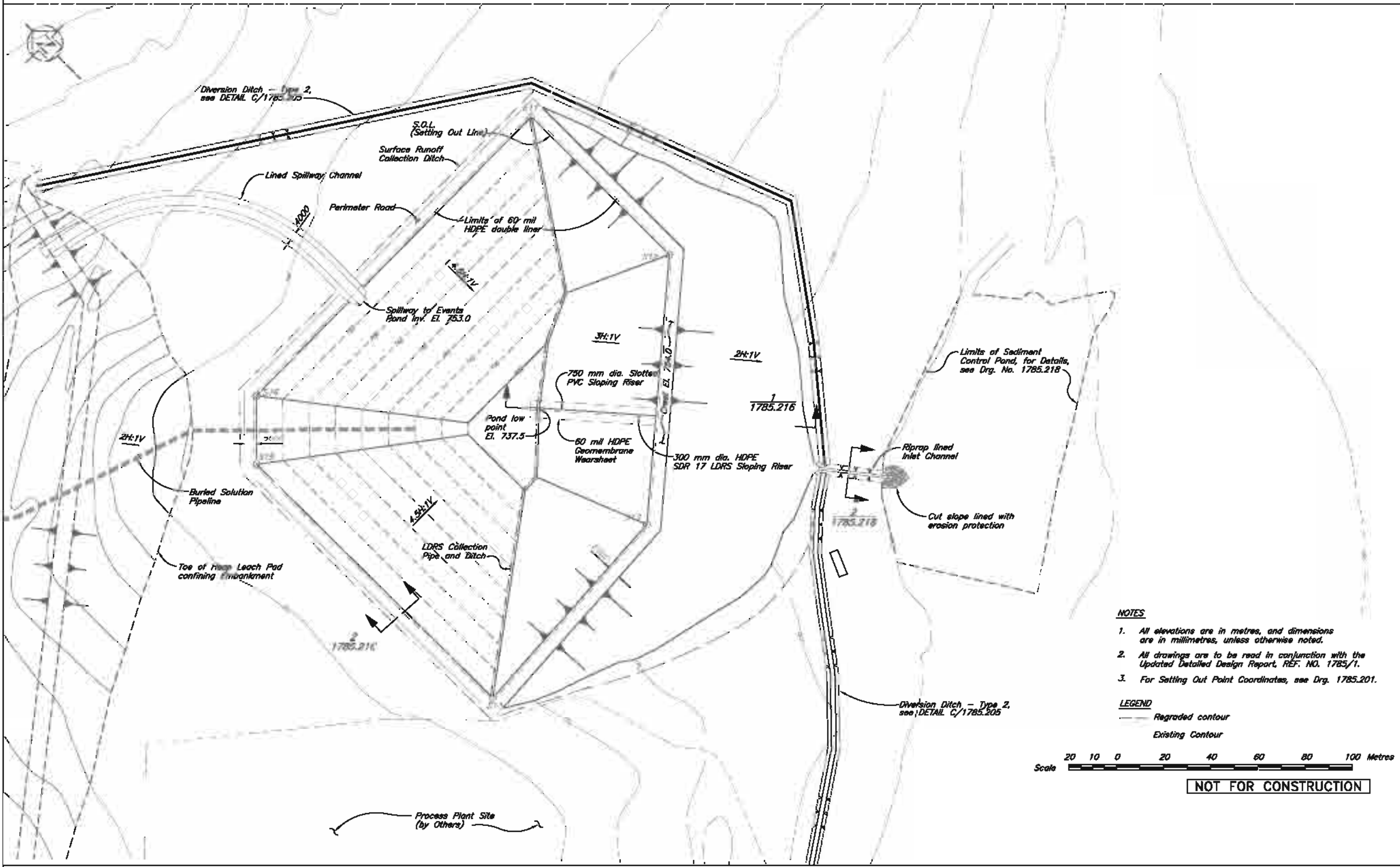
Original drawing from Knight Piesold Limited,
"Events Pond General Layout",
Drawing #1785.214

Events Pond

Figure Number:
3-8



Revised by: HD Checked by: DDC
Date: April, 2005



The pad loading conveyor system will begin with a 914 mm x 350 m long overland conveyor which will transport the ore down to the operating elevation of the heap. *Refer to Appendix D2 for Western Copper's Heap Leach Pad Loading Plan (July 2006) which includes figures that show the heap leach facility staged construction plan and loading plans.* The overland conveyor will be followed by a series of standard 914 mm x 38 m portable conveyors which will transport the ore to the section of the pad being loaded. An "index" feed conveyor will transfer the ore to the index conveyor which in turn will transfer the ore to the radial stacker. The pad will be loaded in an uphill direction by removing horizontal standard conveyors and allowing the stacker to retreat. Once a row in the heap is loaded, the stacker will be moved to a new position adjacent to the starting position of the first row and the portable standard conveyors are added. The stacker will again be retreated, forming a new cell for leaching. Pad design is discussed in greater detail in the subsequent sections. Crushing and conveying are directly linked without any surge capacity provided, other than the coarse ore stockpiles, prior to the primary and secondary crushers.

Drawing 200-03-01 presents a flowsheet of the crushing and screening process.

3.2.5.2 Agglomeration

The ore, crushed to a nominal 25 mm, will be agglomerated with 5 kg of concentrated sulphuric acid per tonne of ore. Agglomeration is expected to bind the fine material to the coarse particles, thus preventing them from compacting in the pore space of the heap which could result in a loss of percolation. Agglomeration will be effected by spraying a solution containing 350 g H₂SO₄/L directly onto the ore at conveyor transfer points and mixed as it is transferred between portable conveyor sections. For environmental protection the agglomeration step will take place on the overland conveyor section on lined pad areas only. Portable conveyor drop points will allow mixing of the acid and ore prior to placement on the pad. The acid and water will be premixed and added using a plastic pipe delivery system. Additional benefits of agglomeration result from the availability of free acid in the ore prior to solution addition. Heat is generated with the addition of solution to the heap due to the exothermic hydrolysis reaction, and reaction of the acid with the ore may improve the stability of the leach solution pH during the initial stages of leaching.

3.2.5.3 Heap Leaching

As determined by laboratory and pilot testing, the agglomerated ore will be leached by applying a weak sulphuric acid solution (raffinate from the solvent extraction circuit) to a section of the crushed ore for a period of time. Previous testwork has demonstrated that copper can be leached successfully from Carmacks materials by crushing to minus ¾ inch followed by heap leaching with a weak sulphuric acid solution. Such a process is practiced widely for the recovery of copper from oxide copper ores and the parameters required for the Carmacks deposit are consistent with general practices in the industry.

The leaching testwork, summarized in the "Leaching and Decommissioning of Carmacks Samples" prepared by Beattie Consulting Ltd. in 2001 (Appendix E), was initiated to evaluate the potential for leaching of the Carmacks deposit at Run-of-Mine size. A parallel test on a portion of the same sample crushed to minus ¾ inch was conducted to enable the results for this sample to be compared to those obtained previously with drill core composites. The most recently completed test program conducted by Beattie on samples from the Carmacks Copper oxide deposit has confirmed the following:

- The copper is readily leachable by means of crushing to minus ¾ inch followed by heap leaching. A copper extraction of just over 85% was achieved over a leach period of 187 days. Over the design leach time of 120 days the column achieved a copper extraction of 83%, corresponding to a commercial extraction of about 78%. For a multiple lift leach configuration it is recommended that the primary leach cycle be ended when about 70% copper extraction has been achieved in order to minimize acid consumption. For the current sample the primary leach cycle would be about 60 days;
- The predicted acid consumption for Carmacks is 22 kg/tonne. It is recommended that 20 kg/tonne be added to the cure stage with the balance being added to solution for control of feed pH; and
- Leaching of the Carmacks material at Run of Mine size results in a significant loss in copper extraction of about 20% unless very long leach times, in excess of 1,000 days are used. The test was conducted with a top size of 10 inches and some additional loss in copper extraction can be expected with the presence of even coarser material. The present test operated for 360 days and has not demonstrated the ultimate copper extraction achievable at a Run of Mine size.

The design primary leaching cycle for the Carmacks Copper ore is 120 days. The ore will be leached through a minimum of two cycles. The initial period when solution is applied directly to it and during the period when the lift above it is leached, resulting in a minimum total leaching period of 240 days. The area under active leaching and thus total solution flow is determined by the ore production rate, the leaching cycle and the nominal solution flow rate per unit surface area of the heap. Solution application will continue 365 days per year so a 120 day cycle will result in 580,000 tonnes under active leaching. The lift height will be 8 m. The resulting area under leach will be 47,374 m². The solution application rate will be 0.204 l/min.m² giving the total leach solution flow rate of 512 m³/h. The pregnant solution (PLS) exiting the heap will be collected in three perforated leach collection sumps within the heap and flow by gravity to the SX plant. Approximately 55% of the PLS will be recycled to the raffinate stream and returned to the heap before solvent extraction. The resulting steady state PLS grade is predicted to be approximately 7.98 g/L copper.

Distribution piping on the heap will be placed as new crushed ore becomes available. It is not intended that a full cell become available before initiation of leaching. By leaching smaller increments of ore in succession, the variation in PLS grade will be minimized.

Solution application in the summer months will be accomplished using drip emitters placed on the surface of the heap. During the winter months, the drip emitters will be used exclusively and buried approximately 0.5 – 1.0 m beneath the pad surface to prevent freezing. Snow cover, estimated to be 75 cm thick, will provide insulation of the heap surface and protection from the wind chill effects.

Pilot heap testing in Carmacks during the winter of 1993-1994 provided data for thermal modeling performed by Brown & Root, Braun. The modeling indicated that freezing will not occur if solution flow rates are maintained above a minimum, emitters lines are buried, and a snow cover is maintained. The project includes the use of heat exchangers, utilizing hot water from recovery boilers on the diesel generators and acid plant, for solution heater during the freezing months as a precaution to ensure solution temperatures will not drop below 10°C. The heating of raffinate solutions may also be

utilized to raise the core temperature of the heap prior to freezing conditions; however, based on operating experience at the Brewery Creek mine, these measures may not be necessary.

Drawing 700-03-02 depicts a flowsheet of the leaching process.

3.2.5.4 Solvent Extraction

Refer to Western Copper's document entitled "The Conceptual LEACH/SE-EW Process" (June 2006), which provides an overview of the chemical aspects of the process proposed for the Carmacks Copper project. The document is presented in Appendix E1.

Further information on the fate of lead at the anode of the electrowinning circuit is provided in a memorandum prepared by Green World Science in August 2006 (Appendix E2).

PLS will be channelled from the heap leach overliner layer containing the network of perforated solution collection piping directly to the PLS sumps and then flow by gravity to the solvent extraction plant at a rate of approximately 512 m³/h. Fifty-five percent of the total PLS flow will bypass the solvent extraction circuit and report to the raffinate pond. Water and makeup acid will be added to the raffinate pond. The raffinate will then be pumped to the heap at the full rate of approximately 540 m³/h. The remaining 232 m³/h of PLS solution will report to the solvent extraction circuit.

The solvent extraction circuit consists of a single train of extraction and stripping mixer settlers. The extraction circuit consists of two mixer settlers in series and the stripping circuit consists of two stripping mixer settlers in series. The design capacity of the solvent extraction circuit is 270 m³/h providing flexibility in solution application rates to the heap. The design solution flow rate equates to the quantity of solution required to provide a leaching cycle of 120 days assuming similar design criteria as presented. In addition, the option exists for operating the circuit in a series parallel configuration providing additional though less efficient capacity.

The extraction and stripping mixer settlers are the same size and are a conventional design configuration. The mixers are two stage and consist of two 2.6 m diameter by 3.1 m tanks in series. The first stage provides the mixing, contacting the aqueous with the organic, and the second stage provides pumping as well as mixing to deliver the head required to move the solutions through the mixer settler circuit. The settler consists of a wide launder that is mounted above the main settler providing initial phase separation and transport of the organic/aqueous mixture to the feed end of the settler which consists of a 27 m long by 5.6 m wide by 1.0 m tall rectangular vessel. The settler provides low flow velocities and sufficient retention time to allow disengagement of the organic phase from the aqueous phase and hence separation of the two streams by the underflow and overflow weirs at the end of the settler.

PLS solution entering the solvent extraction circuit will initially be contacted with organic in the E-1 mixer where the copper in the PLS will be transferred to the organic. The organic is composed of a liquid ion exchange reagent (extract) dissolved in a kerosene base diluent. The organic/aqueous mixture will then pass over the launder and into the settler for phase disengagement as previously described. Aqueous solution will then discharge from the settler through the underflow weir and flow to the E-2 mixer settler where it will again be contacted with organic to reduce the copper concentration further.

The organic will discharge the settler by passing over the overflow weir and reports to the loaded organic tank. The aqueous solution discharging the E-2 mixer settler will then pass through an entrainment separator for the coalescing and removal of trace amounts of organic before flowing to the raffinate pond. The raffinate will be pumped from the raffinate sump to the heap leach pad becoming new leach solution. Makeup water, acid, and, if required, heat will be added to the raffinate solution in the raffinate sump. Overall extraction efficiency for the solvent extraction circuit is approximately 90%.

Organic transfers the copper from the PLS or leach solution to the electrolyte. The electrolyte is a strong acid solution containing approximately 45 g/L copper from which the copper is recovered as cathode metal by electrowinning.

Stripped organic will flow to the E-2 extraction mixer settler contacting the solution containing the lowest copper concentration. This will provide the greatest driving force for transfer. Organic will then flow to the E-1 mixer settler and on to the loaded organic tank. From here organic will be pumped to the S-1 stripping mixer settler in which the strong acid of the electrolyte will strip the copper from organic, exchanging it for acid. Organic will then progress through the second stage, or S-2 mixer settler, and on to the E-2 extraction mixer settler, to complete the circuit.

The overall process results in the transfer of copper from the PLS or aqueous solution to the electrolyte and the transfer of an equivalent amount of acid from the electrolyte to the raffinate.

Crud is composed of inorganic solids or precipitate that becomes saturated with organic and tends to collect at the organic/aqueous interface in the settler. The crud will be removed by suction through a series of header pipes located at various levels within the settler. Some systems utilize pipes on density floats that aid in finding the interface and allow for efficient removal of crud. Crud build-up will result in loss of organic by entrainment.

Crud will be pumped from the settler using a portable air actuated self-priming diaphragm pump to a crud storage tank. The crud will be pumped to a conical bottomed crud treatment tank where it will be mixed with a relatively large quantity of clean organic from the organic storage tank. The mixture will be agitated to release the crud and aqueous from the organic which settles to the bottom of the tank. The clean organic will be decanted from the top of the tank. The settled crud and aqueous will be pumped from the underflow cone to a plate and frame filter press to separate the remaining aqueous from the crud. The filtered aqueous will be returned to the E-1 mixer settler and the solid crud will be disposed of on the heap.

Drawing 400-10-07 shows the solvent extraction general arrangement plan; Drawing 400-10-09 shows the solvent extraction general arrangement sections; and Drawing 400-03-03 provides a flowsheet for the solvent extraction & stripping process.

3.2.5.5 Electrowinning

Refer to Western Copper's document entitled "The Conceptual LEACH/SE-EW Process" (June 2006), which provides an overview of the chemical aspects of the process proposed for the Carmacks Copper project. The document is presented in Appendix E1.

Further information on the fate of lead at the anode of the electrowinning circuit is provided in a memorandum prepared by Green World Science in August 2006 (Appendix E2).

Rich electrolyte will flow by gravity from the S-1 stripping mixer settler to a column flotation cell for the primary recovery of entrained organic. Air will be sparged into the column floating the entrained organic droplets to the surface to form a froth. The froth will be skimmed and will flow by gravity to the crud treatment tank for recovery. The electrolyte will flow to a high filter feed tank. The electrolyte will then be pumped through two mixed media pressure filters in parallel for recovery of any remaining entrained organic. The organic recovered from backwashing the filters will report to the crud storage tank for treatment.

The filtered electrolyte will then flow through two plate and frame heat exchangers increasing the temperature to the operating level of 45°C. The first exchanger will recover heat from the lean electrolyte as it is pumped from the electrolyte circulation tank to the stripping circuit. Heat for the second, trim heat exchanger will be supplied by a diesel fired hot water heater or boiler. The hot water will be circulated in a closed loop providing final temperature control for electrolyte feeding the electrowinning circuit.

The heated electrolyte will be collected in a divided electrolyte circulation tank and circulated through the electrolyte distribution headers to the electrowinning cells for copper recovery. The lean electrolyte discharging the cells will flow by gravity through the combined electrolyte return launder to the lean electrolyte side of the electrolyte circulation tank where it will mix with rich electrolyte prior to recirculation. Mixing of the two solutions reduces fluctuations in solution concentrations. The copper concentration of the rich electrolyte feeding the cells will be approximately 38 g/L and is reduced to approximately 35 g/L through electrowinning.

The electrowinning cells will be "Dremco" type cells employing stainless steel permanent cathodes. The cathodes will be equipped with plastic edge strips to prevent growth of copper around the edges. Cathode stripping will be accomplished in a semi-manual washing and stripping apparatus. The cathodes will be removed from the cells using a bale connected to the overhead bridge crane and placed in a stainless steel wash tank. The cathodes will be moved to a stripping rack where they will be flexed to allow the copper sheet to break away from the cathode. The copper cathodes will then drop to a roller conveyor and stacked on a pallet for weighing and banding for shipment.

There will be a total of 44 electrowinning cells in the tank house, arranged in two parallel rows of 22 cells. The transformer-rectifier will be located outdoors adjacent to the electrowinning building. The rectifier will be connected by bus bars to the nearest cell on each row. The direct current flows up one row and back down the other.

Sulphuric acid and oxygen will be released during the EW reaction. The regeneration of sulphuric acid is significant and is accounted for in the overall acid requirement calculations. It will be necessary to bleed solution from the EW circuit to the extraction circuit in order to control impurity build-up. This bleed will be made up with cathode wash solution.

The oxygen bubbles formed at the cathode carry sulphuric acid into the air above the cells resulting in the formation of an acid mist in the tank house.

Oxygen produced at the anodes will be scrubbed by a layer of polypropylene balls, and then retained in the cells by the presence of anode gaskets. The extraction system will draw the partially cleaned gas through a duct system to the scrubber where the remaining acid mist will be removed so that only clean oxygen will leave the plant. The recovered acid will be returned to the plant.

The water balance has been established so that fresh water will enter the scrubber where it will clean the gas and pick up the sulphuric acid. This water will be pumped to the cathode wash tank, and then will overflow into the spent collection header for return to the tank farm. The volume of water is intended to match the makeup requirement established by an electrolyte bleed. The latter will be set to control iron transfer in solvent extraction.

The addition of cobalt sulphate to the electrolyte has been shown to decrease the decomposition of the lead anodes. This not only reduces the anode replacement cost, but also reduces the amount of lead particulate, which contaminates the cathode copper. A gaur solution will be added to the electrolyte to improve cathode quality. Both of these reagents will be added by metering pumps, fed from agitated tanks.

Drawing 400-10-11 shows the electrowinning building plan; Drawing 400-03-05 provides a flowsheet for the electrowinning process.

3.2.5.6 Sulphuric Acid Plant

Sulphuric acid will be produced by burning elemental sulphur in a sulphur burner and converting the sulphur dioxide into sulphuric acid. Molten elemental sulphur will be purchased from Fort Nelson and trucked directly into the acid plant. Approximately one 40 tonne truckload per day will be required to produce 120 tonnes of sulphuric acid. Sulphur will be stored molten at the minesite in a heated storage. Molten sulphur will be pumped into a sulphur burner where it reacts with air to form sulphur dioxide.

Steam will be produced from the process, however during a plant start up, a small start up boiler will be required to operate until the process produces enough heat to operate on its own.

Air required to burn the sulphur, as well as in other parts of the process, will be dried in a drying tower. Dry air will be required to prevent humidity in the air forming sulphuric acid early in the process thus, causing corrosion. The gases from the burner are cooled and blown into a converter. In the converter, selected catalysts are used to convert sulphur dioxide to sulphur trioxide with air. Gases are introduced into the catalysts in four stages. The converting process is exothermic producing heat and therefore, between stages, the gases are cooled. The waste heat is used to produce steam, which in turn is used to run the blowers and pumps. Under steady state conditions only 120 kW external power is required to operate the plant.

After the converter, the gases are cooled and introduced into absorption towers. There, sulphur trioxide is absorbed into water thus forming sulphur acid. The absorption will be accomplished in two stages. Two stage absorption produces maximum efficiency and ensures that no toxic air emissions are released. The acid will be produced at 93.5% strength. At this strength the freezing point of the acid is low and can be stored in an unheated tank. Water vapor from absorption is discharged to the atmosphere through a stack.

Boiler quality water is produced in the ion exchange units, which are located in the plant. For every tonne of acid, 1.3 tonnes of superheated steam is produced. To minimize water usage a maximum amount of water is circulated. Steam is condensed and fed back to the system. Cooling water is recycled. During winter heat from cooling water and steam will be recovered and used to heat buildings and process solutions.

Drawing 400-10-16 shows the sulphuric acid plant site layout; Drawing 400-03-13 shows the sulphuric acid plant stream distribution diagram; and Drawing 400-03-12 provides a flowsheet of the sulphuric acid plant.

3.2.5.7 Reagents and Materials

Table 3-1 lists reagents and materials that will be used for processing; Drawing 400-03-06 provides a flowsheet for reagents. Reagents and materials will be segregated and stored to ensure the integrity of product containers and their safety. Secondary containment measures are planned for particular products and emergency response and spill contingency plans will be in place to ensure worker health and safety and environmental protection. Reagents and materials storage and containment areas will be protected, signed, and monitored as part of the Environmental Management System (EMS).

Table 3-1 Reagents and Materials

Crushed Liners	
Material	Steel
Consumption (steel)	0.03 kg/tonne ore
Usage	45 tonnes/year
Distribution	Manual
Storage	Outside storage area on pallets
Sulphuric Acid	
Consumption	25 kg H ₂ SO ₄ /tonne ore
Usage	121 tonnes H ₂ SO ₄ / - 44100 tonnes H ₂ SO ₄ /year
Distribution	93% acid
Control	Metering pump
Storage	Bulk liquid storage – 2° containment
Guartec	
Form	Dry powder
Consumption	0.5 kg/t Cu
Usage	20.0 kg/day - 7,155 kg/year
Distribution	Concentrated solution
Control	Metering pump
Mix system	Agitated tank
Liquid storage	1,000 mm dia x 1,000 mm high tank
Dry storage	Bags on pallets in warehouse
Cobalt	
Form	Cobalt heptahydrate powder
Consumption	100 ppm Co in bleed stream
Usage	9,774 kg/year
Distribution	Concentrated solution
Control	Metering pump
Mix system	Agitated tank
Liquid storage	1,000 mm dia x 1,000 mm high tank
Dry storage	Bags on pallets in warehouse
Lime	
Storage	Powder stored in 75 tonne silo within lined containment dike adjacent to solvent extraction building.
Organic Solvent	
Consumption	25 mg/L
Storage	200 litre kegs in the warehouse
Extractant	
Form	Liquid
Consumption	0.014 kg/tonne ore
Usage	24,900 kg/year
Distribution	Dissolved in diluent
Extractant concentration	27.7%
Storage	Drums in outside, lined containment
Diluent (Kerosene)	
Form	Liquid
Consumption	0.040 kg/tonne ore
Usage	188.2 kg/day - 68,700 kg/year
Bulk Storage	4,500 mm dia x 5,000 mm high tank - 2° containment

Table 3-1 Reagents and Materials (Cont'd)

Cathodes/ Anodes	
Form	
cathodes	Stainless steel
anodes	Lead alloy
Usage	
cathodes	267/year
anodes	542/year
Storage	Pallets, outside
Diesel	
Vehicle fuelling facility fed from steel above	265 m ³ capacity, within a lined bermed enclosure sized to contain 100% of the capacity of the tank, and 300 mm of freeboard
ground vertical tank	
Generator diesel fuel storage facility	Two 265 m ³ tanks similar in design to the above
Gasoline	
Gasoline fuel tank	38 m ³ capacity - 2° containment
Propane	
Propane tanks	Tanks located outside buildings as required for heating. Tank locations protected
Maintenance Shop Lubrication Oils and Solvents	
Bulk storage	Tanks located outside the pit shop in a concrete bermed Area; smaller day tanks located inside the pit shop
Warehouse Storage of Solvents and Degreaser Materials	
Storage	Solvents and degreasers delivered in small containers will be stored inside cold storage warehouses

3.2.5.8 Process Controls and Instrumentation

The central control room for the project will be located in the electrowinning building. Drawing 400-10-11 shows the electrowinning building plan.

The SX/EW process plant will have a Programmable Logic Controller (PLC) looking after all of the analog and discrete controls in the plant. There will be a Man/Machine Interface (MMI) in the form of two (2) computers with monitors located in the central control room. The PLC controller and I/O will reside in system/marshalling cabinets located in the control room. The remote I/O will be in NEMA 4 enclosures and will be controlled by the SX/EW PLC.

The operator will be able to monitor and control every piece of equipment in the process including the water distribution system at the crusher, and remote water supply wells. The operator will be able to only monitor the crusher/conveyor system and acid plant, as they will be supplied as a package with their own complete control system. One remote I/O will be pole mounted by the well pumps, a second will be in the water booster pumphouse and the third will be in the crusher/camp site water distribution pumphouse.

The crusher/conveyor equipment will be supplied as a complete package, with an integral control system. The control system will be a PLC complete with MMI. It will be interfaced with the SX/EW PLC via a data highway. The MMI will be able to monitor and control the crusher/conveyor equipment only. The owner PLC controller in the water distribution pumphouse will serve as a system/marshalling cabinet.

Similarly the sulphuric acid plant equipment will also be supplied as a complete package, including an integral control system. The control system will be a PLC (Allen Bradley) complete with MMI and interfaced with the SX/EW PLC via a data highway. The MMI will allow for the operator to only monitor the sulphuric acid plant equipment.

The data highway for the crusher and acid plant control systems will be a 6-core 200 micron fiber optic cable. The fiber optic cable will be underslung on the overhead power line to the crusher site from the process plant control room.

3.2.5.9 Equipment

The mining equipment required will be purchased and the core mining fleet will be owned by Western Copper. Short term additions of haul trucks to the fleet will be leased.

In addition to the major drilling, dozing, loading and haulage units, a fleet of support equipment will be required. This fleet is based on the requirements at similar open pit mines with adjustments made according to throughput, length of haul roads and size of equipment.

The main criteria by which equipment was selected for the pit were cost, productivity, reliability and maneuverability. Acquiring and maintaining durable equipment capable of working under difficult conditions will be essential.

All equipment selected is diesel powered since both operating and capital cost of generating electric power is high. Table 3-2 details the initial and ongoing equipment requirements.

Table 3-2 Initial and Ongoing Equipment Requirements

		Initial	Ongoing Annual Requirements							
YEAR		-1	1	2	3	4	5	6	7	8
Equipment										
Hydraulic Front Shovel - 10.5 m ³ , 563 kW	no.	1	1	1	1	1	1	1	1	1
Front End Wheel Loader - 10.7 m ³ , 530 kW	no.	0	1	1	1	1	1	1	1	1
Off Road Haultruck - 91t, 699 kW	no.	2	3	4	5	7	7	7	6	2
Motor Grader - 205 kW, 27.2 t, 4.9 m blade	no.	1	1	1	1	1	1	1	1	1
Track Dozer - 425 kW, 65.8 t, w/ Ripper	no.	0	1	1	1	1	1	1	1	1
Track Dozer - 302 kW, 47.9 t, w/Ripper	no.	1	1	1	1	1	1	1	1	1
Excavator - 165kW, 33.7 t, 2 cu m	no.	1	1	1	1	1	1	1	1	1
Wheel Dozer - 235 kW, 5.8 t, 4.5 m blade	no.	1	1	1	1	1	1	1	1	1
Airtrack Drill, 64 mm	no.	1	1	1	1	1	1	1	1	1
Rotary Blasthole Drill, 200mm, 39 t	no.	1	1	2	2	2	2	2	1	1
Water Truck - 90,000 litre, 699 kW	no.	1	1	1	1	1	1	1	1	1
Mine Services Dump Truck, 10.7 cu m	no.	1	1	1	1	1	1	1	1	1
Sand Truck, 10.7 cu m	no.	1	1	1	1	1	1	1	1	1
Personnel Van, 12 man	no.	1	1	1	1	1	1	1	1	1
Blasthole Stemmer, 59 kW, 9.7 t	no.	1	1	1	1	1	1	1	1	1
Offroad Tire Manipulator, 67 kW, 7.9 t	no.	1	1	1	1	1	1	1	1	1
Fuel and Lube Service Truck, 2000 l, 15 t	no.	1	1	1	1	1	1	1	1	1
Mechanical Field Service Truck, 15 t, 5 t crane	no.	1	1	1	1	1	1	1	1	1
Field Welding Truck, 15 t	no.	1	1	1	1	1	1	1	1	1
Service / Utility Flatbed Truck, 15 t, 5 t crane	no.	1	1	1	1	1	1	1	1	1
Pickup Truck, 3/4 ton, 4*4	no.	5	6	6	6	6	6	6	6	6
Blaster's Truck, 1 ton	no.	1	1	1	1	1	1	1	1	1
Dewatering Pumps	no.	2	2	2	2	2	2	2	2	2
Light Stands/Generators, 4 kW	no.	4	4	4	4	4	4	4	4	4

Table 4.6.7-1 in Western Copper Holdings Ltd., Carmacks Copper Project , 1997 Basic Engineering Report by Kilborn

3.2.5.10 Process Buildings

Major process equipment for the project will be located in the SX and EW buildings. Drawing 400-10-11 shows the electrowinning building plan.

The building layout allows for gravity flow from the mixer settlers to tankage located below and between the SX and the EW equipment. This will require solutions to be pumped into the EW cells and return by gravity to the tankhouse. In the SX plant, the elevation of the top of the conventional settlers and mixers will be similar. This has been achieved by locating the mixers on a lower slab foundation adjacent to the settlers.

The EW plant will be constructed with acid-resistant concrete slabs and foundations. The area between foundations will be lined with a geomembrane (HDPE) liner to contain spills. All internal grades will slope to a transverse concrete trench that drains to a sump located in the cathode stripping area. The polymer concrete electrowinning cells will be supported on cast-in-place pier foundations in two rows down the length of the building. The cells will be arranged in two lines and will support the central walkway, power supply cabling, feed and discharge piping. The rectifier will be located at the end of the two lines of cells to minimize the length of the bus bars. The two lines of electrowinning cells and cathode stripping areas will be serviced by an overhead gantry crane running on rails supported by the building columns.

The buildings will be pre-engineered steel structures complete with insulated metal cladding. Building foundations will be concrete spread footings founded below the depth of frost penetration. The exterior of structures not founded on rock will have perimeter rigid insulation to minimize heat loss through concrete foundations and slabs. Space heating for the buildings will be hot water radiant or electric unit heaters. Ventilation equipment will be corrosion resistant and sized to ensure that the required air charges provide a safe environment for operating personnel. The control and electrical equipment areas for the SX/EW buildings will be isolated from the process areas.

The raffinate tank will be HDPE lined concrete, placed below building grade. It will serve as the low point drain and spill containment sump for all process equipment. There will be a high level overflow out of the raffinate tank to permit temporary upsets to discharge into the adjacent double lined events pond.

3.2.6 Haul Roads

Haul roads within and around the open pit, WRSA and heap leach facility will have an overall width of approximately 26 m, including an allowance for ditches and safety berms. The maximum grade will be approximately 10 percent on all main roads and approximately 12 percent on bench access roads. See Appendix A, Drawings 100-13-05 and 100-13-06 for typical road sections and details.

There are no streams that are crossed by any of the planned haul roads; however, all haul roads will be protected from erosion and washout through the use of culverts. Road culverts will be placed to convey runoff and prevent road washout as appropriate. In general, culverts will be sized to convey peak flows from a 25-year return period event without water surcharge above the culvert crown. Extreme peak flows with return periods of up to 100 years may be considered for critical road sections. Small stilling

basins will be excavated at the intake of all culverts to prevent sedimentation and blocking within the culverts and to improve water quality.

Other than the North Williams Creek crossing, haul roads will not intersect with any streams.

3.2.7 Ancillary Facilities and Services

3.2.7.1 Site Layout

The project site will be split into two distinct areas based on the process requirements. The local topography of the area gently slopes east to Williams Creek, which drains to the Yukon River 8 km away. The surrounding area is uniformly tree covered with a maximum elevation above the open pit of 930 m and a minimum elevation of 670 m at Williams Creek.

The open pit mine will be located on a hillside on the southeast side of the property and will have a pit crest elevation of 860 m and bottom elevation of 645 m. The maintenance/service facilities, primary crusher and construction/operations camp will be located above the leach pad area on a saddle west of the open pit at elevation 850 to 880 m. The process plant, acid plant, laboratory, process office and gatehouse will be situated below the heap leach pad at elevation 766 m. The administrative offices will be located off-site at Carmacks. Drawing 400-03-07 illustrates the location of ancillary facilities.

The heap leach pad will be located to the north of the process plant and below the maintenance/service facilities in a local south facing valley which drains towards the process plant. The crushing plant, at elevation 860 m, and the beginning of the leach pad loading conveyors will be located on the west side of the small hill between the heap leach pad and the open pit.

Excerpts from the geotechnical investigations undertaken by Knight & Piesold over the project area generally indicate that:

- The near surface sand and gravel deposits will be suitable for concrete aggregates and borrow materials;
- Facilities should be located on well drained areas, surface and sub-surface, with foundations in ice-free rock or non-frost-susceptible soils due to the possible presence of permafrost;
- Numerous areas of poorly drained, frost susceptible soils and saturated active layers occur;
- Permafrost does not generally occur at higher elevations or on south facing slopes around the project site; and
- Where silty surficial soils are encountered under foundations they will be required to be removed to a depth of 2,500 mm and replaced with well-drained granular material around the foundations, this will minimize the chance of frost heave.

Knight Piesold's detailed geotechnical field investigations should be referred to for further details and information.

3.2.7.2 Access

Access to the project site area is by public highway with the last 33 km from Carmacks via the gravel, all-weather, government maintained, Freegold Road. Access to the mine property will be by a new 13 km road (Figure 2-2).

The responsibility for upgrading and maintaining the Freegold Road, which forms part of the Yukon highway system, belongs to the Yukon Government. *YG is responsible for ensuring the road surface is not damaged and that travelers can safely use the road. YG initiated a program to upgrade the route to 80 km/hr secondary road standards in 1991; only a portion of the road was completed. The remainder of the road is posted to a 40 km/hr speed limit. The Freegold Road is a public highway and minimum design standards for such roads allow significantly larger traffic volume than is anticipated by the Carmacks Copper project. As a result, no significant effects on the Freegold Road are expected that will not be mitigated through routine maintenance (performed by YG Highways and Public Works).*

Mine traffic will follow highway regulations and abide by any weight restrictions on roads (i.e. spring break-up) and bridges that may be imposed. To preserve road surfaces, axle weights may be reduced during the spring thaw period and the Company will abide by these restrictions. Western Copper will ensure contractors and suppliers are made aware of any load restrictions on the road. Truck loads will be managed accordingly.

If heavy loads exceed the legal weight allowed for the axle or axle group or the gross vehicle weight, the vehicle would be considered overweight and an application for overweight vehicle permits would be submitted to YG. YG will only issue a permit once satisfied that highway safety is maintained.

For both the construction and operation phases Western Copper will develop a formal Traffic Management Plan. The plan will describe the steps that the Company will take to ensure the safe and effective use of the Freegold Road and other traffic corridors. In addition to covering items discussed above, it will cover such issues as the means by which Western Copper will control the speed of vehicles used by mine employees and contractors, how loads will be consolidated to minimize the number of vehicles on the road and any special precautions for dealing with large loads."

The bridge over the Nordenskiöld River (1.5 km from Carmacks) and the bridge at Crossing Creek (25.5 km from Carmacks) will handle the required highway transport truck loadings but may benefit from improvements which can be accomplished under routine maintenance. YG HPW may undertake other road maintenance activities to improve highway safety as required.

Western Copper is responsible for *the construction and maintenance* of 13 km of road, from the turnoff at the Freegold road to the project site, including the bridge crossing at Merrice Creek (km 7) and the culvert crossing at Williams Creek (km 11.5). The mine access roadway will be operated as a private controlled access road and maintained by mine personnel.

With reference to site access from Freegold Road, it is proposed to complete construction of a new 13.3 km access road, just east of the property exploration

roadway, from the intersection of the Freegold Road to the process plant area. Clearing and grubbing of the route was completed in 1997. The road will be constructed to resource road standards with a minimum 5 m wide all weather gravel surface (widened at curves and sharp corners or with 8 m wide turnouts at 250 m intervals). The maximum grade for the road will be 8% and the design speed 60 km/h. The route selected for upgrading will follow the existing exploration road as much as possible and will only depart from the existing right of way to comply with grade or road curvature requirements. A p-line survey and field cross-sectioning has been completed and incorporated into the detailed engineering drawings. Additional field information will be required to determine availability of granular surfacing material, (borrow pits), which has been assumed to be available along the route.

Drawing 100-13-46 shows a detailed plan for the mine access road, and Drawings 00-13-05 and 100-13-06 show typical road sections and details.

Planned Road Maintenance

The project site access road will be operated as a private controlled access and be maintained by mine equipment.

Summer maintenance activities are directed at preventative maintenance, correcting deficiencies, and preparing for the coming winter. These include:

- repairs to “breakup” or other damage to road base;
- culvert headwall, flume, apron, and marker post maintenance;
- maintenance of riprap bank protection;
- ditch, culvert, and creek channel clearing;
- removal of dangerous trees;
- scaling of rock faces;
- maintenance of riparian vegetation;
- brush cutting;
- sign maintenance;
- kilometre post maintenance;
- routine surface grading;
- regravelling per annual schedule;
- dust control measures; and
- stockpiling sand, gravel, and riprap for winter use.

Winter maintenance activities are mostly related to controlling the effects of snow and ice. These would include:

- snow removal;
- sanding;
- water/ice control (clear ditches, thaw culverts);
- remove fallen trees, rocks, slides; and
- sign maintenance.

Defined snow deposition areas with sediment traps will be installed to minimize sediment deposition into tributary streams

Culvert Maintenance

Regular maintenance is required to keep culverts functioning properly and free of accumulated sediment and debris. Culverts will be marked in a highly visible fashion such that operators of road maintenance equipment will be able to easily note culvert locations.

In addition to regularly scheduled inspection and maintenance, special measures will be instituted before the rainy season, before freeze-up, and just after spring break-up periods. In sensitive areas, culvert crossings will be checked regularly during high runoff periods. Maintenance personnel will be trained to identify environmentally sensitive situations. Debris or material removed during cleanup operations will not be deposited into a stream or any place from which it may enter the watercourse.

The following culvert maintenance checklist is adapted from Bonsor, Holmes and Sharpe (1877, pp. 10-13):

Culvert Entrance:

- Dispose of floating debris which could be lifted by the headwater pool during a high flood;
- Clear debris barriers (trash racks);
- Remove material from upstream settling basins or channels which may reduce capacity of culverts;
- Backfill scour holes with clean gravel or larger rock;
- Ensure that stream channel leads directly to the culvert entrance;
- Repair or replace riprap alongside pipe to retain fills;
- Tamp in material to prevent flow entering the fill surrounding the pipe;
- Straighten metal entrance aprons;
- Repair aprons and headwalls; and
- Cut brush and clear away debris at entrance.

Culvert Outlet:

- Check for excessive scour;
- Check pipes and endwalls for undermining; replace and protect bedding;
- Replace riprap and ensure that it is large enough and extensive enough to protect the exit channel; and
- Check the downstream channel for blockages and scour.

Culvert Barrel:

- Check for erosion of corrugated metal pipe, and replace damaged paved invert or coating, as necessary;
- Check corrugated metal pipe for corrosion; and
- Check culvert for vertical and horizontal alignment, for distortion and for open joints and leaks.

Bridges and Maintenance

The access road crosses two watercourses, one at Merrice Creek (km 7) and the other at Williams Creek (km 11.5). The Merrice Creek Bridge will be sized to convey peak flows from a 100-year return period event. Riprap and other erosion protection measures for culverts and bridges will be designed for the same event as the culvert or bridge. The proposed clear span bridge abutments are not expected to encroach on the creek wetted perimeter. A culvert crossing is planned for the upper Williams Creek road crossing.

Bridge construction will follow guidelines to ensure that the watercourses are protected and will include the following provisions:

- Machines are not to be serviced adjacent to the river. Waste oil, filters and other such refuse is to be properly disposed of;
- Skidding logs on steep slopes is to be avoided. Lift rather than skid fallen trees from the river channel or hand cut;
- Sediment control facilities are to be provided where runoff from approaches and stockpiled material is likely to erode in to the river;
- Only clean blasted rock or granular fill is to be used in construction of the causeway approaches;
- Disturbance at borrow sites is to be minimized and sediment control is to be provided;
- End dumping fill material is to be avoided. Dozing over from the leading edge of the approaches will minimize disturbance to the river;
- 2 m clearance between underside of the bridge span and the normal high water level is to be provided;
- Areas subject to erosion are to be rip-rapped with 1 m angular rock to above the normal high water level;
- Adequate cables and communication devices are to be available should a rescue of a piece of equipment be required; and
- If necessary, filter cloth will be used to reduce sediment from entering the stream from the bridge deck.

Bridges require frequent inspection and regular minor repairs to increase operational life and safety to users, as well as to reduce possible environmental effects due to improper functioning or failure. The maintenance program will include:

- Regular bridge inspections conducted to determine any changes in the stream channel or deterioration of bridge structure. A full inspection is required annually (just after peak flow) and spot checks are necessary before and during any high flows. The inspection will include, but not be limited to:
 - checking for and repairing superstructure damage;
 - checking for and repairing sub-structure damage;
 - checking for and repairing approach fill damage;
 - checking for and repairing training works damage;
 - replacing or repairing curbs, deck, and delineators when needed;
 - checking bolt tightness; and
 - repainting.

- Depth recordings will be periodically taken around abutments to assess scour and deposition. If excessive scouring or stream bank erosion is found, immediate action will be taken including scour hole filling with clean, coarse gravel and protection with riprap. Stream banks and riprap will be stabilized as required;
- Any debris caught on abutments will be removed to prevent upstream flooding and to reduce stress on the crossing structure; and
- Roadside drainage and bridge deck drainage will be maintained to prevent erosion of approach ramps and sediment transport into the stream.

Other controls include development and implementation of road maintenance schedules.

The conceptual design for the Merrice Creek bridge will be submitted prior to bridge construction.

3.2.7.3 Power Supply and Distribution

The primary source of electrical power for the project will be a diesel generating plant. The average electrical demand at a 0.9% power factor will be 7,860 kW in summer and 6,610 kW in winter. The winter demand is lower because the crushing plant will not be operating. There will be five diesel generating units, each with a minimum continuous operation rating of 1,650 kW. The generators will be equipped with waste heat recovery boilers to generate hot water (cogeneration). The process and laboratory will be serviced by the cogeneration system with back-up hot water boilers for building space heating diesel fired units.

The generator sets will come complete with air filter, lube oil system, starter system, associated diesel engine and generator control system and heat recovery system. The generators have been sized to suit the estimated site maximum electrical demand and relevant environmental emission standards. An assumption of 190°F circulating water temperature was made for the determination of the thermal energy produced.

The units will be supplied in modular steel, weatherproof sound attenuated enclosures, insulated, and will be set on concrete slab foundations. The enclosure will be complete with fire protection, bridge crane, catwalks, lights and HVAC systems. The electrical switchgear/control equipment hot water storage and circulation system, fuel/lubrication systems will be integral with the engine modules or contained in separate insulated enclosures. The bulk diesel fuel and lubrication storage tanks will be located remote from the generators. The power plant will be located adjacent to the SX/EW building.

Distribution

Direct buried cable will be installed between the diesel generator plant and 4.16 kV switchgear housed in the EW building electrical room. The electrical room will also contain the 5 kV load break switches, 600 volt motor control centres, the programmable logic controllers (PLC) and the I/O system/marshalling cabinets.

A 4.16 kV feeder cable will be installed underground from the electrical room to the A and B overhead lines take-off pole. Overhead line A will supply power to the shops and warehouse/crusher areas, firewater pumps and mine. Line A will be constructed along

the roadway west of the leach pad area to an electrical assembly trailer located at the crusher plant. Line B will provide power to the following:

- events pond pumps;
- fresh/fire water distribution pumphouses;
- water wells;
- sediment pond;
- acid plant;
- gatehouse first aid trailer; and
- fuel storage.

3.2.7.4 Explosive Storage

Explosive materials that will be stored on-site prior to consumption include: detonators, primacord, boosters and connectors. These will be stored in prefabricated magazines that will be selected and located in compliance with local and federal regulations. Non-classified ammonia nitrate (AN) prills will be stored in a silo facility provided by the explosives supplier. The explosives supplier is responsible for obtaining any necessary authorizations.

3.2.7.5 Maintenance Shops and Warehouses

The mining maintenance shop together with the warehouse will be housed in a “Sprung” fabric covered, insulated aluminum structure to be located near the primary crusher. The shop will be equipped to handle routine maintenance and most repair work on mine, mobile and process equipment. The warehouse will act as the main distribution centre for spare parts and supplies. Storage space for reagents will be provided at the process plant. A compound adjoining the warehouse will provide additional laydown area.

The buildings will be insulated, and vestibules will be provided to protect main doors from the weather.

An exterior truck ready line, serviced by electric block heating connections, will be provided adjacent to the shop.

Maintenance Shop

The drive-through mine vehicle service area has been sized to accommodate 86 tonne capacity trucks. A welding bay, a truck wash bay and an instrumentation/electrical bay have also been provided. An area adjacent to the drive-through heavy truck repair area has been designated light truck repair shop.

A sloping concrete apron will extend 3 m in front of the major entrances to the shops, and bollards will be provided to protect the building.

The 10 m clear height will allow sufficient clearance to pass a haul truck with its box raised.

A concrete floor will be provided throughout the truck maintenance area. The floors will also be sloped towards a dry sump, which will collect any wash solutions and petroleum

products that result from the maintenance activities. Oil-absorbent products will also be used on the shop floors.

Any accumulated sump water will be separated and oils pumped to the waste oil tank or empty drums. All oily wastes from oil changes, including the sump separation products and absorbent, will be hauled off the site for disposal or recycling in accordance with applicable regulations (Transportation of Dangerous Goods Act, Yukon Environment Act, Special Waste Regulations).

The lubrication bay will have a vacuum evacuation system for waste oil. Hose reels will feed from the lubrication storage area and will dispense antifreeze, grease and various grades of oil to the lubrication bay. An air compressor and receiver will supply air for tools.

Strategically placed roof exhaust fans will ventilate the maintenance shops and repair bays. When necessary, these areas will be heated by propane fired unit heaters in conjunction with propeller type ceiling fans to prevent stratification.

Hose stations and hand held fire extinguishers will be provided for fire fighting purposes in the maintenance shops and repair bays.

Warehousing and Storage

The warehouse will serve as the main distribution centre for the mine and process facilities. It will have 390 m² of inside floor space and include the Company tool crib; 360 m² of yard area adjacent to the building will be available for outside storage. These facilities will be supplemented by reagent storage containers at the process plant, plus explosives storage magazines located near the pits. A separate fenced-in area for oxygen and acetylene gas bottles will also be provided.

The warehouse will be serviced with a forklift truck. Storage shelving and racks will be provided. The warehouse will occupy part of a "Sprung" fabric structure, in common with the truck repair shop.

The heating and ventilation system in the warehouse will be similar to that for the maintenance bays. A sprinkler system will be installed in the warehouse for fire protection.

3.2.7.6 Offices

Administration

The administration office will be a single story prefabricated trailer structure with a total area of 390 m², located in Carmacks. The trailer will contain offices allocated to management, accounting, purchasing, employee relations, safety and engineering staff. A reception area, conference/training room, washrooms, lunch area, utility room, print room, photocopying room, records vault and storage space will also be provided.

The office will have air conditioning and electric heating. Chemical extinguishers will be used for fire protection.

Process

The process offices will be contained in a prefabricated trailer located directly adjacent to the SX building and laboratory trailer. The trailer will have a total floor area of 120 m² and contain offices for process supervisory and metallurgical staff, washrooms and lunch room space will be provided. The office will have independent HVAC and fire detection systems.

3.2.7.7 Laboratory

The metallurgical laboratories will be located next to the SX/EW facilities in a single story, prefabricated trailer with a floor area of 71 m². It will be equipped to perform daily analyses of pit and process samples, screen analyses and environmental analyses of solids and liquids. Sample preparation and column leach test equipment will also be provided in the laboratories.

Any environmental testing which cannot be handled in this facility will be sent off-site to a specialized laboratory.

The laboratory floor plan presented will allow a logical path for the samples to follow from receiving, preparation and analysis. Separate areas and rooms will be allocated to:

- receiving and logging;
- bulk sample preparation;
- drying;
- crushing room;
- splitting;
- pulverizing;
- sample weighing;
- flux mixing and storage room;
- furnace room;
- balance room;
- wet laboratory;
- reagent and supplies storage room;
- metallurgical laboratory; and
- sample storage area.

Bulk samples will be delivered to the laboratory receiving area for identification prior to testing. After testing is complete, the samples will be stored briefly within the sample preparation area and then relocated to a cold sample storage shed.

There will be offices for the plant metallurgist and chemist, plus a mechanical room.

To provide isolation between the SX/EW plant and laboratories access from the laboratory to the process plant will be through two sets of doors.

Areas which are sensitive to dust will be pressurized. In addition, dry type dust collection equipment will be installed to capture at source the dust from sample preparation and flux mixing. Fumes from the furnace room will be directed through a

scrubber suitable for particulate removal. Air from the metallurgical and wet laboratories will be exhausted to atmosphere.

Makeup air, heated prior to entering the building with indirect fired propane equipment, will be supplied to the area to compensate for the exhaust air requirements.

Fire protection for the laboratory will be by hydrant stations and dry chemical fire extinguishers.

3.2.7.8 Mine Dry Offices

The dry offices will be a separate trailer complex in the southeast corner of the operations camp area, complete with separate women's dry offices and assembly areas. The dry offices will serve all employees. Showers, change rooms and individual lockers for 100 men and 20 women will be provided. Offices for the mine and maintenance shift supervisors, the drill and blast supervisor and the process maintenance supervisor will be included.

The dry offices will be heated with indirect propane-fired unit heaters. Air from the washrooms and showers will be exhausted to the atmosphere with makeup air being heated prior to introduction into these spaces.

Hose stations and hand held fire extinguishers will be provided in the dry offices for fire protection.

3.2.7.9 Building Heating, Fuel Storage and Distribution

Heating fuel will be supplied from a central propane storage system. Propane will be delivered to site by tank truck to the independent facilities. Currently, it is planned that the facilities, including tanks, will be the property of the propane supplier. The tanks, at the estimated demand, will have a month's reserve when full. Drawing 100-13-23 and 100-13-24 shows the plan, sections and details of fuel storage, and fuel storage service complex, respectively.

3.2.7.10 Vehicle Fuel Storage and Distribution

Diesel fuel and gasoline will be delivered to the project site in tanker trucks for transfer to storage tanks. A permit under the Environment Act *Storage Tank Regulations* will be acquired for the fuel storage facilities.

The vehicle fuel storage compound will be constructed on the same graded pad as the truck wash facility, which will be located adjacent to the maintenance shop and warehouse.

This compound will contain a 190 m³ diesel fuel tank and a 38 m³ gasoline fuel tank. The diesel fuel tank will be a steel, above ground, vertical type, and the gasoline fuel tank will be a steel, above ground, horizontal or vertical type. The tanks will be located within the lined and bermed enclosure. Space within this enclosure shall also be allocated for a future, second 190 m³ diesel fuel tank. The enclosure will be sized to contain 100% of the capacity of the largest tank, plus 10% of the volume of the

remaining tanks, and 300 mm of freeboard. The tanks will be designed to NFPA Standards for atmospheric pressure, outside storage tanks. A facility will be provided to unload the tank trucks, which will be equipped with pumps to transfer the fuel into storage tanks. Diesel and gasoline dispensing stations will be provided adjacent to the tanks for filling mine and plant mobile equipment. A loading arm assembly, constructed on an elevated platform, will be provided to fill a top loaded 7.6 m³ capacity tanker truck with diesel fuel. Diesel fuel for in-pit mine vehicles will be dispensed from the mobile tanker truck.

3.2.7.11 Site Accommodation

Construction personnel will be accommodated in the prefabricated camp located at the project site. The camp will be complete with kitchen, dining and recreational facilities. The layout of the camp and its relationship to the other process facilities is shown on Figure 3-1. Depending on the mining seasonal requirements for accommodation, a portion of the camp may be retained to meet any shortfalls in local housing availability. It is anticipated that the influx of operations personnel to the Carmacks area will prompt the construction of local affordable housing. Appendix A, Drawing 100-13-14 shows the layout plan for the camp.

3.2.7.12 Lighting

As all the pit equipment is equipped for nighttime operation, requirements for additional lighting are minimal. Areas that will require lighting are the digging areas and the active waste dump where trucks are dumping. Four portable self-contained lighting plants will be required. These units will be pulled and positioned by a pick-up truck.

3.2.7.13 Maintenance Facilities

Routine preventative maintenance and servicing of the open pit equipment will be carried out at their working place. Preventive maintenance on mobile equipment will be carried out in the shop.

The mine maintenance shop has sufficient floor area for four haul trucks at one time. Scheduled and breakdown repairs will be carried out in the workshops or in situ as appropriate.

3.2.7.14 Security and First Aid

Security at the project site will involve controlled access into the work areas.

In areas where vehicular passage could be accomplished easily, security style mesh fencing and a prefabricated trailer gatehouse will be installed and locked to deter unauthorized entrance to the mine site. This security fencing will extend to reasonably visible distances into the forest. Inaccessible areas will have perimeter fencing consisting of wood and/or barbed wire construction with the exception of the process area, which will be completely enclosed by a 2.4 m high wildlife fence. Additional security fencing will be installed around the warehouse storage yard and the cathode shipment door.

The first Aid station will be contained in the gatehouse, as well as the ambulance and fire truck.

3.2.7.15 Communications

An internal telephone network will serve the various facilities at the property, the cables being routed through conduit within the yard areas and along the overhead pole lines to the process plant and administration offices. Radios will also be installed in supervisor's vehicles and major items of mining equipment for communicating with the operators working in the pits.

Externally, the operation will be linked via a satellite link to provide data, fax, and voice communication. A satellite dish near the administration offices will be installed during the initial construction phase for this purpose. Satellite television will also be provided for workers (construction and operation) at the camp.

3.3 PROJECT ACTIVITIES AND SCHEDULING

Generally, scheduling of project activities is based on economic considerations. Once a decision to proceed to development is made, the duration of engineering and construction activities are kept to a minimum consistent with good practices. The overall operating life of a mine is usually arrived at as a result economic analyses which indicate an operating life that is likely to provide the best returns on the investment; the major factors that influence this are the estimated size of the deposit, the estimated capital cost to develop the property, estimated operating costs, and financing considerations.

A discussion of alternative construction and operations timelines is presented in Section 3.11.1 of the Socio-economic Effects Assessment Report (Appendix P). Essentially, the extension of the construction or operations period will reduce the project financial returns significantly and might compromise project development.

Alternative work schedules are also discussed within Section 3.11.2 of the Socio-economic Effects Assessment Report. Western Copper is committed to providing as much flexibility to its employees as possible.

3.3.1 Mining Method Selection

The mining method selected is intended to maximize the recovery of the resource, and optimize production in the early years of production. Since the SX-EW plant capacity is fixed, the higher the ore grade the fewer the tonnes of ore, for a given copper production, have to be processed.

Having determined the mining method and estimated mining, G & A and processing costs a computer generated Lerchs-Grossmann pit optimization was developed. This ultimate pit was then scheduled manually and yearly plans developed. This schedule is approximate and it is recommended that an integrated computer graphics schedule be done prior to a production decision. The ultimate pit plan is shown in Figure 3-5.

3.3.2 Mining Strategy

In order to minimize start-up costs, the mine will start as a small pit focused on mining higher grade, lower strip ratio material. The pit will be expanded with successive push-backs which will allow for a gradual build-up of haul trucks to maintain production. The mine will start with a strip ratio slightly lower than the mine average. For the last few years of the mining operation, the strip ratio will decrease to below mine average hence allowing for aging equipment to be retired from the fleet.

3.3.3 Pre-production

Pre-production development of the open pit will include removal of waste rock from the area and the mining of low grade ore. This pre-production period for mining will last approximately 6 months at a production rate of approximately 12,000 tpd. Training of pit operations and maintenance personnel will be carried out during this period. Ore mined during the pre-production period will be crushed and utilized for padding the initial heap leach pad liner.

3.3.4 Production Mining

Mining and waste rock removal will be carried out over a 300-day period every year. Ore will be fed directly to the primary crusher where possible. Due to extreme winter conditions, no mining is scheduled in January and February. The mining season will be extended if weather permits.

The average life of mine strip ratio will be 4.6:1. In the first three years of production, the strip ratio will range from 2.8 to 4.8. The strip ratio reaches a high of 6.4:1 in year 4 and then drops to 2.5:1 by year 8. The increasing depth and haulage cycle times in the project's latter years are reflected in increased manpower and equipment requirements.

The pit will be started at the north end and developed in slightly higher grade material. The pit will then be expanded in a series of push-backs in order to mine the balance of the ore.

Table 3-3 and Table 3-4 show the Carmacks Copper Project schedule for the first year after project approval and the annual mining production schedule for the Carmacks Copper Project, respectively.

Table 3-3 Carmacks Copper Project Schedule - 1 Year After Project Approval

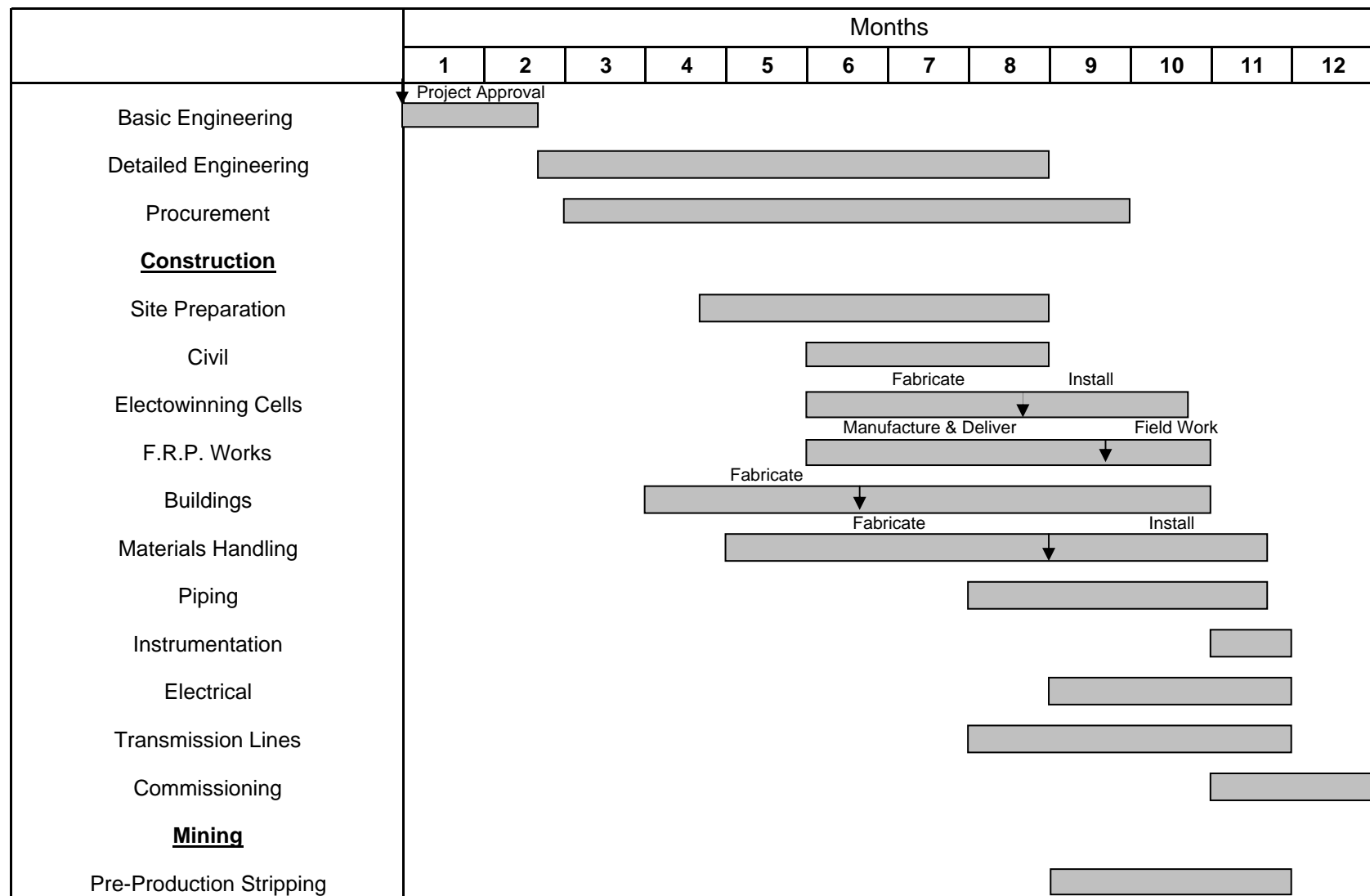


Table 3-4 Annual Mining Production Schedule

YEAR		-1	1	2	3	4	5	6	7	8	Total
Mine Production Schedule											
Available Days	days	365	365	365	365	365	365	365	365	365	3,285
Operating Days	days	180	300	300	300	300	300	300	300	180	2,460
Shifts/Day	shifts	2	2	2	2	2	2	2	2	2	2
Hours/Shift	hours	12	12	12	12	12	12	12	12	12	12
Available Hours	hours	4,320	7,200	7,200	7,200	7,200	7,200	7,200	7,200	4,320	59,040
Operating Delays Factor	%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%
Operating Hours	hours	3,600	6,000	6,000	6,000	6,000	6,000	6,000	6,000	3,600	49,200
Ore Production	tonnes	200,000	1,763,500	1,973,229	1,974,396	1,837,363	1,792,000	1,792,500	1,642,400	302,481	13,277,869
Total Copper Grade	%	0.906	0.912	0.907	0.907	0.974	0.999	0.999	1.090	1.180	0.971
Contained Copper	lbs	3,992,198	35,450,392	39,441,960	39,442,655	39,442,439	39,441,863	39,442,995	39,442,039	7,863,828	283,960,369
Waste Production	tonnes	2,000,000	5,000,000	7,800,000	9,500,000	11,800,000	10,300,000	8,000,000	6,100,000	753,236	61,253,236
Total Material	tonnes	2,200,000	6,763,500	9,773,229	11,474,396	13,637,363	12,092,000	9,792,500	7,742,400	1,055,717	74,531,105
Strip Ratio	(w:o)	10.0	2.8	4.0	4.8	6.4	5.7	4.5	3.7	2.5	4.6
Production Rate-Ore	tpd	1,111	5,878	6,577	6,581	6,125	5,973	5,975	5,475	1,680	5,042
Production Rate-Waste	tpd	11,111	16,667	26,000	31,667	39,333	34,333	26,667	20,333	4,185	23,366
Production Rate	tpd	12,222	22,545	32,577	38,248	45,458	40,307	32,642	25,808	5,865	28,408
Copper Recovery	%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Recovered Copper	lbs.		28,360,314	31,553,568	31,554,124	31,553,951	31,553,490	31,554,396	31,553,631	6,291,063	223,974,537
Copper Tonnes	t	1,448	12,862	14,310	14,310	14,310	14,310	14,310	14,310	2,853	11,447
Copper Tonnes Target	t		14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310	14,310

3.3.5 *Decommissioning and Reclamation*

Decommissioning and site reclamation will occur progressively where possible *and meet the performance standards and terrestrial reclamation standards as described in Supporting Appendix C, Appendix A. Progressive reclamation will follow these standards with the following expected activities:*

- *implementation of measures to control site erosion and sediment release;*
- *initiation of slope stability measures to enable revegetation;*
- *construction techniques and scheduling to minimize disturbance and allow for progressive reclamation activities;*
- *replanting and reseedling in disturbed areas not scheduled for rework as soon as practical;*
- *reclamation of exploration trail; and*
- *possible concurrent rinsing and detoxification of portions of the leach pad during operations to neutralize spent ore for final closure.*

The WRSA would be constructed in such a manner to allow for progressive reclamation and revegetation once areas are completed. Overburden stockpiles will be established during initial site construction and used for future reclamation. Generally slopes will be graded and covered with overburden material and revegetated. Infrastructure and hazardous materials will be removed from the site and reclaimed. The heap will continue to be leached and rinsed with water following the cessation of mining to remove copper *and neutralize the pile. Fresh water rinsing followed by neutralization with sodium carbonate will raise the pH to above 7 and reduce metals levels to meet MMER standards from the detoxified heap effluent. The possibility of concurrent heap detoxification and leaching is also being considered. The heap will be rinsed with water and an evaporative soil cover will be placed over the re-sloped heap. Effluent from the heap will be treated for release using conventional lime treatment technologies to reduce the solution inventory in the heap. Heap effluent will be monitored at closure to ensure standards are met. Contingencies treatment measures such as limestone drains, biological treatment cells and infiltration gallery could be used for final effluent polishing at eventual closure. A further contingency of carbon based nutrient addition to immobilize metals in the infiltration gallery is another adaptive strategy that will be investigated in the future.* Monitoring and maintenance will continue to demonstrate decommissioning and closure success.

3.3.5.1 *Conceptual Closure Plan*

Western Copper has prepared a Conceptual Closure and Reclamation Plan for the project. Details of the plan are provided in Appendix F. This plan presents further information and details respecting closure issues, conceptual closure measures, remaining closure issues and investigations, and closure scheduling. A brief summary is presented in the following sections.

Figures showing closure plans are presented in Appendix F. Appendix A, Drawing ACG-01 provides a schematic of the conceptual heap leach facility closure.

Closure Objectives

There are three overall closure objectives for mine closure:

- protection of public health and safety;
- minimize or prevent adverse environmental impacts; and,
- ensure land use commensurate with the surrounding land.

For the Carmacks Copper mine these objectives have become part of the design process to ensure both physical stability and chemical stability of the site in the long term. Mine design, development and progressive reclamation will be undertaken in such a manner to ensure that the amount of work required at the end of mine life to achieve the above objectives is minimized. *Closure performance standards and terrestrial reclamation standards are presented within Appendix A of the Carmacks Copper Project Performance Standards and Design Criteria Parameters document, located within Appendix C of this proposal.*

The ideal scenario at closure is to be able to achieve the above three objectives in a “walk-away” scenario, that is, one in which there will be no further requirements for monitoring and maintenance. Clearly, for some mines, some level of human activity may be required for a period after closure resulting in either an “active care” or “passive care” closure scenario.

The Conceptual Closure and Reclamation Plan presented in Appendix F describes the concepts that have been developed for closure of the Carmacks Copper Project, and addresses both temporary shutdown and final closure scenarios.

The long-term objective is to achieve a passive “walk-away” closure condition, however it is realised that some active care will be required for a period of time to demonstrate that passive “walk-away” closure is achievable, especially for the heap leach pad. A plan is presented that provides “walk away” closure for all aspects of the project, with the exception of the heap leach pad *where “passive care” will be required for a longer period of time until heap effluent quality is demonstrated (15 years).* The heap leach pad will be rinsed and process solution circulated until no longer economical. Excess solutions will be released from the heap and treated for discharge to the environment. The heap will be covered with an evaporative/transpiration soil cover to reduce infiltration. *To cover the entire heap leach pad (37.2 ha) with roughly 0.5 m of soil cover, approximately 186,000 m³ of material will be obtained from the open pit, heap leach pad, and WRSA stockpiles, which will be set aside during initial stripping operations.* Heap solutions will then be further neutralized and *treated to raise the pH to above 7 and stabilize metals to MMER standards. Contingency treatment measures are planned for polishing long term solution release from the heap if required.*

Closure Issues

Closure issues can be considered in terms of three major areas:

- issues associated with (geo)chemical stability;
- issues associated with physical stability; and,

- issues associated with land use, aesthetics and public health and safety.

For this project, issues of chemical stability and water quality are typically the major issues to be addressed at closure. These issues, which are particularly associated with the heap, are therefore the focus of the conceptual closure plan.

At mine closure, there are no major water retaining structures, diversions or impoundments for which physical stability must be ensured in the long term. The remaining structures for which physical stability must be addressed are the spent ore heap and associated water management facilities, and the mine rock waste dump.

For most of the site, reclamation of the disturbed areas of the mine site and rock waste dumps would raise no issues that are particular to a heap leach project. The primary issue is the control of erosion and public safety.

Closure and reclamation of the spent heap does require special consideration in that the spent ore has been chemically changed from the in-situ condition. Closure of the spent heap is discussed herein primarily in terms of the issues associated with water chemistry. The requirements for control of water quality (i.e. rinsing, solution draindown and active treatment using known lime treatment technology, chemical addition for neutralization and metals stability, soil evaporative/transpiration covering, contingency effluent polishing - biological treatment cell and infiltration gallery) will dictate the conditions under which further reclamation would be done.

The Conceptual Closure and Reclamation Plan in Appendix F presents further information and details respecting closure issues, conceptual closure measures, remaining issues and investigations, and closure scheduling.

3.3.5.2 Reclamation Security and Costs

Preliminary reclamation cost estimates were provided in HKP's IEE No.3 (Conceptual Reclamation and Closure Plan, 1995). Assuming the capital cost estimate for equipment has increased by 17.1% since 1997 (Socio-Economic Effects Assessment Report, Section 3.1.1 – Updated Capital Costs Estimates) and a scaling factor of 22.8% is used to estimate the increase in the cost of labour since 1997 (Socio-Economic Effects Assessment Report, Section 3.2.1 – Updated Ongoing Capital Costs) an average increase of 20% is calculated to estimate overall increased capital costs. The preliminary reclamation cost estimates provided in the 1995 Conceptual Reclamation and Closure Plan have been increased by a factor of 20% to provide an estimate of present day (2006) reclamation and closure costs.

Table 3-5 Reclamation Cost Summary

Facility	Land Use	Area Disturbed (ha)	Area Reclaimed (ha)	Total Estimated Cost
<i>Research Program</i>	<i>Revegetation Research</i>	<i>N/A</i>	<i>N/A</i>	<i>\$1,014,000</i>
<i>Open pit</i>	<i>Rock Cliff</i>	<i>29.5</i>	<i>10.0</i>	<i>\$567,600</i>
<i>Waste Rock Storage Area</i>	<i>Wildlife/Lodge pole/ White spruce</i>	<i>69.6</i>	<i>69.6</i>	<i>\$1,158,000</i>
<i>Heap Leach Pad</i>	<i>Wildlife/Mixed</i>	<i>37.2</i>	<i>37.2</i>	<i>\$2,386,800</i>
<i>Events Pond</i>	<i>Wildlife/Mixed</i>	<i>2.4</i>	<i>2.4</i>	<i>\$36,000</i>
<i>Plant and Ancillary</i>	<i>Wildlife/Mixed</i>	<i>13.3</i>	<i>13.3</i>	<i>\$1,402,800</i>
<i>Borrow Pit</i>	<i>Wildlife/Black spruce</i>	<i>2.5</i>	<i>2.5</i>	<i>\$28,800</i>
<i>Access Road, Haul Road and Exploration Trail</i>	<i>Wildlife</i>	<i>16.0</i>	<i>16.0</i>	<i>\$433,200</i>
Total		170.5	151.0	\$7,027,200

The Company's philosophy for closure and reclamation security is to:

- Undertake progressive closure and reclamation during operations to offset post closure costs *following performance standards and terrestrial reclamation standards (see section 3.3.5 "Progressive Reclamation" and also Appendix C);*
- Develop and prepare a final mine closure and reclamation plan that meets closure objectives;
- Post security for project closure in accordance with applicable Yukon regulations (Yukon Waters Act and Regulations and Yukon Quartz Mining Act), including Yukon Government's mine reclamation policy; and
- Ensure that security provisions are adequate and available to fund closure activities at any time during the operation.

3.4 MINE STAFFING

As stated in the Socio-economic Effects Assessment Report (Section 3.10) provided in Appendix P, basic education requirements for employment at the mine will be high school, with secondary education required for a limited number of positions. Please see the tables reference below for academic qualifications required for the various mine staff positions.

3.4.1 Mine Engineering

The mine engineering department will be directed by the Chief Engineer who will supervise both the engineering and geology staff. The engineering group will be responsible for short and long range mine planning, surveying and grade control. The Chief Engineer will report directly to the Mine Superintendent.

The geology department will be responsible for updating the geological model so that changes can be made to the mine plan as required. This department will also be responsible for assisting the engineering group with grade control. The Mine Geologist will map the ore and waste bench faces on a daily basis, recording both structural and geological data.

Environmental monitoring and compliance will be maintained by an environmental technician who will also report to the Chief Engineer.

3.4.2 Maintenance

The mine maintenance department will be controlled by the maintenance General Foreman who will report to the Mine Superintendent. The maintenance department will carry out the planning, supervision and implementation of maintenance work on the mine equipment and will work intimately with the mine engineering and mine operations departments.

3.4.3 Mine Surveying

Routine surveying will be conducted for setting survey control points, for recording as-built mine data and for setting out mine control points. Mine control points that will be typically set out include high-wall toes and crests, ramps, ore control points, etc. Typical as-built surveying will include high-wall toes and crests, blast hole locations, bench face advance, geologic control points, etc.

3.4.4 Personnel

General administration staff at the mine averages 8 employees per year (Table 3-6). An average of 109 individuals would be working on the mine each year, with 130 the maximum (Table 3-7). Process plant personnel averages 43 employees per year (Table 3-8). Total staff employed at the mine would average *approximately 150* employees per year.

During construction activities it is estimated that a peak of 226 construction staff would be employed at the mine.

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Table 3-6 General Administration Staff

YEAR			PP	1	2	3	4	5	6	7	8
General Administration Staff		<i>Qualifications (Academic)</i>									
General Mine Manager	<i>P.Eng</i>	no.	1	1	1	1	1	1	1	1	1
Administrative Secretary	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Chief Accountant	<i>Certified Accountant</i>	no.	1	1	1	1	1	1	1	1	1
Payroll Clerk	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Personnel/Safety Officer	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Chief Purchasing/Warehousing	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Purchasing/Warehouse Clerk	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Environmental Coordinator	<i>P.Eng Preferred</i>	no.	1	1	1	1	1	1	1	1	1
Total Staff			8	8	8	8	8	8	8	8	8

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Table 3-7 Mining Manpower Complement

YEAR			-1	1	2	3	4	5	6	7	8
Staff	Qualifications (Academic)										
Mine Superintendent	<i>P.Eng</i>	no.	1	1	1	1	1	1	1	1	1
Chief Engineer	<i>P.Eng</i>	no.	1	1	1	1	1	1	1	1	1
Mine Engineer	<i>P.Eng</i>	no.	0	1	1	1	1	1	1	1	1
Mine Geologist	<i>P.Eng</i>	no.	1	1	1	1	1	1	1	1	1
Mine Clerk	<i>High School</i>	no.	0	1	1	1	1	1	1	1	1
Mine Surveyor	<i>High School</i>	no.	1	1	1	1	1	1	1	1	1
Mine Technician	<i>High School</i>	no.	1	2	2	2	2	2	2	2	2
Pit Foreman	<i>High School</i>	no.	2	4	4	4	4	4	4	4	4
Maintenance Foreman	<i>High School + Trades Training</i>	no.	1	1	1	1	1	1	1	1	1
Maintenance Shop Foreman	<i>High School + Trades Training</i>	no.	0	2	2	2	2	2	2	2	2
Maintenance Planner	<i>P.Eng Preferred</i>	no.	0	1	1	1	1	1	1	1	1
Subtotal Staff			8	16	16	16	16	16	16	16	16
Mine Operations											
Shovel Operator	<i>High School Preferred</i>	no.	4	4	4	4	4	4	4	4	4
Loader Operator	<i>High School Preferred</i>	no.	0	4	4	4	4	4	4	4	4
Haultruck Operator	<i>High School Preferred</i>	no.	8	12	16	20	28	28	28	24	8
Water & Sand Truck Operator	<i>High School Preferred</i>	no.	4	4	4	4	4	4	4	4	4
Blasthole Drill Operator	<i>High School Preferred</i>	no.	4	4	8	8	8	8	8	4	4
Grader Operator	<i>High School Preferred</i>	no.	4	4	4	4	4	4	4	4	4
Bulldozer Operator	<i>High School Preferred</i>	no.	4	8	8	8	8	8	8	8	8
Wheel Tractor Operator	<i>High School Preferred</i>	no.	1	2	2	2	2	2	2	2	2
Excavator Operator	<i>High School Preferred</i>	no.	1	2	2	2	2	2	2	2	2
Airtrack Drill Operator	<i>High School Preferred</i>	no.	1	2	2	2	2	2	2	2	1
Blaster	<i>High School Preferred</i>	no.	1	1	1	1	1	1	1	1	1
Helper/Labourer	<i>High School Preferred</i>	no.	3	3	3	3	3	3	3	3	3
Subtotal Mine Operations			35	50	58	62	70	70	70	62	45
Mine Maintenance											
Mechanic - Heavy Duty	<i>High School + Trades Training</i>	no.	2	4	4	8	8	8	8	8	4
Mechanic - Light Duty	<i>High School + Trades Training</i>	no.	2	4	4	4	4	4	4	4	4
Field Mechanic	<i>High School + Trades Training</i>	no.	2	4	4	4	4	4	4	4	4
Apprentice Mechanic	<i>High School</i>	no.	4	4	4	8	8	8	8	8	4
Welder	<i>High School + Trades Training</i>	no.	2	2	4	8	8	8	8	8	2
Tireman	<i>High School Preferred</i>	no.	1	2	2	4	4	4	4	4	2
Fuel and Lube Serviceman	<i>High School Preferred</i>	no.	2	4	4	4	4	4	4	4	4
Tool Crib Attendant	<i>High School Preferred</i>	no.	4	4	4	4	4	4	4	4	4
Subtotal Mine Maintenance			19	28	30	44	44	44	44	44	28
Total			62	94	104	122	130	130	130	122	89

Table 3-8 Process Plant Personnel

Position	# Personnel	Qualifications (Academic)
<i>Operating Personnel (12 months/year)</i>		
Process Superintendent	1	P.Eng Preferred
Process Metallurgist	1	P.Eng
<u>Crusher</u>		
Crusher Operator (7 months/year)	3	High School Preferred
Crusher Labourer (7 months/year)	4	High School Preferred
<u>Heap Leach Pad</u>		
Heap Labourer	4	High School Preferred
<u>SX/EW Plant</u>		
Operator	8	High School Preferred
Labourer	4	High School Preferred
<u>Acid Plant</u>		
Operator	4	High School Preferred
Labourer	2	High School Preferred
<u>Laboratory</u>		
Laboratory Technician/EMT	4	High School Minimum
Subtotal	35	
<i>Maintenance Personnel</i>		
Journeyman	3	High School + Trades School
Apprentice	2	High School
Electrician	2	High School + Trades School
Instrument Technician	1	Technical School Graduate
Subtotal	8	
Total Personnel	43	

3.5 WATER MANAGEMENT

3.5.1 Water Balance

3.5.1.1 General

Leaching and extraction processes have been designed to operate on the basis of 100% recycle of process streams. There will be no direct discharge of process effluents to Williams Creek, however, *during operation provision for water treatment prior to discharge* is planned as a contingency measure should excess process waters require release. The only other releases to Williams Creek will be from the sediment ponds located below the events ponds and WRSA. Water recycling from these sediment ponds is planned along with wastewater from the open pit, which will be used as make-up water. The events pond will remain *largely* empty and will only be used *for the most part* during emergency storm events or pump failure. Discharges from the laboratory wastes and floordrains will be re-routed to the PLS stream and returned to the process stream in order to minimize losses.

Site Drainage and Diversion

The development of the mine, WRSA, leach pad and process facilities will require the altering of local surface water drainage patterns. Surface water quantities will also be affected by the changes in evapotranspiration and infiltration due to land clearing and open pit excavations.

The project will require the diversion of uncontaminated surface run-off from the drainage areas up-slope from the mine and process facilities by means of open, gravity ditching. North Williams Creek, which is north of the project facilities, will be the main drainage of uncontaminated surface water around the WRSA. Waters running through the waste rock will be routed away from North Williams Creek and collected in drainage ditches to a sediment pond. The majority of these waters will be routed into the process plant as make-up water. All leachate from the pad will be routed to the process plant and recycled onto the pad to maintain a closed loop without discharge to the surrounding environment.

Potentially contaminated run-off from the mine and process facilities will be collected in gravity interceptor ditches and directed to settlement ponds adjacent to Williams Creek. The settlement ponds will be provided to trap suspended sediment and contain any accidental spills of process solutions. *Water from these ponds will be used as a source of make-up water for the process.* Overflow spillways from the ponds will ultimately drain into Williams Creek at the lowest point of the property before release to the environment. *Any effluent planned to be* released from the settlement ponds will be monitored to ensure that effluent discharge standards are met.

3.5.1.2 Heap Leach Pad

Clearwater Consultants Ltd. Memorandum CCL-CC7 – Water Balance Update prepared in February 2006 (Appendix D3) presents a summary of the updated water balance results for the leach pad and events pond, the open pit and the waste dump for average 20 year dry year and 100 year wet year precipitation conditions. A series of tables are

presented which show mining related flows and the total estimated flows at several locations within the Williams Creek catchment and in the Yukon River downstream of Williams Creek.

Memorandum CCL-CC7 presents revisions to the water balance model detailed in Design Memorandum CCL-CC4 (1998). Specific revisions have been made as follows:

- The water balance model has been expanded to include the entire site including modules for the heap leach facility and events pond, the open pit, the waste rock storage area, and upstream and downstream receiving waters in Williams Creek and in the Yukon River;*
- Updated hydrological parameters incorporated in the model are based on the Clearwater Consultants Ltd. Memorandum CCL-CC6, "Williams Creek Site Hydrology Update" dated January 13, 2006 (Appendix D4);*
- Ore moistures have been revised to reflect the planned use of crushed ore rather than ROM ore used in some of the previous studies.*

Please refer to Memorandum CCL-CC7 in Appendix D3.

3.5.1.3 Waste Rock Storage Area

As mentioned above, Clearwater Consultants Ltd. Memorandum CCL-CC7 – Water Balance Update prepared in February 2006 (Appendix D3) presents updated water balance results for the waste rock storage area. Tables CC7-1.8A, 8B, and 8C summarize the waste rock storage area water balance including input data and assumptions, monthly flows and the annual summary. Please refer to Appendix D3 for water balance results for the waste rock storage area.

Provisions are included in the design of the WRSA to control the surface inflows into the facility. This will be accomplished by constructing surface and collection drainage ditches that will collect and direct the surface runoff and near surface seepage water to the sediment control pond.

Surface Drainage and Collection Ditches

Surface drainage ditches will be constructed to channel the surface runoff to the surface drainage collection ditch. It is anticipated that additional surface drainage ditches in the footprint of the WRSA may be required to enhance the drainage. These ditches will mainly be of use in the early stages of the WRSA development as the foundation thaws and excess water is released. Eventually these ditches will be covered by waste rock material. The perimeter collection ditch surrounding the WRSA has been designed to intercept all surface run off and near surface seepage from the WRSA and convey this to the WRSA outlet channel, which ultimately drains into the sediment control pond. The perimeter collection ditch and the WRSA outlet channel will be riprap lined to prevent erosion and downcutting. The preliminary sizing of these ditches is based on conveying the peak runoff flow obtained from the 1 in 200 year 24 hour storm event. The peak design flows are estimated to be 1.25 m³/s for the WRSA outlet channel and 0.65 m³/s for the perimeter collection ditch.

Sediment Control Pond

The location and details on the design features of the sediment control pond are shown on Drawing 1785.301 in Appendix A. The sediment control pond design includes a sloping riser for pumpback and will be protected from overtopping by a spillway designed to pass the 1 in 200 year, 24 hour storm event estimated with a peak flow of 1.25 m³/s.

The sediment control pond has also been designed to store a volume of 65,000 m³, which comprises the following:

- 1 in 10 year, 24 hour storm event: 10,000 m³
- Dead storage: 10,000 m³
- Surface runoff storage from the WRSA: 45,000 m³

Pumping of stored water for use at the process plant site will be accomplished using the sloping riser and a pipeline conveying water to the process circuit.

3.5.2 Water Supply

The use of recycled process solutions and contaminated run-off will be maximized to limit the use of makeup fresh water *from groundwater wells*.

3.5.2.1 Water Requirements

Process makeup water will be sensitive to seasonal variations due to the net evaporation loss and ore wetting requirements. Annual total process makeup water requirements for each stage of heap development are summarized in Clearwater Consultants Ltd. Memorandum CCL-CC7, Table CC7-1 (Appendix D3).

It is estimated that 45 m³/day of potable water will be required, that 650 m³/day of process water (maximum daily) and that 190 m³/day of water will be used for road watering during peak dry weather, primarily from water re-use from sediment control ponds. Total project water use requirements are 885 m³/day.

The estimated peak hourly demand to satisfy fire water makeup requirements will be 250 m³/hour.

The quality of process makeup, fire water makeup, and road watering water will be lower than that required for potable use. For example, water from sediment ponds would be used as source water for road dewatering. Potable water treatment packages will be installed at the plantsite pumphouse for local usage, and at the campsite pumphouse for the camp and shop/warehouse requirements.

3.5.2.2 Water Sources

In addition to the collection and storage of run-off, snow melt, and direct rainfall on the leach pad, events pond and settlement ponds, the following sources of water will be available:

- Wells: Water wells are located in the bedrock confined aquifer underlying the Williams Creek drainage. Each of the 8 wells is estimated to provide approximately 150 m³/day of fresh water. Submersible well pumps, installed in the eight bedrock wells to be developed within the Williams Creek Valley, will be connected directly to the fresh water supply pipeline. The capacities and number of the wells will be confirmed by pump testing during detail design. The wells will be the primary source of fresh water for the project;
- Mine pit dewatering: Submersible pumps will be installed in the pit sump and the water will be used at the crusher, for truck washing and road watering. Excess mine water will be directed to the service complex settlement pond;
- Sediment Control Ponds: Storage ponds will be located, at the lowest point of the area, below the shop/warehouse leach pad and waste rock storage area. Pumps will be installed in the ponds to pump the water to storage tanks around the project site. PVC, pipelines connected to the pumps will serve as a secondary water supply for the project. This source of water will be seasonal. Drawings 1785.218 and 1784.301 provide the location and plan for the sediment control ponds; and
- Events Ponds: Excess meteoric water from the events ponds will be used as make up water for the leaching process.

A mine water discharge pipeline will be connected to the maintenance shop/warehouse area from the open pit dewatering pumps for road watering, truck washing and dust suppression. A branch line off this pipeline will supply water to the crushing plant area.

All water pipelines will be buried or heat traced and insulated for freeze protection.

3.5.2.3 Water Distribution

The main water supply pipe from the sediment control ponds and the wells will supply the 265 m³ capacity storage tank at the plant site. Of this, 165 m³ will be reserved for the fire protection system. Two pumps, one a standby, at this tank will distribute water to the potable water system and the process. A water treatment package will be installed in the potable water line branch.

The same pumps will supply makeup water to the fire/fresh water storage tank at campsite. Tank capacity here will be 475 m³, of which 375 m³ will be fire water reserve. With a grade elevation of 879 m, this tank will supply the plantsite fire water system (grade elevation 766 m) by gravity.

The water distribution pumphouse will be located near the fire/fresh water tank. It will house the potable water system for the campsite and the repair shop/warehouse, i.e. the water treatment package, a small potable water storage tank; two fresh water pumps for the shop/warehouse and crusher area, and the fire water pumps.

Drawings 100-13-27 and 100-13-28 provide overall schematics of the water supply and distribution system, respectively. Drawing 100-13-29 shows the water supply pipeline plan and profile; Drawing 100-13-21 illustrates the water distribution pumphouse plan, section and details; and Drawing 100-13-20 shows the fresh water booster pumphouse plan and sections. Drawing 400-03-08 depicts a water and air flowsheet.

3.5.2.4 Fire Water System

There will be a buried fire water loop and hydrant system at plantsite, gravity fed from the fire/fresh water tank at the campsite.

A second fire water system of buried distribution pipes and fire hydrants will cover the campsite, crusher area, and services site. This system will be connected to the electric motor driven fire pump to be located at the distribution pumphouse. A diesel engine driven standby fire pump will be provided, as well as a jockey pump.

In all cases, the fire water hydrant system will be supplemented locally by portable fire extinguishers and hose stations.

A 690 m³ fresh/fire water tank will be located adjacent to the water distribution pumphouse. The lower portion of this tank will be dedicated to storing 345 m³ of fire water which will provide 1.5 hours of reserve at 230 m³/h consumption. An additional supply of up to 345 m³ could be available in the upper portion of the tank. The elevation of the fire water tank will not be sufficient to supply the required flow and pressure by gravity so booster pumps will be required. Around the area, there will be a buried ring main to supply water for hydrants and sprinkler systems in the maintenance shop and warehouse, and administration offices. The process plant will also be connected to the fire water system and will have a chemical foam system in addition to sprinklers for fire protection of the mixer settlers.

3.6 WASTE MANAGEMENT

Proper identification and management of various waste streams is important for worker health and safety and environmental protection. The following section describes planned waste management practices.

3.6.1 Process Fluids Management

An EMS will be developed to ensure that all liquids are accounted for in the operation of the mine. The overall management strategy is based on the following:

- maximizes the recycling and reuse of liquids;
- isolates non compatible or dangerous fluids;
- minimizes the quantity of liquids requiring handling;
- provide secondary containment where necessary;
- provides emergency mitigation measures; and
- monitors environmental effects.

Fluids that will be used at the proposed Carmacks Copper Project include:

- surface water;
- groundwater;
- waste rock runoff;
- mine water;
- site runoff;
- potable water;
- sewage and grey water;
- pregnant leach solution;
- raffinate (barren solution following processing);
- sulphuric acid;
- fuels; and
- reagents (petroleum organic, hydrated lime, cobalt sulphate, guar gum, kerosene).

Fluids management may be broken down into a number of topics found in the sections listed below:

- project and process description – Section 3.0;
- spill contingencies and emergency response plan – Appendix L;
- environmental effects assessment – Sections 7.0;
- environmental monitoring – Section 8.2; and
- closure and reclamation planning – Section 7.8, Appendix F.

Prior to operation the EMS will be finalized including the identification of waste streams, locations, safety and contingency plans, and monitoring plans.

3.6.1.1 Wastewater Treatment and Disposal

Water from the open pit and sediment ponds will be used for process makeup water to the fullest possible extent. Any excess pit water will be discharged to the environment in full compliance with the discharge performance standards (see Appendix C, Section 2.9); where possible this excess water will be recycled for process use.

The leach pad and process plant solutions are designed to be 100% recycled so there will be no release of process streams to the environment. *However, studies indicate that in the unlikely event of several consecutive years of above average precipitation, excess process solution could accumulate that may be discharged by means of the contingency (emergency) water treatment plant. As the treatment system is for contingency or emergency treatment of process solution during the operating period, a simple treatment system approach is proposed that uses known best management practices. This portable treatment system is proven and reliable.*

Other alternative means of reducing the heap solution inventory would be used before the need to release treated water. These measures include:

- *increased evaporation through spray emitters; and*
- *increased temporary water recirculation within the heap.*

However, if necessary, water would be treated and released.

Upon closure, this simple treatment system approach is not appropriate as continuous and long-term treatment using a more permanent facility will be required. The SX/EW plant would be converted and used for this purpose so that rinse water from the heap would be released to the environment after first being treated in the closure water treatment plant (see below). Once treatment is no longer necessary, the leach pad will be covered over to seal it from direct exposure to precipitation.

The two proposed treatment systems are described below.

Contingency Water Treatment Plant (Construction and Mine Operation)

Please refer to the Operational Treatment System Report included in Appendix F1, which details the water treatment that will be available during mine operation. The treatment system is a known and demonstrated treatment technology that utilizes conventional lime precipitation of metals within an emergency containment pond (sediment pond located down gradient of the events pond).

Water Treatment Plant – Closure

Upon closure, a raffinate treatment plant will be constructed for water treatment. Details of the water treatment plans for closure are presented in Appendix A of the Conceptual Closure and Reclamation Plan, found in Appendix F of this report. Information from the Conceptual Closure and Reclamation Plan is provided below.

The filter press and pump, the sludge receiver and sludge bin/dryer will be provided by modifying the existing crud treatment and filter press system which form part of the flotation and organic treatment system.

The plant will include the following major facilities:

- Seepage collection system
- One collection pond;
- Two stirred treatment reactors;
- One Clarifier;
- One sand filter;
- One sludge filter press;
- One sludge dryer;
- Treated water retention pond;
- Utilities and ancillaries including reagent supply, air compressors, emergency and line power, drinking water, etc; and
- Support facilities, including office, control room and maintenance area.

Most of the process equipment will be enclosed in buildings.

The plant will have a treatment capacity sufficient to handle seepage and any contaminated run-off from the area of the closed leach pad. The flow rates will vary with the season and the weather.

Given sufficient capacity in the collection pond, the plant may be operated on a campaign basis, treating larger volumes of accumulated seepage as required.

This water treatment system is relatively simple, but allows flexibility for a number of process parameters, including:

- Aeration and sludge re-circulation;
- Reagent dosages of pH adjustment and flocculation;
- Alternate sludge collection and disposal methods; and
- Alternate & supplementary reagents including:
 - Caustic soda;
 - Soda ash;
 - Sodium phosphate;
 - Lime and limestone; and
 - Commercial precipitant.

Additional details on the water treatment plant are described in Appendix A of the Conceptual Closure and Reclamation Plan, found in Appendix F of this report.

3.6.2 Sewage Treatment

Sewage disposal facilities will include both permanent and portable facilities. The permanent facilities will occupy the maintenance shop and warehouse, dry camp, and administration buildings. Sewage disposal will consist of a conventional septic tank and drainage field. Sewage effluent will flow by gravity in buried 150 mm diameter PVC sewer lines to two 34 m³ septic tanks located at the south side of the plant site area. Septic tank overflow will be dispersed to ground via a buried tile field.

The sewage treatment system for the ancillary facilities will be designed for an average daily flow of 22 m³, which is based on 146 person shifts per day at 150 L per person shift.

3.6.3 Waste Rock

In 2006 a provisional assessment of ARD potential was performed on selected rock samples from the proposed pit location, to represent future waste material stored in the WRSA. Please refer to Appendix G4 for the report containing results from this assessment.

3.6.3.1 Waste Rock Storage

Mining operations will generate approximately 7.5 million tonnes of waste rock per year over the 8 years of mining for a total waste production of approximately 60 million tonnes, yielding a life of mine average stripping ratio of 4.6:1. This waste will be stored in a permanent location north of the open pit.

Trenching (Knight Piesold Ltd., 1992) indicates that overburden in the vicinity of the deposit and WRSA is not extensive: a typical soil profile consists of several inches of root and organic material, overlying up to 1 foot (0.3 m) of white volcanic ash which in

turn overlies several inches of stratified dark brown/black organic silt on top of several feet of silty clay interlaced with some cobble and boulders.

Refer to Appendix G, Figure 5.1, which shows metallurgical sample locations.

The Waste Rock Storage Area Evaluation and Detailed Design Report (Western Copper Holdings Ltd., 1997) included in Appendix G1 provides a discussion of different options considered for the waste rock storage area. (Please note that water balance data present in this 1997 report has since been updated by Clearwater Consultants Ltd. is and presented in Memorandum CCL-CC7 (Appendix D3).)

Please refer to Appendix G2 for EBA's April 19, 2006 Preliminary Review of Existing Information – Waste Rock Dump. The review was completed to address the possibility of relocating the WRSA away from permafrost and potentially thaw unstable foundation soils. Appendix G3 contains EBA's May 29, 2006 Response to Review Questions – Waste Rock Storage Area, which was prepared to address comments made during the YEAA review of the WRSA design component of the Carmacks Copper project.

3.6.3.2 Mineralogy of Waste Rock

Three waste rock samples were thin sectioned and petrographically described: the first sample was a diorite, highly silicified and originally probably undersaturated in silica, accompanied by secondary epidote and almost complete chloritization of biotite, although hornblende and sphene remain fresh. The second sample was identified as a quartz diorite. Relatively weak hydrothermal alteration is shown by partial biotite breakdown with development of some epidote and chlorite. The third waste rock sample was identified as hornblende diorite. There was weak hydrothermal alteration of biotite noted and weak supergene montmorillonite alteration present. Minor limonite indicates slight permeability. There is less than 1% magmatic magnetite present and a small additional amount derived from partial alteration of sphene to carbonate, plus magnetite and /or rutile. Mineralogy of the three waste rock samples is presented in Appendix G, Table 5.1. Refer to the report prepared by Richard W. Lawrence in May 1996 entitled "Evaluation of the Mineralogy of a Sample of Carmacks Acid Leach Residue" for details on the neutralizing potential of the Carmacks ore.

3.6.3.3 Multielemental Scan of Waste Rock

A comprehensive waste rock characterization program was initiated by Western Copper Holdings Ltd. (1992) to determine the necessary design criteria for detailed waste management plan. A total of 23 discrete samples (0.6 m intervals) of waste rock obtained from 6 individual diamond drill holes representing the various waste types were submitted for detailed ICP analyses. Results (summarized in Appendix G, Table 5.2) indicate that waste rock is higher with respect to arsenic (average 197 ppm), bismuth (average 4.14 ppm), cadmium (average 0.92 ppm), copper (average 177 ppm) and silver (average 0.25 ppm), when compared to global crustal averages. Given the mineral composition of the ore, higher than normal levels of copper, cadmium, arsenic and silver would be expected. Major metals that were found to be equivalent to or significantly lower than crustal averages were barium, chromium, cobalt, iron, lead, magnesium, molybdenum, nickel and zinc. Although the concentrations of calcium (1.11 %) and

magnesium (0.52 %) were low, so were concentrations of iron (1.75 %) and sulphur (2.28 ppm).

Combined, these data indicated that the waste rock would be expected to contain very little oxidizable sulphides or pyrite and very little propensity to generate acid leachate. Nevertheless, WRSA runoff settling pond releases *will* be monitored for soluble arsenic, cadmium and copper.

Additional multielemental scans of a further twenty-seven samples of waste material was collected and analyzed. See Appendix G4 which presents results which are consistent with previous test results.

3.6.3.4 Acid Base Accounting of Waste Rock and Ore

Static Testing

Representative samples of composite ore used in metallurgical pilot plant studies and composite samples of ore from drill core were submitted for acid-based accounting, in part to determine the leachability and acid consumption characteristics. In addition, each of the 23 samples of waste rock submitted for ICP analyses were submitted for acid-base accounting. *Additional samples were also collected in 2006 and presented in Appendix G4. In August 2006 further ABA testing was carried out on the fine fraction of samples of spent ore. Results of this testing are provided in Appendix E6.*

Results (presented in Appendix G, Tables 5.3a and 5.3b, *and Appendix G4, Tables 3 and 4*) indicate that both the ore and the waste rock, which have long been oxidized, contain very little remaining oxidizable sulphur. Total sulphur in the trench sample composites, which is primarily chalcopyrite and bornite, averages 0.08%, yielding an average maximum acid generating potential of 2.6 t/1000 t H₂SO₄. The neutralization potential of the three metallurgical composites averaged 11.6 t/1000 t, yielding a net neutralization potential of 9.0 t/1000 t. This value is consistent with the projected acid consumption of 25 kg/t for leaching purposes.

Samples of ore from drill core averaged 0.06% sulphur and maximum acid generating potential of 2.00 t/1000 t H₂SO₄. The neutralization potential average 19 t/1000 t and net neutralization potential of 17 t/1000 t. Both the metallurgical composites and individual drill hole samples contained NP/AP Ratios of greater than 4:1 indicating that the ore falls in the upper left quadrant of a log/log scale and will not be acid generating.

Only one sample of the 23 waste rock samples tested was found to contain concentrations of sulphur above the detection limit of 0.01% (0.01 to 0.02%). *None of the samples contained sulphur above detection limits (Appendix G4, Tables 3 and 4).* Maximum acid generating potential using the detection limit as worst case was calculated to be 0.31 t/1000 t H₂SO₄. Average neutralization potential of waste rock was found to be 28 t/1000 t (10.1 to 89.8 t/1000 t) and a net neutralization potential of greater than 27 t/1000 t (9.8 to 89.5 t/1000t). The overall NP/AP Ratio averages 90:1. The waste rock material satisfies the Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia and Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia.

Data Analyses

All results from static acid-based accounting of high and low grade ore; spent ore and waste rock were plotted on a plot of sulphur content vs. NP/AP Ratios on a log/log scale. Quadrants are defined horizontally by an NP/AP Ratio of 4:1 and vertically by the sulphur content of 0.3%.

Sample results that fall below the 0.3% sulphur range are regarded as having insufficient sulphur content to sustain acid generation. Sample results located above NP/AP Ratio 4:1 are regarded as containing sufficient buffering capacity to neutralize any oxidation products of the contained sulphur. Samples which fell below an NP/AP Ratio of 4:1 and above the 0.3% sulphur boundary are regarded as being acid generating.

In the case of the Carmacks Copper samples, the two spent ore samples (leach tailings) are regarded as potentially acid generating. However, this is because the samples, although stripped of their sulphides and obviously non-acid generating, still contain residues of sulphuric acid.

Acid/Base Accounting (ABA) ARD Screening Criteria

No federal guidelines are currently in place with regards to testing protocols for acid rock drainage; however, as a reference the "Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (August 1998)" as well as the "Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (April 1997)" have been used for this assessment. Guidelines for minesites in the Yukon are currently being developed using the BC guidelines as a basis, with the first draft due March 31, 2005.

The "Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (April 1997)" outlines three ABA criteria, as follows:

1. No testing is required on unconsolidated materials such as glaciofluvial and fluvial deposits, derived from wide areas, and having little opportunity for either sulphides or trace element concentration or deposition;
2. Materials with a sulphides-S content less than 0.3% and a subsoil pH greater than 5.5 require no further ARD testing and, if there is no other metal leaching concern, will be considered safe to excavate. A cutoff of 0.3% sulphides-S is appropriate for most geological conditions. The exceptions are where the rock matrix consists entirely of base poor minerals (for example, quartz and sericite, in pervasive phyllic alteration) or where the sulphides minerals contain heavy metals, such as and Zn, which are soluble in weakly acidic leachate.

If the sulphides content is 0.3% or more, an ABA assessment is required. Due to the greater solubility of metals at low pH, if the pH is less than 5.5, the soluble metal content must be determined.

This abbreviated ABA screening criteria is intended for situations, like road construction in non-mineralized terrain, where there is no reason to expect a low

NP or significant trace element release. Where materials are likely to be mineralized or hydrothermally altered, a proponent is advised to carry out the full ABA/metal leaching analysis, and to use the NPR screening criteria listed in #3; and

3. Where materials are mineralized, the suite of ABA testing should be carried out. ARD Screening criteria based on the results of standard ABA test results are as follows:

Potential for ARD	Initial Screening Criteria	Comments
Likely	NPR<1	Likely ARD generating unless sulphide minerals are non-reactive
Possibly	1<NPR<2	Possibly ARD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides
Low	NPR 2-4	Not potentially ARD generating unless significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP
None	NPR>4	

The main conclusion to be drawn from the above is that samples with an NPR greater than 4 are judged to be of no ARD concern and no further ARD testwork is required, unless the materials are to be used as a source of alkalinity.

The ratio of 4:1 is a conservative screening criteria selected to ensure the detection of all sites where there is an unfavorable balance between acid generation and neutralization reactions or where the composition of the reactive fraction (for example, a waste rock's fine-sized fraction) varies significantly from the analysis of the entire sample. It is recognized that a 4:1 ratio is conservative and will be higher than the maximum NPR of acid drainage generating materials.

Kinetic Test Program

Kinetic tests consists of various forms of leaching to determine the rate of either acid, alkalinity, or metal releases under various simulated conditions and include column leach tests, humidity cell tests, B.C. Special Waste Extraction Procedure (SWEP) tests, and simulated rainfall leachability tests.

Given that the ore and waste rock contains little or no sulphur as confirmed by both ICP and acid based accounting tests, kinetic test using columns or humidity cells would not have produced any useable data, even in the long term, and were therefore deleted from the test program. The open pit mine walls will be also be composed mainly of waste rock which has been shown to be highly acid consuming with a NP/AP Ratio ranging from 20:1 to 200:1.

Sequential Extraction of Waste Rock

Sequential extraction testing was conducted on waste rock composite to determine the potential of resolubilization of metals from the rock. The testing consists of five

consecutive extractions that are increasingly more chemically aggressive. This test is designed to partition metals into five components: ion exchangeable metals, carbonate bound metals, iron and manganese oxide bound metals, organic matter and sulphides bound metals, and silicate and refractory iron oxide bound metals. Results are presented in Appendix G, Table 5.7.

Metals in fractions from Leach 1 and Leach 2 are made available by the presence of excess cations and in the presence of mild acid conditions, respectively. The metals present in these fractions have been considered to be the most available under natural environmental conditions for the purpose of this analysis.

The following metals were present as high concentrations in Leach 1 and/ or 2 fractions: aluminum (118.76 ppm), barium (83.35 ppm), cadmium (2.36 ppm), copper (43.62 ppm), iron (142.76 ppm) and lead (5.8 ppm).

A sediment pond is located down gradient from the WRSA. Runoff from the WRSA will be collected and directed to this pond. Water from this pond will be pumped back to the mine site for water recycle, however if wastewater is to be released, then the effluent quality will be monitored and tested for metal levels. If necessary the effluent would be treated using conventional lime treatment before release to the environment.

Water Leach Extraction Test

Appendix G4, Tables 7 and 8, presents the results of twenty-seven samples analyzed for metal leachate extraction tests. The 24 hour Nano Pure water leach extraction tests (at 3:1 liquid to solid ratio) were performed to determine the readily soluble component of metals in each sample. The results presented indicated that there are limited metals concentrations of concern in the rock samples when compared to the Metal Mining Effluent Regulations. The data indicates that the samples have a relatively low potential for metal release during weathering.

3.6.3.5 Nitrogen Loadings from Waste Rock and Ore

The use of explosives during operations can have a detrimental effect on water quality. The use of nitrogen-based explosives in the surface mining has the potential to impair water quality for drinking, aquatic life, and recreation due to potential toxicity of nitrates, nitrites, and ammonia, and their role in promoting algal growth.

Approximately 30% of the holes are anticipated to be wet as a result of thawing permafrost and discrete perched water tables. Eighty-three percent of these holes will be lined with plastic liners that will be used to keep the explosive dry, while the remaining 17% will be loaded with a water-resistant slurry. On the basis of the average mine production of 1.76×10^6 t ore per year and 7.50×10^6 t waste per year and powder factor of 0.20 kg/t, projected peak explosives use will total 1852 t/a. Approximately 20% (352 t/a) will be used in ore production and 80% (1,500 t/a) will be used in waste production.

Some of the residual nitrogen based compounds from blasting will report to the heap operation combined with the ore, a portion will be combined with the waste, and a portion is expected to report to open pit drainage. For the purposes of this evaluation,

nitrogen losses from ore, waste, and mine water are prorated in accordance with tonnage of waste and ore and a loss of 15% from both sources to mine water is assumed.

Using the methods outlined by Pommen (1982) total losses in open pit operations are expected to amount to approximately 1% of the nitrogen content and AN/FO explosives and 6% for slurry. Based on a nitrogen content of AN/FO being 33% and slurry being 25%, projected annual losses of nitrogen to each of the mine rock reporting to the mill, WRSA, and mine water settling ponds are presented in Appendix G, Table 5.8. Methods to minimize losses of explosives will be employed. Approximately 15% (1.46 t/a) of the nitrogen from the open pit blasting will report to the in-pit-mine water settling pond and will be pumped out and directed to the process cycle to be used as make up water. Approximately 85% (1.59 t/a) of the nitrogen from the ore production will report to the processing plant.

Assuming that all residual nitrogen compounds reporting to the WRSA on an annual basis are solubilized and removed from the WRSA each year (i.e. no retention of nitrogen from year to year) and direct proportion to annual runoff, combined nitrogen loadings to and from the WRSA settling pond would total 6.75 t/a.

For modeling purposes, the losses to waste rock that would be discharged as waste rock runoff were estimated to be 54.88 mg/L (from 6.75 t/a N and $1.23 \times 10^5 \text{ m}^3/\text{a}$). This would be broken down to comprise approximately 48% $\text{NO}_3\text{-N}$, 4% $\text{NO}_2\text{-N}$, and 48% $\text{NH}_3\text{+NH}_4\text{-N}$. In addition, ammonia was analytically measured in waste rock SWEP tests to be 0.61 mg/L, which was subsequently added to the estimated $\text{NH}_3\text{-N}$ from explosives and entered as a total 25.31 mg/L $\text{NH}_3\text{-N}$ effluent concentration into the model.

Concentrations of nitrogen are projected to increase by 1.612 mg/L $\text{NO}_3\text{-N}$ (1.634 mg/L), by 0.144 $\text{NO}_2\text{-N}$ (0.1443 mg/L) and by 1.65 mg/L $\text{NH}_3\text{-N}$ (1.702 mg/L) immediately downstream in Williams Creek at site W4. Predicted nitrite nitrogen ($\text{NO}_2\text{-N}$) levels are expected to be above CCME guidelines for aquatic life; however, water from the waste rock sediment pond is planned for use as recycled process make-up intended for discharge to north Williams Creek.

Nitrogen concentrations were estimated to increase by 0.594 mg/L $\text{NO}_3\text{-N}$ (0.700 mg/L), 0.053 mg/L $\text{NO}_2\text{-N}$ (0.056 mg/L) and 0.61 mg/L $\text{NH}_3\text{-N}$ (0.660 mg/L) at W10. All levels are below CCME guidelines for aquatic life.

3.6.3.6 *Raffinate Characterization*

Analyses of raffinate and neutralized raffinate and the percent reduction in metals after neutralization are presented in Appendix G, Table 5.9. As would be expected, analyses showed several metals were extremely elevated in the raffinate, including aluminum (574 ppm) and iron (1274 ppm). A substantial decrease in the levels of the following metals was noted after neutralization: antimony (89.8%) arsenic (83.3%), cadmium (87.7%), chromium (96.6%), copper (97.9%) iron (99.8%) and zinc (98.5%).

In order to further characterize and determine the mobility of neutralized raffinate precipitates, SWEP testing and sequential extraction was completed for the precipitates.

Results from the SWEP and sequential extraction tests are presented in Appendix G, Tables 5.10 and 5.11, respectively.

Based on the SWEP data, neutralized raffinate precipitate is not classified as a special waste. Sequential extraction results indicate that high levels of the following metals were present in Leach Fractions 1 (ion exchangeable metals) and 2 (carbonate bound metals), and therefore may be considered available under natural environmental conditions: aluminum (12,182 ppm), cadmium (2.42 ppm), iron (750.6 ppm), manganese (319.12 ppm), mercury (5.82 ppm) and strontium (87.3 ppm). These levels are, of course, higher than found in raffinate and are not an indication of their levels in waste rock runoff, but indicate that they may be present.

Please refer to the Operational Treatment System Report (Appendix F1), which contains results of more recent neutralization test work on process solutions.

3.6.3.7 Leach Pad Foundation Characterization

Acid-based accounting was completed for the foundations of the leach pad and events pond. Results are presented in Appendix G, Table 5.12. These materials, including the till layer which will be used as a soil liner contain 0.02 to 0.03% sulphur, have a net neutralizing potential of 8.9 to 41.5, and NP/AP ratios of 18.1 to 133.9.

In order to determine the solubilization of metals in the till layer resulting from seepages, ICP analysis was completed on acid leached till. Results are presented in Appendix G, Table 5.13. The samples were adjusted to pH 2.0 with H₂SO₄, leached for 24 hours and filtered. An ICP analysis was completed on the filtered supernatant. Levels of metals released from the till layer are low and are not considered to affect the surrounding environment in the event of a leak.

3.6.4 Heap Detoxification

Updated information on heap detoxification can be found in the following documents:

- *Detoxification and Rinsing Testwork Report (Alexco Resource Corp., January 2006) – Appendix E3. This report presents the results of the latest test work which demonstrates the technical feasibility of detoxifying the spent ore*
- *Memorandum – Heap Rinsing Additional Information (Alexco Resource Corp., June 2006) – Appendix E4. This report discusses the methodology for scale up of the detoxification test work, expected time lines and how the test work predications are typically applied using industry best practices.*
- *Technical Memorandum – Review of Documents and Meeting Notes related to Mineralogy of Leach Residues (Lawrence Consulting Ltd., May 2006) – Appendix E5*

The criteria that will be used to demonstrate that the heap is rinsed and neutralized will be the water quality emanating from the spent ore pile, namely pH, and metals levels. These standards are presented in Supporting Appendices, Appendix C, Section 2.9.

The most recent test work (Alexco, 2006) is summarized below:

Test results provide proof of significant progress and demonstrate the ability to effectively rinse and neutralize the Carmacks Copper spent ore material. Most significantly are the results of Column 9 demonstrating all the parameters in the MMER list of standards were met for direct discharge. The main conclusions of the test results indicate:

- 1. The use of sodium carbonate over lime is superior for alkaline addition and no plugging problems are observed with Na₂CO₃ as is the case with CaO;*
- 2. Letting the spent ore rest after leaching is complete and before initial fresh water rinsing provides a higher initial pH compared to commencing fresh water rinsing immediately;*
- 3. Additional fresh water pulses continue to reduce soluble copper levels to the point where MMER standards are met;*
- 4. Acceptable copper and pH standards are met within reasonable timelines of 200 column days;*
- 5. Pulsing of fresh water appears to be more effective, likely due to some diffusion controlled mechanism of copper as well as the creation of new solution pathways and more effective overall rinsing;*
- 6. The addition of a carbon source did not provide any obvious benefit for stabilization of copper. However the assessment of this part of the program was not optimized and it should be further investigated;*
- 7. The optimum rinsing process at this point appears to consist of:*
 - a. Initial fresh water pulse to flush residual acidity;*
 - b. Adjustment of pH by pulsing an alkaline solution of 5% sodium carbonate; and*
 - c. Continued pulsing of fresh water followed by rest periods until copper has reached acceptable levels;*
- 8. The environmental testwork indicates the residual acid from leaching was effectively rinsed and the spent ore has very low or no acid generating potential which is consistent with the oxide nature of the material; and*
- 9. It has been demonstrated to be technically feasible to rinse the free acidity and reduce metals to acceptable standards.*

Alexco Resource Corp., Memorandum – Heap Rinsing Additional Information, June 2006 (Appendix E4) discusses scale up of the detoxification test work and demonstrates that detoxification can occur on a year round basis. Further ongoing test work is underway and planned to optimize the detoxification of the heap. Contingency measures include longer rinsing and neutralization periods and out of heap treatment measures. These measures are discussed in the Conceptual Closure Plan – Appendix F. The results of the test work better inform the environmental assessment as the technical feasibility of heap detoxification is demonstrated. As such the resulting mitigation measures and assessment are still representative and appropriate.

The leaching of oxide copper from Carmacks samples has been studied over a number of years and the results have been reported previously:

Metallurgy of the Williams Creek Oxide Copper Deposit
Beattie Consulting Ltd.
May 1994

Pilot Scale Column Testing of the Williams Creek Oxide Deposit
Beattie Consulting Ltd.

February 1996

This previous decommissioning test work consisted of rinsing of test columns with water followed by solutions containing base additions to various pH levels. It was demonstrated that the pH of the effluent from the columns could readily be raised to a value of about pH 4 but appeared to be buffered at this value and was resistant to further increases. In February 2001, Beattie Consulting Ltd. completed another study on the "Leaching and Decommissioning of Carmacks Samples" (Appendix E), which included various tests to improve the understanding of what was controlling the effluent pH and to investigate alternatives for effective decommissioning of the leach pads. The following summarizes the results of this most recent testwork.

- Previous column testwork indicated that the leached solids could be readily neutralized to result in an effluent of pH 4, which was buffered at this pH. Additional tests have indicated that when leached solids are freely mixed with a solution containing an excess of base, the solution readily achieves a neutral pH and this pH is stable. Subsequent column tests have shown that sodium carbonate is effective at altering the leached solids so that effluents have a neutral pH. This condition appears to be stable over extended time periods;
- The most effective rinsing procedure for the spent heaps appears to be to recirculate the solutions until the free acid is consumed and the copper concentration in solution becomes uneconomic to recover. At this point the leach solution should be neutralized out of the heap with lime to precipitate sulphate and other deleterious constituents before being discharged. The heap should then be rinsed with groundwater in a series of pulses with rest periods in between to allow dissolved sulphate, copper and other metals to diffuse from the rock particles. An effluent pH near 4 can be expected with this procedure. To achieve higher pH values, the addition of a base is required and sodium carbonate appears to be the most effective addition. The use of lime as a neutralizing agent will likely only be effective if the lime can be intimately mixed with the solids; and
- It has been observed that the leached solids tend to become less permeable due to both decrepitation and precipitation of secondary mineral phases. This loss of permeability will minimize the quantity of effluent to be treated with time. Consideration should be given to installing collection piping at least every few lifts to optimize the flow of solution from the heap during leaching and to minimize the inventory of dissolved copper in the heap.

Further column test work is *underway to optimize heap detoxification methods*. Heap rinsing and neutralization is discussed in more detail in the Conceptual Closure and Reclamation Plan found in Appendix F.

3.6.5 Solid Waste

Industrial and camp solid waste generated by the proposed operations will be disposed of separately.

Industrial refuse consisting of inert material such as broken drill rods, bits, shop scraps and pipe discards will be collected regularly by surface crews and buried within the WRSA.

Combustible industrial refuse and domestic or putrescible refuses from construction and operations will be disposed of by incineration using a forced air fired burner on regular basis. Incinerator ash will be disposed of in the WRSA.

Municipal refuse originating as camp and office waste, plus warehouse scrap will contain some organic wastes. This solid waste will be collected in covered metal containers located at strategic points around the operations. To minimize the attraction of wildlife, the refuse will be incinerated regularly and the incinerator ash will be hauled to the WRSA.

3.6.6 Special Waste

Any special wastes, as defined by the Yukon Environment Act, *Special Waste Regulations*, will be collected and stored in specially marked containers and then shipped to an appropriate treatment or disposal facility. Wildlife-proof rig bins will be used at the site. These bins provide segregated storage for solid waste that cannot be burned and special wastes in compliance with *Special Waste Regulations*.

Waste oil will be burned and used as a source of heat. Western Copper will obtain a Special Waste Permit for this project and will comply with the Yukon *Special Waste Regulations* and track wastes through the use of Transportation of Dangerous Goods Waste Manifests.

A concrete floor will be provided throughout the truck maintenance area. The floors will also be sloped towards a dry sump, which will collect any wash solutions and petroleum products that result from the maintenance activities. Oil-absorbent products will also be used on the shop floors.

Any accumulated sump water will be separated and oils pumped to the waste oil tank or empty drums. All oily wastes from oil changes, including the sump separation products and absorbent, will be hauled off the site for disposal or recycling in an environmentally acceptable manner.

The lubrication bay of the maintenance shop will have a vacuum evacuation system for waste oil. Hose reels will feed from the lubrication storage area and will dispense antifreeze, grease and various grades of oil to the lubrication bay. An air compressor and receiver will supply air for tools.

Laboratory wastes from sink and floor drains will be disposed of in the raffinate tank.

4.0 ALTERNATIVE MEANS AND ALTERNATIVES TO THE PROJECT

This section presents an evaluation of the alternatives considered for the project. Tables 4-1 to 4-8 (found at the end of this section) provide an evaluation matrix for various project component alternatives.

4.1 PROCESSING CAPACITY AND PROCESSING ALTERNATIVES

Table 4-1 presents an evaluation matrix for the production capacity alternatives and processing alternatives. The selection of production capacity has been based primarily on a combination of economic and technical considerations, and associated socio-economic implications, a reasonable return on investment and reasonable mine-life (8 years) expectancy. Environmental considerations have been dictated accordingly (Table 4-1).

Alternative methods of recovering copper were considered in early phases of the project, and included milling with vat leaching and heap leaching. Economic, environmental and operational factors were compared for each potential process option (Table 4-1).

While it was apparent from the metallurgical test work that overall copper recoveries could be attained using a number of processes, the capital requirement, the requirement for a tailings impoundment and higher operating costs were a major deterrent for conventional milling.

The main considerations which favored the heap leach process were as follows:

- heap leaching has been proven to be environmentally sound technology with proper construction and operation procedures;
- the Brewery Creek mine has been successfully operated and demonstrated heap leaching in cold weather climates; and
- capital costs for a milling facility are significantly higher than for heap leaching – heap leaching allows low grade ore to be treated economically.

Generation of acid for copper leaching is an important processing requirement in the heap leaching process route. Acid generation and supply through an onsite sulfur burning and conversion plant is the primary process option. Alternatives include direct trucking of sulfuric acid and generation of acid through biological oxidation of elemental sulfur.

Trucking of sulfuric acid is discounted as a viable option due to excessive haulage distances from the source and haulage costs. As well, environmental considerations from large quantities of acid transported are not desirable.

Biological oxidation of elemental sulfur to produce sulfuric acid is a process option currently under investigation. Column testwork has recently been completed and demonstrated the potential viability of the process. The biological generation of acid would consist of a series of small reaction tanks and transportation of elemental sulfur. Agglomeration of elemental sulfur and bio-acid produced from bacteria would be required. Additional testwork and economic evaluation is necessary to demonstrate scale-up and commercial application and the Company continues to optimize the process.

Given all of the above factors, a heap leach operation using an onsite acid plant was selected as the preferred alternative, and was based on a balance of environmental, technical, operational and economic considerations.

4.2 LOCATION OF THE MINE AND MINING ALTERNATIVES

There are no alternatives to the location of the ore body. Consequently, environmental and socio-economic considerations play no part in the selection of the location of the mine site.

There are two basic mining methods, open pit bulk mining and selective underground mining, with open pit mining being on the order of 10 times less cost per tonne mined than underground mining. Underground mining is generally only applicable to narrow, *often deep*, high grade vein or tabular type deposits, whereas open pit mining is generally applicable to *relatively shallow*, lower grade type deposits *where stripping ratios are not excessive* like Carmacks Copper. Whereas underground mining generates relatively minor quantities of waste (low waste to ore ratio), open pit operations generate relatively larger quantities of waste (high waste to ore ratio *or stripping ratio*) (Table 4-2).

Because of the *nature and size of the* Carmacks Copper *deposit*, it would not be *economically* feasible to mine the deposit using underground methods. Although, the ore *has a reasonable* grade, being 1.01 % copper, it is of insufficient value to support underground mining. As the waste rock is acid consuming, there would be no environmental benefit to using underground mining techniques for ore extraction.

Consequently, the selection of the mine and mining methods are dictated almost exclusively by technical engineering and economic considerations. Beyond the implications of mine drainage, environmental and socio-economic aspects have only minor roles in mine site and mining method selection. However, the fact that the project is based on open pit methods, limits the selection of waste and ore storage areas, and the fact that the ore deposit is of relatively small size, limits the selection of extraction and processing alternatives.

4.3 MINE WASTE ROCK STORAGE AREA ALTERNATIVES

Open pit operations typically generate larger quantities of waste (high waste to ore ratio). The Carmacks Copper operation is projected to have an overall life-of-mine waste to ore stripping ratio of 4.6:1 and is projected to generate approximately 60 million tonnes of waste over the 8 year mine life.

Waste rock generated by the mining operations has been tested for comprehensive whole rock, multielemental scans, ABA testing and petrographic evaluation. On the basis of laboratory testing using acid-base accounting techniques and simulated weathering techniques, neither the waste rock nor the open pit wall rock was found to be capable of generating acid or liberating metals at concentrations which would be of environmental concern. Test results indicated that the runoff from the waste and open pit wall rock would not require any special treatment, other than settling to remove suspended solids, before it was released to the environment.

Given the large quantities of waste that have to be stored, it is the general practice to find suitable locations within close proximity to the ore body. Generally the shorter the distance, the lower the environmental effects. Topographical constraints and geotechnical stability are critical in that flat land or bowl shaped features large enough to accommodate the waste volume are preferred over side-hill dumps. In addition to control of acid generation, environmental protection of watersheds, area of disturbance, loss of vegetation and wildlife habitat are the next primary considerations. Haulage distances and associated costs are a significant consideration and did limit a couple of options in the selection process (Table 4-3).

A total of four locations were considered as alternative waste rock storage areas with the evaluation presented in a separate report (Western Copper Holdings Ltd. Carmacks Copper Project Waste Rock Storage Area Evaluation and Detailed Design Report, June 30, 1997). Table 4-3 summarizes the options considered.

On the basis of environmental studies, upper Williams Creek and north Williams Creek were not found to contain fish (Section 5.2.1.1). Similarly, on the basis of baseline studies, all sites were found to have moderately to low capability for wildlife. Geotechnical evaluations indicate some concern with foundation conditions at most sites investigated. Alternative sites were unfavorable from a haulage perspective, conflicted with other mine site components, were too steep or have similar stability issues. As such, the preferred site located north of the pit on the south valley of North Williams Creek has been selected primarily on a balance of environmental, technical, engineering and economic considerations and incorporates mitigative measures to address stability and foundations concerns.

4.4 HEAP LEACH PAD ALTERNATIVES

Three alternatives for heap leach pads include the on/off reusable pad, the permanent heap leach pad, and the valley heap leach pad. Please refer to Table 4-4 which provides a summary of the rationale for choosing the valley heap leach pad.

Ore is temporarily stacked on the on/off reusable pad and leached; then the spent ore is relocated. This type of leach pad operation is better suited to small high grade ore reserves as the cost associated with the necessary rehandling of ore becomes prohibitive in lower grade reserves. The spent ore would require a separate storage and detoxification area resulting in a greater area of disturbance. The type of liner used with the on/off reusable pad is robust (i.e. concrete, asphalt) to facilitate material movement on and off of the pad. These liner types are not conducive to sulphuric acid leaching.

Ore is stacked on the permanent heap leach pad, leached, and reclaimed on a flat or slightly inclined slope comprised of low permeability soil. This type of leach pad has a liner that is expandable in stages and is appropriate for larger low grade reserves. The type of liner used with the permanent heap leach pad is a robust liner system with LDRS. Use of flat areas inhibits the movement of solution to the process plant and potentially increases hydraulic head on the liner. Upon closure, the heap would remain in place on the liner system to enable in-situ detoxification.

Ore is permanently stacked on the valley heap leach pad, leached, and reclaimed within a naturally sloping valley. This type of leach pad has a liner that is expandable in stages and is appropriate for larger low grade reserves. A confining embankment is required at the toe of the pad and the heap must be physically stable. The type of liner used with the permanent heap leach pad is a robust liner system with LDRS. Existing terrain is sloped and gravity facilitates the movement of solution to the process plant and allows for easier control of hydraulic head. Upon closure the heap would remain in place on the liner system to enable in-situ detoxification.

The valley heap leach permanent pad is the preferred option due to the nature of the local terrain, which is a gently sloping valley with no flat areas. The on/off reusable pad is not appropriate due to the nature of the ore reserve. This option minimizes the area of disturbance and allows for better control during heap detoxification at closure.

4.5 HEAP LEACH SITE ALTERNATIVES

A detailed discussion of the heap leach pad alternative site selection process is presented in the following reports. The reader is referred to these reports for a full discussion. Review:

- Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Conceptual layout of Mine; (Report No. 1781/1),* January 1992;
- Hallam Knight Piésold Ltd. (HKP), *Western Copper Holdings Limited, Carmacks Copper Project, Detailed Report on conceptual Design of Heap Leach Facility for Closure (Ref. No. 1783/8);* Initial Environmental Evaluation (IEE), Addendum No. 3, October 1995; and
- Knight Piésold Ltd., *Western Copper Holdings Limited, Carmacks Copper Project, Report on Updated Detailed Design of the Heap Leach Pad and Events Pond (Ref. No. 1785/1);* 23 April 1997.

4.6 SELECTION OF THE HEAP SOLUTION STORAGE SYSTEM

The heap leaching process with out of heap raffinate solution storage system was selected over the in-heap solution storage system primarily for operational, environmental and safety reasons (Table 4-6).

Review of the operational experience at the Brewery Creek Mine in Yukon indicates that heap leaching year round with external solution storage in an extremely cold weather climate is proven and practical. In addition, the acid leach is an exothermic reaction and produces heat which minimizes concerns with freezing conditions on the liner system and piping.

Leakage rates with in-heap storage and the potential for groundwater contamination is a concern due to relatively high hydraulic head on the liner system within the area of solution containment. External solution storage reduces the hydraulic head on the heap composite liner system and ensures that heap leakage rates are below the leakage

guidelines and ensures the protection of local groundwater. Problems with heap liner integrity are more difficult to locate and fix once the ore has been loaded and the heap height advances. With external solution storage, liner problems within the storage pond can be identified and fixed through proper solution management.

Important concepts for successful solution storage in cold weather heap leaching incorporated into the engineering design include:

- Reducing solution inventories in winter and only using the pond in emergencies in winter;
- Burial of drip emitter lines directly into the ore surface prevents freezing during intermittent power or pumping interruptions;
- Proper solution management plans and operation training to prevent high pond solution inventories during winter operations;
- Sloping solution pipelines for drainage, burying and/or insulating and/or heat trace; and
- Providing redundant systems for power, pumps, and piping to ensure that solution flow is continuous and uninterrupted and low pond volumes are maintained.

Although there is increased land requirements and resultant increased disturbance of vegetation and wildlife habitat, the amount of area that must be ultimately reclaimed at the end of mining for an events pond is not considered significant. The benefits of not having in-heap storage are considered an environmental advantage as the hydraulic heads on the liner system are reduced. As such, out of heap storage of raffinate solutions is the preferred alternative.

4.7 SELECTION OF SITE INFRASTRUCTURE

The number of options for site infrastructure (crushers, access roads, SX/EW plant, settling ponds, treatment plant and ore conveyance systems) are relatively wide, however site selection of these facilities is based primarily on economics once the process, mining method, WRSAs and heap leach pad sites have been selected. The selection of site infrastructure is based primarily on efficiency of operations, economics and technical considerations, as they have limited potential for environmental effects.

An economic analysis of ore from the open pit to the leach pad, comparing truck haulage and overland conveyor was undertaken as discussed below. An access road is required regardless of the ore transportation method selected.

4.8 HEAP STACKING ALTERNATIVES

Two alternatives, truck and dozer, and conveyors, were considered for stacking ore on the heap leach pad. Table 4-6 provides an evaluation matrix for heap stacking alternatives considering economic, technical, environmental and socio-economic considerations. The selection of heap stacking alternatives is driven by the necessity for size reduction of the ore prior to leaching. If Run of Mine (ROM) processing is selected, heap stacking by truck and dozer becomes a preferred option. If the ore requires crushing and agglomeration to provide acceptable copper recoveries, heap stacking by

conveyors becomes the preferred alternative. The current testwork for copper recovery suggests crushing will be required and therefore a conveyor system has been selected as the preferred option for the project primarily on the basis of technical concerns. Additional process optimization, testwork and economic evaluation may change the necessity for crushing and provide ROM processing as a viable alternative. Please refer to Appendix A, Drawing 200-03-01 for a crushing and screening flowsheet.

4.9 MINE ACCOMMODATION ALTERNATIVES

Socio-economic studies were undertaken by Western Copper in the early part of the planning process to select the best alternative for employee accommodations that would offset negative effects and enhance benefits wherever possible (Volume II of the IEE, "*Community Profiles and Socio-economic Impact Assessment*", (HKP 1994)). *This work has been updated and alternative accommodation scenarios are addressed in Section 4.7 of the 2006 Socio-economic Effects Assessment Report (Appendix P).*

The option of housing all employees in the Village of Carmacks and bussing personnel to the site each shift was considered. Due to the comparatively high number of employees in relation to the size of the local communities, housing all employees within existing local centers would result in the need for some construction of housing and related community infrastructure (Table 4-7).

In assessing socio-economic effects, the existing socio-economic conditions in the Village of Carmacks were documented (*Appendix P*). Projected changes that may be expected to occur were considered and an evaluation completed of the community's capabilities to absorb the affected changes. The principal considerations that were believed to have an overall bearing on the magnitude of effects were as follows:

- evaluation of surrounding communities to accommodate and assimilate the expected growth,
- size and life span of the proposed mine development;
- size and source of the operational work force, and the settlement patterns of people moving into the community;
- LSCFN land claims, cultural considerations, ethnographic and archaeological resources;
- work schedule and accommodations, location of the mine relative to the nearest communities, and
- equipment, supplies and services procurement.

The project-related population increases in Carmacks and Whitehorse are expected to be minimal to moderate, *as presented in Appendix P*. Socio-economic studies incorporated an analysis of community populations, demographics, levels of employment and housing availability for those communities that would be most affected. Municipal and Territorial representatives were interviewed to determine the availability of community services (e.g. recreational facilities, water, sewer systems, solid waste disposal facilities, court services, transportation systems, police and fire protection, educational facilities, medical and health care). Information on community infrastructure, commercial and industrial sectors, communications, average incomes, taxes and transportation was also evaluated.

By providing an initial construction camp and modifying this camp to provide on-site accommodation and allowing the workforce to work on a shift rotation basis, workers will be able to live elsewhere in the Yukon, in addition to the local communities. This spreads the economic benefits of the project, reduces the impact on local communities to a manageable and beneficial level, and eliminates the boom and bust phenomenon associated with mining towns in the past.

Consequently, the on-site accommodation for the *construction* workforce *during* project construction, and modifying this camp facility to provide some on-site accommodations during operations was selected as the preferred alternative almost exclusively on the basis of socio-economic considerations. *An accommodation facility in or near Carmacks may also be considered for the permanent workforce in lieu of, or in addition to, on-site accommodation for the permanent workforce. Further discussions with the Village of Carmacks and LSCFN will occur prior to the option selections. Both of these options were considered in the Socio-economic Effects Assessment Report presented in Appendix P (Section 4.7).*

It is expected that socio-economic effects of the project can be distributed over a broader regional base of communities with developed, existing infrastructures, thereby reducing the impacts to any one community, particularly that of the LSCFN and the Village of Carmacks.

4.10 ALTERNATIVE POWER SUPPLY SOURCE

Project power supply sources were discussed in Section 3.2.7.3. In addition, Yukon Energy Corporation completed an environmental assessment and routing analyses for supplying power to the project (Yukon Electrical Company Ltd, 1995). On-site diesel generation of power was calculated in 1997 to be less expensive over the mine life of 8 years compared to the economics of constructing a powerline from Carmacks. In addition, the operations would require a supply of on-site, dedicated standby and back-up power for operation of critical environmental protection facilities such as heap leach pad recirculation pumps, leak detection and recovery systems, and the water treatment plant, as well as the camp accommodation.

The selection of on-site power generation over installation of a powerline *will be* based primarily on economics – *electrical energy* being one of the most significant operational costs. Environmental, technical and operational considerations, such as utilization of waste heat, line and plant maintenance, access, reclamation and need for back-up power *are of* secondary importance in the selection of power supply alternatives (Table 4-8).

The *originally stated plan* for the Company is *on-site* diesel generation however, the underlying assumptions, particularly those in the economic analyses, used in the selection process *have changed considerably in recent years with the considerable escalation in the price of diesel fuel and* as a result of discussions with Yukon Energy. If Yukon Energy proceeds with the construction of the Carmacks-Dawson extension of the grid as they have indicated, tapping off that line close to the plant site may prove a viable option for Western Copper. *However, construction of this project is subject to regulatory and assessment reviews, with the results not known at this time. As such, the project presently relies on onsite diesel generation and this is the proposed option at this time.*

Table 4-1 Production Capacity and Process Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Production Capacity					
Low tonnage <1000 t/d	Incapable of supporting infrastructure capital costs given short annual operating period	Equipment requirements for low tonnage mismatch known ore reserves	Not applicable	National, regional and local benefits would be smaller and spread over extended period (30 years or more)	9,872 tonnes of ore per day, for 300 days, 1,700,000 tonnes ore per year selected as the preferred alternative production capacity over annual operating period
Moderate 1000 to 10,000 t/d	10,000 tonnes per day required to support viable rate of return, optimizes capital expenditure	Equipment requirements better match to known reserves, optimizes crusher capacity if required	Not applicable	Positive, well-matched benefits to national, regional and local economy more significant and more definite in short term	
High tonnage >10,000 t/d	Capital cost for significantly larger operations would be excessive with under-utilized equipment.	Known reserves and winter operations do not support high daily tonnage. Logistics complicated.	Not applicable	Larger project would have much larger but potentially negative impacts on small communities	
Processing Alternatives					
Grinding, gravity concentration followed by flotation	Moderate recovery (50 to 60%) high capital and operating costs	Moderate equipment requirements, year-round operations, tailings area, additional offsite processing required	Large tailings area, no liners or water treatment required. Wildlife and fisheries habitat impacts significant	Moderately large staff, on-site housing, year-round mining and milling operations.	Heap leaching preferred due to good recovery, absence of tailings area, lower power requirement, flexibility of operation. Company to optimize acid use.
Heap Leaching - Sulphuric Acid leach	A good recovery (60 to 80+) depending on crush size. Low capital and operating costs	Small SXEW plant required, equipment requirements minimized, heap leach pad and water management, allows for flexible annual mine plan. Acid plant or trucking of acid required.	Lined heap leach pad and events pond. Water management with contingency water treatment. Impacts on fisheries and wildlife minimal. Potential accidents from acid trucking. Longer closure detoxification.	Moderately large staff, on-site housing, some flexibility in year round operations.	
Heap Leaching - Elemental Sulphur/Bacteria Leach	A good recovery (60 to 80+) depending on crush size. Low capital and operating costs	Small SXEW plant required, equipment requirements minimized, heap leach pad and water management, allows for flexible annual mine plan.	Lined heap leach pad and events pond. Water management with contingency water treatment. Impacts on fisheries and wildlife minimal. Less aggressive closure detoxification.	Moderately large staff, on-site housing, some flexibility in year round operations.	

Table 4-2 Mining Method Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Mining Method					
Open Pit	Economics of scale and Bulk mining methods relatively high capital but low operating costs.	Applicable to widely disseminated low grade, porphyry deposits.	Large waste to ore stripping ratio Waste is acid consuming.	Not applicable	Carmacks Copper ore body consists of low grade, oxide ore, widely disseminated. Mining by open pit methods is the only viable method economically. Waste is acid consuming and not a hazard to environment.
Underground	High capital and operating costs Selective mining methods.	Applicable to high grade, narrow vein or deep tabular ore bodies.	Low waste to ore stripping ratio Waste is acid consuming.	Not applicable	
Combined Open Pit and Underground	Economics of scale at surface High capital and operating costs to reach ore at depth.	Applicable when stripping ratio too high to reach mineable ore at depth.	Moderate waste to ore stripping ratio Waste is acid consuming.	Not applicable	

Table 4-3 Mine Waste Rock Storage Area Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Waste Rock Storage Area					
North Pit Area					
Option a North of pit, south side of valley - no foundation preparation	Immediately adjacent, haul distance very economical	Capacity limited, foundation problems, valley fill, possible stability concerns.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	Option b - North of pit, south side of valley. Adequate capacity & proximity. Foundations conditions allow remediation. and contingency buffer zone. Contingency buffer zone allows construction of stability berm as noted in Option d. Away from watercourse and fisheries habitat. Vegetation and wildlife capability moderately low to low.
Option b North of pit, south side of valley - foundation prepared no buffer area.	Immediately adjacent, haul distance very economical. Cost to prepare foundation.	Adequate capacity, foundation concerns mitigated, permafrost stripping, side hill dump.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option c North of pit, south side of valley - foundation covered with waste rock insulation	Immediately adjacent, haul distance relatively economical but costly ground preparation.	Adequate capacity, foundation concerns mitigated, side hill dump, winter construction of insulating layer, complicates sequencing.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option d North of pit, south side of valley - no foundation preparation. Stability berm.	Immediately adjacent, haul distance relatively economical. Cost to prepare stability berm.	Adequate capacity, foundation problems, side hill dump, construct keyed in stabilizing berm adds excavation.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
Option h North of pit, south side of valley - remove thaw unstable material	Immediately adjacent, haul distance relatively economical, but overall options highly uneconomic.	Adequate capacity, foundation problems, side hill dump, significant excavation of thaw unstable material	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	
North Williams Creek Area					
Option e North of pit, into north Williams Creek. Use opposite valley to stabilize dump	Moderately adjacent, haul distance not as economical. Requires end dump from high lifts.	Adequate capacity, foundation problems, cross valley fill, rock across stream, flow through drain could plug - likely slumps during construction due to lift height.	No fish habitat, Vegetation and wildlife capability moderate to low. Stream crossed - potential chemical issues.	Not applicable	
Northwest Pit Area					
Option f Northwest of pit, north of leach pad - higher elevation	furthest removed, haul distance uphill, not as economical.	Adequate capacity, foundation problems, side hill dump.	No fish habitat. Vegetation and wildlife capability moderate to low Covers small streams, possible chemical issues.	Not applicable	
South Pit Area					
Option g South of pit on steep slope	Immediately adjacent, haul distance very economical	Capacity limited, foundation better but steep slopes problems, valley fill.	No fish habitat. Vegetation and wildlife capability moderate to low	Not applicable	

Note: Options as reported in Western Copper Holdings Ltd. Carmacks Copper Project Waste Rock Storage Area Evaluation and Detailed Design Report, June 30, 1997

Table 4-4 Heap Leach Pad Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative for Carmacks
Heap Leach Pad Type					
On Off Reusable Pad (Ore temporarily stacked on pad, leached and relocated)	Economics more suited to smaller higher grade ore reserves. Capital savings on constructing large pad. Poor economics with typical lower grade large reserves due to requirement to move ore two or more times.	Robust durable liner needed for on off material movement (i.e. concrete or asphalt). Liner type incompatible for sulphuric acid leach. Spent ore requires separate storage and detoxification area. Greater area of disturbances.	Increases area of disturbance for spent ore storage and detoxification. Incompatibility of liner with leach solution increases risk of solution loss and potential concern with groundwater contamination.	Longer mine/leach process life	
Heap Leach - Permanent (Ore permanently stacked on pad, leached and reclaimed on slight inclined slope)	Economics more appropriate for larger low grade reserves. Liner expandable in stages. Requires flatter area to minimize construction costs. Better economics for closure and detoxification due to lack of rehandling ore.	Local topographic and geotechnical conditions must be suitable at site, i.e. generally flat site with adequate low permeability material. Robust liner system required with LDRS. Flatter slopes impedes solution movement to plant. Hydraulic head on liner may increase on flatter slopes.	Topography and soil condition site controlled. Hydraulic head on liner must be controlled. Single expandable pad retains entire pile on liner system and enables detoxification.	Not applicable	
Valley Heap Leach Pad (Ore permanently stacked on pad, leached and reclaimed within natural sloped valley)	Economics more appropriate for larger low grade reserves. Liner expandable in stages. Utilizes existing terrain to minimize construction costs. Confining embankment required at toe. Better economics for closure and detoxification due to lack of rehandling ore.	Local topographic and geotechnical conditions must be suitable at site, i.e. gently sloping valley. Robust liner system required with LDRS. Steeper slopes improves solution movement to plant. Reduced hydraulic head on liner with steeper slopes. Liner and heap constructability on very steep slopes must be addressed by design.	Topographically and soil condition site controlled. Hydraulic head on liner easier to control. Single expandable pad retains entire pile on liner system and enables detoxification. Need to ensure physical stability of pile.	Not applicable	Valley heap leach pad preferred due to nature of local terrain, i.e. no flat areas and re useable pad not appropriate. Minimizes environmental concerns. Direct gravity solution flow to SXEW plant. Minimizes area of disturbance and better control for closure and detoxification.

Table 4-5 Process Solution Storage Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Solution Storage In-heap Solution Storage	Good economics. Capital savings on constructing storage capacity. Cost savings in conserving heat. Cost savings in wildlife protection.	Increased engineering and design costs. Spill prevention and safety concerns reduced. Cold weather operations improve. Greater hydraulic head on liner.	Minimizes area of disturbance by using available in-heap storage. Heat conservation minimizes winter spill concerns. Pregnant solution isolated from wildlife and water fowl, concern with groundwater contamination	Not applicable	Out of heap solution storage preferred, Economical, minimizes environmental, safety concerns during extreme cold weather. Solutions directed to SXEW. Reduces need for wildlife and water fowl protection. Reduces the need for more robust liner system and risk to local groundwater.
Out-of-Heap Solution Storage	Good economics - robust liner needed. In-heap storage capacity not utilized. Heat losses not substantial. Capital cost and maintenance cost and problems for wildlife protection.	Increased engineering and design costs for events pond. Spill prevention and safety of operations concerns. Cold weather operations to SXEW plant. Lower hydraulic head on liner.	Required additional area of disturbance Avoids available in-heap storage and loss of waste heat in winter. Greater spill concerns. Wildlife and water fowl exposure to process solution is potential concern. Concern with groundwater contamination	Not applicable	

Table 4-6 Heap Stacking Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Heap Stacking Methods Truck and Dozer	Moderately high initial capital costs if extra trucks and equipment required. High operating costs for truck fleet.	Highly flexible. Allows thermal capping and irrigation installation at same time. Rubber tires cause compaction of surface. Area has to be ripped before placing next layer.	Not applicable	Not applicable	Conveyor stacking was selected as the preferred option. Although capital costs higher, compaction concerns were cited as a major consideration over truck and dozer.
Conveyor System	High initial capital costs for equipment.	Relatively inflexible. Interferes with capping and irrigation installation at same time. Compaction of surface not a concern. Ripping not required.	Not applicable	Not applicable	

Table 4-7 Workforce Accommodation Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Mine Accommodations Housing in Existing Communities With Bussing	High capital costs for housing allowance. High capital and operating costs for busses and bussing.	Work schedules lessflexible for crews. Small camp still required for differential shifting. Staffing for reduced winter work force difficult.	More road traffic. Higher incidence of wildlife road kills. Higher potential for vehicle accidents and reagent spills.	Local effects on Carmacks, and Whitehorse predicted. Lack of adequate housing. Community infrastructure adequate. More impact on First Nations Communities and life-style.	On-site construction camp was selected with community based housing and bussing. Less capital, operating costs. Reduced impact on local communities. Less impact on First Nations communities and life-style. Moderate flexibility for operations and shift schedules.
On-site Camp Accommodation (Construction Camp) with Limited Bussing	High capital costs for camp and High operating costs for camp accommodation. Moderate high operating costs for limited number of busses and bussing.	Work schedules more flexible. Accommodates 3 x 8 and 2x12 shifting. Reduce staffing for winter attractive to local residents.	Less road traffic. Lower incidence of wildlife road kills. Lower potential for vehicle accidents and reagent spills.	Moderate impact on Carmacks and Whitehorse predicted. Community infrastructure adequate for expected population increase. Fewer impact on First Nations Communities and life-style. Boom and Bust impacts can be mitigated.	Less traffic and lower impact on families living in established communities. Reduced wildlife hazards on road.

Table 4-8 Power Supply Alternatives Evaluation Matrix

Alternative	Area of Consideration				
	Economic Considerations	Design, Engineering Construction and Operational Considerations	Environmental Considerations	Socioeconomic Considerations	Preferred Alternative
Mine Accommodations On-Site Diesel Generation	High capital and operating costs. No capital costs for power line. On-site diesel back-up power required in any event. Savings in use of waste heat.	Increased engineering and design for generation, substation & distribution. Increased requirement for on-site fuel storage and spill prevention. Constant fuel supply required. Marginally less reliable than overhead power.	Increased source of air emissions. Ability to use waste heat for solution heating winter. Increased risk of spills due to fuel storage and transport. Marginally less reliable than overhead increases risk of power failure and reliance on back-up systems.	Not applicable	On-site diesel generation of power was selected as the preferred alternative due to the overall lower capital and operating costs and use of waste heat for project. However, YEC has completed an EA for routing power to the project. Further discussion with YEC could revise preferred decision.
Overhead Supply from Whitehorse Aishihik Faro Power Grid with on-site back-up capacity (two routing options assessed by Yukon Energy Corporation)	High capital costs for line and substation(cost share). No plant needed. Operating costs based on peak power demands year-round. Capital cost for Carmacks substation upgrade. On-site diesel back-up power required in any event. No advantage in use of waste heat.	Reduced engineering and design for generation, substation & distribution. YEC responsible for system. Much lower fuel requirement, and much lower requirement for on-site fuel storage and spill prevention. More reliable than on-site diesel generation.	No source of air emissions but greater impact at YEC generation sites. Lower risk of spills due to fuel storage and transport. More reliable than having it on-site and reduces risk and reliance on back-up power systems.	Not applicable	Excess power is available on the WAF grid.

5.0 ENVIRONMENTAL SETTING AND SOCIO-ECONOMIC CONDITIONS

P.A. Harder and Associates Ltd. conducted an initial assessment of baseline environmental conditions from 1992 to 1993, and additional work was completed by HKP in 1994. This information is found in Volumes I and IV, respectively, of the Initial Environmental Evaluation (IEE) compiled in 1994. Since the IEE was filed, four Addendums to the IEE were filed by HKP, Knight Piésold Ltd., and Kilborn to reflect additional information collected and changes to the IEE (Section 10 provides a listing of reports). The environmental monitoring program was re-activated in 1998 and again in 2005 to update surface and groundwater quality, hydrological, fisheries and wildlife data for the area. The following sections summarize information from the IEE and Addendums and presents new data where available; specific reports should be referred to for further details and information respecting baseline environmental conditions.

A listing of the extensive physical, biophysical and socio-economic studies completed to document local environmental and socio-economic conditions and used to support project engineering and design for the Carmacks Copper project are below:

- Groundwater and surface water quality sampling program at a number of sites within the Williams Creek drainage basin;
- Surface and groundwater hydrology at a number of sites within the Williams Creek drainage basin;
- Detailed groundwater model of the heap leach pad area;
- Geology, foundation, geotechnical and hydrogeological studies for areas with proposed infrastructure, including the heap leach pad and mine WRSA;
- Waste rock and spent ore characterization including ABA analysis, SWEP testing and metal mobility testing;
- Metallurgical testing on the acid leaching of copper from the Williams Creek deposit;
- Water treatment performance and treatability testwork for heap leach detoxification;
- Water treatment plant effluent and toxicity testing;
- Petrographic and mineralogical reports;
- Terrain hazard analysis;
- Seismic hazard assessment;
- Meteorological studies including regional meteorological analyses, snow pack and snowmelt runoff analyses, and on site automatic climatic stations for precipitation, wind direction and speed, and temperature;
- Stream sediment survey in Williams Creek drainage basin;
- Fisheries studies (species distribution and abundance, habitat use and capabilities) for the project area drainages including drainages crossings along the access road;
- Benthic macroinvertebrate surveys in Williams Creek drainage basin;
- Vegetation survey within the project area;
- Wildlife surveys (species occurrences, habitat potential, traditional knowledge);
- Archeological and heritage resource assessments at the project location and along the access road;
- Traditional and cultural resource use assessment (traditional knowledge); and
- Socio-economic effects assessment of the local and regional communities *(updated in 2006 and presented in Appendix P).*

Details of most of these studies can be found in the references listed in Section 10. Many of these reports already exist in Yukon Government Public Registry for this project.

5.1 PHYSICAL ENVIRONMENT

5.1.1 Climate

The Williams Creek basin is located in an area characterized by moderate total annual precipitation and extreme variations in temperature. Precipitation and temperature data were collected during the summer of 1992, and in 1994 Water Resources Division of DIAND established an automatic meteorological station at the site. The station is still being *operated by YG Water Resources* and continuous records are available from September 1994 to present, except where gaps occur due to equipment malfunctions.

Clearwater Consultants Ltd. Memorandum CCL-CC6 – Williams Creek Site Hydrology Update (January, 2006) in Appendix D4 presents an update to the Williams Creek area site hydrology, using site and regional data available up to 2005. Average monthly precipitation conditions are shown in Table 5-1 below.

Table 5-1 Average Monthly Precipitation Conditions – Williams Creek Site

Month	Rainfall mm	Snowfall mm	Total Precipitation mm
Jan	0	21.7	21.7
Feb	0	16.2	16.2
March	0	13.5	13.5
April	4.1	12.2	16.3
May	24.0	0	24.0
June	39.6	0	39.6
July	57.2	0	57.2
Aug	41.3	0	41.3
Sept	30.5	0	30.5
Oct	0	28.1	28.1
Nov	0	26.7	26.7
Dec	0	23.3	23.3
TOTAL	196.5	141.9	338.4

Data from Table CC6-10 in Clearwater Consultants Ltd. Memorandum CCL-CC6 – Williams Creek Site Hydrology Update (January, 2006)

Average annual precipitation is approximately 300 mm to 400 mm, with July being the wettest month.

Average monthly temperatures range from a low of approximately -30°C in January to a high of approximately 13°C in July. The following table presents a month-by-month breakdown of temperature in the Carmacks Area.

Table 5-2 Monthly Average Temperatures at Williams Creek

	Temperatures
	Daily Mean (C)
January	-27.5
February	-21.1
March	-11.2
April	0.5
May	8.0
June	13.4
July	15.5
August	12.7
September	6.5
October	-2.7
November	-16.1
December	-24.4

Data from Table CC6-12 in Clearwater Consultants Ltd. Memorandum CCL-CC6 – Williams Creek Site Hydrology Update (January, 2006).

Winter conditions may be considered to extend over the period where daytime maximum temperatures average below zero. The extreme cold temperatures in the region make outside construction in the winter difficult. In general the working construction season will be from May to October. The ground is normally frozen in May, and earthworks such as leach pad grading and embankment fills cannot be started until June or July.

Tables CC6-1 through CC6-16 in Memorandum CCL-CC6 (Appendix D4) presents comprehensive hydrological data from the Williams Creek site between 1995 and 2005.

Air quality in the project area as well as for the Village of Carmacks is considered to be good as there is no major development in the region. Yukon Government Water Resources operates an automated weather station at the project site however wind direction has not been monitored. It is expected that the station can be augmented to collect this data during operations. Due to orthographic effects (See CCL-CC6), it is expected that the project site will be slightly warmer in the winter than at the Yukon River and would minimize local thermal inversion effects.

5.1.2 Topography

5.1.2.1 Physiography

The Carmacks Copper Project area lies within the Klondike Plateau and is part of the Pelly River Ecoregion (Oswald et. al. 1997), which is comprised of portions of the Stewart, Macmillan, Lewes, and Klondike Plateaus and Tintina Valley physiographic subdivisions (Bostock, 1970). Surface drainage flows both north and east from the study area. A number of valley streams, of which Williams Creek is the largest, drain northeastward to the Yukon River.

A broadly rolling till plain forms the dominant glacial landform. Isolated pockets of fluvial and glaciofluvial sands and gravels, glaciolacustrine silts and organic deposits mantle the subdued till in places. Surface till is variable in color, moderately stony and has a silty sandy matrix. Volcanic ash forms a veneer from 5 to 30 cm thick in various locations throughout the area.

The Carmacks Copper Project area features a broad valley and rounded ridge crests. Relief is 480 to 900 m within the study area. Till deposits in the valley bottoms and on lower slopes are the result of direct glacial deposition. Tills with a silty sandy matrix reflect the regional glaciation; in the upper valleys a coarser, looser till may be found, which reflects deposition from ablating valley glaciers. The higher elevation areas were likely not glaciated during the Wisconsin Advance; however, these areas were probably influenced by an earlier, pre-Wisconsin Advance.

Large volumes of meltwater emanated from the retreating ice. Loose, surficial deposits were eroded from slopes, transported by meltwater streams and deposited as glaciofluvial terraces, outwash plains and ice-contact kames and eskers. These granular sediments infilled much of the valley lowlands. In places, they are associated with silt deposits laid down in glacial lakes formed by temporary ponding of meltwater.

In post-glacial time, deposition and erosion continues. Colluvial deposits are gravity-transported materials common to sloping ground. Angular bedrock fragments with interstitial sand and silt are ubiquitous on ridge crests and upper and mid-slope positions. Fluvial sediments and organic materials accumulate on floodplains, fans and adjacent valley lowlands. Fluvial erosion, lateral and vertical cutting through existing surface materials, is an on-going but generally imperceptible process; it is usually most dynamic in steeper-gradient channels and where unstable bank materials exist. Landsliding and debris flows are rapid mass movement processes which are modifying some areas of sloping terrain. Where surficial deposits are overlain by a blanket of organic materials, and on many north facing slopes, permafrost tends to occur. In these areas, ground-ice was encountered at depths of 40 to 50 cm.

General

Topography at the property area is subdued. Topographic relief for the entire property is 515 m. In the immediate area of the No. 1 zone, topographic relief is 230 m. Elevations range from 485 m at the Yukon River to 1,000 m on the western edge of the claim block.

Outcrop is uncommon because of the subdued topography and lack of glaciation. The major portion of the claim block lying north of Williams Creek is unglaciated above the 760 m elevation. The claim block area south of the Williams Creek valley and peripheral portions of the claim block, especially to the east, are covered by a veneer of ablation and lodgment bouldery till with a sandy to silty matrix, generally less than 1 m thick.

Williams Creek valley and its tributaries are the dominant topographic features of the study area. The main valley is characterized generally as a broad floodplain containing sands and silts that are covered by a blanket of organic accumulation. Ground ice occurs throughout this area at depths of 10 to 20 cm and peat plateaus are common. The Williams Creek channel becomes more confined downstream of the mine site area, where it has cut through bedrock and extensive deposits of fluvio-glacial sands and gravels.

Near its confluence with Yukon River, Williams Creek is tightly confined in a canyon comprised of bedrock outcrop and steeply sloping outwash terraces. Due to the fact that much of the western portion of the study area was unglaciated during the Wisconsin Advance, the common surficial materials occurring up-slope of Williams Creek are a combination of coarse textured colluvium and medium textured glacial till, and minor fluvio-glacial materials. Weathered bedrock is a dominant feature throughout much of the upland area, where soils exhibit a coarse sandy and rubbly texture. Minor side-slope drainages are usually incised into bedrock and exhibit infilling by fluvial sediments, capped by a veneer of organic accumulation. Extensive areas of the landscape, where slopes are generally less than 20% are poorly drained and covered by a veneer of organic accumulation. Loess and volcanic ash deposits (White River source) cover extensive portions of the study area.

Slope erosion processes are generally confined to minor gully erosion and landsliding. These processes are predominant on the terraces and steep slopes occurring on the north side of Williams Creek. The majority of the gulleys on the side-slopes are stable, exhibiting little erosion. The steeply sloping face on the south side of Williams Creek, upstream of its confluence with the Yukon River is exhibiting minor gully and debris flow activity. The extensive terrace face at the confluence has and continues to undergo mass movement by gully and surface erosion processes.

The proposed heap leach pad site is a moderately sloping area characterized by a blanket of moderately well drained glacial till overlying bedrock. No erosional processes affect this area.

The study area lies within the discontinuous permafrost subzone. During field examinations, ground ice was encountered at depths of 40 to 50 cm on most north facing slopes where glacial till or medium textured colluvium is present. Ground ice is widespread in the main Williams Creek floodplain as well as the north facing tributary gullies.

5.1.2.2 Soils

On the basis of regional mapping and site test pitting, soils in the mine site area are dominated by Eutric Brunisols originating from dissected colluvial parent material. Soil texture is gravely sandy loam (Agriculture Canada 1992, Knight Piésold Ltd., 1993).

According to dominant morphological features and vegetation, well drained soils on south facing slopes are gravely sandy loam and are expected to be moderately alkaline and have moderate to high organic matter content and nutrients. Areas with moderate to poor drainage, dominated by lodgepole pine and black spruce, respectively, are expected to be more acidic with low to very low nutrient content. Lodgepole pine areas are expected to have much lower quantities of organic matter than the poorer drained areas of black spruce stands (Kennedy, 1993).

5.1.2.3 Permafrost

The Carmacks Copper project lies in an area of discontinuous permafrost, which corresponds to an area between the 0°C and -10°C mean annual temperature isotherms. The mean annual air temperature for the site was calculated from the estimated annual freeze and thaw indices. The mean annual air temperature was calculated as minus 5°C for an elevation of 850 m at the Williams Creek site.

Thermistor strings Th-1 and Th-2 were installed on a north and south facing slope respectively to measure the temperature as a function of depth. Thermistor Th-3 was installed in 1995. These thermistors have been measured intermittently since 1992 with the results tabulated in Appendix II of the "Baseline Data Compilation Report" prepared by Access Consulting Group in 1998.

The temperature measurements indicate that the permafrost temperatures are near 0°C generally ranging between -0.1°C and 0.3°C which is classified as "warm" permafrost.

In 1996 two additional thermistor strings (Th-4 and Th-5) were installed in vertical drill holes (DH96-13 and DH96-15) to initiate ground thermal monitoring for foundation design. Installation and completion details are provided in test hole logs included in Appendix A of Knight Piesold's report on "1996 Geotechnical and Hydrogeological Site Investigations."

In July 2006, four of the five thermistors were located, and measurements are expected to be collected this year once the instrumentation is operational. Any results will be reported by end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary.

5.1.2.4 Seismicity

The Carmacks Copper project site is located within the interior of the Yukon Territory, an area that historically is of low seismicity. The site is located within the Northern B.C. source zone (NBC) bounded to the west by the Denali-Shakwak source zone (DSK) and to the east by the Mackenzie source zone (MKZ). In addition, beyond the Denali-Shakwak source zone lays the Fairweather-Yakutat source zone (FWY), a region which produces a high rate of large earthquakes (magnitude 7 and greater). These source zones have been defined in detail by Basham ET. Al (1982). Basham assigns a maximum earthquake magnitude to the following source zones:

Source Zone	Magnitude
NBC	5.0
DSK	7.0
FWY	8.5
MKZ	6.0

These values being one-half magnitude above the observed maximum magnitude, based on historical earthquake data.

Refer to Appendix C – Carmacks Copper Project Performance Standards and Design Criteria Parameters, for a summary of project seismic criteria.

5.1.2.5 Terrain Hazards

A terrain analysis of the Carmacks Copper property conducted by Westland Resources Group was presented in Volume IV of the IEE. Results of geomorphic conditions, land forms, and surficial materials were presented in the associated figure. This figure also indicated the location of the project facilities (open pit, heap leach pad, and waste rock stockpiles), as they were contemplated at that time.

Areas under the heap leach pad were designated as comprising M3 surficial materials which are categorized as being wet, subdued to moderately sloping till, featuring poor drainage, seepage, and/or shallow organic capping.

Areas of permafrost occur in the Williams Creek valley in the vicinity of the creek itself and in the north aspect tributaries contained occurrences of permafrost. Areas with evidence of active landsliding were observed on south facing steeply sloping scarps adjacent to Nancy Lee Creek and North Williams Creek. The potential for flooding in the area of the confluence with Williams Creek and the Yukon River, and within the creek valley to approximately 4 km upstream, was high. Flooding potential for Nancy Lee Creek is also high.

On the basis of comments on the early IEE submission, the heap leach pad was relocated at that time from the northwest side of the open pit to ground classified as comprising M4 and M5 surficial materials on the southwest side of the open pit. M4 and M5 surficial materials comprise shallow deposits overlying bedrock.

A Terrain Hazards Map (Figure 5-1) prepared by HKP in 1995, shows the location of the project facilities. Since the mapping covers the entire Williams Creek valley and features are difficult to discern in the mine site area, a larger scale map of the mine site area is given in Figure 5-2.

5.1.2.6 Geotechnical

Knight Piésold has carried out three site investigations at the Carmacks Copper Project area. The first program was a preliminary surficial geotechnical investigation completed between mid August and mid September 1992. This program examined the geotechnical and hydrogeological conditions for the open pit, four potential heap leach pad sites, process plant site, WRSA, and a water storage dam site.

The second geotechnical site investigation program was carried out between February 21 and March 10, 1995. This program examined the geotechnical and hydrogeological conditions at an alternative heap leach pad site, a possible water storage dam site, and identified potential material types for earthworks construction.

Knight Piésold between February 9 and March 4, 1996 carried out additional geotechnical and hydrogeological site investigation programs. The site investigation programs examined the geotechnical and hydrogeological conditions for the process plant site, the camp location, the crusher site, the heap leach pad site, the WRSA, and the open pit. In October 1997 EBA performed additional site investigations. The information obtained from the site investigation programs has provided the geotechnical

and hydrogeological information necessary to characterize the site for detailed design work. EBA undertook a review of available geotechnical information to determine fundamental geotechnical parameters and recommendations for the conceptual heap leach design facilities for the Carmacks Copper Project (EBA, 2005).

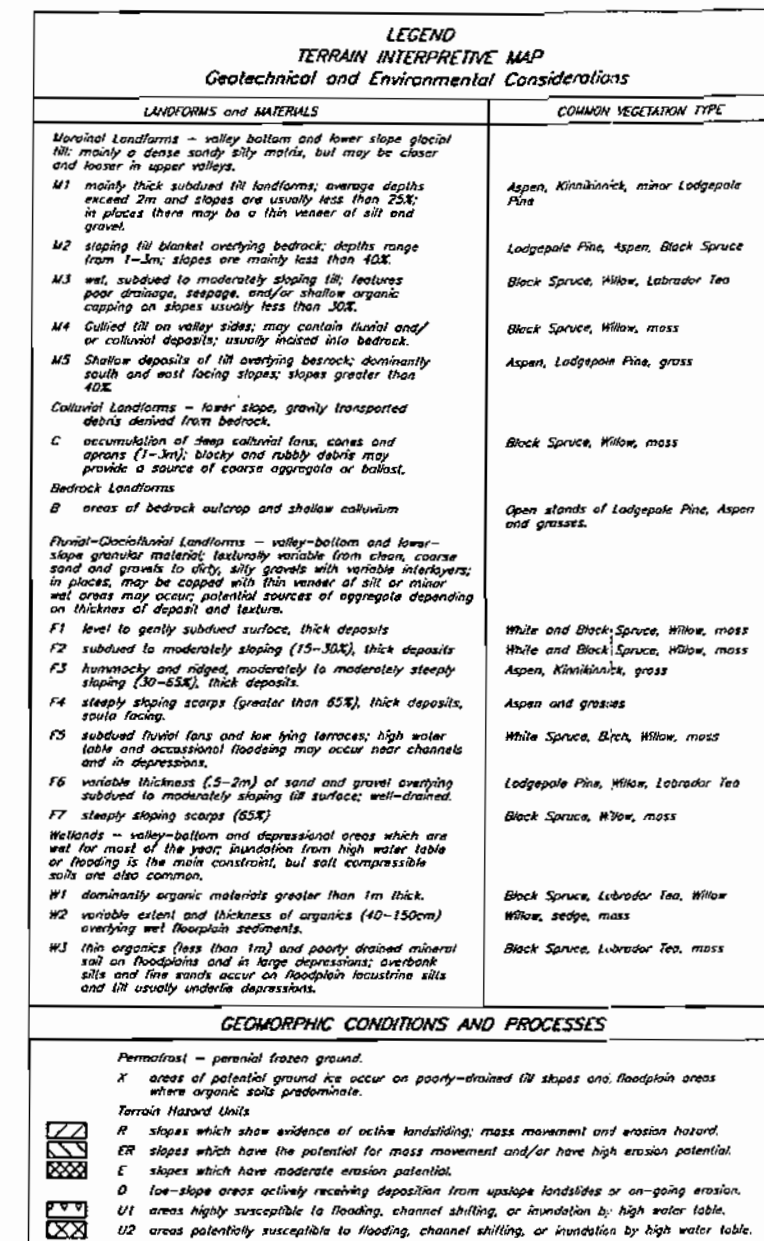
The boreholes and test pit locations for various geotechnical investigations are shown in Figure 5-4 and Drawing 1784.100. The types of surficial materials found across the project area have been grouped into the following categories:

- Organic / Ash Layer;
- Glaciofluvial / Glaciolacustrine Deposits;
- Well Graded Glacial Till;
- Weathered / Decomposed Bedrock; and
- Bedrock.

Overburden is generally thin; a few centimetres of moss and organic material overlie 5 to 20 cm of white felsic volcanic ash (White River ash approximately 1,250 years old). In unglaciated areas, the white ash is underlain by 10 cm of organics or peat, and 15 to 50 cm of soil. Bedrock is extensively weathered, particularly the gneissic units. At the eastern end of Trench 91-6, bedrock is 7 m below surface, the deepest recorded in the unglaciated area. In the glaciated areas, the white ash is underlain by tills, generally 1 m thick, except along Williams Creek valley where an undetermined depth of till and colluvium has collected. Permafrost is present at varying depths in most north facing slope locations and at depth in other areas. Facilities will be located to avoid frost susceptible, poorly drained soils.

Borrow pit locations were previously identified in the Knight Piesold document "Report on Detailed Design, Ref No. 1784/2" and will provide the materials necessary to satisfy the Stage I construction items. Additional borrow areas for soil liner material and LDRS drainage material for ongoing construction activities will be delineated as part of the Stage I construction activities.

Refer to Knight and Piesold's report on "1996 Geotechnical and Hydrogeological Site Investigations" for detailed descriptions of the material types, and foundation conditions encountered at the process plant site, camp site, crusher site, leach pad site, and WRSA.



Map units are defined by one or more symbols representing the occurrence of significance terrain features and conditions and/or geomorphic hazards which may have a beneficial or constraining effect on mine-facility and access-road development.



WESTERN COPPER HOLDINGS CARMACKS COPPER PROJECT

TERRAIN HAZARDS AND SURFICIAL MATERIALS IN THE MINE SITE AREA

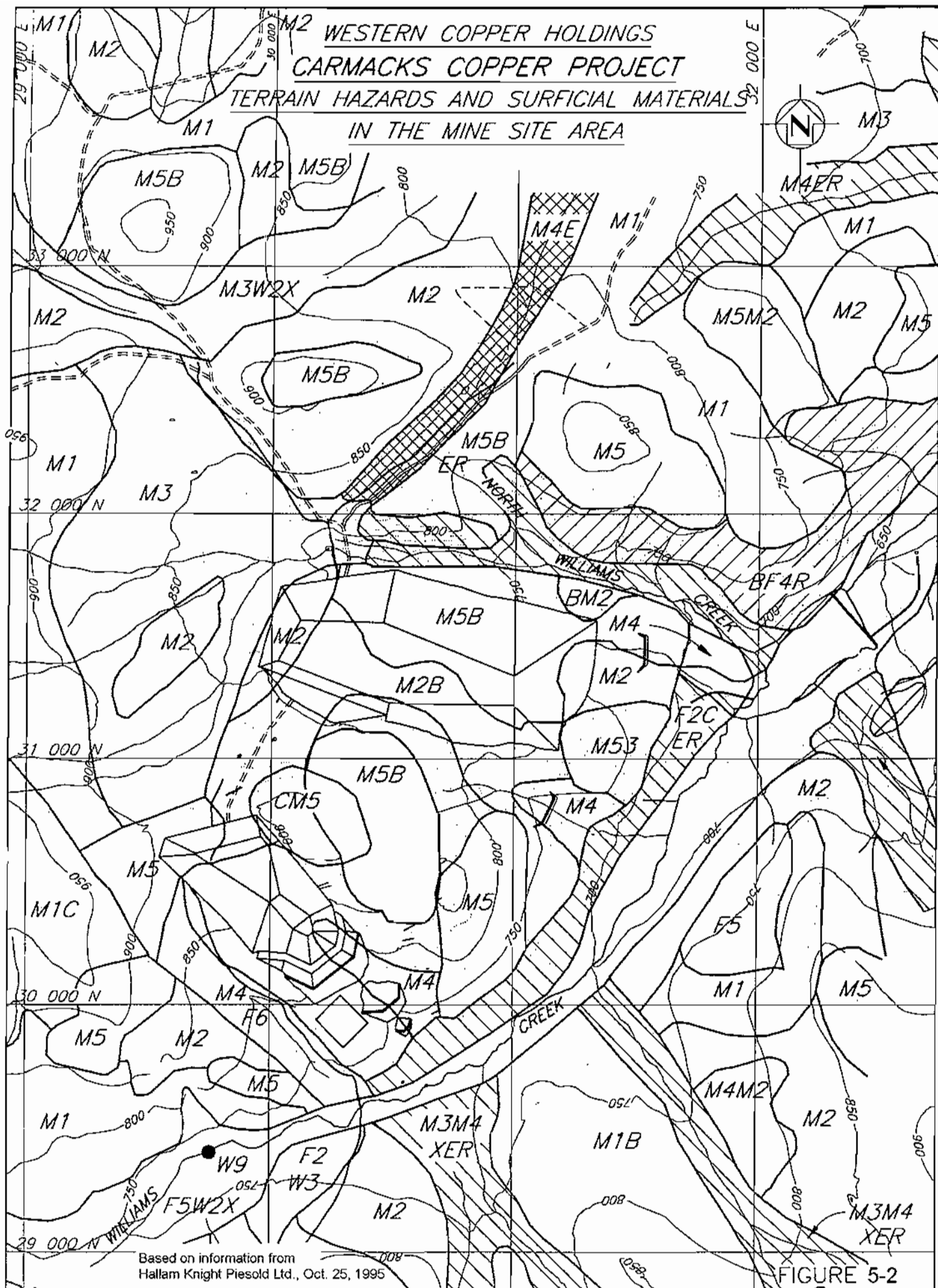


FIGURE 5-2

5.1.3 Water Resources

5.1.3.1 Surface Hydrology

Clearwater Consultants Ltd. Memorandum CCL-CC6 – Williams Creek Site Hydrology Update presents an update to the site hydrology using site and regional data available up to 2005. The hydrology update includes precipitation, evaporation and streamflow distributions. A regional evaluation of streamflow data was undertaken to estimate the seasonal distribution of flows within the Williams Creek catchment area. Please refer to Memorandum CCL-CC6 in Appendix D4 for information on monthly streamflow distributions and mean annual runoff.

A low flow survey on the Williams Creek watershed was performed in March 2006. Flow measurements were impossible to collect at all sample stations as flow was either nonexistent or too slow to measure by salt dilution method, and ice prevented the use of a Price Meter.

Flow data has been collected from Williams Creek in June and July 2006 and results are presented in Appendix H1. Data loggers were installed at stations W4 and W10 in June 2006 to measure water levels on a continuous basis. An update will be prepared by end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary.

Description of Watershed

The orebody is located in the upper reaches of Williams Creek, approximately 9 km upstream of the confluence with the Yukon River (Figure 5-3). Williams Creek is a small tributary originating in the Dawson Range and draining northeast into the Yukon River downstream of Carmacks.

The Williams Creek watershed is comprised of two principal basins, Williams Creek and its tributary, Nancy Lee Creek. A summary of basin characteristics is presented in Table 5-3. Each creek drains approximately half of the 88 km² drainage area. Williams Creek has a main channel length of approximately 15.5 km, an average slope of 3%, and a basin elevation range of approximately 500 m to 1,000 m. The creek is typically a straight, deeply incised, narrow channel about 1 to 4 m in width and 0.5 to 1.5 m in depth with occasional meanders or side channels. Williams Creek flows into the Yukon River about 40 km northwest of the Village of Carmacks. Nancy Lee Creek has a channel length of approximately 13 km, an average gradient of 2.8% and a basin elevation that ranges from 518 to 882 m. It flows east into Williams Creek, approximately 1.3 km upstream of the Yukon River confluence.

Table 5-3 Summary of Basin Characteristics

Parameter	Location				
	Williams Cr. Above Ore Body	William Cr. Above Nance Lee Cr.	Nancy Lee Cr. Above Williams Cr.	Williams Cr. Above Yukon River	Yukon River Above Williams Cr.
Basin Area (km ²)	13.0	42.4	44.3	88.0	90,600
Maximum Elevation (m asl)	823	823	960	960	-
Minimum Elevation (m asl)	680	511	511	488	-
Elevation Difference	137	312	449	472	-
Channel Length (m)	3,500	11,000	14,000	15,500	-
Average Channel Slope (m/m)	0.0395	0.0285	0.0321	0.0304	-

Table 3.4.1 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd.

Regional Stream Flow

Stream flows in the Yukon are generally characterized by peak flows in the spring and low flows in the winter. Maximum discharges typically occur during the spring as the result of snow melt or rain-on-snow events, with flows gradually decreasing following the disappearance of snow. Sizeable flood events may also occur in the late summer due to intense rainstorms. These rainfall events are particularly significant on small basins. The smallest discharges of the year occur in mid-winter. Ice develops on all rivers and many streams freeze entirely, reducing their winter flows to zero.

Williams Creek Stream Flow

Please refer to Memorandum CCL-CC6 in Appendix D4 for an updated estimation of the seasonal distribution of flows within the Williams Creek catchment area.

A summary of flow data collected from Williams Creek in June and July 2006 is also presented in Appendix H1.

The IEE Addendum prepared by HKP in June 1995 also presents information on regional stream flow stations, site stream flow records, mean annual runoff, seven-day average low flow, and peak instantaneous flows. The "Baseline Data Compilation Report" prepared by Access Consulting Group in 1997 contains site hydrological data, including a summary of stream flow measurements recorded between 1991 and 1997.

5.1.3.2 Surface Water Quality

Water quality data from samples collected from monitoring stations between 1989 and *July 2006* on the Williams Creek watershed are presented in *Appendix H2*. *Water sampling and analysis at the site is an ongoing activity. An updated summary of water quality data and discussion of results will be provided by end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary. The baseline data is intended to provide a reference for long term water quality data for the Williams Creek watershed. This data allows for potential effects assessment and effectiveness of*

mitigation measures both during operations and at closure. The existing water quality monitoring program will be continued during construction, operations and at closure as part of the overall environmental monitoring program (see Section 8.2.4).

Sampling programs conducted between 1989 and 1999 and their results are discussed below.

1989 – 1992 Investigations

The following presents a summary of surface water quality data collected quarterly between October 1989 and October 1992 from the Williams Creek watershed. The information has been drawn from the IEE Volume I “Biophysical Assessment of the Williams Creek Mine Site” prepared by P.A. Harder and Associates in 1994. Sample station locations are described in Table 5-4 and shown in Figure 5-3. *Photographs of the surface water quality sample station locations are located in Appendix H4, with the exception of sample station W8 which has always been a dry site.*

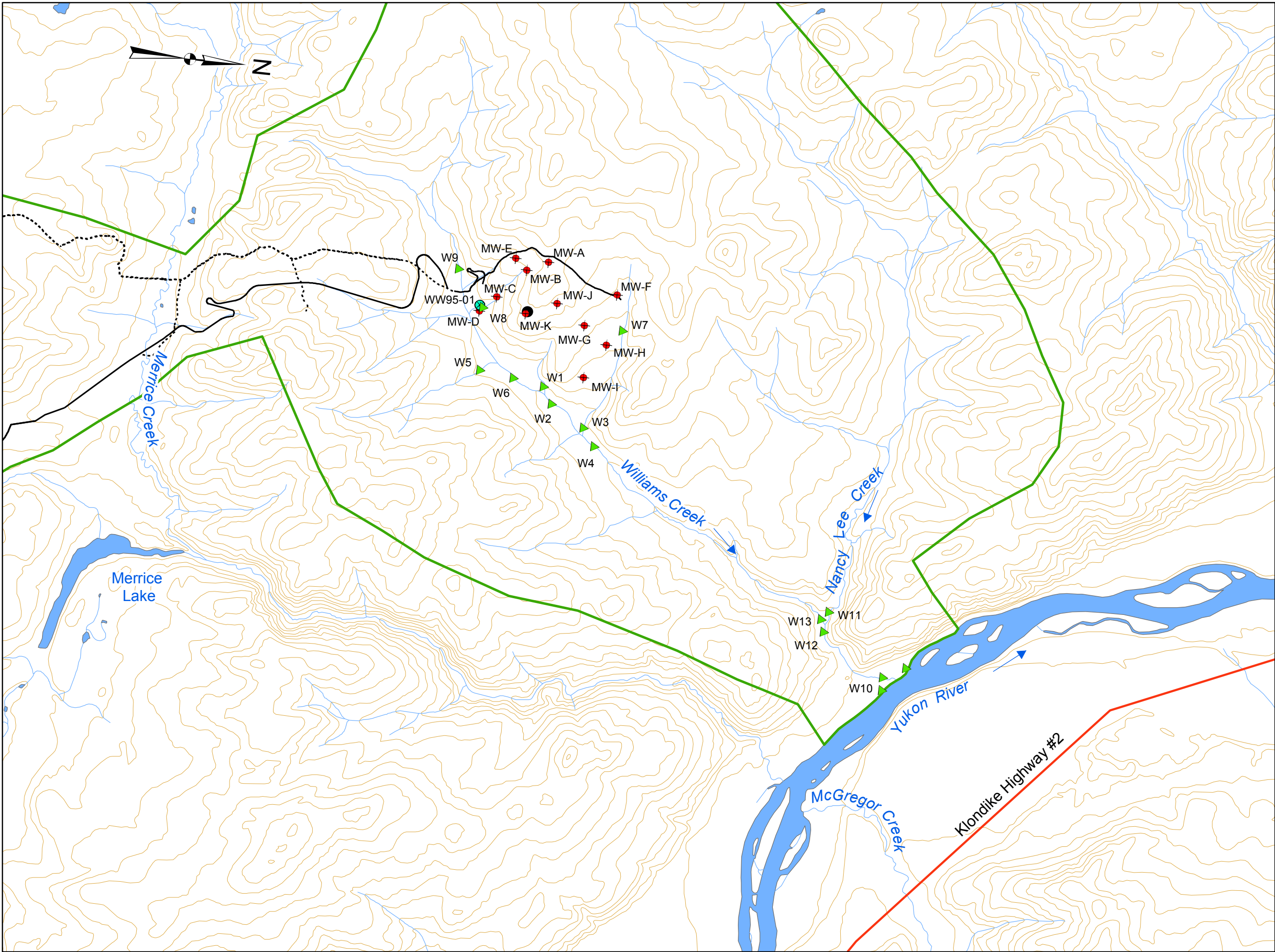
Samples were not collected from every location shown in Figure 5-3 due to the intermittent stream flow at some of the sites. Water samples were collected from Sites W-1, W-5, W-7, and W-9 on six occasions between October 1989 and October 1992. Sites W-3 and W-10 were sampled twice during this period while single samples (October 1989) were collected from Sites W-2 and W-6. Site W-11 on Nancy Lee Creek was sampled four times. Additional samples were collected from two sites in lower Williams (W-12 and W-13) during the August 1992 fish survey.

At each site, samples were collected and analyzed for various parameters including suspended solids, turbidity, pH, conductivity, alkalinity, total hardness, nitrate, nitrite, sulphate, ammonia, total phosphorus, and total and dissolved metals.

Samples were taken from the mainstem of Williams Creek (W-4, W-9 and W-10) and from several tributaries (W-1 to W-3, W-5 to W-8, and W-11). Due to the intermittent stream flow of sites W-2, W-6, and W-8, only one sample was obtained each for sites W-2 and W-6, and no samples were collected from W-8. Therefore, the water quality data from these sites have not been included when average values are discussed.

Table 5-4 Water Quality and Hydrology Monitoring Stations

Station	Description / Location
Water Quality	
W-1	Tributary to Williams Creek
W-2	Williams Creek Downstream of W-1 Tributary
W-3	Tributary to Williams Creek - North Williams Creek (from WRSA)
W-4	Williams Creek downstream of Confluence with W-3 Tributary
W-5	South East Tributary to Williams Creek
W-6	Williams Creek downstream of South East Tributary
W-7	Waste Rock Storage Area Tributary Near Road (Upstream of W-3)
W-8	Tributary to Williams Creek Near Access Road
W-9	Williams Creek Upstream of Access Road
W-10	Williams Creek Upstream of Yukon River
W-11	Nancy Lee Creek (Tributary of Williams Creek)
W-12	Williams Creek Downstream of Confluence with Nancy Lee Creek
W-13	Williams Creek Upstream of Confluence with Nancy Lee Creek
Hydrology Stations	
W-9 (Staff Gauge)	Staff Gauge Site (1991) on Williams Creek Immediately Downstream of Access Road (Immediately Downstream of Water Quality Site W-9)
W-2 (Recorder No. 2)	Data Logger Site No. 2 on Williams Creek Upstream of Waste Rock Tributary
W-4 (Recorder No. 3)	Data Logger Site No. 3 on Williams Creek Downstream of Waste Rock Tributary
W-10 (Recorder No. 1)	Data Logger Site No. 1 on Williams Creek Upstream of Yukon River



**Project Description
& Environmental
Assessment Report**

**Carmacks Copper
Project
Yukon Territory**



- Legend:**
- Monitoring Well
 - Water Well (by Others)
 - Ore Deposit
 - Water Quality Station
 - Road
 - Proposed Access Road
 - Exploration Road
 - Contour
 - Water Course
 - Water Body
 - Environmental Assessment Study Area

Reach and Sample Site Locations obtained from:
"Western Copper Holding Williams Creek Copper Oxide
Project Volume 1 Biophysical Assessment of the
Williams Creek Mine Site"
Figure 2.5.1 Location of water quality and benthic
invertebrate sites in the Williams Creek drainage.

UTM Zone 8 NAD83 Meters
NTS Sheet 115I/07

**Water Quality Sample
Station Locations**

Figure Number:
5-3

Scale:
1:50,000



Drawn by: HD Checked by: DC

Date: April, 2005

Our File: D:\Project\AllProjects\WCH-01\gis\mxd\Fig5_3_WQ.mxd

Physical Parameters, Nutrients and Major Ions

An updated discussion on surface water quality that includes 2006 data will be provided by end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary. Data collection is ongoing and an update on seasonal variations in surface and groundwater quality will be provided.

A summary of average values for physical parameters, nutrients and major ions is presented in Table 5-5.

Alkalinity

Average alkalinity for the Williams Creek mainstem sites (W-4, W-9, and W-10) for the sample period was between 107 and 149 mg/L CaCO₃. Seasonal variation ranged from 38 to 255 mg/L CaCO₃ with highest values detected in December 1991.

Average alkalinity values for the tributary sites (W-1, W-3, W-5, W-7, and W-11) ranged from 84 to 130 mg/L CaCO₃. Seasonal trends in the tributary sites were similar to the mainstem sites. The highest value (140 mg/L CaCO₃) was detected at site W-6 in October 1989.

Water Hardness

Average water hardness for the Williams Creek mainstem ranged from 125 to 161 mg/L CaCO₃. The highest values were observed during the low flow winter period when the relative contribution of ground water was highest. Water hardness values were lowest during the spring freshet period.

Average water hardness values for the tributary sites (W-1, W-3, W-5, W-7, and W-11) ranged from 102 to 206 mg/L CaCO₃. Seasonal trends in water hardness were similar between the mainstem sites and tributary sites, with the exception of W-1, which had relatively high water hardness throughout the year.

pH

Williams Creek mainstem pH values ranged from 7.4 to 8.2 with relatively little variation between individual sample sites for the sample period. Values were lowest during the May sample period due to a dilution effect from high flows. Tributary pH values ranged from 7.2 to 8.2 and exhibited a relatively high degree of variation between sites for the same sample period.

Suspended Solids

Suspended solids values were low during all sample periods. Average mainstem values ranged from below detection level to 258 mg/L with average values of 7, 94 and 13 mg/L for sites W-10, W-4, and W-9, respectively. The highest suspended sediment level (1,825 mg/L) occurred in August 1991 at Site W-5. This high level of suspended solids was likely due to a temporary site disturbance.

Nitrates, Nitrites and Ammonia

Total ammonia concentrations were frequently below detection for at all sample sites. Average values ranged from below detection levels at W-11 to 0.12 mg/L at W-9. The maximum value was observed at site W-9 (0.44 mg/L) in December 1991.

Nitrate and nitrite values were generally below or close to detection levels at all samples sites.

Table 5-5 Summary of Physical Water Quality Parameters for Williams Creek Oct. 1989 to Oct 1992

Average Values									
Sample Site	Number of Samples	pH	Alkalinity (mg/L CaCO ₃)	H ₂ O Hardness (mg/L CaCO ₃)	SO ₄ (mg/L)	Suspended Solids (mg/L)	NO ₄ (mg/L)	NO ₃ (mg/L)	NH ₄ (mg/L)
Mainstem									
W10	5	7.9	113	125	15	13	0.01	BD	0.25
W4	6	7.8	107	146	37	37	0.02	BD	0.05
W9	6	7.8	149	161	30	30	BD	BD	0.12
Tributary									
W11	3	7.8	109	128	27	27	BD	BD	BD
W1	6	7.8	116	206	103	103	0.5	BD	0.06
W3	5	7.7	130	138	12	12	BD	BD	0.06
W5	6	7.5	84	102	4	4	BD	BD	0.07
W7	6	7.5	126	135	11	11	BD	BD	0.05
W2	1	7.7	100	133	76	76	BD	BD	0.06
W6	1	7.9	140	169	51	51	BD	BD	0.05

Total and Dissolved Metals

Twelve of the 32 elements included in the ICAP analysis were consistently below detection levels for total and dissolved metals samples at sites W-1, W-2, W-3, W-5, W-6, W-7, W-10, and W-11 throughout the sampling period. Included were antimony, beryllium, bismuth, cadmium, lead, lithium, molybdenum, selenium, silver, thorium, uranium, and zirconium. Elements which were frequently below detection included arsenic, chromium, cobalt, copper, phosphorous, and vanadium. Average total and dissolved values for selected elements commonly occurring in Williams Creek and its tributaries are summarized for the sample period in Table 5-6 and Table 5-7, respectively. Highlighted cells indicate that the value exceeds the Canadian Council of Ministers of the Environment (CCME) (2003) fresh water aquatic life guidelines. Selected elements are discussed below.

Aluminum

Aluminum was detected in 10 of 17 mainstem (W-4, W-9, and W-10) total metals samples and ranged from 0.026 to 3.89 mg/L. Levels were above CCME guideline values in five samples. The average total aluminum concentration for the lowermost Williams Creek mainstem site (W-10) was 0.18 mg/L. Dissolved aluminum was detected in 10 of 15 samples from mainstem sites and ranged from 0.007 (W-4) to 0.08 mg/L (W-10). All levels detected were below CCME guidelines.

Aluminum was detected in 14 of 28 tributary total metals samples and values ranged from 0.03 to 9.58 mg/L. The highest value was detected at site W-5 in August 1991,

during a period of heavy precipitation. Aluminum levels were above CCME guidelines in five samples. Dissolved aluminum was detected in 11 of 22 samples and values ranged from 0.017 to 0.084 mg/L. All detected values were below CCME guidelines for aquatic life.

Arsenic

Arsenic was detectable in 3 of 17 samples collected from Williams Creek mainstem total metals water samples and ranged from 0.04 to 0.16 mg/L. The average concentration of total arsenic at the lowermost Williams Creek mainstem site (W-10) was 0.05 mg/L. Dissolved arsenic was detected in 3 of 13 samples and ranged from 0.06 to 0.16 mg/L. All detected levels, which were above CCME guidelines, were sampled at sites W-4, W-9, and W-10 in December 1991. Arsenic was detectable in 6 of 28 total metals samples collected from the tributary sites and 5 were above the CCME guidelines (0.11 to 0.16 mg/L). The highest observed total concentrations were detected at Sites W-1 and W-7. Dissolved arsenic was detected in 4 of 22 samples and ranged from 0.09 to 0.12 mg/L. All four samples were collected in December 1991 and were above CCME guidelines.

Barium

Barium was detectable in all total metals and dissolved metals mainstem samples and ranged from 0.013 to 0.175 mg/L. The average concentration of total barium at the lower most Williams Creek mainstem site (W-10) was 0.057 mg/L. Dissolved barium levels ranged from 0.009 to 0.066 mg/L. Barium was also detected in all tributary water samples. Concentrations of total barium at these sites ranged from 0.012 to 0.455 mg/L with the highest values occurring at Station W-1 and W-5. Dissolved values ranged from 0.010 to 0.067 mg/L.

Cadmium

Total and dissolved levels of cadmium were below detection for most water quality samples. A total concentration of 0.0004 mg/L was observed at site W-9 during May 1992.

Total cadmium was detected at levels greater than CCME criteria at sites W-1 and W-5, with values ranging from 0.004 to 0.006 mg/L.

Chromium

Chromium was detectable in 10 of 17 total metals samples collected from mainstem Williams Creek sites. Concentrations of total chromium ranged from 0.0005 to 0.012 mg/L in the mainstem sites. The average concentration for the lowermost site was 0.003 mg/L with a maximum value of 0.009 mg/L. Dissolved chromium was detected in 4 of 15 samples and ranged from 0.002 to 0.005 mg/L.

Chromium was detectable in 16 of 28 total metals samples collected from the tributary sites and ranged from 0.0012 to 0.05 mg/L. The highest observed total concentration was detected at Site W-5. Dissolved chromium was detected in 4 of 22 samples and values ranged from 0.001 to 0.007 mg/L.

Cobalt

Cobalt was detectable in 9 of 17 total metals samples collected from mainstem Williams Creek sites. Concentrations of total cobalt ranged from 0.001 to 0.004 mg/L in the mainstem sites. The lower most mainstem site on Williams Creek had an average value

of 0.001 mg/L and a maximum value of 0.002 mg/L. Dissolved cobalt levels were detected in 5 of 15 samples and ranged from 0.001 to 0.004 mg/L.

Cobalt was detectable in 10 of 28 total metals samples collected from the tributary sites and ranged from 0.002 to 0.016 mg/L. The highest observed total concentration was observed at Site W-5. Dissolved cobalt was detected in 10 of 22 samples and ranged from 0.001 to 0.007 mg/L.

Copper

Copper was detectable in 9 of 17 total metals samples collected from mainstem Williams Creek sites and ranged from 0.001 to 0.014 mg/L. The lowermost Williams Creek mainstem site had an average value of 0.003 mg/L and a maximum value of 0.005 mg/L. Dissolved copper was detected twice during the sample period. In October 1992, levels of detectable dissolved copper were 0.002 and 0.005 mg/L at sites W-4 and W-10, respectively.

Copper was detected in 14 of 28 total metals tributary samples with a range of 0.001 to 0.059 mg/L. The highest observed total copper concentration for the tributary sites was observed at Site W-5. Dissolved copper was detected in 7 of 22 samples with a range of 0.001 to 0.009 mg/L. Total copper levels were intermittently above the CCME guidelines at sites W-1, W-3, W-4, W-5, W-7, W-9, W-10, and W-11 (0.002 to 0.004 mg/L).

Iron

Iron was detectable in all total metals and dissolved metals samples from Williams Creek mainstem sites. Total iron and dissolved iron levels ranged from 0.07 to 6.6 mg/L and 0.022 to 1.24 mg/L, respectively. The average concentration of total iron in Lower Williams Creek (W-10) was 0.354 with a high value of 0.824 mg/L.

Iron was detected in 27 of 28 total metals samples from the tributary sites and ranged from 0.037 to 31.4 mg/L. The highest detected levels occurred at sites W-5 and W-7. Dissolved iron was detected in 19 of 22 samples and values ranged from 0.054 to 9.4 mg/L. Total iron levels were occasionally above CCME criteria at water quality sites W-2, W-4, W-5, W-6, W-7, W-9, and W-10 (0.3 mg/L).

Zinc

Zinc was detectable in 15 of 17 total metals samples collected from mainstem Williams Creek sites and values ranged from 0.003 to 0.195 mg/L. The average value at the lowermost mainstem site was 0.045 mg/L with a maximum value of 0.195 mg/L. Dissolved zinc was detected in 12 of 15 water quality samples and ranged from 0.002 to 0.008 mg/L to 0.01 mg/L.

Zinc was detectable in 27 of 28 total metals samples collected from the tributary sites and zinc levels ranged from 0.002 to 0.108 mg/L; the highest observed total zinc concentration for the tributary sites was detected at Site W-6 in October 1989. Dissolved zinc was detected in 19 of 22 samples and ranged from 0.002 to 0.010 mg/L. Total and dissolved zinc values averaged over the sample period are compared for mainstem and tributary sites in. Total zinc concentrations were periodically above CCME guidelines in water samples from Sites W-1 to W-6 and W-10 (0.03 mg/L).

Table 5-6 Summary of Total Metal Concentrations for Williams Creek, Oct. 1989 to Oct. 1992

(Harder and Associates, 1994)

Element	Mainstem			Tributary							CCME Guidelines Freshwater Aquatic Life
	W10	W4	W9	W11	W1	W3	W5	W7	W2	W6	
<i>n</i>	5	6	6	3	6	5	6	6	1	1	
Al	0.18	1.14	0.03	0.06	0.02	0.04	3.23	0.06	ND	ND	0.005 - 0.1
As	0.05	0.05	0.06	0.07	0.06	ND	0.06	0.06	ND	ND	0.005
Cd	ND	ND	0.003	ND	0.0003	ND	0.0004	0.0003	ND	ND	0.000017
Ca	37.0	37.7	41.1	36.8	60.6	41.2	26.1	40.9	44.2	43.8	
Cu	0.003	0.006	0.002	0.003	0.002	0.005	0.018	0.005	ND	0.001	0.002 - 0.004
Fe	0.35	2.16	0.66	0.14	0.14	0.15	8.43	2.10	0.37	0.64	0.3
Pb	ND	0.004	ND	ND	ND	ND	0.007	0.004	ND	ND	0.001 - 0.007
Mg	7.7	10.2	14.1	8.7	13.3	7.9	7.0	8.3	12.8	13.9	
Na	6.19	9.66	11.9	8.7	9.0	6.5	6.6	6.2	12.8	14.3	
Zn	0.045	0.018	0.006	0.006	0.012	0.014	0.035	0.010	0.033	0.108	0.03

Notes: Units are in mg/L; ND = Not Detectable; No Data for W8

Table 5-7 Summary of Dissolved Metal Concentrations for Williams Creek, Oct. 1989 to Oct. 1992

(Harder and Associates, 1994)

Element	Mainstem			Tributary				
	W10	W4	W9	W11	W1	W3	W5	W7
<i>n</i>	5	5	5	3	5	4	5	5
Al	0.04	0.02	0.18	0.05	ND	0.03	0.04	0.02
As	0.05	0.06	0.05	0.06	0.06	ND	0.005	0.06
Cd	ND	ND	ND	ND	ND	ND	ND	ND
Ca	35.4	34.0	39.5	34.9	59.4	35.0	23.6	37.5
Cu	0.002	0.001	ND	0.002	ND	0.001	0.002	0.002
Fe	0.11	0.37	0.38	0.10	0.05	0.14	0.62	1.98
Pb	ND	ND	ND	ND	ND	ND	ND	ND
Mg	7.1	9.1	12.9	8.4	12.8	7.3	5.9	7.3
Na	5.7	8.7	10.2	6.9	9.5	6.0	5.6	6.2
Zn	0.005	0.004	0.004	0.003	0.004	0.004	0.005	0.005

Notes: Units are in mg/L; ND = Not Detectable; No Data for W2, W6 or W8

Summary of Background Water Quality (1989-1992)

Long term water quality data collected from the Williams Creek watershed provides a baseline from which potential effects can be assessed once the mine is operational, *and a source of comparison for when the mine is in closure.*

Baseline data will also be important to regulatory agencies setting the mine discharge limits for the project. The CCME guidelines for freshwater aquatic life in Canada are generally considered to be a conservative limit set for the protection of fish and aquatic ecosystems based on available data for acute and chronic toxicity responses of aquatic organisms. These guidelines are for the protection of aquatic receiving environments.

Baseline data on total metal concentrations in Williams Creek have been compared to the recommended guideline values established by CCME for the purposes of documenting baseline water quality prior to project development. Of the ten elements compared in Table 5-6, lower Williams Creek, average background concentrations (October 1989 to October 1992) of total aluminum, arsenic, copper, iron, and zinc exceeded the recommended CCME guidelines. The upper site (W-4) also exceeded the CCME guideline for aluminum, arsenic, copper, iron, and zinc.

Water hardness values ranging from 75 to 225 mg/L CaCO₃ for Williams Creek indicate a moderate degree of natural buffering capacity. In lower Williams Creek, water hardness, and therefore buffering capacity, is generally lowest during periods of high stream discharge when the relative contribution of surface water is high compared to the ground water component (Gibson 1991).

Further discussion of water quality investigations in Williams Creek between 1989 and 1992 is presented in the IEE Volume I "Biophysical Assessment of the Williams Creek Mine Site" prepared by P.A. Harder and Associates in 1994.

1994 Investigation

Indian and Northern Affairs Canada also undertook water quality sampling of Williams Creek in May 1994 at five of the established sample sites: W-3, W-4, W-5, W-7, and W-9 (MDA Consulting, 2000). The results of this investigation are found in Appendix III.B of the "Baseline Data Report" prepared by Access Consulting Group in 1998.

1997 Investigation

In 1997 surface water quality samples were collected as part of a site investigation conducted by Access Consulting Group. Samples were taken from stations W-3 (Tributary to Williams Creek); W-4 (Williams Creek downstream of confluence with W-3 station); and W-9 (Williams Creek upstream of access road). Most surface water quality parameters for the samples taken during this event were below CCME freshwater aquatic life guidelines. Two parameters exceeded the guidelines: aluminum and iron. Stations W-3 (tributary to Williams Creek) and W-9 (Williams Creek) both reported aluminum concentrations above the guideline. Iron exceeded the guideline at all three stations.

1999 Investigation

Water samples were also collected from Williams Creek in 1999 by MDA Consulting. The samples were taken at the culvert for the access road near the west end of the camp and at the mouth of Williams Creek. These sample station locations are comparable to W9 and W10, respectively. Samples collected in October 1999 had total metals levels consistently lower than the metals concentrations reported for samples collected between 1989 and 1992. None of the metals measured in October 1999 exceeded the CCME (1999) surface water quality objectives (MDA Consulting, 2000). The dissolved metals for the 1999 samples are also consistently less than previously reported during the 1994 investigation. Even copper is non-detectable in the 1999 samples (MDA Consulting, 2000).

5.1.3.3 Hydrogeology

General

Standpipe piezometers wells were installed at the Carmacks Copper site in 1992, 1995, and 1996 to measure groundwater levels and allow for the collection of water samples. In total, 36 piezometers were installed at the site between 1992 and 1996. The 1996 site investigation work included a program to investigate and establish site hydrogeologic conditions. Standpipe piezometers were installed in drill holes to measure the water levels within specific intervals.

The one inch diameter standpipe piezometers (DH-11, 12, 14, and 15) installed at the process plant site are summarized in Table 5-8, and shown in Figure 5-4. The two inch diameter groundwater monitoring wells (MW-A to K) installed at the leach pad, WRSA, and open pit sites are summarized in Table 5-9, and shown in Figure 5-3. Completion details, monitoring record sheets, and falling head permeability calculation sheets for these piezometers are included in Knight and Piésold's report on "1996 Geotechnical and Hydrogeological Site Investigations."

The locations of the piezometers are also shown on Drawing 1784.100 and hydrogeologic information is shown on section on Drawing 1784.101 to 103.

The "Report on Updated Detailed Design of the Heap Leach Pad and Events Pond" prepared by Knight Piésold Ltd. in 1997 (Appendix D1) provides a hydrogeological impact assessment for the heap leach pad and events pond area. A potentiometric map is provided and groundwater flow regime modeled.

Table 5-8 Summary of Stand Pipe Piezometers at the Process Plant Site

DRILL HOLE NUMBER	PIEZOMETER DESIGNATION	LOCATION			WELL INFORMATION				GROUNDWATER INFORMATION		
		NORTHING (m)	EASTING (m)	GROUND ELEVATION (m)	GEOLOGY OF MONITORING ZONE	PIEZOMETER DEPTH (m)	TIP ELEVATION (m)	PIEZOMETER STICKUP (m)	DEPTH TO WATER (m)	WATER ELEVATION (m)	DATE
DH96-11	Stand Pipe	29,929	30230 ¹	766	Bedrock	15.9	750.1	0.3	Dry well	Dry well	21-Feb-96
DH96-12	Stand Pipe	29,953	30,267	769	Bedrock	17.1	751.9	0.3	Dry well	Dry well	21-Feb-96
DH96-14	Stand Pipe	29,964	30,239	768	Bedrock	14.4	753.6	0.3	7.3 ²	768	23-Feb-96
DH96-15	Stand Pipe	29,982	30,241	769	Bedrock	16.3	752.7	0.3	14.3 ²	769	23-Feb-96

Note: 1. Easting coordinate for DH96-11 was scaled from drawing
2. No groundwater was intersected. The water level measurements were monitoring drilling induced water.

Table 5-9 Summary of Groundwater Monitoring Wells 1996 Drill Program

DRILL HOLE NUMBER	WELL INFORMATION										
	LOCATION	NORTHING (m)	EASTING (m)	GROUND ELEVATION (m)	GEOLOGY OF MONITORING ZONE	PIEZOMETER DEPTH (m)	TIP ELEVATION (m)	PIEZOMETER STICKUP (m)	DEPTH TO WATER (m)	WATER ELEVATION (m)	DATE
MW96-A1	Leach Pad Site	30,755	29,835	861	Bedrock	45.7	815.3	0.60	45.4	816	3-Mar-96
MW96-A2	Leach Pad Site	30,755	29,835	861	Bedrock	91.4	769.6	0.60	60.6	801	3-Mar-96
MW96-B	Leach Pad Site	30,470	29,974	833	Bedrock	91.4	741.6	0.30	41.6	792	3-Mar-96
MW96-C	Leach Pad Site	30,094	30,382	755	Bedrock	50.0	705.0	0.40	40.3	715	3-Mar-96
MW96-D	Leach Pad Site	29,875	30,605	717	Bedrock	41.1	675.9	0.30	12.4	705	3-Mar-96
MW96-E	Leach Pad Site	30,300	29,827	831	Bedrock	91.4	739.6	0.45	53.4	778	3-Mar-96
MW96-F	Waste Rock Storage Area	31,745	30,185	785 ¹	Coarse Sand	62.5	722.5	0.30	13.4	772	3-Mar-96
MW96-G	Waste Rock Storage Area	31,341	30,655	777	Bedrock	74.7	702.3	0.30	48.4	729	3-Mar-96
MW96-H	Waste Rock Storage Area	31,670	30,975	738	Bedrock	55.2	682.8	0.30	16.9	721	3-Mar-96
MW96-I	Waste Rock Storage Area	31,404	31,371	715	Bedrock	54.9	660.1	0.30	18.0	697	3-Mar-96
MW96-J	Open Pit	30,935	30,390	846	Bedrock	90.5	755.5	0.55	dry well	dry well	3-Mar-96
MW96-K	Open Pit	30,515	30,545	849	Bedrock	92.96	756.04	0.30	dry well	dry well	3-Mar-96

Note: 1. Elevation for BH96-F was scaled from drawing.

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Note: Drawing is for
illustrative purposes only,
NOT FOR CONSTRUCTION

Original drawing from Kilborn,
The engineering data on this drawing is solely for the
purpose and project for which this drawing is issued.
"Borehole and Test Pit Location Plan",
Drawing #100-13-35

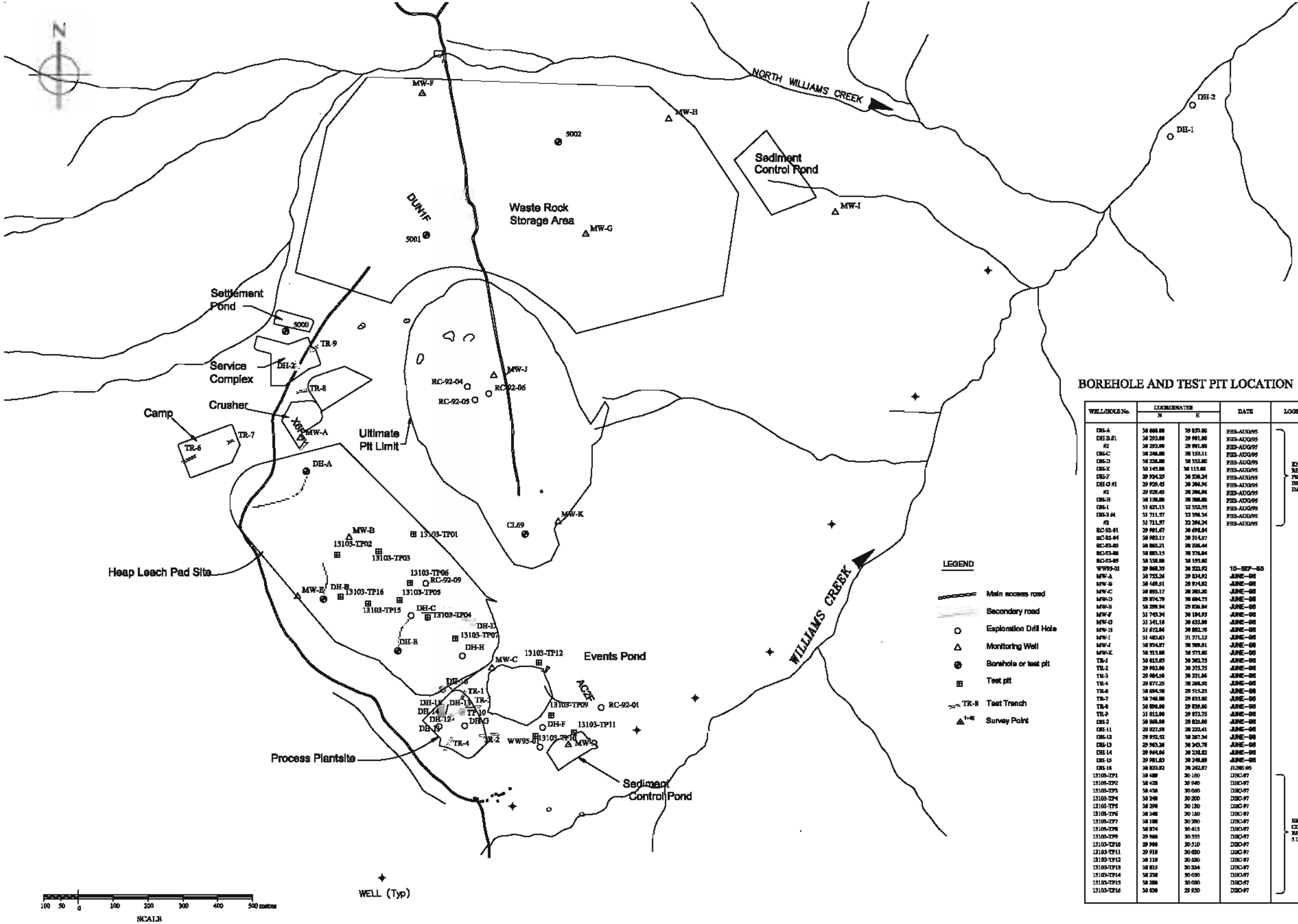
Borehole and Test Pit
Locations

Figure Number:
5-4



Revised by: HD Checked by: DDC

Date: April, 2005



Regional Groundwater System

The Carmacks Copper project site is located adjacent to the Williams Creek drainage. The regional drainage pattern in the area has evolved into a contorted pattern influenced by complicated structural features associated with the intrusive and metamorphic rock types. The regional groundwater flow system at the Carmacks Copper project is further complicated by the presence of permafrost in the valley bottoms, which produces a confining effect and possibly perched water tables. Regional groundwater occurs as an unconfined deep flow system within bedrock in which groundwater is recharged at higher elevations in the upland areas and flows toward the valleys at lower elevations. The groundwater table forms a subdued replica of topography whereby the depth to groundwater increases with increasing elevation. The result of exploration drilling and recent geotechnical site investigations indicate that the groundwater table lies at significant depths over most of the project area. In some areas the presence of discontinuous permafrost has resulted in the development of perched water tables, however, these are isolated and are discontinuous. In addition, minor groundwater flow occurs in the active zone just below the ground surface on a seasonal basis resulting in the development of local swamp areas. The discontinuous permafrost also acts as a barrier inhibiting infiltration in some areas thereby significantly reducing recharge resulting in the overall depression of the region groundwater table. Refer to Knight Piésold's "1996 Geotechnical and Hydrogeological Site Investigations" for details on the site groundwater conditions. Knight Piésold's "Report on Updated Detailed Design of Heap Leach Pad and Events Pond" includes figures showing hydrogeological modelling.

5.1.3.4 Groundwater Quality

Samples and water depth levels were collected from groundwater monitoring wells MW-A and B in June and July 2006. Groundwater quality data for the two monitoring wells is presented in Appendix H2. An updated discussion of the 2006 results will be prepared by end of 2006 as additional data collection is ongoing.

Standpipe piezometer wells were installed at the Carmacks Copper site in 1992, 1995 and 1996 to measure groundwater levels and allow for the collection of water quality samples. In total, 36 piezometers were installed at the site from 1992 to 1996.

In 1997 a field reconnaissance was undertaken that included conducting piezometric measurements at existing monitoring stations and collecting groundwater quality samples. The in situ and laboratory water quality data from the 1997 field trip for piezometers RC-92-01, DH95-B, MW96-B, and MW96-F are contained within the "Baseline Data Compilation Report" prepared by Access Consulting group in January 1998. Selected parameters, and the applicable guidelines for the protection of freshwater aquatic life (CCME, 2003) where applicable are presented in Table 5-10. Highlighted cells indicate that the value exceeds the CCME (2003) water quality guideline. The locations of the groundwater wells are shown on Drawing 1784.100, and Figures 5-3 and 5-4.

Table 5-10 Groundwater Quality for Selected Parameters

Well	RC92-01	MW96-B	MW96-F	DH95-B	CCME Guidelines Freshwater Aquatic Life
Sample Date	27-Sep-97	28-Sep-97	28-Sep-97	28-Sep-97	
Hardness (CaCO ₃), mg/L	273	131	189	140	
Aluminum	0.068	1.35	0.231	26.1	0.005-0.1
Arsenic	0.0003	0.0005	0.0011	0.002	0.005
Cadmium	<0.00005	0.00006	0.00025	<0.0005	0.000017
Chromium	<0.0005	0.001	0.001	0.011	
Copper	0.001	0.0018	0.0147	0.009	0.002-0.004
Iron	0.06	1.14	0.4	3.52	0.3
Lead	0.00024	0.00173	0.0036	0.0121	0.001-0.007
Mercury	<0.00005	<0.00005	<0.00005	<0.00005	0.0001
Nickel	0.0014	0.0011	0.0094	0.005	0.025-0.15
Selenium	0.002	<0.001	<0.001	<0.01	0.001
Silver	<0.00001	<0.00001	0.00002	<0.00001	0.0001
Zinc	0.004	0.007	0.047	0.09	0.03

Notes: Units are in mg/L

As can be observed from Table 5-10 the groundwater quality parameters were generally below CCME guidelines for freshwater aquatic life. Total aluminum and iron concentrations were above the guideline at wells MW96-B, MW96-F and DH95-B. Piezometers DH95-B and MW96-F reported total copper levels above the guideline. Piezometer DH95-B had total lead levels above the guideline. Total zinc concentrations were above the guideline at MW96-F and DH95-B.

5.2 BIOLOGICAL ENVIRONMENT

5.2.1 Aquatic Resources

5.2.1.1 Fisheries

Please refer to the Environmental Monitoring Program Update and Data Summary – Revision #1 (ACG, Jan. 2006) presented in Appendix H3, which provides results of a fisheries investigation conducted in October 2005. Previously reported fisheries utilization in lower Williams Creek was again confirmed during the October survey. Results of the July and September 2006 fisheries investigations will be provided by the end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary.

An “Initial Assessment of Aquatic Resources in Williams Creek” was conducted by P.A. Harder and Associates Ltd. in 1992. This assessment of aquatic resources is

superseded by the 1994 IEE Volume I entitled “Biophysical Assessment of the Williams Creek Mine Site” by P.A. Harder and Associates Ltd. The following summarizes data from the assessments; please refer to these documents for further details and information.

Between August 1991 and August 1992 three fisheries investigations, including biophysical inventory, electrofishing, minnow traps, and spawning surveys, were completed to determine the distribution and abundance of fish in the project area. Williams Creek has been classified into four reaches based upon differing habitat characteristics. Figure 5-5 shows the location of reach boundaries and provides descriptions of the physical habitat characteristics for each reach. Table 5-11 summarizes results of the three surveys.

Of the thirteen fish species typically found in the Yukon River Drainage (Table 5-12), six species were identified in the lower section of Williams Creek to the confluence with Nancy Lee Creek, during the 1991 and 1992 assessments. These species include: juvenile Chinook salmon (*Oncorhynchus tshawytscha*), arctic grayling (*Thymallus arcticus*), slimy sculpins (*Cottus cognatus*), longnose suckers (*Catostomus catostomus*), burbot (*Lota lota*), and northern pike (*Esox lucius*). Other species, such as inconnu, round whitefish, and broad whitefish may also be found in small tributary habitats of the Yukon River system at certain times of the year.

No fish were observed or captured in Williams Creek above the Nancy Lee Creek confluence. Spawning was not observed in the Yukon River near the Williams Creek confluence during the October 1991 survey and based on traditional knowledge no spawning in Williams Creek has been observed by local residents (HKP, 1995).

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Legend:

- ▲ Sample Station
- Ore Deposit
- Proposed Access Road
- - - Exploration Road
- Road
- Contour
- Water Course
- Reach
- Water Body
- Environmental Assessment Study Area

Reach and Sample Site Locations obtained from:
"Western Copper Holding Williams Creek Copper Oxide
Project Volume 1 Biophysical Assessment of the
Williams Creek Mine Site"
Figure 3.6.1 Location of reach boundaries and
summary of physical habitat characteristics for the
Williams Creek study area.

UTM Zone 8 NAD83 Meters

Reach Boundaries &
Fisheries Investigation
Sample Stations

Figure Number:

5-5

Scale:

1:50,000



Drawn by: HD Checked by: DC

Date: April, 2005

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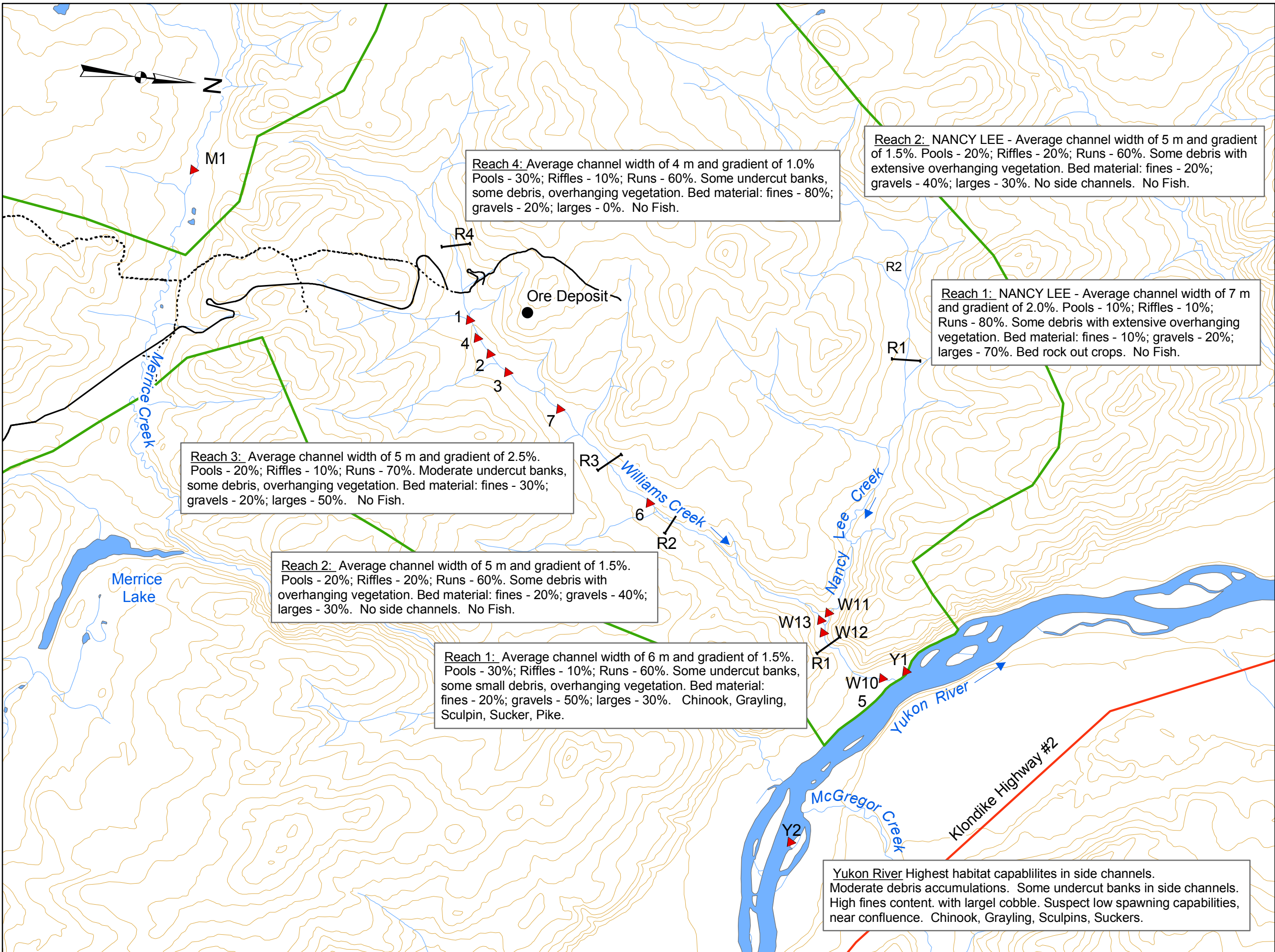


Table 5-11 Summary of Fish Sampling Results for Three Sample Periods between August 1991 and August 1992 in the Williams Creek Study Area

Sample Period and Location	Sample Area (m²)	Sample Difficulty	Total Fish Catch					
			Chinook	Grayling	Sculpin	Burbot	Sucker	Pike
August 1991:								
Site Y1	102	Mod	6	0	2	0	0	0
Site W10	240	Low	0	0	0	0	0	0
Sites 4, 6, 7	285	Low	0	0	0	0	0	0
Sites 1, 2	17 traps	Low	0	0	0	0	0	0
October 1991:								
Site Y2	110	Low	8	3	1	0	8	0
Site W10	154	Mod	10	1	1	0	0	0
August 1992:								
Site W10	81	High	55	1	16	0	2	1*
Site W12	72	Low	0	0	0	0	0	0
Site W13	51	Low	0	0	0	0	0	0
Site W11	92	Mod	0	0	0	0	0	0
Site 1	50	Low	0	0	0	0	0	0
Site M1	90	High	0	0	0	0	0	0

* Angled near the Yukon River confluence.

** Seven more adult grayling were observed at this site.

Table 3.6.3 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd (less site C1)

Table 5-12 List of Fish Species Found in the Yukon River Drainage and Summary of General Life History Requirements

Family	Species	Common Name	Life History/ Requirements
Salmonidae	<i>Onchorhynchus tshawytscha</i> *	Chinook salmon*	anadromous; 1 year fresh water residence as juvenile; occasionally 2; mainstem and tributary spawners - August
	<i>Onchorhynchus keta</i>	Chum salmon	Anadromous; juvenile fish migrate seaward as fry; mainstem spawners - August
	<i>Salvelinus namaycush</i>	Lake trout	Non - anadromous; rear in lakes and large rivers; Fall spawners
	<i>Coregonus clupeaformis</i>	Lake whitefish	Generally lake dwelling; Fall spawning along shallow lake shores
	<i>Coregonus nasus</i>	Broad whitefish	Generally lake dwelling; Summer to Fall spawner - downriver migration of adults in mid- winter
	<i>Coregonus sardinella</i>	Least cisco	Migrating and non-migrating populations; Fall spawners - lake shore or river margins
	<i>Prosopium cylindraceum</i>	Round whitefish	Northern populations are found in rivers as well as lakes; Fall spawning - lake shores and river mouths
	<i>Stenodus leucichthys</i>	Inconnu	Anadromous and non anadromous forms; juveniles rear in rivers up to 2 years; spawn in Summer to Fall
	<i>Thymallus arcticus</i> *	Arctic grayling*	Inhabit clear cold water - rivers, streams, lakes, and ponds; Spring spawning; complex seasonal migrations are common
Esocidae	<i>Esox lucious</i> *	Northern pike*	Spring spawner - in shallow vegetated areas of rivers and lakes; generally sedentary; predacious
Gadidae	<i>Lota lota</i> *	Burbot*	Spawns during mid-winter in rivers, streams, and lakes; migrates into rivers after spawning
Catostomidae	<i>Catostomus catastomus</i> *	Longnose sucker*	Spawns during Spring in streams and along lake shores
Cottidae	<i>Cottus cognatus</i> *	Slimy sculpin*	Occupy a wide range of lake, stream, and river habitats; Spring spawning; nest builders; usually feed on aquatic invertebrates, other fish are also taken

* Indicates species has been recorded in lower Williams Creek drainage.

Table 3.6.4 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site prepared by P.A. Harder and Associates Ltd.

5.2.1.2 Benthic Invertebrates

Benthic invertebrate samples were collected from site W-10 in lower Williams Creek approximately 250 m upstream of the Yukon River confluence in 1991. This site was relocated approximately 1.2 km further upstream (W-12) during the 1992 study and two additional sites were also established; one site (W-13) was upstream of the Nancy Lee Creek confluence and the other site was in the lower reach of Nancy Lee Creek (W-11). Sample station locations are presented in Figure 5-3.

A summary of the benthic invertebrate data collected in Williams Creek during 1991 and 1992 is presented in Table 5-13. Total and average number of invertebrates collected at each of the three sample 1992 sites, including one site in lower Nancy Lee Creek (W-11), were similar with a range in total numbers from 751 to 910 invertebrates. A total of 23 different taxonomic groups were identified in the drainage. Taxonomic richness (number of taxa represented relative to the population size) of the 1992 samples varied between 14 and 19 taxa with the highest number found at the lowermost Williams Creek site (W-12) below Nancy Lee Creek. Plecopterans were the dominant order present in the Williams Creek sites (W-12 and W-13) representing between 50 and 79% of the community. Plecopterans were co-dominant at the Nancy Lee Creek site during 1992 representing 34% of the total community. Dipterans were the sub-dominant order at all three sites during 1992 with Chironomidae (Orthocladiinae) representing between 10 and 35% of the total insect community.

Table 5-13 Summary of Total Insect Numbers and Taxonomic Richness for Triplicate Samples collected at Sites in the Williams Creek Drainage during 1991 and 1992

Sample Site Location and Date	Total Invertebrates *	Number of Taxa	Dominant Taxa	Sub-Dominant Taxa
W-13 Williams - 1992	910	17	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-11 Nancy Lee - 1992	763	14	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-12 Williams - 1992	751	19	Plecoptera: Nemouridae	Chironomidae: Orthocladiinae
W-10 Williams - 1991	266	25	Chironomidae: Orthocladiinae	Plecoptera: Perlodidae

* Total invertebrates numbers refers to number of individuals collected in three basket samplers.

Benthic invertebrate sampling is scheduled for late August/early September 2006 to update baseline data for Williams Creek. These results will be reported by end of 2006.

5.2.1.3 Stream Sediment Quality

A summary of sediment data that includes sampling events up to July 2006 is presented in Appendix H2. Additional results of sediment sampling in 2006 will be summarized by the end of 2006 in Revision #2 of the Environmental Monitoring Program Update and Data Summary.

Sample Collection

Sediment samples were collected from six stations (W-4, W-9, W-10, W-11, W-12, and W-13) during the July 1992 survey. Duplicate sediment samples were collected from Sites W-11, W-12, and W-13. Samples were collected from exposed portions of the bank, selecting the finest grained sediments available and analyzed for metal levels and particle size. A composite sample was collected for three points of the channel cross section at Site W-10. The W-4 and W-9 samples were collected by selecting a composite of available sediments within a 10 m stretch of the stream bank.

Results

The analysis of sediments collected from Williams and Nancy Lee creeks during July and August 1992 indicate that the major constituents are iron, aluminum, calcium, and magnesium. The minor constituents include, in decreasing order of relative concentration, zinc, chromium, copper, nickel, lead and cadmium. Of the 32 elements analyzed, seven were below detection in all samples including: antimony, arsenic, bismuth, molybdenum, selenium and uranium. Samples collected from the mainstem of Williams Creek during July 1992 indicated relatively small variation in the concentration of all components between upstream and downstream sites. A second set of samples collected from Williams and Nancy Lee creeks during August 1992 generally indicated the same sediment composition with respect to the relative concentration of major and minor constituents.

A summary of the range of concentrations found for each element is presented in Table 5-14. Sediment samples from the site near the Yukon River (W10) were mostly comprised of 250 μm (50%) and 500 μm (40%) particles. The 150 μm particles represented 5% of the sample. Sediments from the Williams Creek mid-reach (W4) and headwaters (W9) sites were of similar composition. The mid-reach sample was comprised of approximately 30% 150 μm particles, 25% 63 μm particles and 10% 125 μm particles. The headwater sample was composed of 30% 63 μm particles, 20% 150 μm particles and 10% 125 μm particles.

Results of the sediment analysis for the major constituents from the Williams and Nancy Lee creek samples were compared to results from Big Creek located 60 km west of Williams Creek. In all cases, the concentrations of aluminum, calcium, iron and magnesium are substantially lower in the Williams Creek sites than the Big Creek sites.

The CCME (1999) sediment quality guidelines for the protection of aquatic life for arsenic, cadmium, chromium, copper, zinc, and lead are presented in comparison to the observed range in metal concentrations for the Williams Creek sites in Table 5-15.

Sediment concentrations of arsenic, cadmium, chromium, zinc, and lead at the Williams Creek mainstem and Nancy Lee's sites were all below the CCME sediment quality guidelines. One of the mainstem Williams Creek samples collected from below Nancy Lee Creek during August 1992 had an unusually high copper value, which was above the CCME guideline value (Table 5-15).

Table 5-14 Summary of Sediment Metals Concentrations - Williams and Nancy Lee Creeks

Parameter	Concentration Range (ug/g)	Parameter	Concentration Range (ug/L)
Aluminum	6750 - 9980	Potassium	
Barium	67 - 201	Lead	5.0 - 9.0
Beryllium	0.2 - 0.3	Lithium	BD - 200
Calcium	6550 - 9770	Selenium	BD
Cadmium	BD - 0.3	Silicon	270 - 760
Cobalt	5.2 - 7.4	Sodium	230 - 540
Chromium	16.4 - 22.4	Strontium	46.6 - 70.7
Copper	10.1 - 75.8	Thorium	BD - 7.0
Iron	13300 - 21800	Titanium	539 - 704
Potassium	940 - 1400	Uranium	BD
Magnesium	3730 - 5370	Vanadium	30 - 52
Manganese	184 - 412	Zinc	30.8 - 48.0

Note: Samples collected during July and August 1992.

Table 5-15 CCME Sediment Quality Guidelines Compared to Range of Metal Concentrations -Williams Creeks Sites

Element	CCME Guideline		Williams Creek Drainage	
	Interim Freshwater Sediment Quality Guidelines (ug/g)	Probable Effect Levels (ug/g)	Williams Creek Mainstem (ug/g)	Nancy Lee Creek (ug/g)
Arsenic	5.9	17.0	BD	BD
Cadmium	0.6	3.5	BD - 0.3	0.3
Chromium	37.3	90	16.4 - 22.4	17.7
Copper	35.7	197	10.1 - 75.8	11.4
Zinc	123	315	30.8 - 48.0	30.8
Lead	35	91.3	5.0 - 9.0	7.0

Note: Samples collected during July and August 1992.

5.2.2 Wildlife

5.2.2.1 Wildlife Occurrence

A post-rut field survey took place in December 2005 to study moose and other wildlife within the Carmacks Copper project area. For a discussion of the results from this study, please refer to Appendix H3 for the Environmental Monitoring Program Update and Data Summary – Revision #1 (ACG, Jan. 2006). Another wildlife field survey was undertaken in July 2006 and a discussion of observations made is presented in Appendix H5.

Additional wildlife aerial surveys are planned as part of the pre-operational monitoring for the project. Details of the wildlife monitoring program as discussed are presented in Section 8, Environmental Monitoring Program.

The wildlife field inspection was conducted in mid-August (1992) in order to optimize logistics within the environmental program. This is a suitable time to describe habitat, but not the best time to encounter wildlife. Ungulates and large carnivores are best surveyed in winter, and birds in May or June. In addition, this inspection was done one year after the lynx population crash in the 10-year cycle, further reducing the abundance of wildlife and sign.

Ungulates

Moose (*Alces alces*):

Moose were not seen during the field visit, and moose sign was relatively scarce; willow stands showed minimal browse. Exploration camp records reported only two moose sightings in the previous two summers. Aerial surveys in the Casino Trail area immediately west of Williams Creek gave an estimate of 0.04 moose/km² of habitable moose range, the lowest density found in the Yukon to date (Markel and Larsen, 1988). Markel and Larsen (1988) concluded that forage was not limiting, and speculated that the area could support a larger moose population than presently exists there. Snow depth is not believed to limit moose use of this area. In parts of the Yukon, moose populations are held below carrying capacity by grizzly predation on calves, wolf predation on all age classes, or human harvest. It is not known which if any of these factors apply to moose in the Casino Trail-Williams Creek area. The Williams Creek area previously provided winter range for the 40-mile caribou herd. Range abandonment of this area has occurred and it is possible that this niche has not yet been filled by other ungulates (T. Hunter, pers. comm.).

Caribou (*Rangifer tarandus*):

Single caribou tracks in two locations along an exploration road north of the Williams Creek camp were observed. Although some good winter range habitat exists, there were no caribou sightings in the project area. The Klaza caribou herd is known to range as far west as Victoria Mountain, approximately 30 km southwest of Williams Creek (Farnell *et al.* 1991) and individuals could presumably range farther west.

Large Carnivores

Wolf (*Canis lupus*):

One probable wolf scat was observed. This species is presently of a sporadic occurrence due to low moose numbers and the decline phase of the hare cycle. Exploration personnel sighted the occasional wolf, and they are reported to be taken by trappers. Markel and Larsen (1988) indicated that wolf densities in the general area were likely to be low.

Grizzly Bear (*Ursus arctos horribilis*):

A probable grizzly scat was observed near the Williams Creek/Yukon River confluence during the wildlife survey and grizzly tracks were noted on the Williams Creek access road in the spring. Grizzlies occur more commonly in the Dawson Range west of Williams Creek, where alpine-subalpine habitats occur, but occasionally descend to low elevations. Dr. M. Hoefs (pers. comm.) stated that grizzlies had recently frequented the Village of Carmacks. Grizzly densities may approximate 10 to 16 animals per 1,000 km² in the general area (Markel and Larsen, 1988). Being wide-ranging, none are expected to reside entirely within the Williams Creek watershed.

Black Bear (*Ursus americanus*):

Black bear sign was noted in August, 1992, including old scats and recent ones. Habitat in the project area is moderately good for this species, and several individuals are probably present, however, population densities are not known.

Furbearers

Lynx (*Lynx canadensis canadensis*):

Lynx were probably common here at the peak of the hare cycle (winter 1990/91) and the following year, when tracks were regularly seen. The species is important in the regional trapline catch, and Yukon densities of up to 9 per 100 km² have been estimated in years of snowshoe hare abundance (Slough and Ward, 1990).

Coyote (*Canis latrans*):

Coyote sign was moderately common in the Williams Creek area in August 1992. Most scats were old, but two fresh ones contained squirrel feet. Coyotes likely move to lower elevations within the study area during the winter. The species is of some importance in the trapline catch for this area.

Red Fox (*Vulpes fulva*):

One probable fox dropping was observed within the Williams Creek Project area. Foxes are a minor component of the trapline catch for this region.

Wolverine (*Gulo luscus*):

Although this wide-ranging species is never abundant it does occur within the study area. Tracks were noted twice. Wolverines are a small component of the trapline catch, but are economically important because of the price they fetch.

Marten (*Martes americana*):

Marten are apparently uncommon in the immediate area of Williams Creek, although they are taken by local trappers. No sightings were reported and population levels in this area are not known.

Mink (*Mustela vison*):

One set of mink tracks was reported near the exploration camp. Mink are expected to occur primarily along the Yukon River and large streams and wetlands, but it is expected that this species is rare in the study area.

Ermine (*Mustela ermineamuricus*):

Based on trapline catch records ermine are expected to occur in the Williams Creek area, but they are of little economic impact. No sightings of ermine were reported.

River Otter (*Lutra canadensis*):

River otter are expected to occur along Yukon River and possibly in lower Williams Creek, but are not expected elsewhere in the watershed. No sightings of river otter were reported in the project area.

Beaver (*Castor canadensis*):

The beaver have a similar distribution to the river otter. No sightings of this species were recorded.

Other Mammals

Snowshoe Hare (*Lepus americanus*):

No hares or fresh sign were seen in August, 1992, however old sign in the form of runways, carpets of droppings, and browsed shrubs were widespread and abundant. The population apparently crashed in this area in the spring of 1991. This species is an important food base for several predators.

Red Squirrel (*Tamiasciurus hudsonicus*):

Red squirrels were very common throughout the study area in August 1992.

Ground Squirrel (*Spermophilus* sp.):

Two apparent ground squirrel burrows were noted within the study area, but the species was not observed. Suitable habitat appears to be present, and reason for its rarity here are not known.

Porcupine (*Erethizon dorsatum*):

Porcupine sign was noted in two locations within the study area, but the species was not observed.

Birds

Waterfowl:

No standing water habitat is present and no waterfowl use the watershed. Waterfowl were not observed.

Grouse:

Occasional spruce grouse (*Dendragapus canadensis*) droppings were noted, but no birds were seen, and the species appeared to be at a low ebb. Populations may be cyclic, and higher at other times. Suitable habitat occurs through most of the study area. Ruffed grouse (*Bonasa umbellus*) may occur in rich aspen or willow sites along streams, but such habitats are not extensive. This species is also cyclic, and may have been at its cyclic low.

Raptors:

Golden eagle (*Aquila chrysaetos*) nests were seen on cliffs at two locations near the Yukon River. No eagles were seen during the field inspection (August, 1992). It is likely that the birds had completed nesting by this time. Another option is that nesting was minimal or did not occur at all due to low snowshoe hare numbers. Several other species of raptors are also known to occur in the area, but only the American kestrel (*Falco sparverius*) was observed.

5.2.2.2 Habitat Potential

Seven wildlife habitat units have been identified in the project area including the Yukon River Valley floodplain & slopes, willow dominant wetlands of the Williams Creek watershed, spruce dominant wetlands, aspen dominant uplands, conifer dominant uplands, steep grassy slopes, and cliffs.

The following table is associated with Figure 5-1 (Terrain Hazards) presented in Section 5.1.2.6. Each wildlife habitat type correlates with particular terrain units shown in Figure 5-1; this correlation is shown in the table below.

Table 5-16 Wildlife Habitat Types and Associated Terrain Units

Wildlife Habitat Type	Terrain Units Included
Yukon River Valley Floodplain & Slopes	F1; F5 F7; M2B; BF4R
Willow Dominant Wetlands	F5; F5/W2; M3/W2
Spruce Dominant Wetlands	F2/W3; F3/W3; F2; F2/F3; F5; M4; M4/M2
Aspen Dominant Uplands	BF4; M1; M1F6; M5; M5/M2
Conifer Dominant Uplands	M1B; M2; M2B; F6; F6; CM5
Steep Grassy Slopes	BF4
Cliffs	BF4

Table has been modified from Table 3.3.1 in IEE Volume I, Biophysical Assessment of the Williams Creek Mine Site, prepared by P.A. Harder and Associates in 1994.

Using the correlation described in Table 5-16, an approximate percentage of each habitat type can be ascertained. Table 5-17 summarizes the habitat potential for various wildlife within each habitat unit, as well as the approximate percentage of each habitat type with the project area.

Table 5-17 Carmacks Copper Project Wildlife Habitat Potential

Habitat Unit	Approximate % of Habitat Type Within Project Area	Habitat Potential	Species	Notations
Yukon River Valley Floodplain & Slopes	5%	High	Moose Snowshoe Hare Red Squirrel Black Bear Wolf Lynx Golden Eagle Peregrine Falcon	Sightings and signs are low Widespread, abundant, but presently at low numbers Common Observed Sporadic occurrences Common but presently low numbers due to hare population Good nesting on slopes; nests observed on Yukon River
		Moderate	Marten Grizzly Bear Beaver Ruffed Grouse Small Mammals Forest Birds	Not common 6 -10 animals per 100 km ² during foraging season
Willow Dominant Wetlands	10%	High	Moose Snowshoe Hare Wolf Lynx Coyote	Sightings and signs are low Widespread, abundant, but presently at low numbers Hare predation Hare predation Hare predation; moderately common
		Moderate	Black Bear Birds	Early summer herbaceous foraging Nesting
Spruce Dominant Wetlands	15%	Moderate	Moose Snowshoe Hare Wolf Lynx Coyote Black Bear Red Squirrel Spruce Grouse	Sightings and signs are low Widespread, abundant, but presently at low numbers Hare predation Hare predation Hare predation; moderately common
Aspen Dominant Uplands	35%	Moderate	Moose Snowshoe Hare Wolf Lynx Coyote Black Bear Ruffed Grouse	Sightings and signs are low Widespread, abundant, but presently at low numbers Hare predation Hare predation Hare predation; moderately common
Conifer Dominant Uplands	25%	High	Red Squirrel Spruce Grouse	Common Presently at low numbers
		Moderate to low	Snowshoe Hare Wolf Lynx Coyote Moose	Widespread, abundant, but presently at low numbers Hare predation Hare predation Hare predation; moderately common
Steep Grassy Slopes	2.5%	High	Snowshoe Hare Moose Groundsquirrel Mule deer	In areas with abundant shrub and juvenile aspen Sightings and signs are low Rare Fresh sign, calf and adult
Cliffs	2.5%	High	Golden Eagle	Nesting

¹Where a species is not noted, habitat potential is expected to be low. Other species noted included fox, ermine, river otter, porcupine, and American kestrel.

²Based on studies completed by D.A. Blood and Associates Ltd.

Table 4.1 in IEE Volume IV, Environmental Mitigation and Impact Assessment, prepared by HKP. in 1994.

The above table shows that the Yukon River floodplain and cliffs were rated as high to very high for habitat use and importance. Habitat use and importance of the valley slopes and willow dominated wetlands were rated as moderately high to high while spruce dominated wetlands and aspen dominated uplands were rated as moderately important (HKP, 1994). An overall importance rating of low has been assigned to the conifer dominant uplands.

For a detailed description of habitat types, refer to the IEE Volume 1, “Biophysical Assessment of the Williams Creek Mine Site” prepared by P.A. Harder and Associates in 1994.

5.2.2.3 LSCFN Fish and Wildlife Management Plan

The “Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009” identified a need to protect the Yukon River from Tatchun Creek to Minto as important habitat for moose, salmon, and other wildlife. This section of the Yukon River contains a number of sloughs and islands, and was identified as important habitat for moose during calving, summer, and winter. Moose were commonly seen in this area back in the 1960s, but fewer have been seen in recent years. One area, located approximately 2.5 km downstream of the confluence with Williams Creek and the Yukon River, named “Dog Salmon Slough”, was noted as an important habitat area. Bears use this area for fishing. Moose might be staying away from river corridors now with the increased river travel traffic during summer.

The Fish and Wildlife Management Plan states that some people feel that moose are being pushed away from the Yukon River by the many river travellers. In the last ten years, moose numbers have dropped along the river. Hunting does not seem to be the problem, as few people are hunting along the river, and licensed harvests are low.

5.2.2.4 Wildlife Key Areas

Two wildlife key areas have been identified in the EA study area based on information provided on YG mapping. A key area for golden eagles is considered to be in the northern portion of the study area, near the Yukon River. The southern portion of the study area, where a portion of the access road is located, is considered to fall within a key area for moose. No wildlife key areas have been identified in the central portion of the study area, where the main project activities will occur.

The Village of Carmacks and Freegold Road fall within the wildlife key areas for Bison and Bald Eagles. The project lies outside the known range of Wood Bison with no known record of permanent occupancy in the area (refer to Appendix H5 for further information).

The project area is also within Game Management Zone 5, Subzone 524. Wildlife key areas and game management zones are shown in Figure 5-7.

5.2.2.5 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://www.environmentyukon.gov.yk.ca/fishwild/specrisk.shtml>), and whose ranges could conceivably overlap within the study area include:

- wood bison, 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 were observed within the study area during the wildlife surveys that were conducted in 1992 nor were any key habitats for these species at risk encountered.

5.2.3 Vegetation

Please refer to Appendix H6 which contains results from vegetation field investigations at the Carmacks Copper site in 2006. Primary vegetation types within the project area are described and a listing of vascular plant species is provided.

White spruce (*Picea glauca*) and black spruce (*Picea mariana*) are the common tree species in the project area. Black spruce is dominant in poorly drained areas whereas white spruce tends to occur mainly in better drained areas, and in particular, near the Yukon River. Paper birch (*Betula papyrifera*) is present throughout the forest stands with trembling aspen (*Populus tremuloides*) and poplar (*Populus balsamifera*) often occurring on disturbed sites. Lodgepole pine (*Pinus contorta* var. *latifolia*) occurs throughout the study area, particularly on areas that have been influenced by fire.

Where black spruce occurs as a continuous forest stand, feathermoss tends to dominate the understorey and form a complete ground cover. Willows (*Salix spp.*) and ericaceous shrubs occur where the stands of trees are less dense. In floodplain and poorly drained areas, sedge and sphagnum tussocks are common. On south facing slopes, sagewort (*Artimesia sp.*) grasses and forbs occur as a continuous cover with trembling aspen stands occupying protected draws and gulleys.

In July 1994, a vegetation survey of the Carmacks Copper Project area was conducted by HKP. Sampling consisted of eight 20 m² transects of understorey and ground cover species. Refer to the IEE "Addendum to Volume 1 – Biophysical Assessment of the Carmacks Copper Mine Site" for a listing of tree and plant species encountered during the survey. No unique or endangered vegetation is known to occur in the mine site area (HKP, June 1995).

5.3 HERITAGE RESOURCES

An archaeological impact assessment was conducted in the Williams Creek Valley for the proposed project by Antiquus Archaeological Consultants Ltd. (AAC) in August 1992. AAC also conducted "An Archaeological and Heritage Resource Overview Assessment of the Proposed Carmacks Copper 138 kV Transmission Line Project Route Options Near Carmacks, Yukon Territory" in September 1994. The following sections summarize relevant aspects of these archaeological assessments.

Valued cultural components include heritage sites, spiritual areas, and those important to maintaining current land use patterns (trapping cabins, existing trails, hunting and gathering areas, etc.). Heritage sites include archaeological sites as well as sites which are of value for cultural reasons. They can represent sites with “moveable heritage resources” (artifacts) or designations without material evidence that are culturally significant such as spirit places or traditional trails.

Traditional knowledge (TK) provides an important source of knowledge in identifying cultural sites as well as key ecological areas. The proposed program area is located within the traditional territories of the LSCFN and SFN. As part of archaeological assessments of the Williams Creek Valley and the proposed transmission line, interviews were conducted with Johnny Sam and Wilfred Charlie from the LSCFN to acquire information about First Nation use in the project area. Previously documented historic, ethnohistoric and ethnolinguistic research has also been used to reconstruct traditional Native land use practices in the Williams Creek valley.

5.3.1 Williams Creek Valley Archaeological Assessment

5.3.1.1 Historic Use

In the 20th century, the Williams Creek Valley was used by Natives for winter trapping (J. Sam). Snowmobiles permitted the entire trap line to be checked in one day (12 hours) from a base camp on the opposite shore of the Yukon River (J. Sam). Dogsleds would have allowed similar practices at an earlier date. The valley continued to be used as a hunting area for moose and caribou, but most hunting was done by single Native hunters in the winter while in the area for trapping (J. Sam). These activities would have produced small, scattered kill and/or butchering sites in the valley.

Fishing sites used to catch salmon, as well as, pike, sucker, whitefish, and graylings were constructed along the bank of the Yukon River where deep water with currents and eddies forced the fish close to shore (J. Sam). The river bank was also used as a travel corridor. The “Old Dawson Trail” from Whitehorse to Dawson City followed either the eastern or western bank of the river, while the “Old Telegraph Trail” built in 1899 between Whitehorse and Klondike crossed the mouth of Williams Creek (J. Sam; W. Charlie). Other trails constructed before and since (such as the Toboggan-Dog Race Trail) probably followed the same routes. Small transit and campsites should be expected at the mouth of Williams Creek where these trails were located.

5.3.1.2 Traditional Use

Moose is the most common ungulate now hunted in the Williams Creek Valley, but caribou are also present on occasion and were probably more common in the past before the large migratory herds of caribou in the region were reduced to the current small scattered populations (J. Sam). In the summer (May to October) these animals could have been hunted from fishing base camps on the Yukon River, while in the winter they may have been hunted, as they are now, while trapping in the valley (J. Sam). Given current estimates of ungulate populations, individual hunts rather than communal hunts were probably the norm for the valley. Other wildlife that may have been hunted or trapped in the valley include: grizzly bear, black bear, marten, weasel, mink, otter, red fox, coyote, woodchuck, ground squirrel, wolf, beaver, muskrat, rabbit, pika, and porcupine. Lynx and wolverine are two other important species trapped in the valley (J.

Sam). A few waterfowl may also have been caught in the spring and fall at the small ponds. These traditional activities would have produced small scattered kill and/or butchering sites throughout the drainage, and a few small base camps in the creek valley.

Salmon, whitefish, pike and graylings spawn in the Yukon River and summer fish camps were probably constructed along the shore of the river to catch these fish. Unfortunately archaeological remains from these sites may have been buried or destroyed by flooding and ice flows on the river. Any raised beachlines may afford better site preservation. Early trade and travel routes (predecessors to the historic routes) probably followed the Yukon River and crossed the mouth of Williams Creek. As a result, small transit camps may be expected in this area. All sites in the study area are expected to be small and on flat, well-drained locations.

5.3.1.3 Historic Archaeological Sites

No archaeological sites were identified within the areas proposed for the open pit mine, leach pads and WRSA. However, two historic archaeological sites were identified and recorded during the 1992 assessment. The first site (115-I/07/005) is located at the confluence of Williams Creek and one of its tributaries, located approximately 1.25 km southwest of the confluence of Williams Creek and the Yukon River (Figure 5-1). At this site there is a partially collapsed log cabin, a partially collapsed log barn, and associated domestic and mining related refuse and artefacts. A mine adit was also identified on the north side of the creek, about 400 m west of this site along a well-defined trail. It is believed that the area was occupied during the 1930s and 1940s.

The second site (115-I/07/001) is located along the bank of the Yukon River about 1.25 km southeast of the confluence with Williams Creek (Figure 5-1). This location lies along what has been referred to as the old "Dawson Trail" and consists of the collapsed remains of a historic log cabin. This site is connected to the first site by a horse trail and appears to be a supply and ore transfer station for the mine, which was facilitated by river transport.

These sites are known and documented and will not be disturbed.

Refer to the report entitled "An Archaeological Impact Assessment for the Proposed Williams Creek Copper Oxide Project" prepared by Antiquus Archaeological Consultants Ltd in August 1992 for further discussion on the archaeological impact assessment

5.3.2 Proposed Transmission Line Archaeological Assessment

In September 1994, AAC conducted an archaeological/heritage resource "Overview Assessment" study for two proposed route options for a transmission line to the mine site on behalf of Yukon Energy Corporation. Although the preferred option for supplying power to the project is on-site diesel generation, the possibility of constructing a transmission line has been considered. The information gathered during the 1994 assessment is particularly relevant as route option 1 for the transmission line corresponds closely with the proposed access road to the mine site.

There are three locations near the proposed mine access road considered to have medium heritage site potential. One large medium heritage site potential area is located

on both sides of Crossing Creek between the bridge over the creek on the existing Freegold Road and the turnoff to the mine access road (Figure 5-6). The remains of prehistoric or historic camps may be located in this area. The other two medium heritage site potential areas are located where the mine access road crosses Merrice and Williams Creeks (Figure 5-6).

Antiquus Archaeological Consultants recommends that areas identified as having medium heritage site potential be subjected to further study prior to the initiation of any land-altering activities.

5.4 CURRENT LAND USES

Western Copper is the 100% owner of 240 claims on the Carmacks Copper property (Figure 5-6).

As mentioned previously, the property is located within both the LSCFN and SFN Traditional Territories. The LSCFN has one land claim selection in the vicinity of the project: R-9A. R-9A is located west of the site and extends into the project EA study area (Figure 5-6). No project activities are expected to occur on the LSCFN R-9A land selection. As the land selection is located upstream of the Williams Creek project area, no downstream effects to water quality or quantity are predicted. Discussion on traditional and cultural land uses in and adjacent to the project area is provided within the Socio-economic Effects Assessment located in Appendix P.

There are three LSCFN settlement lands located adjacent or near to the Freegold Road between the Village of Carmacks and the project area, starting just outside of Carmacks (see Figure in Appendix H7). A fourth LSCFN settlement land is located near the Freegold Road, past (west of) the site access road, outside of the project area. Within the Village of Carmacks there are residential lots along the Freegold Road, near the Nordenskiöld River.

Access to the three LSCFN settlement lands will be maintained and land located outside of the right-of-way will not be encroached upon by project activities. Please refer to Appendix H7 for a Figure and table showing land tenure adjacent to Freegold Road. The table provided in Appendix H7 is shown below.

Table 5-18 Properties Adjacent to Freegold Road

Location	Lot Information	Direction from Freegold Road	Approximate Distance from Freegold Road (m)	Tenure
1	1123 115 I/1 LSC S-198B1 HJ-02	East	325	Site specific settlement land, typically selected for residential, heritage or cultural areas.
2	1115 115 I/1 LSC R-32B 84839 CLSR	East	0	Rural settlement land (areas typically defined by: traditional pursuits / residential / mineral or forestry potential). There is a fish camp within this area along the Yukon River.
3	1089 115 I/1 LSC R-20B 84371 CLSR	West	0	Rural settlement land (areas typically defined by: traditional pursuits / residential / mineral or forestry potential).
4	1020 115 I/7 LSC S-130B1 83452 CLSR	North	47*	Site specific settlement land, typically selected for residential, heritage or cultural areas.

*Property located beyond mine site access road

Project Description
& Environmental
Assessment Report

Carmacks Copper
Project
Yukon Territory



- Legend:
- Ore Deposit
 - Historic Archaeological Sites
 - Contour
 - Water Course
 - Trail
 - Limited-used Road
 - Road
 - Access Road
 - Exploration Road
 - First Nations Traditional Territory Border
 - Little Salmon/Carmacks First Nation
 - Mineral Parcel
 - Western Copper Holdings Limited Claims
 - Other Claims
 - Expired License or Lease
 - Environmental Assessment Study Area
 - Water Body
 - Medium Heritage Site Potential

UTM Zone 8 NAD83 Meters

Heritage Resources &
Current Land Uses

Figure Number:
5-6

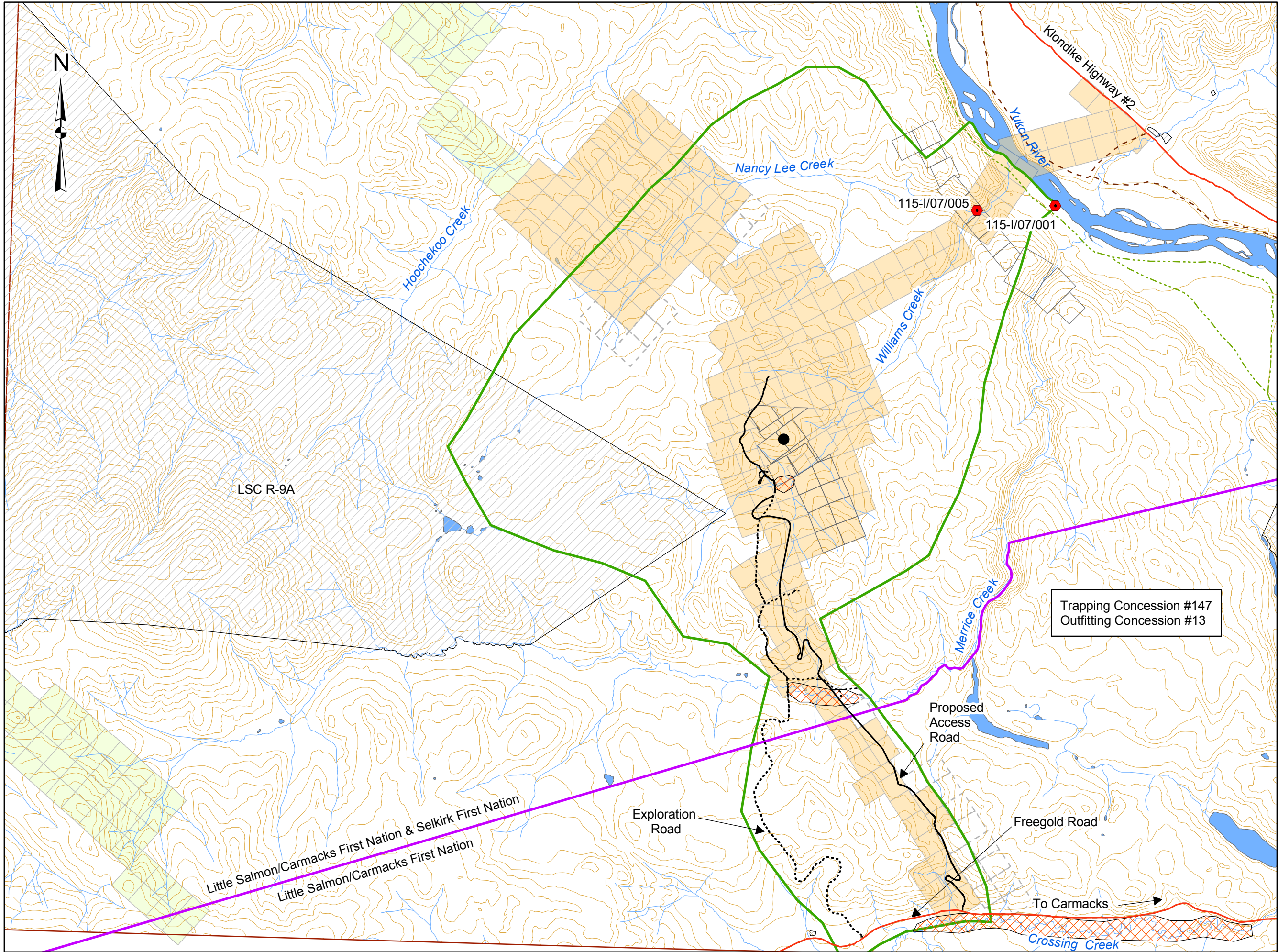
Scale:
0 500 1,000 2,000 3,000 Meters

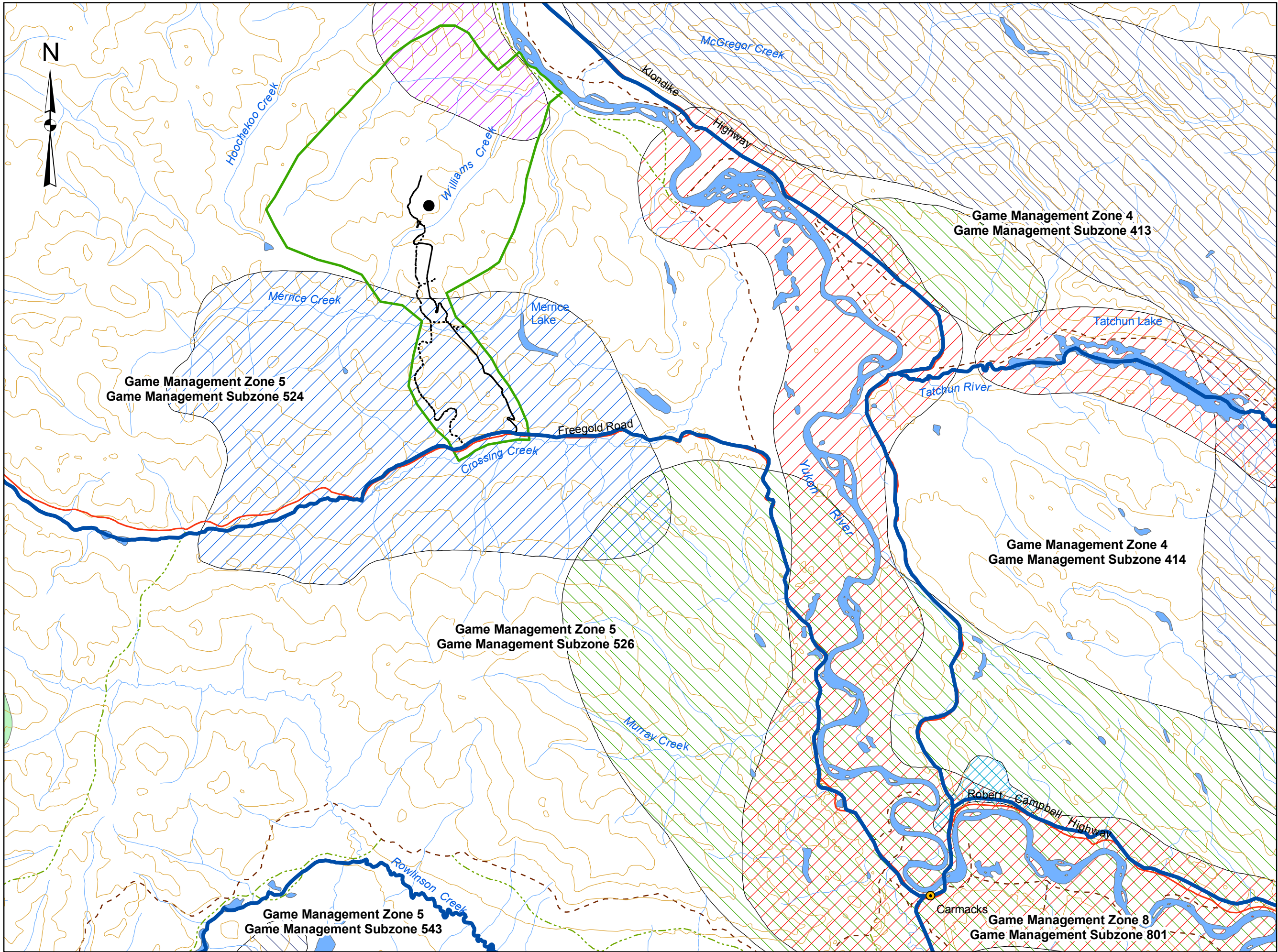


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Project Description & Environmental Assessment Report

Carmacks Copper Project Yukon Territory



Legend:

- Town
- Ore Deposit
- Water Course
- Proposed Access Road
- Exploration Road
- Limited-used Road
- Road
- Trail
- Contour
- Water Body
- Environmental Assessment Study Area
- Game Management Zone

Wildlife Key Areas (Source: YG DoE)

- Bald Eagle
- Bison
- Golden Eagle
- Moose
- Mule Deer
- Woodland Caribou

UTM Zone 8 NAD83 Meters

Game Management Zones & Wildlife Key Areas

Figure Number:

5-7

Scale:

1:150,000



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Checked by: DC

Date: April, 2005

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5.5 SOCIO-ECONOMIC CONDITIONS

A broad range of existing socio-economic conditions in the Village of Carmacks are summarized in Section 2 of the Socio-economic Effects Assessment Report, located in Appendix P. Discussion is provided on:

- *community demographics;*
- *levels of knowledge and education within Carmacks;*
- *health status of the community;*
- *the local economy;*
- *community governance, infrastructure & services; and*
- *community stability, vulnerability & resiliency.*

The reader is referred to this report for full discussion of socio-economic conditions for the project.

5.6 ENVIRONMENTAL STUDY PROGRAMS

Additional studies have been and continue to be undertaken for the Carmacks Copper project in 2005 and 2006. These studies have been initiated to:

- *build upon the existing environmental baseline data in preparation for mine construction, operation and closure;*
- *collect additional data in support of mine and infrastructure development;*
- *refine and optimize heap leaching and metal recovery processes; and*
- *develop and refine closure methods for eventual mine decommissioning, reclamation and closure.*

A brief outline of the environmental study programs are presented below.

Water Use Licence Monitoring

It is expected that the Environmental Monitoring Plan will form part of the water use licence monitoring and reporting requirements. This plan outlines monitoring during construction, operation and at closure. The program is discussed in detail in Section 8.2.4. Monitoring programs include: meteorological; hydrology, surface and groundwater quality; aquatic resources; geotechnical conditions and study plan requirements. This information is typically reported to the Yukon Water Board monthly and compiled annually. The Water Board maintains a registry which is open to the public.

Quartz Mining Licence Monitoring

It is expected that the Construction and Operational Monitoring Programs will form part of the quartz mining licence monitoring and reporting requirements. This program outlines monitoring requirements for physical structures, process control, mine and waste rock management during construction, operation and at closure. The program is discussed in detail in Section 8.2. This information is typically reported to YG Energy, Mines and Resources and compiled annually.

Environmental Effects Monitoring

A requirement of the Metal Mining Effluent Regulations is the development of an Environmental Effects Monitoring (EEM) program for the project. The objectives of the EEM program are to determine the potential effects of the project operations on the receiving water aquatic ecosystem in Williams Creek and assist in determining the effectiveness of various environmental protection measures at the mine site.

Prior to the initiation of mine construction an EEM study plan will be developed and submitted to regulatory agencies for review. It is expected that existing baseline environmental data will be augmented with current data to confirm the understanding of environmental conditions in the area. Monitoring stations in the study area will be reactivated and data collected for surface water quality and stream flow, groundwater quality and level, stream sediments, benthic invertebrates, algae and fisheries, including fish tissue analyses. These data will be used to monitor changes and trends in the aquatic ecosystem and develop supporting data to interpret biological monitoring results.

In addition, the EEM study program will also characterize effluents from the site including possible effluents from the contingency raffinate treatment plant and sediment control ponds. Acute toxicity testing will be conducted along with sublethal toxicity testing (fish, invertebrates, algae and plant).

All results will be reported to regulatory agencies as part of the licences and permits.

Archaeological Study

Previous archaeological investigations identified areas on the project access road that may have medium heritage site potential. Prior to access road construction these medium heritage potential sites located near Williams and Merrice Creek will be investigated to determine if heritage resources exist. The work will be conducted by qualified personnel in conjunction with the LSCFN.

In Situ Biological Oxidation Studies

Column test work has recently been completed to investigate the biological oxidation of elemental sulfur to produce sulfuric acid as part of the heap leaching process. This process option is currently under investigation with positive results. Large scale columns test work is being investigated. Leach test columns are also being used to further test heap detoxification methods.

Further test work would consist of a series of small reaction tanks and transportation of elemental sulfur. Agglomeration of elemental sulfur and bio-acid produced from bacteria would be required. Additional test work and economic evaluation is necessary to demonstrate scale-up and commercial application and the Company continues to optimize the process.

Decommissioning and Closure Related Studies

It is expected that additional closure related studies would be undertaken once operations begin. These studies would include the following:

- revegetation test work and test plots to optimize revegetation seed mixtures, application rates, nutrient supplements and natural species recolonization success;
- characterization of overburden soils for revegetation
- reclamation test work to optimize heap cover design; and
- heap leach detoxification studies, including column studies to optimize heap rinsing, neutralization, and *in situ* biological treatment.

The results of the studies and test work would be used to optimize closure measures and designs for the final mine decommissioning and reclamation plan.

6.0 PUBLIC ENGAGEMENT / INPUT

The report entitled "Consultation Summary Report", Access Consulting Group, 2006 (previously filed with YESAB and included electronically with this Project Proposal) provides a summary of detailed project consultations between 1991 and February 2006. This report demonstrates the efforts that were undertaken to provide adequacy notice and information to various parties about the project, the type of comments received, and how the company incorporated those comments into the project proposal.

Further project consultations have since occurred between company representatives and members of the communities of Carmacks and Pelly Crossing. Summary tables of Western Copper's additional community consultations in 2006 are presented in Appendix I.

Meeting Summaries:

On May 23, 2006 Western Copper met with LSCFN Chief and Council. There was discussion of previously identified issues and comments, as well as means for further project dialogue.

On May 24, 2006 Western Copper met with SFN Chief and Council. Discussions took place on details of the project as well as appropriate means for further project dialogue.

On June 11, 2006 Western Copper attended the LSCFN General Assembly where Chief Skookum and three Councilors were in attendance. An outline of poster presentation was discussed and presented (see Appendix J). Specific comments on water management and closure were discussed. Project posters were revised to incorporate comments received.

On July 4, 2006 Western Copper attended the Selkirk First Nation's Annual General Assembly in Pelly Crossing, displaying a series of posters that had been produced to introduce the Carmacks Copper Project to the public (see Appendix J). The community was notified that the company would be attending the General Assembly in advance of the assembly. A number of copies of the Project Proposal had previously been provided to SFN in advance of the meeting. The posters were displayed in the food hall, which incurred more than 100 individuals during the lunch break. A summary of discussion points raised follows:

- Location of Carmacks Copper project area – discussed and demonstrated on several posters;*
- Requested to explain the concept of the 'liner system';*
- Availability of community training, business and service opportunities – discussed and listed on poster;*
- Potential environmental effects and mitigation measures;*
- Heap leach system;*
- Percentage of copper to be extracted from the site;*
- Discussion about what stage the project is in;*
- Request for a site visit in August 2006; and*
- Enthusiasm to see the project go ahead and give the community the opportunity to fulfill the training and employment requirements of the project.*

The company has acknowledged that the project lies within the traditional territory of the SFN and will continue discussions regarding project development and SFN involvement. The comments received have been acted upon or incorporated into the project proposal. For instance, a site tour was coordinated with SFN involvement and measures to protect the environment were noted and expanded upon as part of this project proposal.

On October 11, 2006 the company sent the SFN a letter expressing interest in any views or comments the SFN may have in relation to the project. In response, the SFN indicated that they are too consumed with other projects to participate in the Carmacks Copper project at this time (letter is provided within Appendix D of the Socio-economic Effects Assessment Report – Appendix P). The intention is to continue to work with the SFN, when they are prepared to participate in the project to discuss project opportunities and participation.

As part of the socio-economic effects assessment numerous contacts have been made with community residents and officials at all levels of government. The tables presented in Appendix I provide a summary of project contacts made, and evidence of those contacts and consultations relating to the socio-economic effects assessment can be found in Appendix P.

Consultations with the LSCFN were planned for July 5, 2006 and subsequently cancelled as the First Nation was not yet prepared to initiate consultations.

On July 6, 2006 Western Copper rented a room in the Village of Carmacks Recreation Centre to display and discuss the poster series with community members between 4:00 p.m. and 8:00 pm. Fliers inviting members of the community to attend had been distributed in Carmacks a week prior to the Open House meeting. A steady flow of stakeholders attended the Open House, including the Acting Mayor, Village Council Staff, and other interested constituents. A summary of discussion points raised and views expressed follows:

- Youth issue – it became apparent through several discussions that the majority of youth in Carmacks have experienced problems with alcoholism, drugs (i.e. crack cocaine and crystal meth) and have a background of abusive families. There seems to be a general lack of motivation and disillusionment, derived from reliance on welfare and lack of opportunities within the Village. It was said that of youth between the ages of 10 and 16, 85% get involved with drugs;*
- Negative perception of mining from prior BYG mining operation;*
- Confusion expressed over Western Copper's association with Glamis Gold. There is a negative perception of Glamis Gold in relation to recent Guatemala fatalities;*
- Discussion of training and employment opportunities for ongoing work;*
- Potential environmental effects and proposed mitigation measures, particularly in relation to managing the heap leach facility;*
- Discussion about making contracts attractive to First Nations communities by offering flexible work hours such as three-day weekends, regulated breaks, and an allowance for 'grievance leave', acknowledging that First Nations communities place high importance on attending memorial services and paying respect to fellow community members;*
- Discussion of recent performance of WRN stock; and*
- Positive attitude expressed regarding future opportunities for the community.*

On August 15, 2006 a tour of the Carmacks Copper project area was guided by Western Copper representatives. A poster series was presented and discussed with attendees. A project newsletter was provided to those in attendance and is included in Appendix J.

The following individuals, representing YG, YESAB, LSCFN, SFN, Selkirk Renewable Resources Council (SRRC), Village of Carmacks, and Yukon Energy, attended the site tour:

<i>Randy Clarkson</i>	<i>New Era Engineering Corp (YG).</i>
<i>Stephen Mills</i>	<i>YESAB</i>
<i>Travis Ritchie</i>	<i>YESAB</i>
<i>Patricia Randell</i>	<i>YESAB</i>
<i>Randy Lamb</i>	<i>Yukon Government – Department of Environment</i>
<i>Chuck Hubert</i>	<i>Yukon Government – Department of Environment</i>
<i>Bill Klassen</i>	<i>Yukon Government – Environmental Coordinator</i>
<i>Cory Bellmore</i>	<i>Village of Carmacks</i>
<i>Elaine Wyatt</i>	<i>Village of Carmacks</i>
<i>Gerry Whitely</i>	<i>Yukon Government – Water Resources</i>
<i>Arlene Kyle</i>	<i>Yukon Government – Energy, Mines & Resources</i>
<i>Joanne Osberg</i>	<i>Yukon Government – Energy, Mines & Resources</i>
<i>Hector Campbell</i>	<i>Yukon Energy Corporation</i>
<i>Dorothy Bradley</i>	<i>Selkirk Renewable Resources Council</i>
<i>Lana Vandeen</i>	<i>Yukon Government</i>
<i>George Skookum</i>	<i>Little Salmon Carmacks First Nation</i>
<i>Malcolm Taggart</i>	<i>Research North</i>
<i>Gerry Kruse</i>	<i>Selkirk Renewable Resources Council</i>
<i>Dorothy Bradley</i>	<i>Selkirk Renewable Resources Council</i>
<i>Kevin Vaughn</i>	<i>Selkirk Renewable Resources Council</i>
<i>Calvin Menzi</i>	<i>Selkirk Renewable Resources Council</i>
<i>Luigi Curt</i>	<i>Selkirk Renewable Resources Council</i>
<i>Styd Klusie</i>	<i>Selkirk First Nation</i>
<i>Roger Alfred</i>	<i>Selkirk First Nation</i>

The company has considered all comments received to date by various stakeholders and considered them as part of the project proposal. Alterations have been made to the project design as a result of these comments, mainly to address concerns related to environmental protection. Numerous studies and additional monitoring programs have also been undertaken to address comments regarding the technical adequacy of project component designs and documentation of baseline environmental conditions. The company has given full consideration to stakeholder comments by implementing design alterations, undertaking further studies, and continuing environmental monitoring programs. A summary of key considerations made by the company to address LSCFN, SFN, Village of Carmacks, and other stakeholders are noted below:

Project component design considerations:

- heap leach pad liner system design;*
- Merrice Creek Bridge crossing;*
- Waste rock storage area design; and*
- Heap leach pad closure.*

Project studies and monitoring considerations:

- *Spent ore detoxification test work;*
- *Hydrological update and water balance revisions;*
- *Water treatment test work;*
- *Water quality modeling; and*
- *Continued environmental baseline data collection programs to document pre mining conditions and provide a basis for long term data comparison, analyses and effects assessment (surface and ground water quality, stream sediments, fisheries, wildlife and hydrology).*

Western Copper continues to strive towards a close working relationship with the First Nation communities in the Carmacks Copper Project area, particularly the LSCFN and SFN, and is committed to working with the Village of Carmacks and all stakeholders as part of its ongoing project activities. Specifically, the Company is committed to:

- Participating in local meetings and information sessions, and taking other appropriate steps to promote consultation and communication;
- Working directly with First Nation communities regarding the EA process and their involvement and management of local environmental and socio-economic issues;
- Consulting in an ongoing manner with communities, individuals, groups and stakeholders, so that local people are kept informed regarding plans and activities and employment opportunities;
- Providing local First Nation communities with notice of potential employment and contracting opportunities; and
- Maximizing opportunities for northern benefits from the Carmacks Copper project.

6.1 1991-1993 PUBLIC CONSULTATIONS

The opinions/concerns regarding the effects of the Carmacks Copper Oxide Project on the LSCFN have been documented in the IEE Volume II (January, 1994) prepared by HKP. A partial list of consultations that took place in 1991, 1992, 1993, and 1994 between individuals involved in the project and the LSCFN is presented in Appendix I.

A number of LSCFN members and several other residents of the Carmacks community were interviewed regarding their opinions/concerns about the Carmacks Copper Project. They were asked how they felt the proposed project would affect the LSCFN. Some of those opinions are given below.

The following individuals/agencies participated in the interview:

Paul Taylor (Yukon College)
Darlene Johnson (NNADAP)
Joseph O'Brien (NNADAP)
Tim Gooding (First Nation Staff)
Viola Mullet (First Nation Staff)
Jane Jack (Village Office)
Clyde Blackjack
Joyce Gage
Health & Welfare – Health Centre

Royal Canadian Mounted Police (RCMP)

The Yukon College is interested in working with Western Copper in order to prepare further training programs such as the mill operator course which will provide specific training programs. It is hoped that the Company will work with the college and pass on information which would assist in this regard.

Many individuals felt that there are both positive and negative aspects of the proposed Carmacks Copper Project. On the one hand, it could provide an opportunity for Carmacks to grow. There are few opportunities for those currently without work. On the other hand, the influx of new people (miners & their families) could have a negative effect on the LSCFN people. They feel that the First Nation community is in the process of healing and that the influx of new people (miners) may disrupt the advances that have been made. There are many severe social problems already in the native community such as alcohol and drug abuse. In a mining community more alcohol and drugs may become available. Several people were also concerned about the influence of single males (working at mine and living in community) on young girls with low self esteem (unwanted pregnancies).

Several individuals expressed the desire for a more in-depth study completed on the social impacts of the mining project on the First Nation community.

One individual interviewed expressed concerns about the environment. He has worked previously in several mines and observed that the mine sites were left in poor condition after closure. He feels that abandoned mines should be cleaned up and that waste materials should be removed and that the site should be revegetated. He indicated that most elders are concerned about the effects of a mine on the environment and are often concerned about chemicals escaping into the environment. He also voiced some concern about animals affected by the mining operation (i.e. the animals would move out of the area).

Health and Welfare Canada were concerned about increased alcohol and drug abuse and increased violence (e.g. rape, unwanted pregnancies). They were apprehensive about additional health needs of new people in community as well as occupational health & safety (i.e. accidents, injuries at mine site) and felt that additional staff would be required.

The RCMP voiced concern about the increase in the law enforcement workload with influx of people to the community. They feel that they will probably require an increased staff as they are currently dealing with over 500 complaints per year.

Several individuals were enthused by the prospect of a local mining operation and were very interested in the opportunities for employment.

The following has been included from the "Environmental Assessment, Western Coppermine/Williams Creek, Yukon Region – Final Report" prepared by MDA Consulting Limited in March 2000.

"The Little Salmon/Carmacks First Nation has had a long standing concern about the development of the site, particularly with respect to the impact of the heap leach facility on the natural water resources, and habitat within. As well, they

have a concern as to the impact of the development on the wildlife and the habitat within traditional areas. On the other hand, with the recent closing of another mine in the vicinity, which employed numerous band members, there is a strong interest in the development with appropriate environmental safeguards.” (MDA, 2000)

Throughout the development of the proposed Carmacks Copper Project, Western Copper has endeavoured to maintain cooperative and interactive association with the *First Nation communities and the Village of Carmacks*.

6.2 RECENT PROJECT MEETINGS/DISCUSSIONS

Since reactivating the project Western Copper has undertaken a number of meetings with Yukon Government, LSCFN and the Village of Carmacks. A summary of these discussions is presented in the following sections.

6.2.1 Yukon Government

In August 2004, Western Copper approached YG regarding the environmental assessment process for major mines in Yukon. As the Carmacks Copper project had previously undergone an environmental assessment, the Company was interested in YG's EA process changes relating to new mine development in the Yukon. A series of meetings were held with senior government officials within the Departments of Energy Mines and Resources, Environment, and Executive Council Office to refine the Company's understanding of the EA review and permitting processes. A draft Project Agreement was developed between the Company and YG following the outline provided by Yukon Government in their document entitled “Administrative Procedures for Major Mining Projects in the Yukon, September 2004”.

(http://www.emr.gov.yk.ca/mining/info/procedures_ea_yukon.pdf)

The Project Agreement provides overall guidance for the conduct of the EA review process, including the roles and responsibilities for the parties, consultation requirements and the use of technical committees and consultants, the project performance standards and objectives for the project, EA transition and harmonization provisions, project tracking and a public registry requirements and timelines.

The Performance Standards and Objectives for the project as outlined in the Project Agreement are presented in Appendix C of this report. It is understood that the performance standards were reviewed by YG departments to provide the Company with the minimum requirements for the project EA review. The Company has used these performance standards as a basis for completing engineering designs for the project and assessing potential environmental and socio-economic effects and determining their significance.

It is expected that further meeting will be convened with YG and the LSCFN and SFN as the EA review process continues and various stakeholders are consulted.

6.2.2 First Nations Communications

On February 7, 2005 a conversation took place between LSCFN Chief Eddie Skookum and Councilor Terry Billy, and Dan Cornett of Access Consulting Group. The purpose of

the meeting was to reintroduce LSCFN to the project and the Company's project plans. The main points addressed by the LSCFN during this project discussion include:

- LSCFN continued interest in the project and working with Western Copper to advance the project;
- Project effects on local ground and surface water resulting from the heap leach pad. LSCFN wants a design and project that does not effect local downstream resources including during future reclamation;
- Project effects to the local trapper's ability to harvest and use the area;
- Project effects to local wildlife;
- The LSCFN's interest in economic benefits from the project including employment opportunities; and
- LSCFN's interest in providing local infrastructure and housing support in Carmacks for the project.

On February 16, 2005, Western Copper representatives met with the LSCFN Chief and Council (Chief Eddie Skookum, Councilors Terry Billy, Darlene Johnson, George Skookum, Johnny Sam, Mary Tulk and administrative staff, Cathy Cochrane, Elizabeth Skookum, Violet Mullett, Susan Davis) to reintroduce them to the project and the Company's plans to complete the EA and permitting process. At these meetings the Company provided corporate background on Western Copper and their development plans. The subject matter covered was generally similar to that discussed during the February 7, 2005 conversation (above). In addition to the already mentioned concerns/points, the importance of social benefits was discussed. A draft socio-economic agreement was previously developed between the Company and LSCFN for the project and LSCFN is interested in renegotiating a benefits agreement with the Company to address socio-economic benefits for the project. The fact that more recent baseline data should be collected from the project area before project start-up was also discussed.

On March 7, 2005, Western Copper representatives met with the LSCFN Lands and Resources Branch personnel (Johnny Sam – elder, Susan Davis, Mark Nelson, and Robbie Cashin) to discuss the EA process, present an overview of the project development and review environmental and traditional use information for the project description documentation.

LSCFN wants to be an active participant in the EA process. Further meeting with YG should include LSCFN representatives. Methods to continue to brief LSCFN members and the community were discussed. Previous environmental, heritage and cultural data was reviewed and recent maps compiling data collected from past studies was provided to the Branch for review and input.

Additional community meetings are planned in Carmacks to provide project updates to LSCFN members.

6.2.3 Village of Carmacks

On February 16, 2005, Western Copper representatives met with the Village of Carmacks Council and administrative staff (Mayor Ed Larkin, Councilors Stuart Harris, Elaine Wyatt, Cory Belmore and Bob Jackman, Village CAO) to reintroduce them to the project and the Company's plans to complete the EA and permitting process. At these

meetings the Company provided corporate background on Western Copper and their development plans. The Village continues to support the Company's development plans. The importance of social benefits was discussed and the need to ensure employment equity hiring for all Village and LSCFN members. The Village is looking at a number of new developments within the community including a new school, wastewater treatment system and water distribution system. These developments bode well for the Company's future plans. Continued communication with the community will be important as the project moves through the EA and permitting processes.

6.3 OPEN HOUSES

Western Copper's open house was advertised in local newspapers and held in the Village of Carmacks on February 16, 2005 to give the public an opportunity to present their comments or concerns directly with Western Copper and their consultants. Approximately 12 community members participated in the open house. Five large 3' x 5' posters were produced to present key project and environmental information. The focus for the posters was on visual material (diagrams, maps, photos). Key team members were on hand to discuss the posters and respond to and document questions arising. A newsletter was prepared and available as a hand out for the public (see Appendix J). A visitor's log recorded public participation. Additional open houses are planned for the LSCFN, Village of Carmacks, and Whitehorse.

6.3.1 Poster Displays

The following posters were prepared for the open houses:

Poster 1 – Project Overview – Text providing Western Copper's corporate information and commitments, as well as the scope of the Carmacks Copper project, with a photo of the project area.

Poster 2 – Project Components – Drawing showing the overall site plan for the project with text describing main components; simplified flowsheet of the Carmacks Copper project process; and photos of the project area.

Poster 3 – EA Study Area – Map, photos, and text illustrating the Carmacks Copper environmental assessment area and local geography.

Poster 4 – Project Studies – Maps, photos, and text showing assessment activities, heritage resources and current land use, game management zones, and key wildlife areas.

Poster 5 – Conceptual Reclamation/Closure Plan – Drawing, flowsheet, and text explaining reclamation measures to be undertaken upon mine closure.

Many of the questions raised by the public during the open houses focused on economic and employment benefits and opportunities. Community members were interested in the project plans and encouraged to see Western Copper reactivating the project EA.

Posters were used to explain the project location and environmental setting. Visitors were advised that an environmental assessment report was in preparation and this document would be available to the public for review and comment. Visitors were interested in the fisheries resources in Williams Creek and the measures to protect them. They were advised that national environmental quality guidelines would be used to ensure downstream resources are protected. Many questions surrounded the EA

review process and opportunities to community input. Western Copper has acknowledged the community issues raised during this public process, incorporated where appropriate in the EA document, and will consider them in future planning. The Company intends to continue to provide the community with information updates as the project proceeds.

6.4 NOTIFICATION

Notification to trappers, outfitters, and other resource users in the project area is being undertaken as a part of this environmental assessment. Initial contact has been made with the local trapping family regarding project activities. Formal notifications will be made to the following prior to commencement of project operations:

Individual Trapper

Trapping Concession #147
Kathleen Sam
Carmacks, YT

Outfitter Concession

Outfitting Concession #13
Mervyn's Yukon Outfitting
Tim & Jen Mervyn
Box 33036
Whitehorse, YT
Y1A 5Y5

7.0 POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

The IEE report for the Carmacks Copper Project dated October 1994 was prepared by HKP for Western Copper Holdings Ltd. Volume IV of the IEE, "Environmental Mitigation and Impact Assessment" contains the Environmental Impact Assessment, while the IEE Addendum submitted in June 1995 by HKP contains a revised environmental impact assessment. The following text and information has been included from the revised assessment, which supersedes the impact assessment presented in Volume IV of the IEE. However, the IEE and addendums should be referred to for further details and specific information where noted. The following section comprises the assessment of potential effects resulting from the development of the Carmacks Copper Project.

7.1 ENVIRONMENTAL ASSESSMENT APPROACH

The environmental assessment included the identification of Valued Ecosystem and Cultural Components (VECC's), and an assessment to determine whether or not the project is predicted to cause significant adverse environmental effects on each identified VECC, after the implementation of appropriate mitigation measures. The following section consists of an assessment of potential adverse effects as a result of the Carmacks Copper project using the baseline environmental data for the EA study area with proposed mitigation measures.

To determine whether or not the potential adverse environmental effects were considered significant, seven criteria were taken into consideration. The first five descriptors follow those identified in The Responsible Authority's Guide to the Canadian Environmental Assessment Act prepared by the Federal Environmental Assessment Review Office (FEARO) in 1994. The descriptors for economic and social context, risk characterization and directions have been added to address potential socio-economic effects from the project and to incorporate the risk assessment into the significance determination. *The descriptors for frequency and the determination for likelihood were taken from the YESAB "Assessor's Guide to the Assessment of Environmental Effects."*

- **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 could not be significant. *The occurrence may be once, or rare or even continuous;*
- **Reversibility:** Degree to which the adverse effect is reversible or irreversible. Reversible adverse environmental effects may be less significant than effects that are irreversible;
- **Ecological Context** of the potential environmental effect. 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 ecologically fragile and have little resilience to imposed stresses;

- **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
- **Risk Characterization:** The potential consequences (adverse effects) of failure modes or hazards may be significant if potential failure and exposures are a high risk and likely to cause adverse effects.
- **Direction:** *The adverse effect may be negative or beneficial.*
- **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:*
 - *Probability: The chance or possibility that a specific event will occur.*
 - *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 7-1. Table 7-2 provides a summary of the assessment of potential environmental effects, a listing of mitigation measures, and a determination of the significance of the potential effects using quantifiable measures. The components that were evaluated for potential environmental effects include: soils; vegetation; groundwater quality and hydrology; surface water quality and hydrology; aquatic resources including fisheries resources and benthic invertebrates; wildlife and habitat; and aesthetics, including air quality, visibility, and noise. Socio-economic effects including *social demographics; community wellness; justice; education; employment; business opportunity; infrastructure and community services; and human health and safety* are addressed within the *Socio-economic Effects Assessment Report (Appendix P)*.

Subsequent sections within Section 7 present the determination of VECC's, the details of the effects assessment and mitigation measure for various environmental conditions, a cumulative effects and risk assessment, closure planning, and capacity of renewable resources to meet present and future needs.

Table 7-1 Significance of Effects Descriptors

Descriptor	Direction	Duration	Geographic Extent	Magnitude	Reversibility*	Ecological Context	Economic & Social Context	Risk Characterization**	Frequency	Significance
Very low (1)	+ = <i>Beneficial Effect</i>	<1 to 5 years (1)	<1 ha (1)	negligible effects to surrounding environment (1)	95-100% (1)	community with very good ecological fitness and a very high degree of resilience (1)	community with very good economic and social fitness and a very high degree of resilience (1)	negligible risk (1) : negligible to high hazard assessment; negligible to very low exposure assessment; and negligible consequence assessment	<i>Occurs once (1)</i>	<i>Not significant adverse environmental effect (NS)</i>
Low (2)	<i>n = neutral effect</i>	5 to 10 years (2)	1-75 ha (2)	low effects to surrounding environment (2)	75-95% (2)	community with good ecological fitness and a high degree of resilience (2)	community with good economic and social fitness and a high degree of resilience (2)	very low risk (2) : negligible to high hazard assessment; negligible to very low exposure assessment; and negligible consequence assessment	<i>Occurs Rarely and at Sporadic Intervals (2)</i>	<i>Positive environmental effect (P)</i>
Moderate (3)	- = <i>negative effect</i>	10 to 25 years (3)	75-200 ha (3)	moderate effects to surrounding environment (3)	60-75% (3)	community with moderate ecological fitness and a moderate degree of resilience (3)	community with moderate economic and social fitness and a moderate degree of resilience (3)	low risk (3): very low to high hazard assessment; low to medium exposure assessment; and very low to low consequence assessment	<i>Occurs on a regular basis and a regular interval (3)</i>	<i>Significant adverse environmental effect (S)</i>
High (4)	+/- = <i>beneficial and negative effect</i>	25 to 100 years (4)	200-300 ha (4)	extreme effects to surrounding environment (4)	40-60% (4)	community with poor ecological fitness and a low degree of resilience (4)	community with a poor economic and social fitness and low degree of resilience (4)	medium risk (4) : low to high hazard assessment; medium to high exposure assessment; and low to medium consequence assessment	<i>Continuous (4)</i>	
Very High (5)		100 years-permanent (5)	>300 ha (5)	catastrophic effects to surrounding environment (5)	<40% (5)	community with very poor ecological fitness and a low degree of resilience (5)	community with very poor economic and social fitness and a low degree of resilience (5)	high risk (5): low to high hazard assessment; medium to high exposure assessment; and medium to high consequence assessment		

Notes:
Numbers in parenthesis () equals numerical weighting value. * Descriptors for reversibility are opposite to the effects descriptors. ** Risk characterization adapted from Van Zyl, Koval and Li (1992).

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

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

NA = Not Applicable

Table 7-2 Summary of the Assessment of Potential Environmental Effects Resulting from the Proposed Carmacks Copper Project

Parameters	Development	Occurrence	Consequence and Effect	Mitigation	Direction	Significance of Effects										Significant	Likelihood	
						Duration	Geographic	Magnitude	Reversibility	Ecological	Economic & Social	Risk	Frequency	Overall Rating	Probability		Uncertainty	
Atmospheric	OP	O	fugitive dust	road watering	-	10 years - low	low	low	high	low	moderate	v. low	2	LOW	NS	2	3	
	MWRSA	C,O	fugitive dust	road watering	-	10 years - low	low	low	high	low	moderate	v. low	2	LOW	NS	2	3	
	HLP	C,O,C/P	fugitive dust, gaseous emissions	road watering/closed distribution system	-	10 years - low	low	low	high	low	moderate	low	2	LOW TO MODERATE	NS	2	3	
	AR	C, O, (C/P)	fugitive dust	road watering	-	10 years - low	low	low	high	low	moderate	v. low	2	LOW	NS	2	3	
	AF		fugitive dust, gaseous emissions	baghouse dust collectors, ventilation system, scrubbers	-	10 years - low	low	moderate	high	low	moderate	low	2	LOW TO MODERATE	NS	2	3	
Topography	OP	O, C/P	permanent open pit	some recontour, and access barriers	-	permanent-v.high	29.5 ha - low	high	low	low	moderate	low	1	MODERATE	NS	2	3	
	MWRSA	O, C/P	single storage area	recontoured and revegetated	-	permanent-high	69.6 ha - low	moderate	moderate/high	low	moderate	low	1	MODERATE	NS	2	3	
	HLP	O, C/P	valley fill	recontoured, covered and revegetated	-	permanent-high	37.2 ha - low	moderate	moderate/high	low	moderate	low/moderate	1	MODERATE	NS	2	3	
	AR	C, O, C/P	road cuts	recontoured and revegetated	-	15 years - moderate	12.3 ha - low	low	high	low	moderate	v. low	1	LOW	NS	2	3	
	AF	C, O, C/P	facility area cuts	recontoured and revegetated	-	15 years - moderate	13.3 ha - low	low	high	low	moderate	v. low	1	LOW	NS	2	3	
Soils (including permafrost)	OP	C,O,C/P	Stripping of soils	n/a	-	permanent-high	29.5 ha - low	high	low	low	moderate	low	1	MODERATE	NS	2	3	
	MWRSA	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	-	10 years-low/mod.	69.6 ha - low	low	high	low	moderate	low	1	LOW	NS	2	3	
	HLP	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	-	10 years-low/mod.	37.2 ha - low	low	high	low	moderate	low	1	LOW	NS	2	3	
	AR	C,O,C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	-	10 years-low/mod.	12.3 ha - low	low	high	low	moderate	low	1	LOW	NS	2	3	
	AF	C, O, C/P	Stripping and erosion of soils	stockpiling of overburden for cover/revegetation. Prevent erosion.	-	15 years-moderate	13.3 ha - low	low	high	low	moderate	low	1	LOW	NS	2	3	
Surface Water Hydrology	HLP	C,O,C/P	discharge of effluent to Williams Creek	controlled discharge	-	15 yrs-moderate	moderate	moderate	v. high	low/mod.	moderate	low/moderate	2	LOW TO MODERATE	NS	2	3	
	MWRSA	C,O,C/P	discharge of effluent to North Williams Creek	controlled discharge	-	15 yrs-moderate	moderate	low	v. high	low/mod.	moderate	low	2	LOW TO MODERATE	NS	2	3	
	AR	C,O,C/P	stream crossings	bridge crossing on Merrice Creek	-	15 yrs-moderate	v. low	v. low	v. high	low/mod.	moderate	v. low	2	LOW	NS	2	3	
Surface Water Quality	AR	C, O	sediments	minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low	low	v. high	low	moderate	low	2	LOW	NS	2	3	
	HLP	O,C/P	nitrogen compounds/metals/acid/sediments	no discharge, contingency treatment plant, sediment ponds, heap treatment, monitor	-	15 yrs-moderate	low/mod.	moderate	high	moderate	moderate	moderate	2	MODERATE	NS	2	3	
	MWRSA	O,C/P	nitrogen compounds/metals/sediments	maximize collection and water recycle. Settlement of runoff from disturbed areas.	-	15 yrs-moderate	low/mod.	low	high	moderate	moderate	low	2	LOW TO MODERATE	NS	2	3	
	OP	O	nitrogen compounds/metals/sediments	maintain vegetation buffer zones, no release of water from pit	-	10 yrs-low/mod.	low	low	high	low	moderate	low	2	LOW	NS	2	3	
Groundwater Hydrology	HLP	O,C/P	cone of depression in groundwater table	foundation drainage	-	permanent-high	low	moderate	moderate	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	MWRSA	O,C/P	groundwater mounding	foundation drainage	-	permanent-high	low	low	moderate	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	OP	O, (C/P)	cone of depression in groundwater table	n/a	-	25 to 100 yrs-high	low	moderate	high	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	AF	C,O, (C/P)	cone of depression in groundwater table - water source	multiple well locations, monitoring	-	10+ yrs-low/mod.	low	moderate	high	low	moderate	low	1	LOW TO MODERATE	NS	3	3	
Groundwater Quality	HLP	O,C/P	nitrogen compounds/metals/acid	LDRS, double composite liner	-	15 yrs-moderate	low	moderate	moderate	moderate	moderate	moderate	2	MODERATE	NS	2	3	
	MWRSA	O,C/P	nitrogen compounds/metals	waste chemically stable, sediment collection pond	-	12 yrs-moderate	low	low	moderate	moderate	moderate	low	2	LOW TO MODERATE	NS	2	3	
	OP	O	nitrogen compounds/metals	rock geochemically stable	-	25 to 100 yrs-high	low	low	high	low	moderate	low	2	LOW	NS	2	3	
Fisheries: Water Quality	AR	C, O	sediments	minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low/mod.	low	v. high	low	moderate	low	2	LOW	NS	2	3	
	MWRSA	C, O, C/P	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	-	15 yrs-moderate	low/mod.	low	high	moderate	moderate	low	2	LOW TO MODERATE	NS	2	3	
	HLP	C, O, C/P	nitrogen compounds/metals/acid/sediments	no discharge, treatment plant, heap treatment, collect and settle runoff from disturbed areas	-	15 yrs-moderate	low/mod.	moderate	high	moderate	moderate	moderate	2	MODERATE	NS	2	3	
	OP	O	nitrogen compounds/metals/sediments	minimize instream construction, maintain vegetation buffer zones	-	10 yrs-low/mod.	low	low	high	low	moderate	low	2	LOW	NS	2	3	
Habitat loss	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	-	15 yrs-moderate	low/mod.	low	v. high	moderate	moderate	low	2	LOW	NS	2	3	
Benthic Macro invertebrates	AR	C, O, (C/P)	sediments	minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	MWRSA	O, (C/P)	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	HLP	C, O, C/P	nitrogen compounds/metals/acid/sediments	treatment plant, SCP, minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	moderate	2	LOW TO MODERATE	NS	2	3	
Periphyton	AR	C, O, (C/P)	sediments	minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	MWRSA	O, (C/P)	nitrogen compounds/metals/sediments	sediment control ponds, monitor discharge	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	AF	C, O	decrease in surface flows	water recycling, ground water wells, monitor surface flows	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	low	2	LOW	NS	2	3	
	HLP	C, O, (C/P)	nitrogen compounds/metals/acid/sediments	treatment plant, SCP, minimize instream construction, maintain vegetation buffer zones	-	15 yrs-moderate	low	low	v. high	low/mod.	moderate	moderate	2	LOW TO MODERATE	NS	2	3	
Wildlife	ALL	C, O	Direct habitat loss	revegetating (see reclamation program)	-	20-30 yrs-mod/high	170.5 ha - mod.	high	mod./high	low	moderate	low	2	MODERATE	NS	2	3	
	ALL	C, O	Indirect habitat loss, avoidance, habitat fragmentation	revegetating (see reclamation program)	-	15-20 yrs-moderate	170.5 ha - mod.	moderate	high	low	moderate	low	2	MODERATE	NS	2	3	
	ALL	C, O, C/P	Harassment	wildlife management plan	-	10 yrs-low/mod.	170.5 ha - mod.	low	high	low	moderate	low	2	LOW TO MODERATE	NS	2	3	
	AR	C, O, C/P	Hunting & poaching pressure	wildlife management plan, on-site no hunting policy	-	10 yrs-low/mod.	12.3 ha - low	low	high	low	moderate	low	2	LOW	NS	2	3	
	AR	C, O, (C/P)	Road kills	wildlife management plan, posted speed limits and wildlife crossings	-	10-15 yrs-moderate	12.3 ha - low	moderate	high	low	moderate	low	2	LOW TO MODERATE	NS	2	3	
Vegetation	HLP	C, O, C/P	Removal of vegetation	revegetating (see reclamation program)	-	15 yrs-moderate	37.2 ha - low	high	high	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	MWRSA	C, O	Removal of vegetation	revegetating (see reclamation program)	-	15 yrs-moderate	69.6 ha - low	high	high	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	OP	C, O, C/P	Removal of vegetation	n/a	-	permanent-high	29.5 ha - low	v. high	low	low	moderate	low	1	MODERATE	NS	2	3	
	AF	C, O	Removal of vegetation	revegetating (see reclamation program)	-	15 yrs-moderate	13.3 ha - low	high	high	low	moderate	low	1	LOW TO MODERATE	NS	2	3	
	AR	C, O, (C/P)	Removal of vegetation	revegetating (see reclamation program)	-	15 yrs-moderate	12.3 ha - low	high	high	low	moderate	low	1	LOW TO MODERATE	NS	2	3	

C=construction, O=operations, C/P=closure/post-closure

OP=open pit, HLP=heap leach pad and associated ponds, MWRSA=mine waste rock storage area, AF=ancillary facilities, AR=access and haul roads, ALL=all mine activities

() = if occurrence is bracketed, it is occurring to a lesser degree

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

7.2 VALUED ECOSYSTEM AND CULTURAL COMPONENTS

The following information has been included from the “Administrative Procedures for Environmental Assessment of Major Mining Projects in the Yukon” prepare by Yukon Government in September 2004 and *YESAB’s “Assessor’s Guide to Assessment of Environmental Effects”*.

Valued Ecosystem and Cultural Components (VECC’s) are defined as elements of the environment, which are valued for environmental, scientific, social, aesthetic or cultural reasons. Selecting the project specific VECC’s or indicators are essential for focusing the impact assessment and determination of significance of effects.

The approach to selecting VECC’s and indicators has been based on the following:

- Identification of impacts to affected resources, rather than to specific VECC’s or indicator species;
- Stakeholder consultations and VECC importance ranking;
- Determining species vulnerability by reviewing the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists; and
- Determining which species or VECC’s that are likely to be affected based on issues identification.

The process for identifying the VECC’s varies with each project, however it usually begins with consultations with Responsible Authorities (RAs) and other stakeholders, particularly local First Nations. Baseline research, literature review, species vulnerability, community consultations and other initiatives are also used.

Examples of attributes that influence the selection of VECC’s include and noted in Table 7-3 (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 VECC’s selected for other Yukon mining projects has included, First Nation/ Resident/Community and commercially important wildlife and fish species such as caribou, moose, or Chinook salmon, important cultural or heritage sites, designated protected or special management areas, and ground and surface water quality.

VECC selection should consider the likelihood of project effects on the VECC’s, whether or not proposed VECC’s effects mitigation can occur through existing regulator mechanisms and the potential for cumulative environmental effects.

Table 7-3 Identification of Valued Ecosystem and Cultural Components

Component Type	Identified Group/Rationale for Selection/Attribute
Environmental	
Air Quality	<i>Identified by FN, G, OP.</i> Fugitive dust and gaseous emissions. <i>Attributes include EI, V, SE.</i>
Surface Water Quality	<i>Identified by FN, G, OP.</i> Williams Creek is receiving water for effluent discharge; support aquatic resources. <i>Attributes include EI, V, SE, RS.</i>
Groundwater Quality	<i>Identified by FN, G, OP.</i> Possible infiltration of metals/acid/nitrogen compounds with recharge to Williams Creek surface waters. <i>Attributes include EI, V, SE, RS.</i>
Permafrost	<i>Identified by FN, G, OP.</i> Disturbance of permafrost in WRSA and along road alignments. <i>Attributes include EI, V, SE, RS.</i>
Fisheries Resources – Lower Williams Creek and Yukon River Juvenile Chinook Salmon Arctic Grayling	<i>Identified by FN, G, OP</i> Sensitive fish species; important commercial and native food fisheries; downstream indicator. <i>Attributes include EI, FS, SI, CI, V, SE, RS.</i> Species of importance for First Nations and sport fisheries. <i>Attributes include EI, FS, CI, V, SE, RS.</i>
Wildlife Resources Moose Furbearers	<i>Identified by FN, G, OP</i> Important moose habitat along the Yukon River; increased harvest pressure, avoidance. <i>Attributes include EI, FS, SI, CI, V, SE, RS.</i> Direct/indirect habitat loss, avoidance, habitat fragmentation, increased harvesting, road kills. <i>Attributes include SI, CI, V.</i>
Socio-economic/Cultural	
Traditional Use – Trapping	<i>Identified by FN, G.</i> Trapping concession provides employment benefits and sustenance lifestyle. <i>Attributes include SI, CI, V.</i>
Traditional Use – Wildlife and Cultural	<i>Identified by FN, G, OP.</i> Wildlife, fish, berries, plant harvesting support sustenance lifestyle and cultural pursuits. <i>Attributes include SI, CI, V.</i>
Heritage Resources	<i>Identified by FN, G.</i> Known historic archaeological sites in EA study area; other sites along access road have medium heritage site potential. <i>Attributes include CI, V, SE.</i>
Social <i>(Demographics, Community Wellness, Justice, Education)</i>	<i>Identified by FN, G, OP.</i> LSCFN and Village of Carmacks local community resources and infrastructure required to support the project. <i>Community growth.</i> Possible social problems such as <i>substance abuse, gambling, family violence, crime and education.</i> <i>Attributes include SI, CI, V, RS.</i>
Economic <i>(Employment, Business Opportunity – Infrastructure/Community Services)</i>	<i>Identified by FN, G, OP.</i> LSCFN and Village of Carmacks interested in economic and employment benefits and opportunities resulting from the project. <i>Use and maintenance of infrastructure. Taxation.</i> <i>Attributes include SI, CI, V, RS</i>
Human Health and Safety	<i>Identified by FN, G, OP.</i> Worker health and safety on the project and Freegold Road. Public health and safety. <i>Attributes include SI, V, RS</i>

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

With respect to cumulative environmental effects, even if the project on its own is unlikely to affect a VECC, the combined effects of the proposed project along with other projects and activities (e.g., harvesting) should be considered. Potential cumulative effects are discussed in Section 7.5 of this report.

The approximate spatial boundaries for identifying VECC's are the same as the boundaries proposed for the EA study area, which are primarily based on the potential geographic extent of effect. However, for certain VECC's a regional context is more appropriate for certain wildlife species, such as moose, which move into and out of the study area boundaries. The identification of socio-economic/cultural VECC's is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole. Input from the public (Section 6.0) including traditional knowledge has contributed to the identification of VECC's.

Table 7-3 provides a complete list of the VECC's 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 LSCFN, the Village of Carmacks, the public and regulatory agencies, knowledge of local environmental conditions and best professional judgment lead to the selection of the project VECC's.

Potential effects on each VECC were examined within specified spatial and temporal extents and defined with the results presented in Table 7-4 for each VECC.

Table 7-4 VECC Spatial and Temporal Boundaries

Component Type	Spatial Boundaries	Rationale	Temporal Boundaries	Rationale
Environmental				
<i>Air Quality</i>	<i>Project Area, Access Road, Freegold Road</i>	<i>Geographic extent of expected effects.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure</i>	<i>Dust and emissions expected during these project phases.</i>
<i>Surface Water Quality</i>	<i>Williams Creek Watershed, Yukon River</i>	<i>Project receiving waters.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure, Post Closure</i>	<i>Water quality data collected during all project phases, including pre start-up and post closure, to ensure baseline conditions maintained.</i>
<i>Groundwater Quality</i>	<i>Williams Creek Watershed, focus on Project Area</i>	<i>Receiving environment.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure, Post Closure</i>	<i>Groundwater quality data collected during all project phases, including pre start-up and post closure, to ensure baseline conditions maintained.</i>
<i>Permafrost</i>	<i>Within footprint of Project Area (i.e. disturbed areas), Access Road.</i>	<i>Newly disturbed areas.</i>	<i>Construction, Mine Operation</i>	<i>Disturbance likely to occur during these project phases and may affect design of project components.</i>
<i>Fisheries Resources</i>	<i>Lower Williams Creek and Yukon River</i>	<i>Fish bearing receiving waters.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure, Post Closure</i>	<i>Water quality data collected during all project phases, including pre start-up and post closure, to ensure baseline conditions maintained.</i>
<i>Wildlife Resources</i>	<i>Regional Context</i>	<i>Range of wildlife resources is not confined to a specific area.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation</i>	<i>Direct effects to wildlife likely to occur during these project phases.</i>

Component Type	Spatial Boundaries	Rationale	Temporal Boundaries	Rationale
Socio-economic/ Cultural				
<i>Traditional Use – Trapping</i>	<i>Actively Trapped Area</i>	<i>Trapping activities only impacted in the actively trapped area.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation</i>	<i>Potential effects to wildlife likely to occur during these project phases.</i>
<i>Traditional Use – Wildlife and Cultural</i>	<i>Regional Context</i>	<i>Traditional use of the land not confined to a specific area.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation</i>	<i>Traditional activities potentially affected during these project phases.</i>
<i>Heritage Resources</i>	<i>Within Footprint of Project Area (i.e. Disturbed Areas) and Access Road</i>	<i>Potential for encountering heritage resources in disturbed areas.</i>	<i>Construction, Mine Operation</i>	<i>Potential for heritage resources to be unearthed during these project phases.</i>
<i>Social (Demographics, Community Wellness, Justice, Education)</i>	<i>Regional Context</i>	<i>Social activities/ effects not confined to a specific area.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure, Post Closure</i>	<i>Potential for social effects to occur during all project phases.</i>
<i>Economic (Employment, Business Opportunity – Infrastructure/Community Services, Government)</i>	<i>Regional Context</i>	<i>Economic activities/ effects not confined to a specific area.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation, Closure, Post Closure</i>	<i>Potential for economic effects to occur during all project phases.</i>
<i>Human Health and Safety</i>	<i>Within Project Area, along Access Road and Freegold Road.</i>	<i>Company accountable for worker and public health and safety at site and along access to site.</i>	<i>Construction, Mine Operation, Decommissioning and Reclamation</i>	<i>Project phases where site is being regularly accessed.</i>

7.3 SUMMARY OF POTENTIAL ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

This section summarizes key potential environmental effects for the project and proposed mitigation measures. *Appendix K provides a tabular summary of the significance assessment and proposed mitigation presented in the following sections. This table provides a detailed characterization of the effects to VECC's and description of planned mitigation measures for potential adverse effects. The summary table presents the direction of effects and assesses the residual environmental effects. A significance determination is made along with a determination of the likelihood of occurrence. A similar tabular summary of potential socio-economic effects, proposed mitigation and enhancement measures, and significance assessment is provided in Appendix B of the Socio-economic Effects Assessment Report (located in Appendix P of this report).*

Section 5 of the IEE Addendum prepared by HKP in June, 1995 presented an initial environmental effects assessment for the project. This information has been summarized and updated to reflect the current project and potential environmental effects and mitigation measures.

7.3.1 Atmospheric

Overall atmospheric emissions from mining operations at the Carmacks Copper project will be primarily limited to fugitive dust from open pit mining, hauling and crushing operations, and will be typical of most mine sites. As there will be no roasting or smelting operations, gaseous emissions will be limited to ventilation of the reagent area, the process plant (solvent extraction and electrowinning areas), acid plant, the fume hoods in the assay laboratory, equipment emissions, and diesel generators. An approved gas fired incinerator would be used to incinerate camp domestic waste. Therefore, no sources of significant chemical air emissions would require special treatment or control. The main sources of air emissions are primarily limited to:

- fugitive dust from mining;
- road dust;
- gaseous emissions from the SX/EW process and acid plant;
- gaseous emissions from diesel generators; and
- gaseous emissions from solid waste incinerator.

Potential Effects

- Release of SO₂ or volatile hydrocarbons could cause injury or mortality to living organisms by fire, explosion, toxicity, or asphyxiation;
- Settling of SO₂ produced by acid plant can cause high level ground level concentrations that could damage vegetation and soils and affect human and animal health;
- Burning of diesel, gasoline, and propane causes emissions of air polluting gases;
- Noise generated during operations may have a negative effect on the quality of life for residents and wildlife in the vicinity of operations;
- Particulate matter during operations (fugitive dust) may have a negative effect on worker health and safety and the local environment (vegetation, wildlife, aquatic);
and

- *Valleys prone to pollution are surrounded by mountains and hills, which block prevailing wind. At night, cold air tends to drain downhill where it settles into low-lying basins and valleys. Air pollution in mountain valleys tends to be greatest during the colder months. (Ahrens, 2000)*

Mitigation

- Fugitive dust from blasting and hauling will be controlled to the maximum extent possible by employing normal dust control procedures such as watering main haul roads or calcium chloride addition;
- Mitigation for dust generated from crushing and screening will be baghouse type dry dust collectors. Ore transported from the crusher to the heap leach pile via conveyors is not expected to produce significant dust since the freshly crushed ore contains 1 to 2% moisture;
- Process controlled production (*closed system*) of sulphuric acid to minimize gaseous emissions. Any gaseous emissions will meet national emission standards. *Occupational health and safety requirements will be followed to ensure for personnel protection;*
- Process plant and laboratory area equipped with gaseous scrubbers and ventilation systems to remove particulate matter and gaseous emissions;
- Gas monitoring meters, to measure L.E.L., SO₂, and O₂ level, and equipped with both audio and visual alarms, will be used at all times in process *facilities and acid plant*. Safety procedures will be initiated in the event of L.E.L. > 10%, SO₂ 450 mg/m³, and O₂ < 19% or > 23% by volume in air;
- Sulfur dioxide monitors will be used. Ground level concentrations will not exceed 450 mg/m³;
- Gas meters will be calibrated regularly to ensure accuracy;
- Personnel trained in the appropriate safety measures will be on site at all times during operations to manage emergency response plans;
- Wind direction will be monitored to ensure appropriate zone of safety established in the event of an uncontrolled release of gas;
- Emergency Response Plan will be followed as required;
- Acid plant emissions will be strictly regulated to ensure emissions standards are adhered to;
- Air contaminants will be monitored;
- Equipment installed with approved manufacturers devices for controlling air emissions;
- Proper maintenance of vehicles, pumps, compressors, generators, and other internal combustion engines will minimize emissions of polluting gases;
- Exhaust gases must be vented to outside of enclosed spaces and adequate ventilation supplied;
- Worker Health and Safety program monitored so that sound levels will be maintained below worker safety requirements;
- No public vehicle access will be allowed to the site;
- Peak traffic operations occur during brief periods (project construction);
- No known sensitive habitats in the project area;
- Approved gas fired incinerator with high efficiency burner;
- *As there are no sources of significant air emissions, it is unlikely that weather or seasonally induced change will greatly impact the air quality in the project area.*

Potentially adverse effects to air quality are considered to be low to moderate as duration is low (approximately 10 years), geographic extent is limited, magnitude is low/moderate, reversibility is high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is very low/low (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.2 Topography

Mining operations will result in three permanent changes to local topographical features:

- An open pit covering an area of approximately 29.5 ha and a maximum depth of 230 m;
- A WRSA covering an area of approximately 69.6 ha and a maximum height of 140 m; and
- A heap leach pad and events pond covering an area of approximately 37.2 ha.

Other minor changes to the local topography will result from the construction of diversion channels, drainage ditches and road ways, most of which will be restored to their original configuration on closure and reclamation.

The disturbance of soils due to mining activity will occur at a number of areas including:

- the open pit;
- waste rock storage area;
- the process plant and ancillary facilities;
- the heap leach pad (including events pond and sediment control pond);
- along road corridors; and
- borrow areas.

During construction, soils will be stripped from areas of development and stored for reclamation purposes on mine closure. Prior to construction, soil quality will be tested to confirm regional mapping and determine if the soils have sufficient nutrients and organic matter to support plant growth. Although soils and overburden material provide valuable growth medium, supplementation with fertilizer and other soil amendments may be required for successful revegetation.

Borrow areas will be developed with due consideration for drainage and runoff from the excavated surfaces so as not to cause erosion of the adjacent terrain. The borrow area will be excavated in near-horizontal layers and in such a manner that water will not collect and stand therein.

Areas of permafrost occur in the Williams Creek valley in the vicinity of the creek itself and in the north aspect tributaries. Permafrost areas are subject to mass wasting when vegetation is cleared and vehicle disturbance occurs. Ice layers begin to melt from increased heat absorption on bare ground resulting in mud sliding downhill and exposing more ice. As a result, roads in particular become unfit for travel and difficult to stabilize and reclaim.

Road alignments will be chosen carefully and constructed in a manner that avoids road cuts and therefore does not expose permafrost. Gravel roads will be engineered and constructed to maintain permafrost conditions (i.e., the -5°C isotherm) under and surrounding the road. Typically, this involves construction of a gravel road base up to approximately 3 m thick directly on top of existing soils with no pre-construction stripping of organic material. If necessary, other design considerations (such as mixing insulating material with gravel and installation of thermal siphons to vent off heat) may be used to prevent permafrost degradation. The road will be maintained by installation of cross-drains and waterbars. Equipment movement over roads will be minimized and included in construction of diversion ditches, heap leach pad, waste rock storage area, and process and ancillary facilities to minimize the potential for permafrost degradation.

The heap leach pad and events area was cleared in 1997 and it is expected that any remaining permafrost within this area would have melted. Geotechnical conditions in the WRSA indicate the presence of permafrost. Mitigative measures have been incorporated into the design to minimize environmental effects associated with WRSA construction. This includes stripping and thawing of soils, drainage ditches and sediment control pond to capture melt water and a contingency perimeter berm to ensure the long term stability of the WRSA.

Potential Effects

- Loss or disturbance to topography or ground. Disturbance to the soil profile (i.e. soil loss, compaction, admixing, etc.);
- Disturbance to erosion prone banks and slopes;
- Disturbance of surface and subsurface drainage systems;
- Contamination of soil/potential for fuel and/or other substance spillage; and
- There is a potential for localized melting of permafrost in isolated portions of the heap leach pad, WRSA, and roads.

Mitigation

- Stockpiling of soils for future reclamation;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No unnecessary disturbance to the organic mat and soils. EMS will be followed as required;
- Surface disturbance will be re-sloped and covered with soil or revegetated as appropriate;
- Vehicle movement will be restricted to access or haul roads to prevent permafrost and organic mat disturbance;
- No recreational off-road use of wheeled vehicles will be allowed;
- Permanent alteration to local topography (open pit, heap leach pad, WRSA) – recontouring and revegetation will take place to enhance changes to topographic relief;
- Facilities and WRSA located to minimize erosion prone banks and slopes, as well as reduce the possibility of inadvertent surface disturbance;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;

- *Recontour and re-sloping of disturbed areas and progressive revegetation and reclamation following performance standards and terrestrial reclamation standards (see section 3.3.5 "Progressive Reclamation" and also Appendix C);*
- All activity will be conducted on constructed roadways;
- Facilities located in areas away from surface water drainage systems to minimize environmental impact;
- Hand cutting will be employed near access road stream crossings to reduce disturbance to riparian areas;
- Access road with clear span bridge structure across Merrice Creek to reduce disturbances;
- Ensure drainage channels are maintained and free of debris;
- *Reclaim surface drainage (recontour and revegetate) to follow performance standards and terrestrial reclamation standards (see section 3.3.5 "Progressive Reclamation" and also Appendix C);*
- Routine monitoring and maintenance in accordance with EMS to prevent disturbances;
- Heap leach pad and events pond constructed with double liner and LDRS system to prevent solution migration to soils and groundwater. Facilities located greater than 50 m from any watercourse;
- Heap leach pad and events pond LDRS will be monitored and sampled regularly. If leakage rates are exceeded in the LDRS then site-specific investigations will be undertaken to identify and mitigate the leakage;
- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A spill contingency plan is in place, as part of the EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Upon closure, assessment of soils for local contamination and completion of remediation activities;
- All hydrocarbons, chemicals, and waste materials resulting from the project will be removed from the area and cleaned up;
- The heap leach pad area has been previously cleared and stripped to enable local thaw. Additional geotechnical drilling should be conducted to confirm permafrost existence under leach pad area to minimize environmental effects;
- Stripping of the WRSA to allow permafrost thawing and construction of drainage ditches and sediment ponds to control water. Staged WRSA construction and monitoring with contingency berm;
- Road alignments chosen and constructed to maintain permafrost conditions. Gravel road base to be approximately 3 m thick directly on top of existing soils;
- Wheeled vehicles will be used only on access roads and mine areas. No recreational off-road use of wheeled vehicles will be allowed;
- Equipment operators will be instructed not to disturb ground unnecessarily;
- Physical stability of the heap leach pad and WRSA routinely monitored. EMS inspection and monitoring plans; and

- An evaporative transpiration cover will be applied over the heap to minimize water infiltration and provide for vegetation growth on closure of the mine.

Potentially adverse effects to topography are considered to be low to moderate as duration ranges from moderate to high (15 years – permanent: open pit), geographic extent is localized, magnitude ranges from low – high, reversibility ranges from low to moderate/high (open pit), ecological sensitivity is low, economic and social context is moderate, and risk characterization ranges from very low to low/moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.3 Water Resources

7.3.3.1 Surface Hydrology

The proposed operations will result in a slight modification to the mean annual distribution in runoff. As all process streams are designed to operate at 100% recycle, limited adverse effects on the flow in Williams Creek are predicted.

Potential Effects

- Erosion of stream banks;
- Groundwater well use effects downstream surface flow in Williams Creek;
- Increased flows in Williams Creek from possible discharge; and
- Flood events associated with structure failure.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No recreational off-road use of wheeled vehicles will be allowed;
- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Project footprint with buffer zone between riparian areas. Sediment ponds to control water releases;
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;

- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of heap leach pad solutions to prevent direct hydrological effects to local drainage;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;
- No direct discharge of process solutions or wastewater to surface waters during the operations. Recycling of process solutions and wastewater for other water uses;
- Contingency water treatment plant;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
 - During the first year of operation, 100% of the total potential heap draindown volume;
 - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m³/hr this volume is 26, 000 m³; and
 - Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- At closure, covering, rinsing, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek; and
- Progressive cleanup and remediation will be completed where possible *following performance standards and terrestrial reclamation standards (see section 3.3.5 “Progressive Reclamation” and also Appendix C).*

Potentially adverse effects to surface water hydrology are considered to be low to moderate as duration is moderate (15 years), geographic extent is very low – moderate, magnitude is very low to moderate, reversibility is very high, ecological sensitivity is low/moderate, economic and social context is moderate, and risk characterization is considered very low to low/moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.3.2 Surface Water Quality

Since the proposed operations will operate with a water deficit and on the basis of 100% recycle of process streams, there will be no routine release of effluent to the receiving environment during operations. A contingency water treatment plant is planned; however, this plant should not be required until closure, based on average water balance conditions.

Any mine water encountered will be pumped out of the open pit and used as process water. Site drainage and wash water will be directed to the sediment control pond, recycled, or filtered back into Williams Creek below the ancillary facilities. A sediment pond located below the WRSA will capture drainage from this area with water to be recycled for process use.

Results from acid-base accounting work on waste rock and ore, presented in Section 3.6.3.4, indicates that runoff from these sources would be neutral to basic in pH. Site runoff, on most occasions, is expected to carry a heavy suspended solids load during periods of high precipitation. These flows will be routed to the heap site sedimentation pond and WRSA sediment pond before release.

Williams Creek geochemistry was assessed for the project and is provided in Appendix Q. A series of analyses and simulations were conducted on water quality and streamflow data from Williams Creek, for the purposes of determining the potential impacts of a copper mining operation within the watershed. The analyses and simulations were comprised of bulk geochemical equilibrium and attenuation calculations and advanced 2-dimensional hydrologic flow simulations. The results and discussion of these exercises are found in the report entitled "Williams Creek Geochemistry", Woolpert, September 2006 (Appendix Q). Model runs for the Williams Creek chemical condition assessment bulk analysis and hydrologic simulation and chemical condition assessment are available on CD.

The general findings of these analyses and simulations indicate the following:

- 1.) Williams Creek is a well buffered natural stream with geochemistry and flows ample and adequate to assimilate, dilute, and attenuate treated effluent from the proposed mining operation.*
- 2.) Williams Creek already transports relatively high concentrations of naturally occurring total dissolved copper. However, given its high alkalinity, the natural total dissolved copper is likely not present as toxic free copper, but rather as non-toxic chelates of carbonates and hydroxyl groups. Soluble copper added through treated waste streams will likely take the same soluble forms and not impact aquatic life forms to any significant degree.*
- 3.) The Creek is also sufficiently buffered with adequate flows in order to assimilate limited accidental discharges of acidic copper solutions as well as controlled discharges of treated excess process solution without significant harm to downstream aquatic life forms.*

Flows calculated in the IEE Addendum (HKP, 1995) were used to project impacts on water quality at downstream stations using an arithmetic model that theoretically superimposes effluent quality on natural background concentrations to determine a resulting downstream concentration as follows:

$$R_c = \frac{[(B_c \times B_q) + (E_c \times E_q)]}{R_q}$$

Where:

- Bc = Background Concentration (mg/L)
- Bq = Background Flow (m³/s)
- Ec = Effluent Concentration (mg/L)
- Eq = Effluent Flow (m³/s)
- Rc = Resulting Concentration (mg/L)
- Rq = Resulting Flow (Bq + Eq) (m³/s)

Receiving water quality input to the model were based on mean, maximum and minimum background water quality data generated from baseline data collected between 1989 and 2006 (*Appendix H2*). Projected effluent quality inputs to the model were based on effluent test work for the neutralized raffinate (Table 5.9, Appendix G) and SWEPP tests for the waste rock (Table 5.6, Appendix G). The average concentration for copper was recalculated from the SWEPP test results in Table 5.6, Appendix G for the waste rock, so that outlying data (sample considered as low grade ore) were not included in determining average conditions. The quantity of waste rock runoff used in the model was calculated on the basis that make-up water will be obtained from the waste rock runoff sediment pond. Resulting water quality in Williams Creek for a point immediately below North Williams Creek (W4) and at the mouth (W10) are compared to federal "CCME Canadian Water Quality Guidelines" for protection of aquatic life at ambient pH, hardness, alkalinity, and conductivity (Tables 7-4 to 7-7).

Four separate model predictions are presented in Tables 7-4 to 7-7. Tables 7-4 and 7-5 present the effects of waste rock seepage during operations on surface water quality in North Williams Creek (W4) and on lower Williams Creek (W10), respectively. These tables are provided to predict the effects of waste rock seepage on surface water if wastewater is not recycled during operations. Tables 7-6 and 7-7 present the effects of both waste rock and water treatment plant effluent during operations and closure on surface water quality in North Williams Creek (W4) and on lower Williams Creek (W10), respectively.

Water quality parameters that are predicted to exceed CCME Guidelines cannot exclusively be attributed to the proposed mine operations as the background water quality parameters for some metals (As, Cu, Pb, and Zn) have occasionally exceeded CCME Guidelines. For example, As concentrations are predicted to exceed CCME guidelines during all model runs due to naturally high mean concentrations for this parameter. In lower Williams Creek (W10) where fisheries resources are known to exist, CCME guidelines are met for Cu, Pb, and Ni. Zn marginally exceeds the CCME guideline. These predictions are considered worst-case modeling values, as waste rock runoff is not expected to be as predicted by the aggressive SWEPP test results, and can be treated if required. Once operations commence, systems will be in place to recycle wastewater or to treat waste rock runoff if monitoring results require action.

Results from the fisheries sampling from 1991 to 1992 indicated that fish only utilize the lower reach of Williams Creek, downstream of the Nancy Lee Creek confluence. For the purposes of this assessment, the point of compliance for water quality criteria is to meet CCME guidelines for the protection of aquatic life in lower Williams Creek (W10).

Water quality monitoring will be routinely conducted at sediment control pond effluents to ensure that discharge criteria are being achieved. Downstream receiving water quality monitoring is also planned as part of the environmental surveillance network.

Based on the results of water quality monitoring, if the waste rock runoff or treatment plant effluent results in an increase in metals to lower Williams Creek such that metals levels exceed beyond natural background levels, then adaptive management and contingency measures could include one of the following:

- recirculation of waste rock runoff onto the dump to enhance evaporation;
- installation of an waste rock evaporation pond;
- treatment with lime at the sediment control pond to precipitate out heavy metals;
- decreasing the cutoff grade to reduce the quantity of mineralized rock in the dump; and
- other treatment alternatives including a biological treatment cell or infiltration gallery.

Potential Effects

- Erosion of stream banks causing siltation; and
- Degradation or contamination of watercourses or groundwater.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Clear span bridge located at Merrice Creek to minimize disturbance to riparian zones;
- Existing trails and disturbed areas will be used where suitable to minimize environmental impact;
- No recreational off-road use of wheeled vehicles will be allowed;
- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- *Riparian areas will not be unnecessarily disturbed. A 30 m buffer will be maintained from watercourses to protect riparian area. Sediment ponds will control water releases;*
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Hazardous materials stored with secondary containment away from watercourse in controlled areas;
- Spill Contingency and Emergency Response Plans in place as part of EMS to prevent materials from accidentally entering watercourses;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;
- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of treated heap leach pad solutions to prevent degradation of local drainage water quality;

- No direct discharge of process solutions or wastewater to surface waters during the operations. Recycling of process solutions and wastewater for other water uses;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;
- Sediment pond located below heap leach pad, waste rock storage area, and ancillary facilities to prevent sediment release and treat surface water if necessary;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
 - During the first year of operation, 100% of the total potential heap draindown volume;
 - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m³/hr this volume is 26, 000 m³; and
 - Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- Heap leach pad and events pond LDRS will be monitored and sampled regularly;
- Contingency water treatment plant constructed using known technology on site to treat process solutions, if required;
- Sediment ponds will be monitored and sampled regularly to ensure wastewater quality;
- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A spill contingency plan, as part of the Emergency Response Plan and EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Any deleterious material that accidentally falls into a watercourse will be removed. A spill response plan will be implemented;
- Segregation of camp and ancillary facility wastewaters and treatment using in ground disposal and tile/absorption fields;
- At closure, covering, rinsing, neutralization, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek;
- Progressive cleanup and remediation will be completed where possible *following performance standards and terrestrial reclamation standards (see section 3.3.5 “Progressive Reclamation” and also Appendix C);*
- All waste materials containing fuels, chemicals and special waste will be properly stored and removed from the area; and
- A revegetation program using indigenous flora will be implemented for disturbed sites (access/haul roads, ancillary facilities, waste rock storage area, and heap

leach pad) where native vegetation has been removed or destroyed, to prevent degradation of stream water quality.

Potentially adverse effects to surface water quality are considered to be low to moderate as duration is low to moderate (10-15 years), geographic extent is low – moderate, magnitude is low/moderate, reversibility is high, ecological sensitivity is low to moderate, economic and social context is moderate, and risk characterization is low to moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

Table 7-5 Impact of Effluent (Waste Rock) During Operation on the Water Quality of Williams Creek at Station W4

Parameter	Bc			Bq	Ec ¹	Eq ¹	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	(m ³ /s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	258	3	70.1	0.0558	15.00	0.0039	0.0597	242.1256	3.7839	66.5005	
Arsenic	0.12	0.0006	0.029	0.0558	0.03	0.0039	0.0597	0.1141	0.0025	0.0291	0.005
Copper	0.016	0.0005	0.006	0.0558	0.03	0.0039	0.0597	0.0169	0.0024	0.0076	0.002-0.004
Lead	0.01	0.00005	0.002	0.0558	0.04	0.0039	0.0597	0.0120	0.0027	0.0045	0.001-0.007
Nickel	0.014	0.001	0.004	0.0558	0.01	0.0039	0.0597	0.0137	0.0016	0.0044	0.025-0.15
Zinc	0.0578	0.001	0.014	0.0558	0.13	0.0039	0.0597	0.0625	0.0094	0.0216	0.03

Ambient Conditions: pH 7.4 to 8.1

Conductivity 98 to 465 umhos/cm

Hardness 85.6 to 216 mg/L CaCO₃

Alkalinity 28 to 169 mg/L

Shaded cells indicate concentrations below detection limits

¹ Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)

Bolded mean Rc values exceed federal CCME guidelines

Table 7-6 Impact of Effluent (Waste Rock) During Operation on the Water Quality of Williams Creek at Station W10

Parameter	Bc			Bq	Ec ¹	Eq ¹	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	(m ³ /s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	25	5	11	0.1575	15.00	0.0039	0.1614	24.7584	5.2416	11.0967	
Arsenic	0.08	0.04	0.0317	0.1575	0.03	0.0039	0.1614	0.0788	0.0398	0.0317	0.005
Copper	0.005	0.001	0.0023	0.1575	0.03	0.0039	0.1614	0.0056	0.0017	0.0030	0.002-0.004
Lead	0.03	0.004	0.0043	0.1575	0.04	0.0039	0.1614	0.0302	0.0049	0.0052	0.001-0.007
Nickel	0.01	0.001	0.0041	0.1575	0.01	0.0039	0.1614	0.0100	0.0012	0.0042	0.025-0.15
Zinc	0.195	0.003	0.038	0.1575	0.13	0.0039	0.1614	0.1934	0.0061	0.0402	0.03

Ambient Conditions: pH 7.4 to 8.1

Conductivity 98 to 465 umhos/cm

Hardness 85.6 to 216 mg/L CaCO₃

Alkalinity 28 to 169 mg/L

Shaded cells indicate concentrations below detection limits

¹ Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)

Bolded mean Rc values exceed federal CCME guidelines

Table 7-7 Impact of Effluent (Waste Rock & WTP) During Operation and Closure on the Water Quality of Williams Creek at Station W4

Parameter	Bc			Bq	Ec ¹	Eq ¹	Ec ²	Eq ²	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	(m ³ /s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	258	3	70.1	0.0558	15.00	0.0039	15.00	0.011	0.0707	206.7878	5.5290	58.4877	
Arsenic	0.12	0.0006	0.029	0.0558	0.03	0.0039	0.02	0.011	0.0707	0.0995	0.0052	0.0277	0.005
Copper	0.016	0.0005	0.006	0.0558	0.03	0.0039	0.04	0.011	0.0707	0.0205	0.0083	0.0126	0.002-0.004
Lead	0.01	0.00005	0.002	0.0558	0.04	0.0039	0.02	0.011	0.0707	0.0132	0.0054	0.0069	0.001-0.007
Nickel	0.014	0.001	0.004	0.0558	0.01	0.0039	0.02	0.011	0.0707	0.0147	0.0045	0.0068	0.025-0.15
Zinc	0.0578	0.001	0.014	0.0558	0.13	0.0039	0.13	0.011	0.0707	0.0730	0.0282	0.0384	0.03

Ambient Conditions: pH 7.4 to 8.1

Conductivity 98 to 465 umhos/cm

Hardness 85.6 to 216 mg/L CaCO₃

Alkalinity 28 to 169 mg/L

¹ Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)

² Effluent from Water Treatment Plant - concentration (mg/L) from neutralized raffinate test results (Table 5.9, Appendix G)

Shaded cells indicate concentrations below detection limits

Bolded mean Rc values exceed federal CCME guidelines

Table 7-8 Impact of Effluent (Waste Rock & WTP) During Operation and Closure on the Water Quality of Williams Creek at Station W10

Parameter	Bc			Bq	Ec ¹	Eq ¹	Ec ²	Eq ²	Rq	Rc			Federal CCME Guideline (mg/L)
	Max (mg/L)	Min (mg/L)	Mean (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	total (mg/L)	(m ³ /s)	(m ³ /s)	Max (mg/L)	Min (mg/L)	Mean (mg/L)	
TSS	25	5	11	0.1575	15.00	0.0039	15.00	0.011	0.2364	17.6015	4.2766	8.2741	
Arsenic	0.08	0.04	0.0317	0.1575	0.03	0.0039	0.02	0.011	0.2364	0.0547	0.0281	0.0225	0.005
Copper	0.005	0.001	0.0023	0.1575	0.03	0.0039	0.04	0.011	0.1724	0.0078	0.0041	0.0053	0.002-0.004
Lead	0.03	0.004	0.0043	0.1575	0.04	0.0039	0.02	0.011	0.1724	0.0296	0.0058	0.0061	0.001-0.007
Nickel	0.01	0.001	0.0041	0.1575	0.01	0.0039	0.02	0.011	0.1724	0.0106	0.0024	0.0052	0.025-0.15
Zinc	0.195	0.003	0.038	0.1575	0.13	0.0039	0.13	0.011	0.1724	0.1894	0.0140	0.0460	0.03

Ambient Conditions: pH 7.4 to 8.1

Conductivity 98 to 465 umhos/cm

Hardness 85.6 to 216 mg/L CaCO₃

Alkalinity 28 to 169 mg/L

¹ Effluent from Waste Rock - concentration (mg/L) from SWEP test results (Table 5.6 in Appendix G)

² Effluent from Water Treatment Plant - concentration (mg/L) from neutralized raffinate test results (Table 5.9, Appendix G)

Shaded cells indicate concentrations below detection limits

Bolded mean Rc values exceed federal CCME guidelines

7.3.3.3 *Hydrogeology*

The distribution of groundwater at the site is limited to the active layer, small perched water tables above the discontinuous permafrost and at considerable depths along the main drainage courses as subpermafrost groundwater. Investigations at the site have intersected groundwater in the active layer during test pit excavations. Groundwater was encountered in only two drillholes (DH-C and RC-92-01). The depth to groundwater in DH-C, in the proposed leach pad area, was 6.8 m as a shallow perched water table above the permafrost. The depth of groundwater in RC-92-01, south of the events pond adjacent to Williams Creek, has been monitored since 1992 at 15.5 m (HKP, 1995).

Open Pit

Development of the open pit will result in a cone of depression in the groundwater table radiating from the floor of the pit outwards. This water, which normally migrates to North Williams and Williams Creeks as groundwater, will be collected in the pit and pumped to the process plant as make-up water.

On mine closure the pit will be allowed to accumulate water; however, the currently available data indicates that the groundwater table may not be intercepted in the vicinity of the open pit. Although the exact pre-production conditions will be altered by the loss of water to the open pit, the resulting flow conditions in Williams Creek will not be significantly altered.

Based on modeling results it is expected that the pit will take a significant period of time to fill (>300 years).

Waste Rock Storage Area

The hydrogeological effect at the WRSA is not expected to be significant. Most of the precipitation onto the waste rock will runoff and be collected in drainage ditches along the toe of the pile. The amount of runoff which enters the pile will be minimal and will flow in the near surface groundwater at the base of the pile for collection in the toe drains and ultimately into the sediment control pond for use as make-up water for leaching operations and for dust control on the roads.

The organic layer covering the WRSA will be removed during the initial development thereby initiating thawing of the permafrost. This will result in an increase in the hydraulic conductivity of the thawed soil and the generation of near surface groundwater, which will flow downslope and be intercepted by drains along the toe of the dump. The water quality effect model presented in the IEE indicates that if 50% of the total effluent from the waste dump is collected and recycled then the effect on receiving waters is not significant. The seepage losses into the groundwater will be an insignificant fraction of this amount and therefore seepage losses to North Williams Creek are not a concern.

Heap Leach Pad

During construction, the entire leach pad area will be lined in order to prevent leakage to groundwater. Consequently, surface recharge to the groundwater table in the area of the heap leach pad will not occur over an area of approximately 37 ha (~ 0.4% of the 88 km² watershed). There is the potential for the permafrost levels to lower under the heap

leach pad due to heat losses from leach solutions into the ground possibly melting the permafrost. This could partially divert near-surface groundwater flows within this area. However, this effect is not expected to be significant, as the leach pad area has been cleared to allow the permafrost to thaw.

Well Water Supply System

To provide domestic and process water for the project, 8 wells located in the bedrock confined aquifer underlying Williams Creek drainage will be drilled. Each well is estimated to provide ~ 150 m³/day.

Potentially adverse effects to ground water hydrology are considered to be low to moderate as duration is low/moderate to high (10+ years / permanent), geographic extent is low, magnitude ranges from low to moderate, reversibility is moderate to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.3.4 Groundwater Quality

Extensive control measures have been included in the design of the Carmacks Copper project to ensure that the effects to groundwater are minimized. The measures include maximizing recycle of process streams, inclusion of primary and secondary liner systems, LDRS, containment berms, seepage detection systems and groundwater monitoring systems.

Groundwater was not encountered by the exploration geologists or the geotechnical engineers in any of the exploration drill holes or geotechnical evaluations except in two isolated locations, which consisted of perched water tables over permafrost. Groundwater flow is restricted to minor seasonal flows within the active swampy zones just below the ground surface.

Western Copper intends to proceed with the installation of a double synthetic geomembrane liner system for the entire heap leach pad overlying by a low permeability soil liner. The primary and secondary liners will be separated by a HDPE geonet LDRS. A high level of QA/QC will be employed during liner placement ensuring liner integrity.

Any seepage collected by this system will be pumped back to heap storage. In addition to the geonet leak detection and recovery system, the entire heap leach pad below the secondary soil liner will be equipped with foundation drains, which are located in natural draws within the heap leach pad area. This secondary drainage system, which is designed to provide drainage and pore pressure relief for groundwater generated by thawing permafrost, terminates in the events ponds and acts as a secondary leak detection and recovery system. Consequently, minimal contamination to the groundwater is expected since any seepage through the primary leak detection system and any seepage picked-up by the foundation drains will be directed to heap storage.

The events pond is also equipped with a double synthetic geomembrane liner separated by its own geonet leak detection and recovery system, independently equipped with a pump-back recovery system.

Any seepage which escapes the leak detection and recovery system and the foundation drainage system, if any, is expected to be extremely minor and will be restricted to the active layer above the underlying permafrost. If this water layer is active, or activated at a later date, it will migrate down gradient toward the events pond, the mine site sediment control pond and then to Williams Creek.

Knight Piésold Ltd. (amended design report, 1995) estimate that seepage rates through the outer liner from the heap leach pad will be in the order of 0.1 m³/day when applying a contact coefficient of 0.21 for the liner moulding and 0.5 m³/day when using an extremely conservative coefficient of 1.15. Even if these seepage rates could not be intercepted by the fountain drains, they would have little or no effect on regional groundwater quality and were found to be too small to project effects on Williams Creek water quality. Seepage through the liner and seepage collection systems would be minor, given that the active layer is relatively restricted and shallow. If localized groundwater was adversely affected, measures could be implemented to intercept this water within the draw down-gradient of the heap leach pad for pump-back or treatment, as required.

Waste rock storage facilities will not be lined, but analyses of the waste (acid-base accounting) indicates that waste rock is overwhelmingly acid consuming. The WRSA will be equipped with a sediment pond and a foundation drainage system to collect waste rock seepage, both lined with 8 oz. non-woven geotextile. The WRSA will also be equipped with perimeter drainage ditches to intercept and collect surface runoff. The sediment pond will allow for the removal of suspended solids in the runoff.

Although effects to groundwater quality are projected to be negligible, a comprehensive groundwater monitoring program has been initiated and will be ongoing through construction and operation. Twelve groundwater piezometers have been installed in the vicinity of the heap leach pad and downslope of all facilities will be sampled to ensure a monitoring system that could detect potential losses from the site during operations.

Potentially adverse effects to ground water quality are considered to be low to moderate as duration is moderate to high (12-100 years), geographic extent is low, magnitude is low to moderate, reversibility is moderate to high, ecological sensitivity is low to moderate, economic and social context is moderate, and risk characterization is low to moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.4 Aquatic Resources

7.3.4.1 Fisheries

Williams Creek drains the Carmacks Copper project area and combines with flows from Nancy Lee Creek before flowing into the Yukon River. The Yukon River then flows north and west before discharging to Norton Sound on the west coast of Alaska. Fisheries

studies including biophysical inventory, electrofishing, minnow traps, and spawning surveys were completed for three periods between August 1991 and August 1992.

Fisheries results indicate that fish inhabit the lower section of Williams Creek to the confluence with Nancy Lee Creek. Species in lower Williams Creek include juvenile Chinook salmon (*Oncorhynchus tshawytscha*), arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), longnose sucker (*Catostomus catostomus*), burbot (*Lota lota*), and northern pike (*Esox lucius*).

No fish were observed or captured in Williams Creek above the Nancy Lee Creek confluence. Spawning was not observed in the Yukon River near the Williams Creek confluence during the October 1991 survey and no spawning in Williams Creek has been observed by local residents.

Based on modelling, fisheries could potentially be affected by changes to metal concentrations; however baseline water quality data collected in lower Williams Creek naturally exceeds CCME guidelines for total aluminum, arsenic, copper, iron, and zinc. These metals may be slightly elevated during operations. Maximum recycle of waste rock runoff will take place during operations to avoid high metal loadings in the receiving environment. If heap discharge were required, wastewater would be treated prior to discharge to reduce metals. Downstream water quality will be monitored to determine if the projected metal levels occur and whether treatment or further mitigation measures are required.

Increased sediment loads caused by construction and erosion of fine particles disturbed by mine operations result in scouring attached algae from the stream substrate and a reduction in habitat for benthic macroinvertebrates, both resulting in a reduction in the fisheries food source. Increased sediment loads in the water column can also cause abrasion of fish gills. Fine particles abrade the gill surface reducing the capacity for gas exchange potentially resulting in suffocation and rendering the fish more susceptible to infection and gill parasites.

In order to minimize and mitigate this potential effect, strict construction guidelines will be adhered to and monitored. Construction guidelines will include the following items:

- ditch construction along roadways will incorporate settling ponds and baffles to reduce erosion and to settle out sediments;
- diversion ditches and settling ponds will be constructed around waste piles and leach pads;
- creek disturbance will be minimized by building engineered bridges or properly installing culverts and prohibition on fording;
- construction during heavy rainfall or snowfall events will be minimized; and
- construction will be minimized around streams during critical spawning periods in August and September for salmon and for May and June for grayling.

7.3.4.2 *Benthic Macroinvertebrates*

Benthic macroinvertebrates are an important component of the ecological network and are useful in assessing environmental effects from mining activity. They are efficient indicators of water and habitat quality in streams because the majority of their life cycle is intimately linked to the aquatic environment. Therefore, they reflect any disturbance to surrounding vegetation or changes in water quality. Juvenile and adult stages of important fisheries species, particularly salmon and other insectivorous species, depend on the availability of benthic macroinvertebrates as a food source.

Benthic macroinvertebrates may typically be adversely affected by in-stream construction, removal of overstorey cover, increased heavy metals, sediment and nutrient loadings, acid rock drainage or reduction or loss of flows. Increased sediment loads abrade the gill membranes of macroinvertebrates, scour algal growth from rock surfaces, which reduces the food source, and fill interstitial pore spaces of substrate, which reduces habitat availability. These have a direct effect on benthic organisms, their food resources and their habitat, respectively. Under extreme conditions, increased nutrients such as nitrates and phosphates (from blasting) may have a direct toxic effect or may result in excessive eutrophication, which reduces available habitat and oxygen. Moderate increases in nutrient levels causes community stress and increased algal growth which may, for example, result in a shift to a community dominated by herbivorous species. High concentrations of chemicals and heavy metals have the potential to be acutely toxic to benthic macroinvertebrates, or chronically toxic if they are bioaccumulated and interfere with normal physiology.

Effects to benthic communities in the Carmacks Copper Project area will be minimized by:

- maximizing the recycle of process water;
- maximizing the collection and settlement of runoff from disturbed areas to the greatest extent possible;
- minimizing instream construction;
- maintaining buffer zones of vegetation adjacent to streams;
- monitoring seepages from the WRSA, open pit and leach pad; and
- taking precautions during blasting to reduce nutrient losses to receiving waters.

Potential Effects

- Erosion of stream banks;
- Physical damage to fish habitat and spawning sites;
- Contamination of watercourses or groundwater; and
- Other aquatic issues – hydrogeological effects.

Mitigation

- Project components and operations will be located away from watercourses, except at Merrice and Williams Creek stream crossings;
- Construction minimized around streams during critical spawning periods (May-June for grayling);

- Bridge crossing (Merrice Creek) and culvert (Williams Creek) designed to protect watercourse and prevent erosion;
- Ditch construction along roadways will incorporate settling ponds and baffles to reduce erosion and settle out sediments;
- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- No recreational off-road use of wheeled vehicles will be allowed;
- Any material that accidentally falls into watercourses will be removed;
- Erosion protection measures (rip rap, cross ditches, breaks) along roads and facilities;
- Project footprint with buffer zone around riparian areas. Sediment ponds to control water releases;
- If the surface is disturbed in an area such as drainage channels where erosion is a possibility, control measures may include using earth breaks or cross ditches;
- Upper Williams Creek does not support fish. Project mine components and operations will be located at least 50 m away from watercourses;
- Clear span bridge located at Merrice Creek to minimize disturbance to riparian zones;
- Hazardous materials stored with secondary containment away from watercourse in controlled areas;
- Spill Contingency and Emergency Response Plan in place to prevent materials from accidentally entering watercourses;
- Heap leach pad and events pond constructed with composite liner and LDRS system to prevent solution migration to surface and groundwater. Sediment pond located downstream from events pond. Facilities located greater than 50 m from any watercourse;
- Water for mining and processing will be collected from deep wells in the Williams Creek drainage basin and numerous sediment ponds. No direct surface water use;
- Recycling of water from ancillary facilities and sediment ponds to minimize groundwater well use;
- At closure, controlled release of heap leach pad solutions to prevent direct hydrological effects to local drainage;
- Environmental monitoring program with stations on Williams Creek to monitor stream hydrology and water quality. Perform required MMER EMM program;
- No direct discharge of process solutions or wastewater to surface waters during operations. Recycling of process solutions and wastewater for other water uses;
- Sediment pond located below heap leach pad, waste rock storage area, and ancillary facilities to prevent sediment release and treat surface water if necessary;
- Heap leach pad and events pond design to withstand combinations of critical events – operating solution volume, plus excess runoff inflows from the critical duration 100-yr return period event occurring at the most critical point in time, plus, an allowance for heap draindown as follows:
 - During the first year of operation, 100% of the total potential heap draindown volume;
 - During subsequent years of operation, 48 hours of draindown at the full rate of solution application. For a solution application rate of 540 m³/hr this volume is 26, 000 m³; and

- Redundant systems (i.e. pumps, power, spare parts) to prevent direct release of process solutions;
- Heap leach pad and events pond LDRS will be monitored and sampled regularly;
- Contingency water treatment plant constructed on site using known technology to treat process solutions, if required;
- Sediment ponds will be monitored and sampled regularly to ensure wastewater quality;
- Liquid hydrocarbons, acids, and other chemicals will be stored in appropriate containers during transportation. No fuels or chemicals will be stored within 100 m of a watercourse;
- Main fuel, acid, and chemical storage facilities located at the plant site. Storage tanks with secondary containment. Segregation and controlled storage of plant chemicals. All hazardous materials located within controlled facility and routinely inspected and monitored as part of EMS;
- A Spill Contingency Plan, as part of the EMS;
- In the event of a spill, the Spill Contingency Plan will be implemented. Spills will be immediately reported to the Spill Report Line;
- Any deleterious material that accidentally falls into a watercourse will be removed. A spill response plan will be implemented;
- Segregation of camp and ancillary facility wastewaters and treatment using in ground disposal and tile/absorption fields;
- At closure, covering, rinsing, and detoxification of the heap leach pad and treating solutions in a controlled manner to prevent effects to Williams Creek. Long-term heap solutions directed to infiltration gallery to provide final solution polishing and prevent direct release to Williams Creek;
- Progressive cleanup and remediation will be completed where possible *following performance standards and terrestrial reclamation standards (see section 3.3.5 “Progressive Reclamation” and also Appendix C)*;
- Construction during heavy rainfall or snowfall events will be minimized;
- All waste materials containing fuels, chemicals, and special waste will be properly stored and removed from the area;
- A revegetation program using indigenous flora will be implemented for disturbed sites (access/haul roads, ancillary facilities, waste rock storage area, and heap leach pad) where native vegetation has been removed or destroyed, to prevent degradation of stream water quality;
- Water will be collected in the pit and pumped to the process plant as make-up water. Resulting flow conditions in Williams Creek will not be significantly altered. Expected that the pit will take >300 years to fill;
- Runoff that enters the WRSA will be minimal and will flow in the near surface groundwater at the base of the pile for collection in the toe drains and ultimately into the sediment control pond for use as make-up water;
- Near-surface groundwater flows could be partially diverted in the heap leach pad area; however, the effect is not expected to be significant, as the leach pad area has been cleared to allow permafrost to thaw; and
- Water recycling and use of events and sediment ponds for make-up water.

Potentially adverse effects to fisheries are considered to be low to moderate as duration ranges from low to moderate (10 – 15 years), geographic extent is low/moderate, magnitude ranges from low to moderate, reversibility is high/very high, ecological sensitivity is low/moderate, economic and social context is moderate, and risk

characterization is low/moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

Potentially adverse effects to benthic invertebrates and periphyton are considered to be low to moderate significance as duration is moderate (15 years), geographic extent is low, magnitude is low, reversibility is very high, ecological sensitivity is low/moderate, economic and social context is moderate, and risk characterization is low/moderate (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.5 Wildlife

7.3.5.1 Species Concerns

No significant effects to wildlife are foreseen. This interpretation is based on information obtained in the wildlife surveys to date, whereby a basic knowledge of the broad patterns of distribution and seasonal movement of key species is presented. From 1991 and 1992 surveys and wildlife logs, very little ungulate, furbearer, or other mammal activity was noted. Historically, caribou herd migration extended into this area, however, this does not presently occur and no ungulates appear to have filled this abandoned niche (Little Salmon Carmacks First Nation, Carmacks Renewable Resources Council, 2004). A field survey conducted in July 1994 indicated that the steep sloping south scarps may provide habitat for mule deer, but this area will not be affected. Waterfowl were not observed, likely due to the absence of productive wetland habitat. Although raptor nests were observed on cliffs near the Yukon River, only the American kestrel was sighted. Key summer nesting habitat is recognized to occur northeast of the project in the Nancy Lee and Hoochekoo creeks watersheds. However, these creeks will not be affected, as the project site is located nearly 9 km away.

One possible explanation for the apparent limited wildlife use of the area is a cyclic low in the different species cycles, analogous to the lynx and hare 10-year population low, which occurred in 1991 according to territorial government information.

Effects to wildlife habitat are discussed in the following generalized categories which are typically recognized for similar construction projects in remote and undeveloped regions.

7.3.5.2 Direct Habitat Effects

Open pit development will result in permanent loss of approximately 29.5 ha of low capability conifer dominant upland habitat. The heap leach pad, process plant and camp facilities will result in a temporary loss of around 41 ha of moderate habitat capability land, which is aspen dominant uplands. Waste rock storage will cover approximately 69.6 ha of moderate capability conifer dominant wetlands. Aspen dominant uplands have moderate potential for moose, snowshoe hare, black bears, and ruffed grouse. Conifer dominant uplands have high potential for red squirrel and spruce grouse, low to moderate potential for hare and its predators, and very low moose habitat potential.

Access roads (12.3 ha) will transect similar habitat to the mine facilities including low capability conifer dominant uplands and moderate capability conifer dominant wetlands.

7.3.5.3 Indirect Habitat Effects

Habitat loss also occurs where some form of disturbance prevents a species from using an area or reduces the frequency of use, even though no physical loss of habitat occurs. This may involve avoidance by animals to normal feeding activities in the vicinity of a road or through blocking access to traditional habitats used seasonally. This also includes avoidance by species due to machine noise and operational activity.

It is difficult to predict or estimate the actual area of wildlife habitat lost by avoidance behaviour. McLellan and Shackleton (1988) provide the best comparative data for grizzly bears, in which a seven year study in southeastern B.C. showed most bears used habitats within 100 m of roads less frequently than expected. Avoidance of roads was independent of traffic volume, which suggested that even limited vehicle use can displace bears.

It is expected that there will be some effect on wildlife from mine construction and operation. Some degree of habituation is expected with ungulates as noted at many mining projects. Since the project does not cut through any major migration routes and from field surveys does not lie in critical habitat, the project is expected to cause minimal indirect habitat loss for caribou.

Some disturbance to wolf, black bear and grizzly bear is expected due to mine operations, however, due to the relatively low abundance of these species in the mine site area, little indirect effect is expected.

To prevent injury to wildlife the Company proposes to encompass the heap leach pad, events pond, and process area with fencing to prevent entrance into these areas.

Despite what appears to be an area of good wildlife habitat the project area is currently underutilized (HKP, 1994).

Bears

The following text has been included from the “Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009.” Talks in the community about bear species and their behaviour may help to minimize conflicts between bears and people. The Company will have an employee bear awareness program. A YG Conservation Officer will work with the Carmacks Renewable Resources Council and LSCFN to identify appropriate times and places to hold these talks.

The “Community-Based Fish and Wildlife Management Plan – Little Salmon Carmacks First Nation Traditional Territory 2004-2009” identified a need to protect the Yukon River from Tatchun Creek to Minto as important habitat for moose, salmon, and other wildlife. The proposed solution to this concern is to pursue designating this area along the Yukon River as a Habitat Protection Area under the Wildlife Act. The Fish and Wildlife Management Plan states that the community and governments need to get together to decide what kind of activities should happen in this important wildlife habitat.

Potential Effects

- Disturbance to wildlife from direct habitat loss;
- Disturbance of wildlife migration or blockage of wildlife movement corridors;
- Project components may create fragmentation and alter wildlife movements;
- Attraction of nuisance animals;
- Encroachment on endangered species or important wildlife habitats; and
- Roads could allow for increased access for wildlife harvesting or direct mortalities.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- All project activities will be maintained to the project area;
- No hunting, trapping or fishing will be allowed on the project. A “no firearms” policy will be enforced (banned except as authorized for protection of employee’s safety while in the field). Employees will be instructed regarding the project’s “no wildlife harassment” policy, which will encompass, no wildlife feeding, employee wildlife education, and wildlife avoidance;
- Environmental personnel on site to monitor project activities and modify operations to address wildlife concerns;
- Wildlife surveys of the area indicated no sensitive habitats or unique wildlife habitat features. Avoidance of sensitive habitats, such as denning or nesting sites, if encountered during operations;
- Routine garbage patrols will be undertaken to remove materials, (e.g., metals, plastics, grease) which may be potentially harmful to wildlife;
- No recreational off-road use of wheeled vehicles will be allowed;
- All encounters with wildlife, and/or mortalities, will be reported to a YG Conservation Officer;
- Avoidance and buffer zones between stream riparian areas and facilities to minimize wildlife disturbances and protect wildlife corridors;
- Personnel movement will be restricted to the project area and access routes;
- Project footprint localized and buffer zone between riparian area and corridors. Wildlife movements will not be restricted;
- No unnecessary disturbance to local surroundings;
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate;
- Natural revegetation will be encouraged as part of the revegetation plan;
- Snow banks on access roads will be plowed back, with breaks in the bank to ensure adequate road wildlife sighting and escape;
- Garbage and debris will be collected routinely for disposal, or stored in wildlife proof containers for disposal at approved facilities;
- Use of incinerator for camp facilities;
- Project avoids key habitat areas (raptors, moose) along Yukon River;
- Very few waterbodies exist within the project area. However, no disturbance within 50 m of a watercourse will occur;
- Restrict direct access to mine site and project area by using a gate during operations to prevent opportunities for increased hunter access;

- Provide and encourage project bussing and transportation to mine site to minimize hunting opportunities and direct road mortalities;
- Post speed limits and signage at wildlife crossings to minimize direct road mortalities; and
- Fencing of heap leach pad area to minimize direct mortalities.

Potentially adverse effects to wildlife are considered to be low to moderate significance as duration is low/moderate/high (10 – 30 years), geographic extent is localized, magnitude ranges from low to high, reversibility is moderate to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.6 Vegetation

The amount of existing and proposed clearing will total approximately 152.17 ha as follows:

- the ultimate open pit mine configuration will encompass approximately 29.5 ha on an area presently dominated by lodgepole pine, white and black spruce, and aspen;
- waste rock storage to the north of the open pit adjacent to North Williams Creek will require that approximately 69.6 ha of land be cleared of predominantly lodgepole pine, aspen and black spruce;
- construction and operation camp facilities, maintenance shop, warehouse, process plant, and ore conveyors are dominated by lodgepole pine, aspen and black spruce. Approximately 3.57 ha of land will need to be cleared for these facilities;
- the leach pad facilities, sediment control pond and events pond will encompass approximately 37.2 ha of land dominated by aspen, lodgepole pine and grasses; and
- main access road will encompass approximately 12.3 ha;

Removal of vegetation will result in the loss of wildlife habitat and, if acceptable procedures are not employed, may also result in spread of forest infestation, increased fire hazard, increased runoff and increased erosion.

No unique or endangered vegetation is known to occur in the mine site area. Most of the leach pad area was cleared in 1997; however, a certain amount of regrowth will have taken place. The amount of merchantable timber removed for site preparation at the time was extremely low, as climate and elevation near the mine site limit forest productivity. Clearing and recovering merchantable timber from approximately 152.17 ha was contracted out, and if further clearing is required during construction this also will be contracted out. Efforts will be made to stockpile suitable logs for various requirements such as temporary bridges, retaining walls and guard rails. Slash will be burned or buried as necessary, or stockpiled for used as cord wood for the local community.

Effects will be minimized by incorporating engineered standards of construction where clearing and earthworks are required; the size of such areas will be kept to a minimum and vegetated buffer strips will remain adjacent to streams. Reclamation and revegetation of existing disturbed areas such as the exploration camp, old drill pads, and road side margins will be initiated immediately after construction, wherever feasible, and monitored to determine if additional seeding and fertilizing are required.

Potential Effects

- Loss of vegetation communities;
- Loss of timber;
- Fire hazards; and
- Potential disturbance to rare, sensitive or unique plant species or vegetation communities.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- No unnecessary disturbance to ground (EMS);
- No recreational off-road use of wheeled vehicles will be allowed;
- Access road width will be restricted to 8 m. Clearing for new access and facilities will be kept to the minimal amount required;
- Hand cutting will be employed near access road stream crossings to reduce disturbance to riparian areas;
- Windrows will not be created so that wildlife movements are not restricted, and fire hazards are minimized;
- Recontour and re-sloping of disturbed areas and progressive reclamation *following performance standards and terrestrial reclamation standards (see section 3.3.5 "Progressive Reclamation" and also Appendix C);*
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate;
- Routine monitoring and maintenance in accordance with EMS to prevent disturbances;
- In areas with denser woodlands (access/haul roads, ancillary facilities, heap leach pad), clearing will be kept to the minimal amount required;
- Surface disturbance will be re-sloped, covered with soil or revegetated as appropriate to promote natural revegetation;
- Fire safety measures and responses, as provided in the EMS will be adhered to;
- Fire protection and distribution systems and equipment will be located at the project area;
- Trained personnel for fire response as part of EMS;
- Redundant systems for key operations (heap leach pad, ancillary facilities) as part of fire contingency plans;
- If fire hazards exist in the area during operations, procedures will be implemented to avoid fire hazard areas and prevent inadvertent fires;
- Vegetation survey indicates that no rare or sensitive plant species are located in the project area; however, surface disturbances will be kept to a minimum; and

- A revegetation program using indigenous flora will be implemented for disturbed sites where native vegetation has been removed or destroyed. Natural revegetation of disturbed areas will be promoted as part of revegetation plans.

Potentially adverse effects to vegetation are considered to be low to moderate as duration ranges from moderate to high (15 years / permanent), geographic extent is localized, magnitude is high/very high, reversibility is low (open pit) to high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is low (Table 7-2). The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.7 Heritage Resources

Two sites were identified by Antiquus Archaeological Consultants in August 1992 in the EA study area. One site consists of an old mine adit on upper Williams Creek and is associated with a log cabin and remains from mining activity from the 1930s or 1940s which is located approximately 400 m away. An old horse trail leads from this cabin to a cabin on the banks of the Yukon River which was probably used as an ore transfer station for river transport. More details on these sites and study may be found in the report entitled "An Archaeological Impact Assessment for the Proposed Carmacks Copper Project, Williams Creek Valley, Near Carmacks, Yukon Territory" prepared by Antiquus Archaeological Consultants in 1992 (IEE, Volume 3).

It was determined that no archaeological effects are expected from development of the open pit, heap leach pad, or WRSA. Additionally, if access roads into these areas are required they will avoid land-altering activity at these sites. If it is necessary to disturb these sites then a systematic data recovery program will be carried out by a qualified archaeologist (Antiquus Archaeological Consultants, 1992).

As the project footprint is not expected to affect the lower Williams Creek, Yukon River Valley, these sites will not be disturbed.

There are three locations near the proposed mine access road considered to have medium heritage site potential. One large medium heritage site potential area is located on both sides of Crossing Creek between the bridge over the creek on the existing Freegold Road and the turnoff to the mine access road. The remains of prehistoric or historic camps may be located in this area. *Western Copper will not be disturbing these heritage areas as they are part of the YG Freegold Road. If the road is ever upgraded in this area, then YG would be responsible for further heritage assessment prior to road construction.* The other two medium heritage site potential areas are located where the mine access road crosses Merrice and Williams Creeks. *Western Copper is committed to conducting further heritage assessment in conjunction with local First Nation prior to any road construction in these areas.*

Antiquus Archaeological Consultants recommends that areas identified as having medium heritage site potential be subjected to further study prior to the initiation of any land-altering activities.

Potential Effects

- Loss, damage, or alteration of heritage sites or sites of archaeological/historical interest or cultural artefacts.

Mitigation

- Existing trails and disturbed areas will be used where suitable to minimize environmental effect;
- A heritage site survey was completed. Known sites located off the project area (Yukon River) will be avoided. Medium potential sites will be investigated prior to construction;
- Should any archaeological or palaeontological sites be discovered during construction or operations, work will be suspended at that location until permission is sought and granted to continue operations; and
- In the event previously unknown heritage resources are discovered during mining operations, staff of the YG Heritage Branch and LSCFN will be notified and consulted for advice on mitigation. *The effects assessment is based on the fact that the identified site will not be disturbed.*

Potentially adverse effects to heritage resources are considered to be low as duration is moderate, geographic extent is localized, magnitude is low, reversibility is high, ecological sensitivity is low, economic and social context is moderate, and risk characterization is very low (Table 7-2). The summary table provided in Appendix B of the Socio-economic Effects Assessment Report (Appendix P) presents associated mitigation and enhancement measures for each potential socio-economic effect, assesses the residual effects, and presents a significance assessment along with a determination of the likelihood of the effect.

7.3.8 Socio-economic Effects

Please refer to the updated Socio-economic Effects Assessment Report completed in 2006, which is provided in Appendix P. The data collected and presented in this report addresses the request made by YESAB and LSCFN to update local socio-economic conditions. The information will continue to be assessed and utilized by the company for project development and operations. Identified effects by various stakeholders have been integrated and considered in the socio-economic effects assessment.

7.3.9 Effects of the Environment on the Project

Potential Effects

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

Mitigation

- Heap leach pad, events pond, and facilities designed to retain and store excess precipitation events and 100 year snow melts. Redundant systems in place to ensure solution pumping and power systems operational during extreme events;
- Onsite fuel storage and back up power generators to ensure pumping and process systems operational;
- Spare parts and equipment to ensure equipment failures are replaced and repaired and ensure continued solution processing;
- Sediment ponds and other water management structures designed for extreme events (10 yr return period 24 hr duration storm);
- Trained personnel onsite to maintain redundant systems during emergency situations;
- Monitoring of heap leach pad solutions inventory and climatic conditions to forecast solution storage requirements;
- Contingency water treatment system in place if controlled release necessary;
- Heap leaching proven technology in winter conditions. Sulphuric acid heap leach an exothermic reaction and produces heat. Redundant systems in place as contingency measures;
- Facilities and equipment design has been previously proven and personnel are trained to work under Arctic conditions;
- Government of Yukon is expected to maintain the Freegold Road year-round;
- 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;
- Trained first aid staff will be on site at all times during operations; and
- Scheduled changes and alternative delivery methods (aircraft) will be implemented in case environmental changes affect usability of the winter access.

Potentially adverse effects of the environment on the project are considered to be low to moderate based on implementation of mitigation measures. *The summary table in Appendix K presents associated mitigation measures for each potential environmental effect, assesses the residual environmental effect, and presents a significance assessment along with a determination of the likelihood of the effect.*

7.4 ENVIRONMENTAL HEALTH AND SAFETY AND ACCIDENTS AND MALFUNCTIONS

A Spill Contingencies and Emergency Response Plan provided in Appendix L outlines response protocols for spills of potentially hazardous substances that may be used during the construction and operation of the Carmacks Copper Mine. The purpose of this plan is to minimize effects of environmental disturbances and the resultant hazard to people, aquatic systems, and wildlife. The plan is consistent with Western Copper Policy on Health and Safety and Environment (Appendix B).

The area covered by this plan includes not only the mine site operations area but also the operation of the access road. Special mitigative measures for the mine site area including containment structures, response equipment, and the presence of trained spills-response personnel will be instituted to minimize the possibility of contamination of watersheds adjacent to these facilities.

The mine site access road will be a radio controlled road. In addition, heavy truck traffic along the Freegold Road will also be radio monitored by vehicle operation and mine site staff as an added safety precaution. The public will be discouraged from using the mine access road through signage, although the Company does not have the right to prevent such use. At the immediate property boundary (mill lease site) a staffed gatehouse with security gate and property fencing will be installed to restrict unauthorized personnel from entering the mine site. This will ensure that the public is not allowed to stray unintentionally onto the property and be exposed to mine operations resulting in potentially serious accidents.

The potential for accidents and malfunctions was also considered in detail as part of the risk assessment for the project. The details of the risk assessment are presented in Section 7.6 and consider the effects of various failure modes by project component. The potential for accidents or equipment failures or malfunctions was assessed and mitigation measures identified to address these potential failure mechanisms.

Once construction details and personnel are determined, a comprehensive Spill Response Contingency Plan will be updated for submission to regulatory agencies.

Potential Effects

- Accidents and malfunctions;
- See risk assessment for various failure modes, hazards, exposure pathways and consequences.

Mitigation

- Training will be provided to all staff on general safety and safe vehicle operations;
- Supervisors and emergency personnel on site at all times to address accidents/malfunctions;
- Safety meetings will be held for all staff at the beginning of each work assignment period;
- Medical equipment and trained personnel will be on site 24 hours a day during operations;
- Occupational health and safety standards will be enforced for all personnel on the site;
- Consumption of alcohol and 'recreational' drugs will not be allowed on site. Employees will be required to undergo drug testing;
- Emergency Response Plan will be implemented as necessary;
- Employees will be eligible for Workers Compensation;
- Transportation crews will be instructed on traffic safety. Traffic will be controlled on mine access road. Communication and notification of hazardous materials transport to the site;
- Vehicles will be equipped for winter travel and will carry emergency first aid kits;
- Posting of warning signs on the highways and access road;
- Heavy truck traffic along the River Road will be restricted to day light hours of operation. All highway regulations will be followed for speed limits and use of air brakes;
- Project engineering designs with appropriate factors of safety, containment systems, and redundant systems to minimize accidents and malfunctions; and

- Monitoring and maintenance programs to ensure facility and worker safety and equipment integrity.

Refer to the Risk Assessment in Section 7.6 for further discussion of the possible malfunctions or accidents associated with the project activities.

7.5 CUMULATIVE ENVIRONMENTAL 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 impacts on the environment from other sources.

The approximate spatial boundaries for assessing cumulative effects are the same as the boundaries proposed for the EA study area, which are based on the potential geographic extent of effect. The geographic boundary for the project site has been identified as the Williams Creek watershed and the area encompassing all mine infrastructure including the access road and waterways in the downstream flow path from the mine (Figure 2-2, Section 2.3). The assessment of cumulative social and economic effects is presented in a regional context, including the Village of Carmacks and the Yukon Territory as a whole.

With the area for the cumulative effects study defined, the next stages of the assessment were to conduct the following:

- To revisit the identified VECC's and identify environmental effects from the project's activities on these components;
- Identify other likely projects or activities that would occur in the study area during the operation of the Carmacks Copper project, and assess linkages and cumulative effects from other potential projects or activities with project related effects;
- Consider mitigation measures and evaluate significance of cumulative effects; and
- Summarize finding of cumulative effects assessment.

Table 7-3 in Section 7.2 provides a listing of VECC's and rationale for their selection. To summarize, the VECC's for the project include:

- air quality;
- surface water quality;
- groundwater quality;
- permafrost;
- fisheries resources – lower Williams Creek and Yukon River: juvenile chinook salmon, arctic grayling;
- wildlife resources: moose, furbearers;
- traditional use – trapping;
- heritage resources;
- social;

- economic; and
- human health and safety.

7.5.1 VECC Project Interactions

With the VECC's identified, the potential interactions between the project disturbances or activities and the VECC were then assessed. Interactions within the spatial boundaries of the study area as well as regionally were also considered. Table 7-9 provides a summary of the possible types of project environmental effects, the VECC's effected, and an assessment of mitigative measures designed to address potential effects. As noted in Table 7-9, all project effects are mitigable.

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Table 7-9 Identification of Local Effects on VECC's and their Mitigation

Possible Types of Project Effects	VECCs Affected	Effects Mitigable ?		Mitigation Description
		Y	N	
Environmental				
Altered air quality	air quality, wildlife, human health and safety	X		dust control procedures, air emissions control devices (baghouse dust collectors, ventilation system, scrubbers), monitoring and maintenance
Altered surface water quality	surface water quality, fish, wildlife, traditional use	X		no release of effluent to the receiving environment during operations, contingency treatment plant, minimize instream construction, buffer zones, sediment control ponds, monitoring (EPP) and maintenance
Altered groundwater quality	groundwater quality, fish, wildlife, traditional use	X		maximizing recycle of process streams, double composite liner, LDRS, sediment control ponds, containment berms, seepage detection systems, and groundwater monitoring systems
Disturbance of permafrost	permafrost, groundwater quality?	X		road alignments chosen and constructed to avoid exposing permafrost
Altered fish habitat	fish	X		water recycling, ground water wells, monitoring and maintenance
Sensory disturbance/habitat alienation	wildlife	X		wildlife management plan
Habitat fragmentation	wildlife	X		revegetation
Direct wildlife mortality	wildlife	X		wildlife management plan, on-site no hunting policy, posted speed limits and wildlife crossings
Cultural				
Reduced wildlife resource use/harvest	traditional use	X		trapper to be compensated
Loss of cultural value	heritage resources	X		known heritage resources not to be disturbed, further investigations to be completed prior to project construction, discovery of new sites will be reported to appropriate persons
Increased community pressure	social	X		community resource and infrastructure planning, social programs
Erratic economic development	economic	X		widespread employment distribution
Altered human health	human health and safety	X		

Note: Table modified after DIAND, 1997

7.5.2 Other Projects and Activities

With an understanding of the potential effects to VECC's resulting from the project, interactions with any likely projects or activities that would occur during the operation of the Carmacks Copper project have been considered. The Carmacks Copper project is located in a relatively remote area and other regional activities are limited. The current activities in the region include:

Current Land Uses:

- traditional use;
- subsistence and recreational harvesting of wildlife and fisheries; and
- trapping (1 trapline).

Other: In addition to considering the current land uses, which may cumulatively interact with the project, consideration was also given to interactions, based on future land use activities. Upon review of the current land use activities, the potential future land use activity was identified as follows:

- upgrading of the Freegold Road and installation of Nordenskiöld bridge.

7.5.3 Interactions and Significance Assessment

Once all of the potential effects to VECC's, as a result of project related activities, were assessed, an interaction assessment was completed and a significance ranking assigned to determine potential cumulative effects. Significant rankings were based on DIAND, 1997 guidelines (Hegmann, et al, 1997) and defined in Table 7-10. Table 7-11 summarizes the results of assessment. The interaction assessment of the VECC's with the project related effects were based on three types of interactions: duration, magnitude, and geographic extent. Refer to Table 7-1 (Section 7.1) for the significance and ranking of effects descriptors. Overall significance rankings of low, moderate or high could be assigned to each VECC based on duration, magnitude and extent of interaction of effects associated with the project.

Table 7-10 Significance Ranking Definitions

Questions for each VECC Type	Significance Rankings			Significance
	Low (L)	Moderate	High (H)	Conclusion
Biological Species VECC's				
1. How much of the population may have their reproductive capacity and/or survival of individuals affected? Or, for habitat, how much of the productive capacity of their habitat may be affected?	<1%	1-10%	>10%	L if Low. If M or H, go to question 2.
2. How much recovery of the population or habitat could occur, even with mitigation?	Complete	Partial	None	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year or 1 generation	1-10 yrs or 1 generation	>10 yrs or > 1 generation	L, M or H
Physical-chemical VECC's				
1. How much could changes in the VECC exceed that associated with natural variability in the region?	<1%	1-10%	>10%	L if Low. If M or H, go to question 2.
2. How much recovery of the VECC could occur, even with mitigation?	Complete	Partial	None	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year	1-10 yrs	>10 yrs	L, M or H
Socio-economic VECC's				
1. Could the effect be of concern to local residents or administrative authorities, or directly impact on commercial operations or subsistence livelihood, or alter quality of life of residents or recreational enjoyment by visitors?	Little or no concern or change	Some concern or change	Substantial concern or change	L if Low. If M or H, go to question 2.
2. Could the effect be unacceptable to users even after the application of compensation measures, mitigation or the ready availability of reasonable alternatives?	Acceptable to most people	Somewhat acceptable	Unacceptable to most people	L if Low. If M or H, go to question 3.
3. How soon could restoration occur to acceptable conditions?	< 1 year	1-10 yrs	>10 yrs	L, M or H

Table 7-11 VECC Project Interaction and Significance Ranking for Potential Cumulative Effects

VECC	Duration of Effect	Magnitude of Interaction	Geographic Extent of Interaction	Significance Ranking
Air Quality	Low	Low	Low	Low
Surface Water Quality	Low	Low	Low	Low
Groundwater Quality	Low	Low	Low	Low
Permafrost	Low	Low	Low	Low
Fisheries Resources – Lower Williams Creek and Yukon River (juvenile Chinook salmon, arctic grayling)	Low	Low	Low	Low
Wildlife Resources (moose, furbearers)	Moderate	Moderate	Low	Low - Moderate
Traditional Use – Trapping	Moderate	Moderate	Low	Low - Moderate
Heritage Resources	Moderate	Low	Low	Low
Social	Moderate	Moderate	Low	Low - Moderate
Economic	Moderate	Moderate	Low	Low - Moderate
Human and Health Effects	Moderate	Moderate	Low	Low

Legend: Level of interaction or significance ranking defined as low, moderate, or high and considers mitigation success. Where duration of interaction = short term (1-3 years); medium term (4-10 years); long term (>10 years); Magnitude of interaction defines magnitude of effects on VECC; Extent of interaction = low (local); medium (regional); high (territorial or national).

After the interaction assessment and significance rankings were completed for project related environmental effects, effects were considered in combination with other project activities in the study area.

Table 7-12 presents a summary of the VECC interactions with other project activities and the significance of these effects were ranked. The types of other project activities' environmental effects were noted and summarized in the table. An evaluation was undertaken to determine the interaction of VECC's with other project activities and significance evaluated. The potential for cumulative interactions was then identified.

Table 7-12 VECC and Other Activities Effects Significance Rankings

VECC	Significance Ranking	Other Activities Environmental Effects	Significance Ranking for Other Activities	Interaction for Cumulative Effects
Air Quality	Low	Low	Low	Low
Surface Water Quality	Low	Low	Low	Low
Groundwater Quality	Low	Low	Low	Low
Permafrost	Low	Low	Low	Low
Fisheries Resources – Lower Williams Creek and Yukon River (juvenile Chinook salmon, arctic grayling)	Low	Low	Low	Low
Wildlife Resources (moose, furbearers)	Low - Moderate	Moderate	Low - Moderate	Low - Moderate
Traditional Use – Trapping	Low - Moderate	Low	Low	Low
Heritage Resources	Low	Low	Low	Low
Social	Low - Moderate	Low	Low	Low
Economic	Low - Moderate	Low	Low	Low
Human and Health Effects	Low	Low	Low	Low

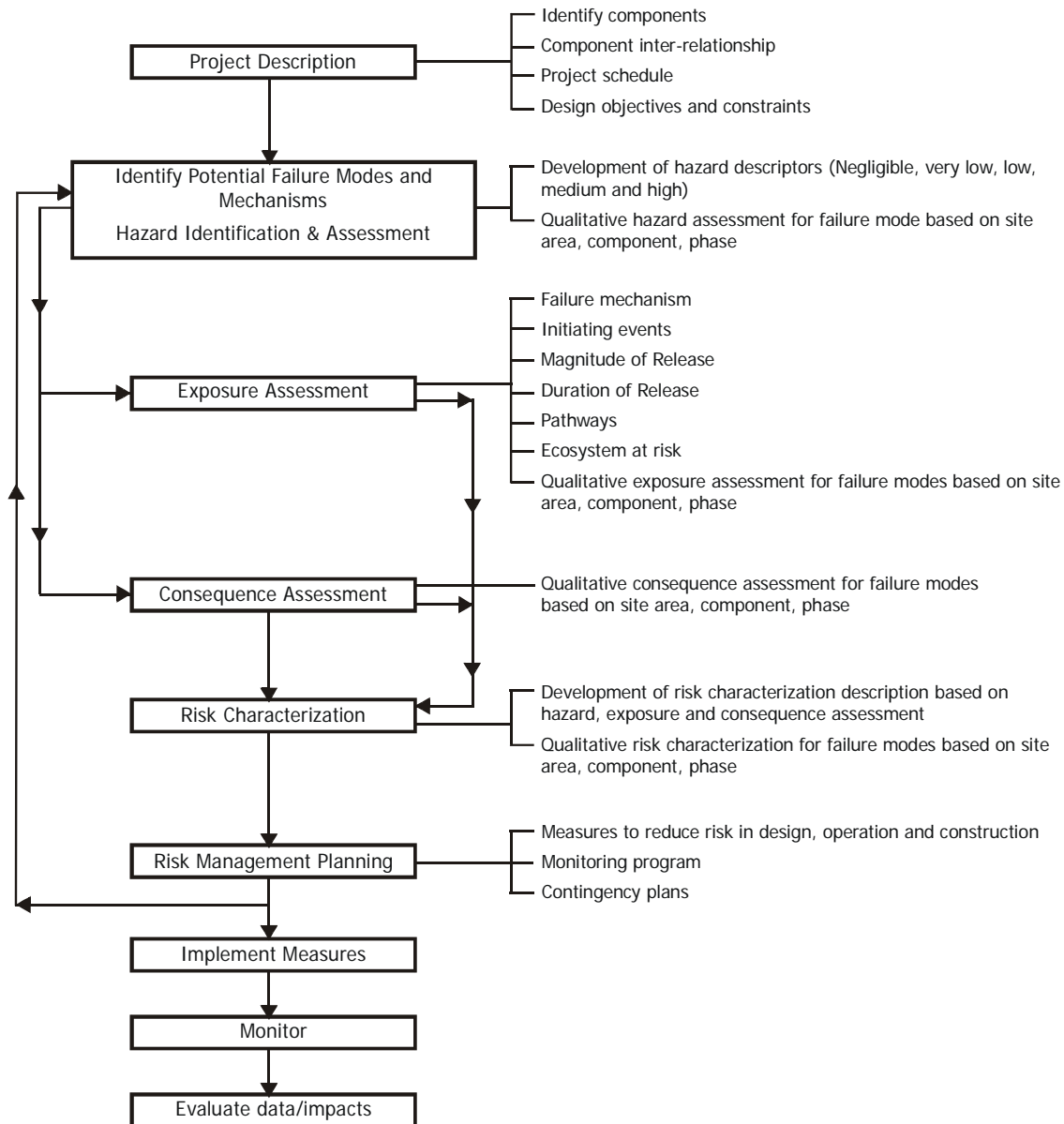
Based on this evaluation, wildlife resources have a low to moderate potential for significant cumulative interactions, while all other VECC's have a low potential for significant cumulative interactions. However, activities associated with increased use of the Freegold Road can be mitigated through controlling access to the road, posting speed limits signs, and upgrading the road to decrease effects to wildlife. With the appropriate mitigation measures applied, the cumulative effects to wildlife resources are not significant.

7.6 RISK ASSESSMENT

A qualitative risk assessment was completed for the project based on procedures presented by Van Zyl, Koval and Li (1992). Project team members were involved in the selection of potential failure modes and the preparation of selected failure analyses. The qualitative risk assessment was used to:

- address the hazards;
- determine the probability of occurrence or exposure assessment;
- perform consequence assessments of various failure modes and hazards; and
- conduct risk characterization.

A simplified flowsheet for identifying the steps in the qualitative risk assessment are presented in Figure 7-1.

Figure 7-1 Qualitative Environmental Risk Assessment

Adapted from Van Zyl, Koval and Li, 1992, Broughton, 1997

The primary objectives for the project development are the protection of human health and safety, and the protection of the environment. At this stage in the project development, engineering plans; technical designs and data were collected to identify the issues that may pose a risk to either the public or the environment. The potential concerns or consequences (adverse effects) associated with these issues were then evaluated, and assessed for overall risk associated with the project development plan. This evaluation or risk assessment is used to assess potential hazards, the potential for “failure” of a facility or structure, the pathways and exposures mechanisms and the likelihood and level of concern that would result from the failure.

Risk can be defined as the chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to human health, property, the environment, or other things of value (CSA, 1997). A risk assessment consists of answering the following three questions:

- What can happen - that is, what can go wrong?;
- How likely is it to happen?; and
- If it does happen, what are the consequences?

A risk assessment is a systematic evaluation process used to assess the potential failure modes under investigation and determining the likelihood and consequences as a result of each failure.

A qualitative risk assessment was used to systematically assess the project components and design features, and determine if the mitigation measures and environmental management plans are adequate to protect socio-economic values and the environment during project construction, operations and at closure. The risk assessment was used to help assess the significance and likelihood of potential adverse effects from the project as part of the environmental and socio-economic assessment process.

The risk assessment was undertaken in the following manner. First, the project team members reviewed the project to describe and identify what can happen, that is, what are the "hazards". Table 7-13 identifies the project areas or components, potential failure mechanisms, the likelihood of the failure mechanism occurring, potential hazards or contaminants resulting from the component or area, potential release mechanisms (vectors), proposed mitigation, and the overall risk characterization. This approach allows for a preliminary identification of potential failure modes and component areas that require further evaluation. These component areas are considered in detail using a detailed worksheet. Appendix M provides detailed qualitative risk assessment worksheets for these key/critical areas or components and failure mechanisms.

The areas/components and failure mechanisms in Table 7-12 are labeled (e.g. A1.1 represents seepage through faults in the open pit). These labels are used in Figure 7-2 to illustrate the likelihood and risk of the failure mechanism occurring. Figure 7-2 identifies key/critical areas or components and failure mechanisms that have a moderate to high likelihood and risk of occurrence and therefore require further assessment. Details of these components are presented in Appendix M.

Risk characterization includes an overall assessment of hazard, failure modes, exposure pathways, and hazard consequence. Table 7-13 provides principal failure mechanisms; combinations of failure modes have not been considered further as the principle mechanism identification enabled completion of the risk assessment.

Table 7-13 Component Hazard Identification and Potential Release Mechanisms

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Mine (A)						
Open pit A1	1. Seepage through faults. 2. Spillage from haul trucks. 3. Failure of pit wall.	1. Moderate 2. Moderate 3. Low	Sediment, metals (copper and others), nitrates from explosives, physical.	1. Groundwater. 2. Surface runoff. 3. Slope stability.	1. Low 2. Low 3. Low	1. None required. 2. Maintenance of drainage collection ditches. 3. Monitoring of pit wall stability.
Waste rock storage area A2 *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure, including permafrost degradation. 2. Blocked drainage ditch. 3. Seepage through waste rock.	1. Low 2. Moderate 3. High	Sediment, metals (copper and others), nitrates from explosives, physical.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Groundwater seepage.	1. Low 2. Low 3. Moderate	1. Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations. 2. Maintenance of drainage collection ditches. Geochemical assessment of waste rock; seepage collection; progressive reclamation of WRSA.
Mine plant, crushing, and explosive storage A3	Equipment failure leading to discharge of contaminant (water or air).	Moderate	Sediment, fuel, oil, nutrients (nitrates from explosives).	Surface runoff, air.	Low	O&M manual procedures; emergency response training; monitoring; maintenance of emission equipment.
Overburden dump A4	Embankment failure, including permafrost degradation.	Low	Physical, sediment.	Surface runoff, slope stability.	Low	Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations.

Table 7-13 (cont'd)

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Water management (ditches, sediment ponds, and pipelines) A5 *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure. 2. Blocked drainage ditch or pipe or spillway. 3. Overflow (extreme event). 4. Equipment or pipe failure, accidents. 5. Seepage through ground.	1. Low 2. Moderate 3. Low 4. Moderate 5. Low	Physical, sediment, metals from pit and waste rock, nitrates from explosives.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Surface runoff, slope stability. 4. Surface runoff, slope stability, spills. 5. Groundwater.	1. Low 2. Low 3. Low 4. Low 5. Low	1. Pre-construction geotechnical ground study and construction plan; embankment monitoring during operations. 2. Maintenance of drainage collection ditches; decant pipes; emergency spillways. 3. Design incorporates extreme hydrologic events and monitoring. 4. O&M manual procedures; emergency response training; monitoring. 5. Monitoring and maintenance.
Heap Leach Pad, Events Pond and SX/EW Plant (B)						
SX/EW plant and chemical storage B1	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	H ₂ SO ₄ , kerosene, sulfur oxide, various other chemicals.	1. Surface runoff, seepage, air. 2. Surface runoff, seepage, air. 3. Surface runoff, seepage, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures, emergency response training, monitoring, maintenance of equipment, redundant systems.

Table 7-13 (cont'd)

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Power plant and fuel storage B2	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	Nitrogen and sulfur oxide, fuel.	1. Surface runoff, seepage, air. 2. Surface runoff, seepage, air. 3. Surface runoff, seepage, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant systems.
Service/haul roads B3	1. Embankment or road failure. 2. Blocked drainage ditch or culvert.	1. Low 2. High	Sediment	1. Surface runoff, slope stability. 2. Surface runoff, slope stability.	1. Low 2. Low	1. Pre-construction geotechnical ground study and construction plan. Embankment monitoring during operations. 2. Design incorporates extreme hydrologic events; monitoring and maintenance of drainage collection ditches.
Low grade ore, stock pile B4	Seepage through rock.	High	Sediment, metals (copper and others), nitrates from explosives.	Surface runoff.	Moderate	Geochemical assessment of rock; seepage collection; processing of low grade ore

Table 7-13 (cont'd)

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Heap leach impoundments (solids, fluids), events pond & solution management B5 *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment failure.	1. Low	Physical, H ₂ SO ₄ , copper and other metals, pH, sediments.	1. Surface runoff, slope stability.	1. Low	1. Pre-construction geotechnical ground study; construction QA/QC plan; embankment monitoring during operations.
	2. Blocked drainage ditch or pipe or spillway.	2. Moderate		2. Surface runoff, slope stability, groundwater.	2. Low	2. Maintenance of drainage collection ditches; decant pipes; emergency spillways; redundant systems.
	3. Overflow (extreme event).	3. Low		3. Surface runoff, slope stability, groundwater.	3. Moderate	3. Design incorporates extreme hydrologic events with events pond storage; operational water balance; redundant systems; water treatment plant; monitoring.
	4. Equipment, liner or pipe failure leading to discharge of contaminant (water or ground).	4. Moderate		4. Surface runoff, slope stability, groundwater.	4. Low	4. O&M manual procedures; emergency response training and plans; redundant systems; LDRS; monitoring.
	5. Accidents (spills).	5. Moderate		5. Surface runoff, groundwater.	5. Low	5. O&M manual procedures; emergency response training and plans; redundant systems; monitoring and maintenance.
	6. Seepage through liner to LDRS or ground.	6. Low		6. Groundwater.	6. Low	6. Pre-construction geotechnical ground study; construction QA/QC plan; operational water balance; redundant systems; monitoring.
	7. Power failure during winter.	7. Moderate		7. Surface runoff, slope stability, groundwater.	7. Moderate	7. O&M manual procedures; emergency response training and plans; emergency spillways; redundant systems; monitoring; LDRS.

Table 7-13 (cont'd)

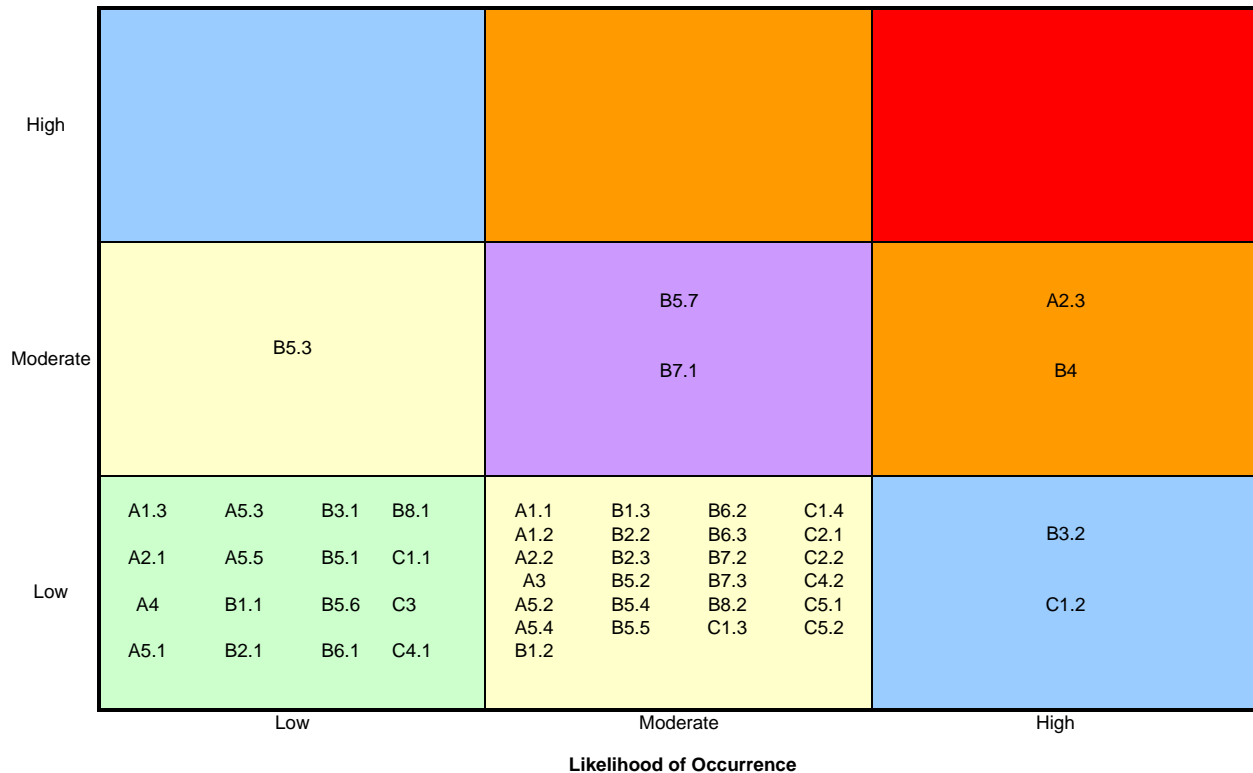
AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Acid Plant B6	1. Equipment failure leading to discharge of contaminant (water, air, or ground). 2. Accidents (spills). 3. Blocked pipe or containment failure.	1. Low 2. Moderate 3. Moderate	Sulfur, SO ₂ , H ₂ SO ₄ .	Surface runoff, spills, air.	1. Low 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment. 2. O&M manual procedures; emergency response training; monitoring. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant systems.
Water Treatment Facility B7 *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Equipment failure leading to discharge of contaminant (water). 2. Blocked pipe or containment failure. 3. Blocked drainage ditch.	1. Moderate 2. Moderate 3. Moderate	Metals from acid heap, pit and waste rock, pH, nitrates.	1. Surface discharge. 2. Surface runoff. 3. Surface runoff, groundwater, slope stability.	1. Moderate 2. Low 3. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 3. Maintenance of drainage collection ditches.

Table 7-13 (cont'd)

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Pipeline and Wells B8	1. Equipment failure leading to discharge of water. 2. Blocked pipe or containment failure.	1. Low 2. Moderate	Sediment, physical.	1. Surface runoff. 2. Surface runoff.	1. Low 2. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system. 2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; redundant system.
Transportation, Storage and Handling Facilities and Camp (C)						
Access roads, haul roads, lay down area, storage facilities C1 *See Appendix M for detailed Qualitative Risk Assessment Worksheet.	1. Embankment or road failure. 2. Blocked drainage ditch or culvert. 3. Equipment failure leading to discharge of contaminant (water, air, or ground). 4. Accidents (spills).	1. Low 2. High 3. Moderate 4. Moderate	Sediments, chemicals, fuels, acids.	1. Surface runoff, slope stability. 2. Surface runoff, slope stability. 3. Surface runoff, groundwater. 4. Surface runoff, groundwater.	1. Low 2. Low 3. Low 4. Low	1. Pre-construction geotechnical ground study; construction plan; embankment monitoring during operations. 2. Design incorporates extreme hydrologic events; monitoring and maintenance of drainage collection ditches. 3. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; secondary containment systems. 4. O&M manual procedures; emergency response training; monitoring.

Table 7-13 (cont'd)

AREA / COMPONENT	FAILURE MECHANISM	LIKELIHOOD OF OCCURRENCE	HAZARD / CONTAMINANT	VECTOR	RISK CHARACTERIZATION	MITIGATION
Chemical storage C2	1. Equipment failure leading to discharge of contaminant (water, air, or ground).	1. Moderate	Cobalt, kerosene, processed chemicals.	1. Surface runoff, groundwater.	1. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment; secondary containment systems.
	2. Accidents (spills).	2. Moderate		2. Surface runoff, groundwater.	2. Low	2. O&M manual procedures; emergency response training; monitoring.
Borrow/gravel pits C3	Embankment failure.	Low	Physical, sediment.	Surface runoff, slope stability.	Low	Pre-construction geotechnical ground study; construction plan; embankment monitoring during operations; interceptor ditch; progressive reclamation.
Sewage treatment C4	1. Equipment failure leading to discharge of contaminant (water).	1. Low	Bacteria, nitrates	Surface runoff, groundwater seepage.	1. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.
	2. Blocked pipe or containment failure.	2. Moderate			2. Low	2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.
Camp C5	1. Equipment failure leading to discharge of contaminant (surface water and groundwater).	1. Moderate	Bacteria, nitrates	Surface run off, spills.	1. Low	1. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.
	2. Accidents (spills).	2. Moderate			2. Low	2. O&M manual procedures; emergency response training; monitoring; maintenance of equipment.

Figure 7-2 Likelihood and Risk of Failure Mechanisms Occurring

Legend: Table depicts relative ranking of the likelihood of project component failure and subsequent risk characterization based on hazard failure, exposure, and consequence assessment.

	Low likelihood of occurrence, low risk.
	Moderate likelihood of occurrence, low risk; or moderate risk, low likelihood of occurrence.
	High likelihood of occurrence, low risk; or high risk, low likelihood of occurrence.
	Moderate likelihood of occurrence, moderate risk.
	High likelihood of occurrence, moderate risk; or high risk, moderate likelihood of occurrence.
	High likelihood of occurrence, high risk.

	AREA/COMPONENT
A	Mine Area
A1	Open pit
A2	WRSA
A3	Mine plant, crushing, & explosives storage
A4	Overburden dump
A5	Water management (ditches, sediment ponds, pipelines)
B	Heap Leach Pad, Events Pond and SW/EW Plant
B1	SW/EW plant and chemical storage
B2	Power plant and fuel storage
B3	Service/haul roads
B4	Low grade ore, stock pile
B5	Heap leach impoundments, events pond & solution management
B6	Acid plant
B7	Water treatment facility
B8	Pipeline and wells
C	Transportation, Storage and Handling Facilities and Camp
C1	Access roads, haul roads, lay down area, storage facilities
C2	Chemical storage
C3	Borrow/gravel pits
C4	Sewage treatment
C5	Camp

*See Table 7-13 for specific failure mechanism.

Project Description:

Generally the project area was divided into three large areas (Table 7-13) including:

- Mine area (open pit, WRSA, mine plant and crushing area, explosive area, and associated water management structures such as sediment ponds and ditches;
- Heap Leach Pad, events pond and SX/EX Plant area (heap, events ponds, sediments ponds, pipelines, emergency overflow structures, SX/EW plant, power plant and acid plant); and
- Transportation and Storage/Handling and Camp areas.

Section 3 provides a detailed description of the various project components and their operations, while Appendix F provides a conceptual closure and reclamation plan for the project. These areas were used to help identify individual component failure modes resulting from the three project phases (construction, operations, and decommissioning, reclamation and closure). From this, the types of hazards and effects that may arise are determined.

Hazard Assessment:

As noted in Table 7-13, the potential hazard or contaminant and release mechanism have been identified for each component or area. This systematic approach was further evaluated to select hazards that were then further assessed. (See Appendix M). Other hazards that were identified in Table 7-13 were not analyzed further due to lower concentrations or volumes. The hazard assessment descriptors for key hazards of concern are presented in Table 7-14. Table 7-14 presents the concentrations of contaminants and their relative toxicity or detrimental affect to the receiving biota. For example, copper concentrations of 0.002 mg/L would have a “negligible” risk to, or effect on, biota; however, greater than 10 mg/L would be very toxic or have a “high” risk to, or effect on, biota. Similarly for pH, a pH with a range from >6.5 to <9.0 would have a “negligible” effect, while a pH of 2.0 would be very toxic to the environment and a “high” risk assigned to this value. Table 7-14 adapted from Van Zyl, Koval and Li (1992) reflects contaminants of concern if released due to a failure from the heap leach pad and events pond system, the water treatment plant or other component area.

Table 7-14 Hazard Assessment Descriptors

Raffinate Leach Solution and Treated Solution		
<u>Metals</u>	Basis negligible very low low medium high	copper (mg/L) <0.002 0.002-0.05 0.05-1 1-10 >10
<u>pH (acidity)</u>	Basis negligible very low low medium high	pH (unit) >6.5<9.0 >6.0<9.5 5.0-6.0 2.0-4.0 >2.0
Physical		
<u>Material</u>	Basis negligible very low low medium high	slope failure (tonnes) <50 50-1,000 1,000-10,000 10,000-100,000 >100,000
Other Contaminants		
<u>Sediments</u>	Basis negligible very low low medium high	concentration (mg/L) <5 5-100 100-1,000 1,000-50,000 >50,000
Fuels/Lubricants	Basis negligible very low low medium high	concentration (liters) <50 50-500 500-5,000 5,000-50,000 >50,000

Source: Adapted from Van Zyl, Koval and Li (1992)

Exposure Assessment:

The exposure assessment must take into account the failure mechanism from each failure mode, the potential for that event, magnitude and duration of a release, pathways or vectors for release and the ecosystem at risk. The exposure assessment considers how the contaminant would be modified or reacts in the ecosystem (diluted, attenuated, degraded, precipitated) from the point of release and a result of a failure; determine the exposure mechanism to receptors in the environment. Both the aquatic and terrestrial ecosystems can be exposed to the release of hazards as well as to humans.

For most failures, losses of process solutions or wastewaters were predicted to enter surface water or groundwater regimes as the exposure pathway. Surface water releases from the leach pad and events pond area will enter upper Williams Creek and travel downstream to lower Williams Creek and eventually to the Yukon River located some 11 kilometres downstream. Groundwater in the heap leach and events pond area, open pit and WRSA is expected to be relatively deep, however losses to groundwater were assumed to eventually contribute to surface recharge in the upper Williams Creek drainages.

Key receptors in the receiving environment are generally limited to the aquatic environment and include surface water and groundwater quality, algae, benthic macroinvertebrates and fish. Fisheries resources have not been documented in the upper reaches of Williams or North William Creek near the project area. Fish have been documented in lower Williams Creek near the confluence with the Yukon River (juvenile Chinook salmon, arctic grayling and slimy sculpin). The Yukon River supports an important fisheries resource; terrestrial habitat and wildlife resource and is critically important for cultural and traditional pursuits and other resource users. In the upper reaches of Williams Creek, it is expected that surface and groundwater water quality, periphyton and invertebrate communities would be the most effected receptors. Wildlife is at risk through ingestion, diet and direct contact. Human use in the area includes hunting and trapping near the project area and First Nation subsistence food fisheries located downstream in the Yukon River. A full description of the environmental conditions located in the project area is described in Section 5.

Contaminants such as excessive sediment, heavy metals such as copper, and acidity have the potential to be acutely toxic or chronically toxic to aquatic resources. Acutely toxic levels of contaminants result in physiological changes that are lethal to fish and other aquatic biota. Chronically toxic levels are sublethal concentrations of contaminants that result in physiological changes that affect the reproductively, birth rate, and life span. Chronic toxicity is many times less apparent than acute toxicity, but is reflected by changes in the species composition of a population, population size, the appearance of another, more tolerant species, or species distribution. These aspects of various receptors (receiving ecosystem) were considered as part of the exposure assessment, so that potential ecosystem sensitivities are defined and used as a basis for evaluating the consequences. Consequences can then be compared, and evaluated for various failure modes based on project components and used to develop an overall risk characterization.

Consequence Assessment:

Potential consequences of a failure first require the identification of the contaminant pathway and identification of the receiving biota and particular sensitive ecosystem components that might be affected by a potential contaminant release. Relative descriptors are provided for hazard and consequence assessments and the relative magnitude of risks associated with failures events and consequences are characterized. An assessment of consequence addresses how the biotic populations respond to the contaminant. For example, is the contaminant lethal, sublethal, or what percent change in the population might be expected? Table 7-15 indicates the descriptor that is used for different scenarios of effects.

Risk Characterization:

Once the hazard, exposure and consequences have been identified, assessed and rated, a risk characterization descriptor can be obtained according to Table 7-16. The resulting risk characterization descriptor is more dependent on the exposure and consequence rating than the hazard rating. In addition, there is an interpretive factor that gives the range of each of the hazard, exposure and consequence ratings. Best professional judgment, and the various experience of the various team members involved in the assessment provide the basis for selecting the risk characterization descriptor.

Risk Management Planning:

The risk characterization identifies key project components that require measures to reduce risk in the design, construction, operation and closure of the facility. Specific preventative engineering measures can be incorporated into the project design to reduce the potential for failure. Monitoring programs, operational plans and contingency and response plans can reduce the likelihood of an event occurring and thus minimize the potential for failure and effects.

Appendix M provides the individual qualitative risk assessments that were completed for individual key components with failure modes that required further assessment for the project. These include failure modes associated with:

- Sediment release from various construction and operation activities associated with project components;
- Metals and low pH released from the heap leach pad, events ponds;
- Metals and low pH released from the water treatment plant;
- Metals and low pH released from the mine WRSA; and
- Fuels/acids released from transportation of products and process reagents to the site.

Table 7-15 Consequence Assessment Descriptors

Descriptor	Terrestrial Ecosystem	Aquatic Ecosystem or Biota	Fish Populations
Negligible	no effect	no effect	no effect
Very low	productivity or biomass (<5%)	slight loss in aquatic biota or species diversity (<5%)	slight effects on growth or mobility (5%)
Low	loss in species or productivity (5-10%)	reduction in species or productivity 50-60	loss in growth or mobility, reproduction (5-10%)
Medium	large or long-term loss in species or productivity (>10%)	2.0-4.0 large reduction in species diversity or productivity (>10%)	sublethal effects on large fish population or fish mortality and loss of reproduction (>10%)
High	total destruction of terrestrial ecosystem in a large area (>100 ha)	total or long-term degradation of a long reach of stream (>15 km) or a large body of water (>75 ha)	large and permanent fish kill (>5,000 or one cohort) or destruction of spawning habitat in total stream

Source: Adapted from Van Zyl, Koval and Li (1992)

Table 7-16 Qualitative Risk Characterization

Hazard Assessment	Exposure Assessment	Consequence Assessment	Risk Characterization
Negligible to High	Negligible to Very Low	Negligible	Negligible
Negligible to High	Very Low to Low	Negligible to Very Low	Very Low
Very Low to High	Low to Medium	Very Low to Low	Low
Low to High	Medium to High	Low to Medium	Medium
Low to High	Medium to High	Medium to High	High

Source: Adapted from Van Zyl, Koval and Li (1992)

Summary/Conclusion:

Table 7-12 presents a summary of the qualitative risk assessment results for the project assessment. In addition, risk characterization was also considered in the significance assessment for various VECC's and this is presented in detail in Appendix K.

The risk characterization was then used in the risk management planning for the project. Component areas with the potential for significant exposure and consequence assessments supported the requirement for robust engineering design and facility operation. As such, the heap leach pad has been designed to minimize the potential failure mode hazards and lower the risk characterization for this component.

7.7 CAPACITY OF RENEWABLE RESOURCES

7.7.1 Introduction

Section 12 (2) (d) of YEAA requires that the EA consider whether the project effects the capacity of the renewable resources to meet present and future needs. This report assesses the effects from the Carmacks Copper project and determined the significance of those effects to the local environmental (renewable resources) and socio-economic conditions in the project area, after the implementation of appropriate mitigation measures.

Extensive baseline environmental data for the project is presented to enable a prediction of project effects to those resources. The project incorporates detailed engineering designs and preventative engineering measures to address potential project effects. Specific mitigation measures, plans and monitoring programs have been developed to address project environmental and socio-economic effects and a determination of the significance of residual effects made.

The following steps were used in determining the capacity of renewable resources to meet present and future needs based on guidelines prepared by the CEAA Agency:

- Identification of the renewable resources;
- Determining if they are to be significantly affected by the project; and
- If a renewable resource is likely to be significantly affected by the project: define how the capacity is measured; determining time scales; assessing the capacity of the

resource to meet present and future needs; providing mitigation measures; determining the significance of residual effects; and identifying risk or uncertainty which must be addressed.

7.7.2 Renewable Resources Identification

Environmental and socio-economic baseline data was gathered for the Carmacks Copper Project and summarized in Section 5. Valued ecosystem and cultural components (VECC's) were identified and used to complete the associated environmental effects assessment for the project (Section 7). These VECC's are essential to the renewable resources components for the project and considered in this assessment.

In summary the following valued renewable resources were described and environmental effects determined: terrain (including soils); air quality; hydrology (including surface and sub-surface waters); water quality (including surface and groundwater); aquatic resources (including fisheries, with Arctic grayling and juvenile Chinook salmon identified as valued components, benthic invertebrates and periphyton); vegetation (including forestry resources); and wildlife (including moose as VECC's). Other noteworthy socio-economic components include LSCFN traditional resources use including, hunting, fishing, gathering and trapping.

7.7.3 Significance of Effects

To determine whether or not the adverse environmental effects to renewable resources were considered significant *nine* criteria were taken into consideration when determining the significance of effects:

- **Direction of adverse effect, whether beneficial or negative;**
- **Magnitude** of the adverse environmental effect, where magnitude refers to severity;
- **Geographic** extent of the adverse environmental effect;
- **Duration and Frequency** of the adverse environmental effect;
- Degree to which the adverse effect is **reversible** or irreversible;
- **Ecological Context** of the adverse environmental effect;
- **Social and Economic Context** of the project effects; and
- **Risk Characterization** and likelihood of the adverse environmental effect.

In addition, a likelihood determination of the residual effects was made based on probability and uncertainty. A criteria ranking was assigned to each of the above descriptors ranging from very low to very high. The overall rating for the significance of effects was determined using a numerical scoring system and calculating an overall average. The descriptors were quantified, as shown on Table 7-1. A discussion of the environmental and socio-economic effects and the significance of those effects was presented in detail in Section 7 *and Appendix P* and summarized in Table 7-2.

7.7.4 Summary

Valued ecosystem and cultural components were identified for the project and predictions made of the environmental effects on those VECC's. A determination of the significance of those effects on the noted resource components was completed considering the mitigation measures, a cumulative effects assessment, and a risk

assessment. Table 7-2 presents a summary of the projects effects, their occurrence, proposed mitigation measures and significance of effects for the various renewable resource components.

The overall significance of project effects ranged from low to moderate with none of the environmental or socio-economic effects considered significant after implementation of mitigation measures. This assessment is based upon the detailed significance determination presented in Section 7.3 and best professional judgment of the project team. Western Copper considers that the capacity of renewable resources to meet present and future needs would not be significantly affected by the project.

8.0 FOLLOW-UP PROGRAMS

8.1 PROJECT PERFORMANCE STANDARDS AND OBJECTIVES

8.1.1 General Approach

This section describes the project performance standards and objectives and design criteria that will be used to ensure that project components are designed, constructed, operated and closed in a manner that ensures environmental and socio-economic protection. These standards and objectives are consistent with the Company's Environmental Policy (Appendix B). The standards and objectives will ensure that:

- Measurable performance standards and design criteria are set to ensure that various mine and infrastructure components are constructed and operated;
- Mine and project component performance is monitored and performance tracked;
- *Mitigation measures and programs are performing as predicted;*
- Maintenance measures or contingency plans can be implemented if project component performance is not achieved;
- The Company, regulatory agencies, First Nations and the public will know the performance standards and objectives that are required for the project to ensure environmental and socio-economic protection;
- *Routine regulatory reporting of environmental monitoring and inspection programs as required by authorizations to enable public access to monitoring results;*
- Closure measures for various project components are designed, implemented and monitored in the long term; and
- The Company, regulatory agencies, First Nations and the public will know when the project's closure and reclamation liability obligations have been met.

Measurable performance standards and objectives have been developed to guide the environmental assessment for the project and implementation of project development. It is expected that these measurable performance standards and objectives will be established in key project authorizations (Water Use Licence and Quartz Mining Licence) to ensure that the project is constructed, operated, and closed as intended.

Table 8-1 presents a summary of the performance standards and objectives, along with monitoring or follow up programs for the various mine components for the project. *The performance standards provide measurable triggers for action and response. Action and response measures are also listed.* The performance standards are presented in three categories: water/chemical stability, physical stability and revegetation. *Triggers for performance and action and response measures are listed within each category.* Monitoring and potential follow-up programs are also outlined where required *along with expected regulatory reporting requirements.*

Appendix C, *within Volume II*, presents a detailed report outlining the performance standards and design criteria parameters for the project.

Table 8-1 – Carmacks Copper Project Summary of Performance Standards, Objectives, Triggers and Actions

Mine Component	Water / Chemical Stability	Physical Stability	Revegetation	Monitoring
Open Pit	<p><u>Triggers</u></p> <ul style="list-style-type: none">Water License Effluent Standards for direct discharge and Metal Mining Effluent Regulations standards (MMER);Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek. <p><u>Action/Response</u></p> <ul style="list-style-type: none">Routine monitoringResampling to confirm resultsWater recycle to reduce or eliminate releaseWater treatment in sediment control ponds	<p><u>Triggers</u></p> <ul style="list-style-type: none">Inter-ramp angles of 55° with overall angles of 41° in the NW & SE sectors and 45° & 55° in the NE & SW sectors respectively;Double benching to be used with bench height and catchment berm width 12 m and 8 m respectively;Bench face angles will be blasted to 70°;Terrestrial Reclamation Standards for terrain stability and erosion control. <p><u>Action/Response</u></p> <ul style="list-style-type: none">Physical inspection and survey controlEngineering evaluation and geotechnical assessmentPit slope revision	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none">Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER, Water Licence and CCME requirements. Weekly MMER monitoring (effluent) and water licence monitoring (effluents) and monthly (receiving waters). Annual sediment monitoring (receiving waters) and biannual benthos monitoring (receiving waters);MMER environmental effects monitoring. EEM program to be developed with Environment Canada;Routine physical inspections and monitoring (survey hubs). Annual geotechnical inspection;Revegetation monitoring (annual);Monthly Water Quality reporting to YWB; Quarterly Water Quality Reporting to Environment Canada & Annual reporting to YWB and YG EMR.
Waste Rock Storage Area (WRSA)	<ul style="list-style-type: none">Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER);Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek. <p><u>Action/Response</u></p> <ul style="list-style-type: none">Routine monitoringResampling to confirm resultsWater recycle to reduce or eliminate releaseWater treatment in sediment control ponds	<ul style="list-style-type: none">WRSA slopes 2½ h: 1v;100 m wide stripped buffer below the toe of the waste rock pile until final configuration achieved;Terrestrial Reclamation Standards for terrain stability and erosion control. <p><u>Action/Response</u></p> <ul style="list-style-type: none">Physical inspection, survey control, piezometer and thermister monitoringEngineering evaluation and geotechnical assessment for permafrost controlReview of WRSA permafrost contingency planImplement WRSA control measures	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none">Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER, Water Licence and CCME requirements. Weekly MMER monitoring (effluent) and water licence monitoring (effluents) and monthly (receiving waters). Annual sediment monitoring (receiving waters) and biannual benthos monitoring (receiving waters);MMER environmental effects monitoring. EEM program to be developed with Environment Canada;Routine physical inspections and monitoring. Annual geotechnical inspection;Revegetation monitoring (annual);Monthly Water Quality reporting to YWB; Quarterly Water Quality Reporting to Environment Canada & Annual reporting to YWB and YG EMR.
Diversion Channels & Stream Crossings	<ul style="list-style-type: none">Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER);Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek. <p><u>Action/Response</u></p> <ul style="list-style-type: none">Routine monitoringResampling to confirm resultsPhysical inspection to identify erosionImplement erosion control and stability measures	<ul style="list-style-type: none">Convey peak flows from a 100-year return period storm event with 250 mm freeboard;Culverts at stream crossing sized to convey peak flows from a 25-year return period event; extreme peak flows with return periods of up to 100-years may be considered for critical road sections;Stilling basins will be excavated at the intake of all culverts to prevent sedimentation and blockage;Terrestrial Reclamation Standards for terrain stability and erosion control.Clear span bridge – Merrice Creek <p><u>Action/Response</u></p> <ul style="list-style-type: none">Physical inspection and survey control and meteorological monitoringPhysical inspection to identify erosionHydrological evaluation and/or geotechnical assessmentImplement erosion control and stability measures	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none">Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER, Water Licence and CCME requirements. Weekly MMER monitoring (effluent) and water licence monitoring (effluents) and monthly (receiving waters). Annual sediment monitoring (receiving waters) and biannual benthos monitoring (receiving waters);MMER environmental effects monitoring. EEM program to be developed with Environment Canada;Routine physical inspections and monitoring. Annual geotechnical inspection;Revegetation monitoring (annual);Monthly Water Quality reporting to YWB; Quarterly Water Quality Reporting to Environment Canada & Annual reporting to YWB and YG EMR.

Mine Component	Water / Chemical Stability	Physical Stability	Revegetation	Monitoring
Heap Leach Pad	<ul style="list-style-type: none">Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER);Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek;Contaminated Site Regulations for Industrial Groundwater. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>Routine monitoring and solution management tracking</i><i>Resampling to confirm results</i><i>Water Balance review control measure implementation</i><i>Water recycle to reduce or eliminate release</i><i>Spray or evaporation measures to maintain solution balance</i><i>Water treatment in sediment control ponds</i>	<ul style="list-style-type: none">Heap will be designed to store ~13.3 million tonnes of ore at a dry density of 1.9 tonnes/m³;Ore will be placed for 8 yrs at about 9,872 tonnes/day for up to 300 days/yr;The 31.5 ha leach pad will be constructed in 3 stages ahead of ore placement;Ore will be placed in 8-m lifts at an overall slope of 2½h: 1v;Raffinate will be applied at a rate of 0.204 litres/min/m² and total raffinate flow to the heap will be 540 m³/hr for a cycle of 120 days;Leach pad design exceeds YG criteria with a double composite liner system with a LDRS;The pad will be surrounded by a 2-m high perimeter berm on the north and west sides and a perimeter bench on the east side;A confining embankment will form the lower limit to the leach pad to support the heap (CDSG, high consequence);With a crest elevation of 780 m, it will be ~22 m high and 350 m long;Terrestrial Reclamation Standards for terrain stability and erosion control. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>Construction QA/QC program</i><i>Physical inspection, survey control, piezometer, process solutions, LDRS and thermister monitoring</i><i>Engineering evaluation and geotechnical assessment</i><i>Review of Heap Leach Solution Management plan</i><i>Implement Heap Leach Solution Management plan</i>	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none"><i>Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER, Water Licence and CCME requirements. Weekly MMER monitoring (effluent) and water licence monitoring (effluents) and monthly (receiving waters). Annual sediment monitoring (receiving waters) and biannual benthos monitoring (receiving waters);</i><i>MMER environmental effects monitoring. EEM program to be developed with Environment Canada;</i><i>Meteorological and water balance monitoring;</i><i>Routine physical inspections and monitoring. Annual geotechnical inspection;</i><i>Revegetation monitoring (annual);</i><i>Monthly Water Quality reporting to YWB; Quarterly Water Quality Reporting to Environment Canada & Annual reporting to YWB and YG EMR.</i>
Events Pond	<ul style="list-style-type: none">Water License Effluent Standards for direct discharge – Metal Mining Effluent Regulations (MMER);Receiving Water Quality Objectives – CCME Freshwater Aquatic Life Guidelines – Lower Williams Creek;Contaminated Site Regulations for Industrial Groundwater. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>Routine monitoring and solution management tracking</i><i>Resampling to confirm results</i><i>Water Balance review control measure implementation</i><i>Water recycle to reduce or eliminate release</i><i>Spray or evaporation measures to maintain solution balance</i><i>Water treatment in sediment control ponds</i>	<ul style="list-style-type: none">Capacity of approximately 160,000 m³ and will have a lined area of about 62,000 m²;Storage to be created by a dam across the valley at the lower end of the pond about 30 m high, 380 m long with a crest elevation of about 754 m (CDSG, high consequence);Allowable leakage rate into the events pond LDRS is 200 L/day averaged over a 12-month period, and 600 L/day averaged over a 3-month period. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>Construction QA/QC program</i><i>Physical inspection, survey control, piezometer, process solutions, LDRS and thermister monitoring</i><i>Engineering evaluation and geotechnical assessment</i><i>Review of Heap Leach Solution Management plan</i><i>Implement Heap Leach Solution Management plan</i>	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none"><i>Operational & Closure Monitoring Program for effluent discharge and receiving waters (surface and groundwater water quality, sediment, benthos, flows) to meet MMER, Water Licence and CCME requirements. Weekly MMER monitoring (effluent) and water licence monitoring (effluents) and monthly (receiving waters). Annual sediment monitoring (receiving waters) and biannual benthos monitoring (receiving waters);</i><i>MMER environmental effects monitoring. EEM program to be developed with Environment Canada;</i><i>Routine physical inspections and monitoring. Annual geotechnical inspection;</i><i>Revegetation monitoring (annual);</i><i>Monthly Water Quality reporting to YWB; Quarterly Water Quality Reporting to Environment Canada & Annual reporting to YWB and YG EMR.</i>
Infrastructure and Buildings	<ul style="list-style-type: none">Infrastructure and buildings removed. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Terrestrial Reclamation Standards for terrain stability and erosion control. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none">Terrestrial reclamation standards for buildings and infrastructure;<i>Routine physical Inspection;</i><i>Revegetation monitoring (annual);</i><i>Annual reporting to YWB and YG EMR.</i>
Haul Road and Trails	<ul style="list-style-type: none">See Stream Crossings. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Haul roads will have an overall width of 26 m including an allowance for ditches and safety berms;Maximum grade will be 10 % on all main roads and 12 % on bench access roads;Bridge will be sized to convey peak flows from a 100-year return period event;Terrestrial Reclamation Standards for terrain stability and erosion control. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Terrestrial reclamation standards for revegetation.	<ul style="list-style-type: none">Terrestrial reclamation standards for buildings and infrastructure;<i>Routine physical Inspection and annual geotechnical inspection;</i><i>Revegetation monitoring (annual);</i><i>Annual reporting to YWB and YG EMR..</i>
Main Access Road	<ul style="list-style-type: none">See Stream Crossings. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Options for closure to be determined with community;Physical inspection. <p><u>Action/Response</u></p> <ul style="list-style-type: none"><i>See Stream Crossings</i>	<ul style="list-style-type: none">Options for closure to be determined with community;Physical inspection.	<ul style="list-style-type: none">Terrestrial reclamation standards for buildings and infrastructure;<i>Routine physical Inspection and annual geotechnical inspection;</i><i>Revegetation monitoring (annual);</i><i>Annual reporting to YWB and YG EMR..</i>

8.2 MONITORING PROGRAMS

8.2.1 Introduction

The following Monitoring Program describes the proposed environmental, geotechnical, and operational monitoring requirements for the project. Environmental and physical monitoring programs are required at all stages of the mine development including construction, commissioning, operations, closure and post-closure. These programs are designed to monitor:

- the effectiveness of component design;
- mitigation success; and
- potential impacts to the receiving environment.

The program is intended to act as an Operational Monitoring Manual for site personnel, once operations commence. Detailed reclamation program plans and monitoring requirements are presented in the "Conceptual Reclamation and Closure Plan" (Appendix F).

8.2.2 Environmental Management System

An environmental management system (EMS) is a defined "system" or process of measuring and documenting compliance with environmental standards and for seeking continuous improvement at a facility such as the Carmacks Copper Project. An EMS utilizes training, environmental monitoring, audits, inspections and other tools to measure and manage actual environmental performance against established written standards. Monitoring and inspections following documented procedures ensure that predicted environmental effects can be tracked to ensure that mitigation is appropriate and environmental performance is assured. An adaptive management approach to progressive action and response is another means of ensuring that monitoring and inspection data is reported within the company and that response measures are implemented. Routine inspections and monitoring are a proactive measure to ensure that the effects of accidents and malfunctions are prevented and identified for response if required.

Western Copper will prepare an EMS for the project. The EMS is intended to provide guidance to supervisory and environmental personnel regarding environmental protection and health and safety measures for the project.

The EMS will outline the:

- Corporate commitment and various policies;
- EMS goals and objectives;
- Organization responsibilities;
- Detail plans and programs for the project, including Health and Safety Plans, Spill and Emergency Response Plans, Construction QA/QC Plans, Operational Plans, Environmental Monitoring Plans, Maintenance Plans and other plans as required;
- Implementation strategy to identify capabilities, and support mechanism to achieve the goals and objectives;

- Measurement and evaluation mechanisms;
- *Reporting mechanism*; and
- Review and improvement mechanisms.

The Carmacks Copper Project will employ such tools to maintain and improve environmental performance. This program will be continued into the post closure period of the mine life. The EMS for the project will be completed prior to project development and be available for use during construction. Several of the key components of the environmental management system are presented in the following sub-sections.

8.2.2.1 Inspections and Monitoring

The environmental management system will employ several types of scheduled periodic inspections to ensure that the facility is meeting environmental performance objectives and complying with appropriate regulatory standards:

- *Routine health and safety meeting and briefing for all employees;*
- *Periodic inspections of key components of the mine site to monitor environmental performance and as a preventative measure for accidents and malfunctions;*
- *Scheduled water quality and biological sampling and inspection tours of the local receiving water streams;*
- *Scheduled environmental tours of the workplace to look for environmental and safety hazards, potential accidents, and assess waste management activities;*
- *Scheduled groundwater sampling using piezometers and wells; and*
- *Annual inspections by a qualified geotechnical engineer of waste rock storage areas, the heap leach and associated retention dikes, and the heap leach process solution ponds for physical stability.*

With the exception of the last item, these programmed inspections will be conducted by site based environmental personnel. The geotechnical inspections are carried out during the summer months when the surface and sides of the various rock fill structures are not obscured by snow. It is anticipated that the number and frequency of inspection tours will continue until closure and then diminish once the heap leach has been fully decommissioned.

The results of all monitoring programs will be assessed on an ongoing basis to determine if any negative trends in water quality or other biological or physical parameters are occurring. If the results indicate that there are no negative environmental impacts, then the frequency schedule and length of operational and post closure monitoring and maintenance would continue as proposed. Adaptive management plans will be put in place to respond to any negative trends observed through the post closure monitoring. Table 8-1 outlines specific actions and responses for implementation should performance triggers be exceeded.

8.2.2.2 *Adaptive Management Plans (AMP)*

An adaptive management plan (AMP) is a component of the company's EMS and a management tool designed to provide a response to unforeseen or contingency events. There are a number of contingency measures that the company has proposed as part of the Conceptual Closure and Reclamation Plan. These include contingency plans for the leach pad effluent. An AMP will be used as a framework to guide the assessment of the operation and reclamation measures, the plan's effectiveness, and provide guidance for orderly implementation of responses. This framework encompassing active company management as part of the EMS would include:

- Routine inspection and environmental monitoring and maintenance of project components;*
- routine assessment of monitoring and performance data;*
- triggers and thresholds for appropriate levels of responses that could be implemented; and planned contingency measures, including engineering designs where appropriate;*
- An AMP will be developed for the leach pad and submitted to regulatory agencies as part of an updated Closure and Reclamation Plan.*

8.2.2.3 *Reporting*

It is expected that reporting on all environmental monitoring and management issues at the Carmacks Copper Project will continue to be directed to the Yukon Water Board (YWB) and YG in accordance with the requirements of the Water Use Licence, Quartz Mining Licence, and other operating permits and approvals. It is expected that monthly and annual reporting will continue during the construction, operation and closure phases until it can be demonstrated through the monitoring results that the reclamation objectives have been achieved.

Western Copper will also continue to liaise with the regulatory agencies, Little Salmon and Selkirk First Nation's, and the local community on environmental issues relating to the construction, operation and closure of the Carmacks Copper Project.

8.2.3 Construction Monitoring

During construction, a Construction Supervisor, or Owners Representative (employed by Western Copper), who is a Professional Engineer (P.Eng.), will be responsible for supervising all construction activities. An Environmental Monitor will establish monitoring programs and monitor construction activities. The construction supervisor and environmental monitor will be charged with ensuring that environmental protection and mitigation facilities are incorporated as designed and that environmental safeguards are implemented by the various contractors. The supervisors will also have the responsibility of ensuring that the requirements of the applicable acts and regulations are complied with. A third party independent geotechnical engineer will monitor key construction activities such as the heap leach pad and events ponds construction.

These personnel will oversee all phases of the construction within the operations area (mine, heap leach pad, and process plant). A Construction Quality Assurance/Quality Control (CQA) manual will be prepared and outline personnel responsibilities. The CQA program will be implemented by a resident engineer, a geotechnical engineer, and several inspectors, all suitably qualified in the specialized requirements of each job.

8.2.3.1 Physical and Geotechnical Monitoring

The CQA Manual will be prepared for the project and guide construction. A third party, responsible to the Owner, provides CQA. CQA is a planned system of activities that provides assurance that the facility complies with the design, specifications and drawings, including inspections, verifications and evaluations of materials, and workmanship.

Component facilities to be covered by the specific CQA plans are:

- heap leach pad, embankment, piping, and diversions;
- events ponds and sediment control ponds;
- solution piping;
- fuel and acid storage secondary containment facility;
- SX/EW plant excavation and concrete floor; and
- WRSA berms, drains, lifts, sediment ponds and spillways.

The CQA Manual will be developed for these facilities and submitted prior to construction once the detailed designs are completed.

8.2.3.2 Environmental Monitoring

The Construction Supervisor and Environmental Monitor will be responsible for ensuring environmental protection by ensuring mitigation measures are implemented and facilities are constructed as designed. Monitoring programs will be established. Monitoring will include:

- proper installation of spill containment devices, instrumentation, monitoring facilities, bridge and culverts;
- protection of all water courses from siltation, spills, and blockages during site development; and
- proper clean up and disposal of construction debris and the proper incineration and/or disposal of refuse.

These personnel will ensure compliance with regulatory authorizations including the Water Licence and Production Licence.

To guide environmental monitoring procedures an Environmental Procedures Manual will be developed. The Manual will outline monitoring procedures and protocols, environmental specifications, and regulatory requirements to be followed by engineering staff, construction workers, and environmental technicians.

8.2.4 Operational Monitoring

An operational monitoring program will be developed and maintained for the project. The program is to ensure that all process and water and waste management facilities are operating properly, that the EMS is implemented, and that facilities are geotechnically stable.

It is intended that many components of the mine will be equipped with automated monitoring devices for continuous surveillance. Automated monitoring systems equipped with alarm systems will be used to monitor remote equipment. Regular inspections of the entire system will be undertaken on a routine basis to physically inspect monitoring equipment, facilities, and structures. A program of geotechnical, physical and environmental monitoring will be maintained during operations as shown in Table 8-2.

8.2.4.1 Geotechnical Monitoring Plans

Heap Leach Pad and Events Pond

The leach facility will be monitored on an on-going basis to evaluate overall performance of the facility and ensure all design objectives are satisfied during operation of the facility. Instrumentation comprising vibratory wire piezometers, survey monuments, water level monitors and flow meters will be installed at various locations within the facility to monitor the performance of the constructed components. Specific detailed design of the monitoring components will be provided during the detailed design stage of the project. General descriptions of the monitoring requirements are outlined below.

Vibrating wire piezometers will be installed in the following locations:

- Within the embankment foundations to monitor pore pressures;
- Within the geonet leakage collection drain to monitor the head on the outer liner; and
- Within the foundation drains, overliner, leachate collection headers and near the 3 leachate sumps in order to measure water levels and pore pressures.

Survey monuments along the embankment crest, downstream slope, and downstream toe of the embankments will be installed to measure settlements and monitor slope stability.

Water level monitors for the heap leachate collection sumps and in the events pond leachate removal system, which will be connected to the control, room of the process plant will be installed to measure water levels for the various components.

A flow meter in the foundation drain/leak detection system within an insulated manhole will be installed to measure flow out of the leak detection system prior to entering the events pond.

Waste Rock Storage Area

The WRSA will be monitored on an on-going basis to evaluate overall performance of the facility and to confirm design assumptions and parameters used in the stability assessment. The monitoring program will be implemented during initial stages of

production and revised as necessary to ensure design objectives are satisfied during construction and throughout the operation of the facility.

Requirements for monitoring and instrumentation are as follows:

- Installation of vibrating wire piezometers to monitor pore pressure conditions within the thawed foundation layer beneath the waste dump toe;
- Survey monuments along intermediate benches to monitor slope stability and settlement;
- Flow weirs along foundation drains to monitor discharge flow rates;
- Visual inspection during operations to evaluate methods of construction and performance of the facility; and
- Annual review and inspection.

8.2.4.2 Mine and Plant Operations

A monitoring program will be instituted which will ensure the safe and economic operation of the Carmacks Copper mine. Operations monitoring will be focused on ore production, the leach pile and the solvent extraction-electrowinning plant. Note that these represent the minimum standards under which the mine will operate. Education programs will focus on employees being aware of the hazards of the operation and the necessity for early detection and prompt action. There is some overlap with the environmental and geotechnical monitoring program plans outlined in the previous sections.

Ore Production

- Tonnes of ore and waste mined will be monitored daily;
- A running inventory of crushed and uncrushed stockpiled ore will be maintained;
- Inspection twice per shift of acid supply lines for preconditioning; and
- Regular clean up of preconditioned ore, which has fallen off the conveyor belts.

Leach Pad

- Hourly recording of solution temperatures onto and reclaimed from the leach pile;
- Hourly average solution volumes pumped onto and reclaimed from leach pile;
- Daily recording of solution levels in the bottom of the leach pile;
- Daily inspection of water levels in leak detection system;
- Hourly recording of ore temperatures at the drip emitter level in grids scheduled for starting irrigation in January, February or March;
- Hourly recording of temperature gradients in the sides of the leach pile at strategic locations;
- Hourly recording of temperature gradients below and on margins of leach pile at strategic locations;
- Daily inspection for development of surface ice at drip emitters;
- Continuous inspection for ice lenses uncovered during preparation of leach pile surface for placement of new lift;
- Weekly inspection of retention berm crest for over topping by ice or solutions;
- Monthly recording of accumulated snow on top of the leach pile;
- Seasonal shovel tests for ice development in the sides of the leach pile;

- Weekly recording of frost depth;
- Logging of periods of flow into the events ponds from the heap;
- Regular updating of the leach pad area operating water balance and forward projections of expected storage requirements; and
- Periodic inspections of diversion facilities, removal of blockages and stabilization of areas of local erosion as required, and removal of accumulated snow in the channels prior to the annual snowmelt.

SX/EW PLANT

- Twice per shift sampling of pregnant leach solutions grades;
- Continuous monitoring of power consumption;
- Continuous monitoring of propane consumption;
- Weekly inspection of acid, solvent and propane piping and storage facilities;
- Continuous recording of leach solution pumping pressures;
- Daily inspection of acid, pregnant and leach solution pipeline in plant and to and from the leach pile;
- Weekly inspection of piping and storage facilities,
- Recording of solution recycle rates and solution flows to the ADR plant,
- Recording of make-up water inflows;
- Recording of times of water treatment plant operation and treatment rates if required;
- Recording of sediment pond water levels, release rates and times of release;
- Treatment plant process control monitoring (temperature and pH) and internal laboratory testing for specific water quality parameters;
- Periodic inspections of all standby pumping and power facilities;
- Periodic inspection of sediment control dams, and all piping and spillways with clearing of pipe and spillway inlet obstructions as necessary and controlled removal of accumulated sediment as required to maintain design storage capacity;
 - Sampling of sediment pond effluent quality; and
- Daily recording of ambient air temperatures and precipitation (See Meteorology monitoring below).

8.2.5 Environmental Monitoring Plans

Table 8-1 presents a summary of the performance standards and objectives, along with monitoring or follow up programs for the various mine components for the project including *measurable triggers for action and response*. Monitoring and potential follow-up programs are also outlined where required *along with expected regulatory reporting requirements*.

Table 8-2 summarizes the environmental attributes or VECC's that will be monitored, the location for the monitoring, the environmental component that will be monitored, the types of analyses and monitoring frequency and the equipment and protocols that will be used as part of the environmental monitoring program.

8.2.5.1 *Meteorology*

Ongoing meteorological data is required to verify design assumptions. The information will be used to monitor site temperatures, solar radiation, frost and wind speed to assist in scheduling ore loading and heap leach operations near freezing conditions, and snow pack and precipitation data for regulating the water management systems and updating the heap water balance.

The Water Resources Branch of YG Environment established an automatic weather station at the Williams Creek site in September 1994. The station records the following information every half hour and provides a daily average:

- Net radiation (W/m^2);
- Short-wave Incoming Radiation (W/M^2);
- Short-wave Outgoing Radiation (W/M^2);
- REBS Soil Heat Flux (W/m^2);
- Soil Temperature @ 6 cm depth $^{\circ}\text{C}$;
- HMP 35CF Upper Temperature ($^{\circ}\text{C}$);
- HMP 25C Upper Relative Humidity (%);
- Lower Wind Speed (m/s);
- Upper Wind Speed (m/s);
- Precipitation (Tipping Bucket) (mm); and
- Battery Voltage.

Three snow course sites in the Williams Creek watershed were previously operated during the winters of 1994/1995. Each site consisted of 5 sub samples located 20 m apart and measurements of snow depth and water equivalent were taken in accordance with government protocol. A snow course station will be reinstated at the Williams Creek site once operations commence and will be monitored monthly during the period of snow accumulation (November to June).

8.2.5.2 *Hydrology*

The hydrology of the Williams Creek watershed will be required to monitor stream flow for available dilution and downstream water quality impacts. A Stevens water level recorder was installed in Williams Creek near Station W2 upstream of North Williams Creek in 1993 and staff gauges are located in the upper portion of Williams Creek. Once operations commence it will be necessary to monitor daily flows in the receiving environment at several locations as follows:

- Williams Creek and North Williams Creek above operations (W7 and W9);
- Williams Creek and North Williams Creek below operations (W2 and W3);
- Williams Creek outflow from the Water Storage Reservoir (W4); and
- Williams Creek below Nancy Lee Creek (W10).

Other operational flows on site, which will be monitored on a daily basis for environmental purposes, include:

- Open pit water;
- Heap leach leak detection system;

- Heap leach underdrains;
- Elevation of water in the events pond;
- Outflow from the WRSA sediment pond;
- Make-up water recovered from the WRSA sediment pond; and
- Outflow from the plant site and events pond sediment control ponds.

8.2.5.3 Surface and Ground Water Quality Monitoring

An operational water quality monitoring program will be required to ensure that effluent and receiving water quality criteria are being achieved on a consistent basis. The effluent characterization program will follow the program outlined in the MMER EEM. Recommended water quality monitoring locations are listed below, together with recommended analyses and shown in Table 8-2.

Receiving Water Quality Sample Sites (Monthly)

- Williams Creek and North Williams Creek above operations (Control Stations W7 and W9);
- Williams Creek and North Williams Creek below operations (W2 and W3);
- Williams Creek outflow from the Water Storage Reservoir (W4);
- Williams Creek below Nancy Lee (W10); and
- Yukon River above and below Williams Creek.

Effluent Quality Sample Sites (Weekly)

- WRSA sediment pond;
- Open pit sump water;
- Events pond water;
- Plant Site sediment pond; and
- Contingency Water Treatment Plant if required (daily).

In addition, the EEM study program will also characterize effluents from the site including possible effluents from the contingency raffinate treatment plant and sediment control ponds. Acute toxicity testing will be conducted along with sublethal toxicity testing (fish, invertebrates, algae, and plant).

Ground Water Quality Sample Sites (Quarterly)

- Heap leach leak detection system;
- Heap leach underdrains;
- Groundwater wells downstream of the heap leach pad, events pond and plant site sediment control pond (to be located); and
- Groundwater wells downstream of the WRSA (to be located).

Water Quality Analyses

Analyses to include physical parameters (pH, conductivity, alkalinity, total and suspended solids, hardness), anions (nitrate-N, nitrite-N, ammonia-N, total sulphate, total, dissolved and orthophosphate) and total and dissolved metals (ICP scan). Protocols will follow those specified by the MMER EEM program.

8.2.5.4 Annual Receiving Water Biological Assessment

An EEM program will be established in accordance with the MMER. The biological assessment of the receiving environment be conducted at the following water sample stations W2, W3, W4, and control stations W9 and W10, to compare with baseline data. The annual biological assessment would include the following three main components:

- Stream Sediments (Six replicates at each site for CIP metals, TOC and LOI for the - 65 u size fraction;
- Benthic & Macroinvertebrates (Three replicates at each site for species composition and total numbers); and
- Fish Resources Characterization and Tissue Analysis (10 replicates of one species, arctic grayling, for muscle and hepatic Cu, Pb, Hg and Zn and a sub sample submitted for MIMS analyses).

8.2.5.5 Waste Rock

Although results from static testing indicate that both ore and waste, which have long been oxidized, contain very little remaining oxidizable sulphur and are non-acid generating, representative samples of waste rock will be collected from drill hole cuttings from representative blast holes and submitted for acid-base accounting. Any waste material detected as having a propensity of generating acid will be identified by the geological staff and the material will be selectively placed in the internal areas of the waste rock stockpile or blended to ensure that the material is mixed with neutralizing material.

8.2.5.6 Reclamation Research Monitoring

An important component of the Reclamation Plan is an ongoing reclamation research program with the objective of establishing the necessary methods and materials required to implement a successful abandonment plan that will meet with the stated objectives of returning all disturbed lands to pre-mining use and capability, when the operations are closed. The Reclamation Research Program will initially consist of six primary elements:

- On-site detoxification tests of spent heap leach material to determine the optimum method of neutralizing the spent ore and removing heavy metals in the leachate;
- On-site tests to determine the optimum method of capping the spent heap leach pad and to minimize the amount of infiltration;
- On-site tests to characterize the physical and chemical composition and stability of precipitates derived from the heap neutralization process for purposes of determining the optimum method of final precipitate disposal;
- Detailed characterization of soils and soil chemistry in the mine site area for purposes of determining occurrences of growth inhibitor sand soil amendment requirements;
- Establishing a series of test plots on various disturbed materials to determine the optimum depth of materials, soil amendment sand moisture requirements to sustain growth;

- Documenting natural recolonization successes for purposes of determining the optimum species for revegetating various reclamation units (overburden, road sides, riparian areas); and
- Species for revegetating various reclamation units (overburden, road sides, riparian areas).

Each of these research initiatives will be implemented at the end of the first year of operations and monitoring will be ongoing. Each of the programs will have to be sufficiently flexible such that monitoring results can be used to direct each phase of testing.

8.2.5.7 Environmental Surveillance Monitoring

In addition to the operational environmental monitoring program plan outlined in the foregoing, site personnel will be responsible for regular environmental surveillance to ensure that all waste management facilities, such as dump pads, settling ponds, solution pumps, and septic tanks are operating efficiently and to ensure that environmental protection systems such as fuel storage berms, liner aprons, diversion ditches and the fire water tank are maintained and that water treatment facilities are functioning as required.

8.2.6 Wildlife Population and Habitat Monitoring

A wildlife monitoring program will be established during construction and maintained throughout all phases of the mine including post-closure. The program will determine trends or changes in wildlife populations and will include:

- a wildlife observation log;
- wildlife mortality reporting;
- routine monitoring of netting over ponds; and
- working with the LSCFN Lands Branch to track moose utilization in the project area.

Table 8-2 provides further details on the wildlife monitoring program. Western Copper will jointly work with LSCFN, SFN, their Renewable Councils and YG Environment (local wildlife managers) towards implementation of any further monitoring or mitigation measures to ensure that predicted effects to wildlife are adaptively and cooperatively managed. A post moose rut aerial survey for the project area is planned every three years. The survey will follow a similar format as described in Appendix H3.

8.2.7 Socio-economic Monitoring

Socio-economic monitoring of specific indicators is proposed to adaptively manage socio-economic effects. Please refer to Section 4.11 of the Socio-economic Effects Assessment Report provided in Appendix P (Volume III) for details.

Table 8-2 - Environmental Monitoring Programs

Monitoring Program	Related VECC	Location	Component Measured	Analysis	Equipment Required & Protocol	Frequency
Meteorological	Air Quality; Human Health and Safety	Automatic meteorological station at camp site	Ambient air conditions Tipping bucket rain gauge Snow pack	Net Radiation (W/w ²) Short-wave incoming Radiation (W/w ²) Short-wave outgoing Radiation (W/w ²) REBS soil temperature at 6cm depth (°C) Soil temperature at 6 cm depth (°C) HMP 35CF upper temperature (°C) HMP 25C upper relative humidity (%) Lower wind speed (m/s) Upper wind speed (m/s) Precipitation (mm) Snow depth and water equivalents	Automated meteorological station. YG Water Resources data collection protocol	Daily average based on recordings every half hour Monthly November to June
Hydrology	Surface Water Quality; Groundwater Quality; Fisheries Resources; Traditional Use	Water quality sites W2, W3, W4, W7, W9 and W10 Open pit inflow Heap leach pad Heap leach pad Events pond Waste rock sediment pond Waste rock sediment pond Plant site sediment pond	Williams Creek North Williams Creek Open pit inflow Leak detection system Underdrains Storage volume Outflow to storage reservoir Make-up water to mill Storage volume or overflow	Flow Flow Flow Flow Flow Water level Water level or flow Flow Water level or flow	Continuous data loggers with flow sensors. Price type AA and pygmy meters. V-notch weirs. Protocol - MMER Flow Measurement Guidelines	Daily Daily Daily Daily Daily Daily Daily Daily Daily
Water Quality	Surface Water Quality; Groundwater Quality; Fisheries Resources	Receiving water quality sites W2, W3, W4, W7, W9 and W10 Yukon River US/DS Williams Creek Effluent water quality sites Waste rock stilling pond Open pit sump Events pond Plant site sediment pond Ground water quality sites Leach pad leak detection Leach pad leak underdrains Below plant site sed pond Below waste rock stockpile Water treatment plant	Williams Creek North Williams Creek Yukon River Receiving water Effluent quality Overflow or pond water Sump water Pond water Overflow or pond water Groundwater quality Recovery point Recovery point Monitoring wells (to be installed) Monitoring wells (to be installed) Treated effluent	Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO ₂ , NO ₃ , NH ₃ , SO ₄ , TP, DP, Ortho-P, TIC, TOC) Total and dissolved ICP metals Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO ₂ , NO ₃ , NH ₃ , SO ₄ , TP, DP, Ortho-P) Total and dissolved ICP metals Physical parameters (pH, Cond, Alk, TSS, TDS, Hard) Anions (NO ₂ , NO ₃ , NH ₃ , SO ₄ , TP, DP, Ortho-P) Total and dissolved ICP metals	Grab sample and/or automated ISCO composite samplers. Protocol - MMER Effluent Sampling Guidelines and EEM Guidelines	Monthly Weekly Quarterly Weekly/Daily
Wildlife Population and Habitat Monitoring	Wildlife Resources - Moose	Entire project area including the access road	Daily wildlife log and observations. Mortality reporting. Post moose rut survey	Observations of species, sex, numbers, and location Mortality incident report (species, sex, location and cause)	General observations and monitoring log, GPS. Helicopter, observers and GPS for surveys.	Daily observation and occurrence. Post moose rut survey every three years

Table 8-2 - Environmental Monitoring Programs

Monitoring Program	Related VECC	Location	Component Measured	Analysis	Equipment Required & Protocol	Frequency
Annual Biological Assessment	<i>Fisheries Resources; Surface Water Quality</i>	Receiving water quality sites W2, W3, W4, W7, W9 and W10	Sediments Benthic microinvertebrates Fish tissue and hepatic tissue Fish community	Six replicates, -65 u fraction, metals and LOI Three replicates, species composition and abundance Ten replicates, one species, muscle and hepatic Cu, Pd, Hg and Zn, and Hepatic MIMS		Annually <i>Biannual</i> <i>Biannual</i> <i>Biannual</i>
Waste Characterization	<i>Groundwater Quality; Surface Water Quality; Fisheries Resources</i>	Open pit	Waste Rock	Representative compost for static acid-base accounting Drill hole cuttings		Each bench
Physical/ Geotechnical Inspections	<i>Permafrost, Physical Stability for Health & Safety</i>	Pit wall movement - Permanent prism type EDM Targets Pit slope Heap leach pad/events pond LDRS Heap leach pad Heap leach pad surface ice development Heap leach pad ice lenses Heap leach pad /events pond and polishing ponds Heap leach pad /events pond and polishing ponds Diversion facilities piping and storage facilities PLS pipelines Standby pumping and power facilities Leach solution pumping pressures Process plant conveyor line Process plant and ancillary facilities Process plant and ancillary facilities	Survey target Survey target Temperature probes Probe Probe Snow depth Depth gauge Test run Pressure gauge	Elevation data Geotechnical mapping data and pit walls stability inspection Physical stability inspection Heap temperatures data Fall and winter inspection Inspection for ice lenses uncovered on HLP as lifts are added Accumulated thermal snow cover data Frost depth data Physical inspection Physical inspection Physical inspection Physical inspection Pressure data Physical inspection Monitoring of power consumption Monitoring of propane consumption	<i>Survey Equipment, thermistors, pressure transducers, meters following monitoring and maintenance equipment manuals</i>	Monthly Weekly Daily Daily Daily Continuous Weekly Weekly Weekly Daily Monthly Continuous Continuous Continuous Continuous
Reclamation Research		Detoxification trials Heap capping trials Precipitate disposal trials Soil Characterization Recolonization assessment Vegetation trials	Spent leach pad material Spent leach pad material Neutralization precipitates Soils and Overburden Disturbed areas test plots	Flushing, neutralization and leachate chemistry Materials testing, permeability and compaction Physical, chemical stability of precipitates Physical and chemical composition of soils and overburden Species, success, wildlife use, browse and pellet groups Growth, productivity and metal uptake	<i>Column s for leach and detoxification testwor, iover infiltration test galleies; bench scale laboratory testwork; reclamation and revegetation test protocol</i>	Annually ongoing
Surveillance Monitoring		Operations area	Berms, ditches, pumps, pipe, lines, liners ponds	Environmental protection facilities and control systems	<i>Digital camera, observations, and reporting forms and logs.</i>	Annually ongoing

8.2.8 Closure and Post Closure Monitoring

The regular monitoring of all operations will continue for approximately three to five years following the termination of mining activities while the heap leach pad is being rinsed and neutralized. It is expected that closure monitoring will consist of the same level of requirements set out in the operational monitoring program. Routine inspections of facilities and closure activities and reclamation programs will continue. The operational monitoring program will then convert to a post-closure monitoring program once the leachate quality from the heap leach pad has been certified as suitable for direct release to the environment. A detailed post closure monitoring program will be included with a final closure and reclamation plan for the site.

Closure Monitoring

A conceptual closure and reclamation plan is presented in Appendix F. The following activities will require monitoring by an Environmental Coordinator and a Professional Engineer:

- salvage and removal of all ancillary facilities;
- assessment and removal of any hazardous substances;
- rinsing, neutralizing and *in situ* metals stabilization in the heap;
- treatment and release of excess solutions from the heap;
- Treatment of solutions or water in the events ponds and sediment ponds and the excavation and disposal of sediments;
- removal of the geomembranes and geonets, and their disposal in one of the events ponds;
- recontouring, grading and placement of overburden and revegetating the WRSA;
- Replacement of the overburden on the disturbed areas;
- removal of the WRSA sediment control dams;
- removal of all piping from the surface and perimeter of the heap and events ponds; and
- trenching through the top of the containment dike in two places near the abutments, and filling these trenches with coarse rock.

9.0 ACKNOWLEDGEMENT AND CERTIFICATION

Access Consulting Group¹ (ACG) of Whitehorse, Yukon, has prepared this Project Description in conjunction with Western Copper Corporation, ALM Group, and EBA Engineering Consultants Ltd. Western Copper has relied extensively upon previous reports and engineering design work prepared by competent professionals for the Carmacks Copper project. In particular, engineering designs and drawings completed by Kilborn Engineering and Knight Piésold Engineering are still accurate for the project and have been used to support the project description. Where appropriate, new engineering designs or data have been presented in the support of the project. The following people contributed to the report:

Access Consulting Group

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Robert McIntyre (Senior Engineering Technologist)
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Western Copper Corporation

Dale Corman (Chairman and Chief Executive Officer)
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The information within this Project Proposal is submitted to 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.

¹ Access Consulting Group is a registered trade name for Access Mining Consultants Ltd.

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: (867) 668-6463.

I certify that the information provided is true and correct to the best of my knowledge and belief.



Dan Cornett, B.Sc., P.Bio., CCEP
Agent for Western Copper Corporation
Principal, Access Consulting Group

10.0 REFERENCES

The following reports with an * are available on the CD-ROM submitted in conjunction with this report.

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